ABET

Self-Study Report

for the

School of Mechanical Engineering

at

Purdue University

West Lafayette, IN 47907-2088

June 2013

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EXECUTIVE SUMMARY

The objective of this report is to summarize our efforts to update and assess our Mechanical Engineering (ME) program educational objectives (PEOs) and student outcomes and to demonstrate continuous improvement with measurable results. In the past, we had developed our own outcomes (as recommended by ABET) and mapped our outcomes to ABET a-k. However, in 2010 at ABET's suggestion, we adopted the standard ABET a-k outcomes and added 4 additional outcomes: Leadership, Global Skills, Innovation, and Entrepreneurship.

An assessment of the student outcomes was conducted by surveying our primary constituents: *graduating seniors*, *alumni*, and *employers* as well as implementing a variety of direct measures. Surveys of each constituent established graduates' effectiveness in meeting the student outcomes and ranking of the importance of each as well. Longitudinal gap analysis between importance and effectiveness for each outcome was developed along with temporal scatter plots of importance versus effectiveness for the year 2012. This enables comparative ranking of the various outcomes. The direct measures used included the Fundamentals of Engineering (FE) exam, a variety of different course assignments, professional development data from the constituent surveys, course grades in select courses, a leadership rubric, a teamwork rubric, and a collegiate cultural development inventory. For each of the direct and indirect measures, the levels of achievement to meet expectations, to exceed expectations and to not meet expectations were clearly defined.

Results of the student outcomes assessment indicated that, by in large, seniors are meeting or exceeding the minimum levels of expectation for most outcomes. The single most significant deficiency is in outcome B2. Communication Skills (g). As with our last ABET visit, students have consistently fallen below expectation despite our sincere efforts to address this deficiency. While little or no improvement has been demonstrated, the assessment has at least held steady and not declined. This is significant because over the past 6 years, we have experienced a 350% increase in the number of international students in our ME Program (from 84 to 295), over 60% of whom are from China. Being non-native English students, developing strong communication skills is especially difficult. Nevertheless, we have initiated a multifaceted strategy to try to address the special needs of these students by: 1) developing new assessment methods to identify students with the greatest needs, 2) providing special reading, writing, and speaking courses designed for international students, 3) expanding special sections of English composition and speech classes for these students, and 4) incorporating a broad array of different writing and speaking experiences integrated across the curriculum. This is not to imply that the challenge with communication skills is solely an international student issue. A number of our domestic students likewise have weak communication skills. To address their needs, we plan to require all students who have low writing scores on the SAT to take an extra Technical Writing course to gain more writing experience with consistent and detailed feedback. This course can also be used as one of their professional electives and thus is not an extra course.

On a positive note, the greatest improvements in outcomes have come in the areas of A6. Impact of Engineering Solutions and B2. Global Skills. Both of these outcomes have shown dramatic improvement in the longitudinal constituent survey assessments. These dramatic improvements stem from our unique approach to global programs, which continues to expand. The other significant change since our last ABET visit is the completion of the $34.5M LEED Certified Roger B. Gatewood ME Wing. This new facility provides an additional 41,000 assignable sq. ft. including 6000 sq. ft. of critical design space, a new 120-seat collaborative classroom ideal for flipped classes or cooperative learning methods, a new student commons area, and has enabled a doubling of the space for our ME Student Shop facilities.

In summary, the extensive assessment results indicate that Purdue's ME Program largely meets or exceeds the expectations of its constituents in almost all areas of the ME student outcomes. In the very few outcomes not meeting expectations, efforts to continuously improve have been demonstrated and continue to be adapted to address the changing needs of the students. These results clearly indicate that our continuous improvement program is in place and functioning effectively.

BACKGROUND INFORMATION

A. Contact Information

The Head of the School of Mechanical Engineering is Anil K. Bajaj. James (Jim) D. Jones serves as the Associate Head in charge of the Undergraduate Program and will be the primary contact person for the Mechanical Engineering Program for the site visit. Contact information for these individuals is:

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B. Program History

The School of Mechanical Engineering was established in 1882 by Emerson White, the third president of Purdue University. Since its inception Purdue's School of Mechanical Engineering has prided itself on educating students in practical aspects of engineering. In the 1970's with the inception of computers, a dramatic increase in the analytical aspects of mechanical engineering became an integral part of the Purdue experience and led to the inclusion of computer-aided design emphasis. Also, the importance of controls education in the ME curriculum expanded to include a broad array of activities under a new stem of the curriculum referred to as systems, measurements and controls. Today, we continue to strive for a healthy balance between the practical 'hands-on" skills of engineering practice and the important engineering science and computational analysis skills that continue to expand with the ever-increasing computational power of today's computers.

In recent years, a number of changes to the undergraduate program have been implemented. First, a greater manufacturing emphasis in the capstone design course has led to most teams building full-scale mock ups of their concepts. Second, a number of new minors have been developed to enable students to tailor their electives toward strategic career areas of interest. Some of the new minors include: the intellectual property minor for engineers, architectural engineering minor, manufacturing minor, energy minor, sustainable engineering minor, pre-health professions minor, global engineering studies minor, engineering and public policy minor, among others. These minors have led to a more focused and easily identifiable diversification of the career paths for graduates. An increasing emphasis has been placed on key outcomes of our program. New target outcomes above and beyond the core ABET a-k outcomes include: Leadership, Global Skills, Innovation, and Entrepreneurship. We believe that these key outcomes are becoming increasingly critical to the future success of our graduates.

In addition to these past changes, the ME Program is being carefully reviewed. This has resulted in several recent changes (while many more are still in process) including:

1. *Advanced Analysis* - There is a new course in advanced analysis (primarily finite element analysis) that is currently being offered to students on an annual basis. It will start as a technical elective, however, it is planned to offer this course as one of our restricted electives, providing more restricted elective options for students. Ultimately, we hope to make this course as a part of our ME core curriculum, since computational or numerical simulation tools have become essential for design of complex systems.

2. *Enhanced Manufacturing Emphasis* - We plan to incorporate an expanded manufacturing course (ME 36300) to provide more opportunity for students to gain these valuable skills.

3. *Mechanics Sequence* - We have modified ME 27000 Basic Mechanics I to incorporate several mechanics of materials topics (e.g., stress/strain, axial stress, torsional stress, bending stress, shear/moment diagrams, etc.) in place of the long standing particle dynamics topics. We feel this will provide a better integrated mechanics sequence for our students.

4. *Systems, Measurement, and Controls Sequence* - We are currently in the process of evaluating our systems, measurements and controls sequence (ME 36500, ME 37500 and ME 47500). The intent of this review is to restructure some of the topics based on faculty and student feedback. The current plan is to continue with a required two course sequence (ME 36500/ME 37500) that incorporates a healthy balance of systems modeling, introduction to sensing and actuation, and control theory across both courses. ME 47500 would continue as a restricted elective offering including more advanced topics not covered in the ME 36500/ME 37500 sequence. We feel this integrated approach of including lab experiences across both courses in the sequence will further enhance the educational experience of the students.

5. *Machine Design Sequence* - We are currently evaluating our machine design sequence (ME 35200 and ME 45200). Currently, ME 35200 (a course on kinematics and kinetics of machines) is a required course and ME 45200 (a traditional machine design course with stress and reliability) is one of three restricted electives, but not required of all students. Many of our Mechanics and Design faculty (as well as students) have concluded that we should rearrange the topics or possibly morph them together because the traditional machine design topics are much more relevant to most engineering positions.

6. *Lab Component in ME 32300* - Finally, we are considering incorporating a small laboratory component into ME 32300 Mechanics of Materials. Currently, none of the mechanics courses have a laboratory component. Adding a hands-on laboratory component should greatly enhance students understanding of deformation of materials and stress analysis principles for machine components.

Perhaps the most significant change in the ME Program since our last review is the addition of the Gatewood Wing, This wing adds roughly 50% of new assignable space to the main ME Building. A new large collaborative classroom (120 seats) is now available and is especially well suited to quickly transition from a traditional lecture environment to a group oriented collaborative learning environment. In addition, there is substantial new space for senior design including three prototype assembly/fabrication spaces, seven team breakout rooms with projection equipment, and a rapid prototyping room. These spaces have greatly enhanced our ability to provide authentic hands-on experiences in senior design (ME 46300). Furthermore, the additional space has enabled us to roughly double the size of the ME Student Shop. This is important due to the high volume of students we have in senior design.

C. Options

While there are numerous minor and certificate options available to the students, ME does not offer any standardized tracks or concentrations.

D. Organizational Structure

The organizational structure of the upper administration at Purdue University is shown in Figure D1 and the organizational structure of the College of Engineering is shown in Figure D2.

Purdue University Organizational Chart
January 2013

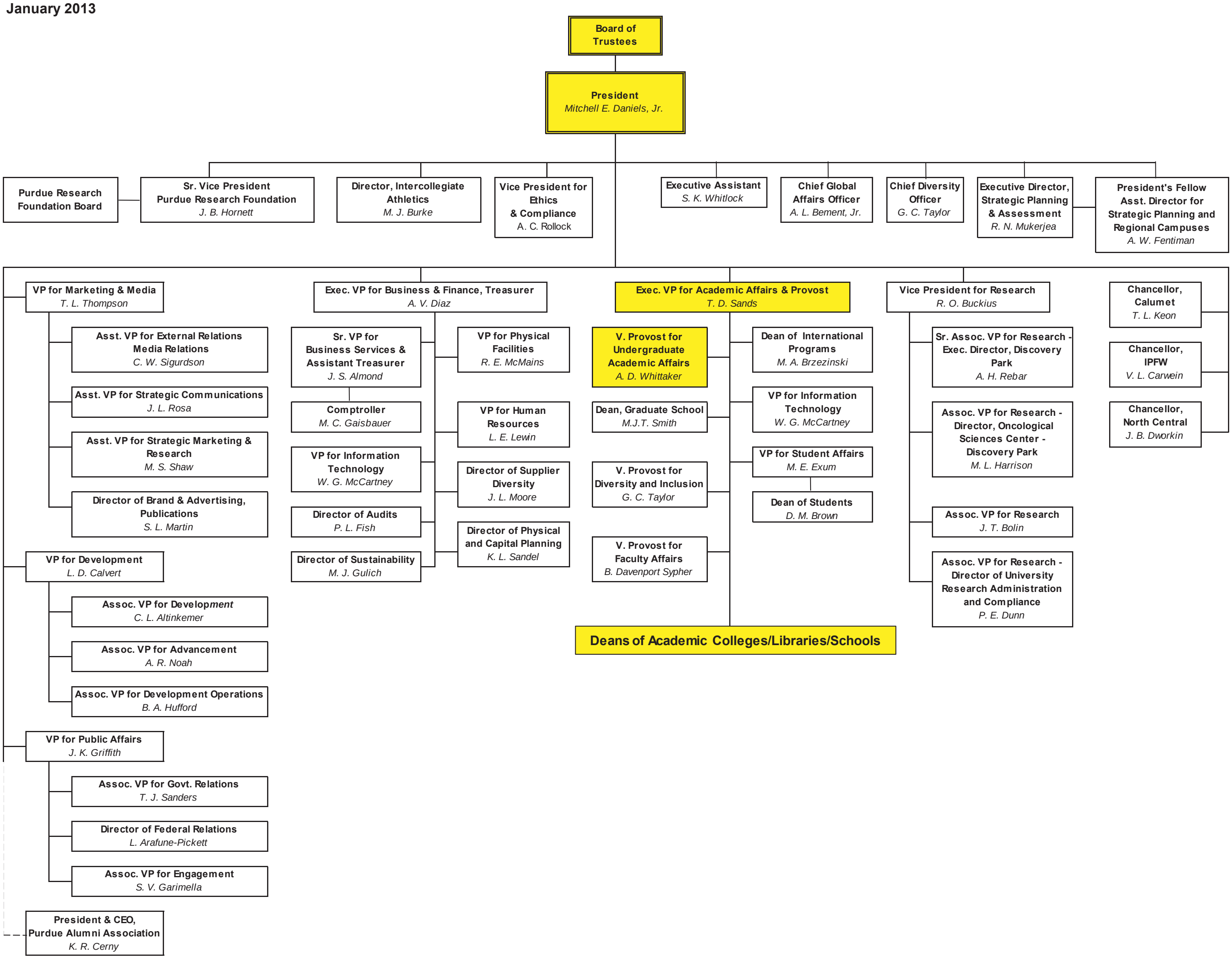


Figure BG.1. Purdue University Organizational Chart

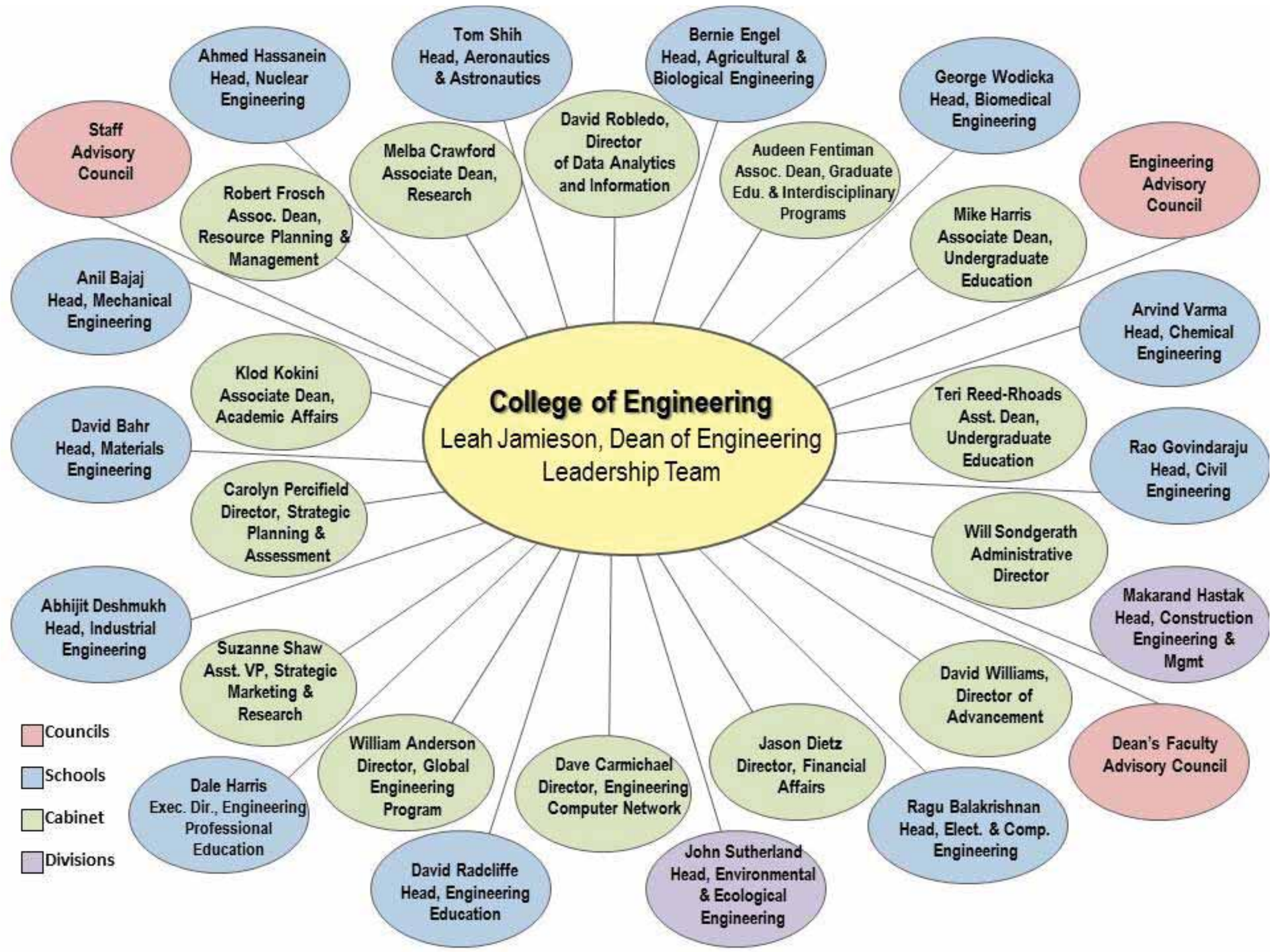


Figure BG.2. College of Engineering Organizational Chart.

E. Program Delivery Modes

The School of Mechanical Engineering offers ME undergraduate courses primarily during week days (M-F) between the hours of 7:30am and 5:20pm. Evening exams are commonly utilized for multi-section ME core courses since all sections cover equivalent content and have common exams. This insures no advantage for students who may have a later course section. Most courses use a traditional lecture format with some of the core courses offering a complimentary laboratory experience (including ME 26300, 30900, 31500, 35200, 36500, 46300, 47500) or project work (ME 30000, 45200). However, since fall 2011 many faculty are beginning to implement cooperative learning methods in class since the availability of our new collaborative learning classroom.

Most ME undergraduate courses are offered exclusively on-campus, with two exceptions, ME 37500 and ME 30000. One section of ME 37500 is offered via the web for our study-abroad students. This enables these students to have one additional option while abroad to complete a core ME course and stay on track toward graduation. On-line versions of both ME 37500 and ME 30000 have recently been added for students on co-op and internship rotations during the academic year. This enables students to make some modest academic progress, even while serving as a co-op or intern.

The School of Mechanical Engineering does not currently offer any undergraduate courses off-campus. However, a number of dual-level graduate ME courses can be taken via distance education. These courses can be used by undergraduate students for their professional electives.

F. Program Locations

The only location Purdue ME courses are offered is on the main campus in West Lafayette, Indiana.

G. Deficiencies, Weaknesses or Concerns from Previous Evaluation and the Actions Taken to Address Them

Below is the Final ABET Statement from the 2007 evaluation. No deficiencies, weaknesses or concerns were expressed in this statement; however, four strengths were noted.

Mechanical Engineering
Program

<u>Introduction</u>
The School of Mechanical Engineering at Purdue University offers a strong program leading to the Bachelor of Science degree in mechanical engineering. The program includes 750 full-time undergraduates, 97 part-time students, and 363 graduate students. The program has 46 tenure-track faculty members, 25 other faculty, and 6 part-time faculty members. In addition, there are 20 office and clerical employees and 9 technicians and specialists.

Program Strengths

1. *The faculty members are committed to excellence in undergraduate and graduate teaching, including exemplary collaborative teaching of courses with multiple sections. The full-time faculty members of the program are divided into six Academic Area Committees that have advisory responsibility for coordination of the curricular activities and content of the program.*

2. *The head of the school has provided a continuity of leadership, stability, and innovation to the program for approximately eight years. His leadership is clearly well appreciated by the students, faculty, and staff, as indicated by comments from several individuals. An associate head assists in the supervision and coordination of all aspects of the undergraduate program, and, with others, he has been key in the assessment and improvement processes that have been going on for several years.*

3. *The program has a central role in the creations and fostering of the GEARE Program, which provides students with the opportunity to participate in global engineering experiences and education. This program now includes multi-disciplinary participation of several other programs within the college.*

4. *The university supports growth for the laboratories and facilities associated with the program. Recently, the Indiana Legislature has approved bonding for the Roger B. Gatewood Wing of the Mechanical Engineering Building. The school participates in the associated fundraising activities.*

H. Joint Accreditation

The School of Mechanical Engineering is neither jointly accredited nor seeking joint accreditation by more than one commission.

CRITERION 1. STUDENTS

1A. Student Admissions

Freshman Admissions to the College of Engineering: Admission of freshmen to the College of Engineering is made by the University's Office of Admissions based on enrollment goals established by the University administration and in close consultation with the College of Engineering. Students are admitted directly to the College (in the First-Year Program), but not to a specific professional engineering school (e.g., ECE, ME, etc.). Most students typically choose a professional school in the middle of the second semester of their first year (this process is discussed below in the following section).

Applications are reviewed on an individual and holistic basis. First and foremost, applicants must be prepared academically for the rigors of college and academic demands specific to the Purdue college, school, or program for which they seek admission.

In its individual review of each applicant, Purdue considers the following factors:

- High school course expectations
- Overall grades in academic coursework
- Grades related to intended major
- Strength of student's overall high school curriculum
- Trends in achievement
- Class rank
- Overall grade point average
- Core grade point average (English, academic math, laboratory science, foreign language, speech)
- SAT or ACT score sent from the testing agency (including writing section). Test scores must be sent electronically from the testing agency. When registering to take one of these tests, students are encouraged to take advantage of the free reporting option to have the testing agency send your scores directly to Purdue (SAT School Code: 1631; ACT School Code: 1230).
- Ability to be successful in intended major
- Essay
- Personal background and experiences
- Other aspects
- Information provided by high school guidance counselor (or other school administrator)
- Time of year the student applies
- Space availability in the intended program

The applicant's past performance based on overall grades and grades in core academic subjects is reviewed. The current minimum core expectations for applicants' requesting admission into the College of Engineering in fall 2013 include: English (8 semesters), mathematics (8 semesters), lab science (6 semesters with at least 2 semesters of chemistry), foreign language (4 semesters) and social studies (6 semesters). Most students who are admitted to Purdue surpass the subject matter expectations listed above. Therefore all students who plan to apply to the College of Engineering are encouraged to exceed these expectations.

Of special interest is the students' performance on engineering related courses (specifically mathematics and laboratory science courses). While no minimum GPA standard is set for admission, other general guidelines are used by the Office of Admission when considering applicants' for admission including class rank and overall trends in grades. A general upward grade trend is more favorably viewed than a general downward trend.

As with grades, no minimum SAT or ACT scores are set for admission. However, the higher the scores, the better is the chance for a student to obtain admission. As a reference point, the average SAT score of entering students in fall 2012 was 1868 (including critical reading, math and writing). Note that, approximately 25% of our admitted student body consists of international students.

Other factors of competitiveness are also considered in the admission process. One of the factors is the strength of the student's high school curriculum as measured by various metrics (e.g., number of national merit scholars, average SAT and/or ACT scores, amount of advanced credit awarded, etc.). The stronger these high school-based factors are, the better the chances for a student to be admitted. Ability to be successful in intended major and personal background and experiences are also considered. Additional information provided by a high school guidance counselor (or other school administrator) may be submitted. This is particularly helpful if a student has unusual circumstances that need special explanation.

Finally, in an effort to support the value of diversity, other factors are considered especially in borderline cases such as socioeconomic/disadvantaged background, 1st generation college student, gender, and underrepresented racial/ethnic identity.

The Office of Admissions also admits students whose overall record and scores meet the admission criteria, but who may need additional preparation in certain high school subjects. Courses in algebra and trigonometry (MA 15800) are provided, but are not allowed for credit towards graduation. Chemistry 11100 and 11200, which when combined are equivalent to chemistry 11500, are available for students needing additional preparation in chemistry. Similarly, students needing added preparation in physics may take PHYS 14900 (again not for graduation credit). Students needing additional preparation in reading and/or study skills may take GS 25000 College Reading Skills and Applications, GS 29400 Reading Efficiency, and/or GS 29500 Effective Study Skills. Likewise, international students are encouraged to take GS 490 Reading, Writing and Speaking for Internationals Students. Finally, students needing added assistance with writing skills may visit and seek guidance and help from the Purdue Writing Lab in room 226 of Heavilon Hall.

An entering freshman who has demonstrated his/her proficiency either by a satisfactory score on a nationally administered Advanced Placement Program Examination or by an examination provided by a Purdue university school or department is allowed appropriate credit toward his/her degree. Credits are also allowed for courses taken at community colleges or other accredited four-year schools during the senior year of high school (enrichment programs) provided the courses appear on a college transcript. These advanced placement credits are most often in mathematics, chemistry, physics, foreign languages, and English.

Admission to the School of Mechanical Engineering (from the First-Year Program): Students who enter the College of Engineering as freshman can select Mechanical Engineering once the required first-year courses are satisfactorily completed (typically at the end of their second semester). The required first-year courses are:

Engineering 13100
Engineering 13200
English 10600 (or 10800)
Math 16500 (or 16100)
Math 16600 (or 16200)
Physics 17200
Chemistry 11500
Science Selective (typically Biology 11000, Chemistry 11600, or Computer Science 15900).

Satisfactory completion requires a minimum grade point average (GPA) of 2.0 or better in the required first-year courses (this index is known as the Engineering Admission Index – EAI). In addition, because more First-Year Engineering students' desire admission into the School of Mechanical Engineering than there is space to accommodate, a student must earn an EAI of 3.2 or higher to be guaranteed a space in ME. Generally, students with EAIs marginally lower than 3.2 may be admitted as well provided there is still space available in the School. The primary factor considered when admitting students who have EAI's below 3.2 is the proximity to the 3.2 threshold. The higher the EAI the more likely they are to be admitted. In an effort to support the value of diversity, other factors are considered especially in borderline cases such as socioeconomic/disadvantaged background, 1st generation college student, gender, and underrepresented racial/ethnic identity. Finally, students who are showing improvements in their academic performance are ranked more highly than students whose performance is declining.

This selection process, known as "declaring a major," typically begins during the middle of the second semester of the freshman year. Students on track to complete their first year courses in the spring and requesting admission into ME, register for their upcoming summer and fall courses with the School of Mechanical Engineering. Once the spring grades are posted, students requesting admission into ME are ranked by their Engineering Admission Index. All students above a 3.2 are automatically admitted. Students interested in admission into ME but below a 3.2 EAI are reviewed on a space available basis.

This admission process is repeated again in August and December for any students who did not complete all of their first year courses by the spring semester. Generally, we admit approximately 350 students in May, 10-15 in August and 55-75 students in December.

On-Campus Transfer: Students who transfer to the College of Engineering from another school or college on the West Lafayette campus (at Purdue this is known as a Change of Degree

Objective – CODO) may enter the School of Mechanical Engineering (on a space available basis) at the sophomore level or higher provided they have:

> * completed all First-Year Engineering requirements with an Engineering Admission Index of 3.2 or higher,
>
> * earned a Purdue West Lafayette cumulative GPA (excluding Regional Campus grades) of 3.2 or higher (with at least 12 credits from the West Lafayette campus.
>
> * have C's or higher in all sophomore-level or higher required courses.

In rare instances we will also consider a student who is marginally under the 3.2 GPA requirement if their recent grades show strong improvement suggesting they are capable of performing at a high level.

1B. Evaluating Student Performance

Students are required to meet with their academic advisor every regular semester they are on campus for the purpose of registering for courses, verify that their program records are consistent with University records, and to address any academic, career or personal advising concerns that might come up.

All students admitted into the ME Program are required to take ME 29000 Mechanical Engineering Professional Seminar during their first semester in ME (if at all possible). One of the goals of the seminar is to acquaint students with the ME degree requirements and to help them create a personal plan of study (POS). All ME students are required to maintain an up-to-date POS in order to register for classes each semester. The POS is used to ensure that all program requirements are met (and alert students in advance to potential problems), to help students make wise choices on course loads (e.g., balancing loads from semester-to-semester), and to monitor the students' progress (to avoid last minute problems in meeting the program graduation requirements).

The procedure for approval of a student's POS is as follows: Students download a POS file from the web and choose from seven standard POS's (a 4-year POS, two study abroad POS's, and four co-op POS's) (see an example in Figure 1.1 below). Students choose the most appropriate standard POS as a starting point and then modify it to fit their specific situation. The POS's are collected in ME 29000 and reviewed for completeness, prerequisites, and reasonable loads. Recommended changes are provided the following week and students make the needed changes prior to registration. An updated POS is required each semester upon registration. This permits the staff to monitor students' progress as they move toward graduation. Prior to the registration for the final semester, the academic advisors conduct a detailed audit of each candidate's plan. By having all audits conducted by the academic advisors, a consistent application of the requirements for graduation can be achieved.

One unique feature of the downloadable POS files is that in addition to the credit hours, an estimate of the average weekly workload (i.e., total in-class and out-of-class hours) is included. This estimate is based on feedback from students who have previously taken the courses. Total credit hours can be a misleading indicator of total work load because typically the workload and expectations of the technical courses are substantially higher than other general education electives. Hence, this gives students a more accurate measure of the actual time required to do well in their selected set of courses. This helps students to balance their workloads from semester-to-semester.

Review of academic performance is done mid-term and at the end of each semester. Faculty are invited to identify and submit the names of students who are having difficulties in class (for example, attendance concerns, low homework/quiz scores, attitude problems, or low exam scores). This information gives advisors the opportunity to query students during their pre-registration meeting to understand the underlying issues for the difficulties and attempt to assist the student in determining the best course of action that will improve their final outcome. Students are also encouraged to meet with their instructors and discuss appropriate concerns. Finally, any excess credits a student may have earned can be applied toward advanced degrees.

ME Plan of Study (4 Yr. Plan)

Name: Doe, John **PUID**: 99999-99999 **Cum GPA**: 0.00 **Sem GPA**: 0.00
Email: doe@ecn.purdue.edu

Fall 2011 (1)	Hr/Wk	Crs
MA 165	12	4
CHEM 115 (L)	12	4
ENGL 106/108	6	3
ENGR 131	12	2
PHYS 172	12	4
Total	**54**	**17**

Spr. 2012 (2)	Hr/Wk	Crs
MA 166	12	4
Science Selective	12	3
ENGR 132	12	2
COM 114	6	3
CGT 163	6	2
Total	**48**	**14**

Sum. 2012 (3)	MM* Hr/Wk	Sum** Hr/Wk	Crs
Internship			
Total	**0**	**0**	**0**

Fall 2012 (3)	Hr/Wk	Crs
ME 200	13	3
ME 270	13	3
ME 290	3	1
MA 261	13	4
PHYS 241	13	3
Gen. Ed. (GE-1)	6	3
Total	**61**	**17**

Spr. 2013 (4)	Hr/Wk	Crs
ME 263 (L)	18	3
ME 274	13	3
MA 262	13	4
ECE 201	13	3
ECE 207 (L)	5	1
Total	**62**	**14**

Sum. 2013 (5)	MM* Hr/Wk	Sum** Hr/Wk	Crs
Internship			
Econ El. (Econ)		6	3
Gen. Ed. (GE-2)		6	3
Total	**0**	**24**	**6**

Fall 2013 (5)	Hr/Wk	Crs
ME 309 (L)	18	4
ME 365 (L)	18	3
ME 323	13	3
MA 303	13	3
Total	**62**	**13**

Spr. 2014 (6)	Hr/Wk	Crs
ME 352 (L)	18	4
ME 375	13	3
MSE 230	13	3
Tech. El. (TE-1)	13	3
Wrld/Cult El (WAC)	6	3
Total	**63**	**16**

Sum. 2014 (6)	MM* Hr/Wk	Sum* Hr/Wk	Crs
Internship			
Gen. Ed. (GE-3)		6	3
Total	**0**	**12**	**3**

Fall 2014 (7)	Hr/Wk	Crs
ME 315 (L)	18	4
Rest. El. (RE-1)	18	3
Tech. El. (TE-2)	13	3
Free El. (free)	6	3
Gen Ed. (GE - 4)	6	3
Total	**61**	**16**

Spr. 2015 (8)	Hr/Wk	Crs
ME 463 (L)	18	3
Rest. El. (RE-2)	18	3
Tech. El. (TE-3)	13	3
Tech. El. (TE-4)	13	3
Total	**62**	**12**

Sum. 2015 (9)	MM* Hr/Wk	Sum** Hr/Wk	Crs
Total	**0**	**0**	**0**

Fall 2015 (9)	Hr/Wk	Crs
Total	**0**	**0**

Spr. 2016 (10)	Hr/Wk	Crs
Total	**0**	**0**

Transfer/AP Cr.			Crs
Total	**0**	**0**	**0**

Total Credits: **128** **Grad. Req.:** **128 credits**

* *Maymester* Total "Hours/Week" is automatically multiplied by a factor of 4 (due to 4 week session).
** *Summer Session* Total "Hours/Week" is automatically multiplied by a factor of 2 (due to 8 week session).

Figure 1.1 Sample Plan-Of-Study (POS).

1C. Transfer Students and Transfer Courses

Off-Campus Transfer Admission: Students who transfer to the School of Mechanical Engineering from another Purdue campus (IUPUI, Purdue-Calumet, Purdue-Fort Wayne, Purdue North Central), are considered as regional campus transfers. These students typically transfer as sophomores or juniors (on a space available basis). To be admitted they must meet the same requirements, stated above for on-campus CODO students. Students who do not meet the GPA requirement, but are still interested in being admitted into Mechanical Engineering are counseled to request admission into another engineering program and take at least 12 credits of technical courses. If their semester progresses well, then they can be considered for CODO into the School in the following semester.

Direct transfer students from other institutions are generally not considered for admission into ME. If interested, these students are counseled to seek admission into another engineering program and register for 12 credits of technical courses. If they meet the CODO requirements (discussed above), then they can be considered for CODO into ME after their first semester at Purdue. There are three exceptions to our direct transfer rules. First, we have had a long standing 3+2 Program with Vincennes University (an in-state university) from which we admit a few students. Second, we have a similar 3+2 program with Bethune-Cookman College (a private historically black college in Florida). The articulation agreement with Bethune-Cookman was established approximately 4 years ago in a strategic effort to improve diversity within the College of Engineering. Third, a 3+2 program with Wabash College (another in-state institution) has been recently approved. Criteria for admission from these programs are consistent with our CODO requirements.

Students who do transfer to Purdue have to complete their upper-level core ME courses at the West Lafayette campus. These courses include ME 29000, ME 26300, ME 30000, ME 30900, ME 31500, ME 32300, ME 35200, ME 36500, ME 37500, ME 45200, ME 46300 and ME 47500. These are the courses which we believe distinguish a Purdue ME graduate from graduates from other institutions. Transfer credit for these courses are not allowed.

Evaluation of Transfer Credit: Transfer credits from other institutions are initially evaluated by the Credit Evaluation Office in the University Office of Admissions. If a course is deemed equivalent and the student has earned a grade of "C" or better, then credit for the course is posted on the student's academic record (No credit is given for Pass/Fail or Pass/No Pass courses). If the course is not deemed equivalent to any existing courses at Purdue, then the course is listed as undistributed ("UND"). This does not mean that credit cannot be used, but that based on the course descriptions, the evaluators were unable to establish equivalency. In this event, the student has the option to collect additional information (e.g., course syllabus, textbook used, course notes, exams, etc.) and go to the appropriate school, department, or program and seek a more detailed review from a faculty member or advisor knowledgeable in the course area. If they deem the courses to be equivalent, then credit can be established by the school, department or program that reviewed the course. If the course is still not deemed equivalent, then the credit will be posted as undistributed ("UND") and the home school will decide if and how the credits may be used towards graduation. As mentioned above, transfer credit for the following courses cannot be established: ME 29000, ME 26300, ME 30000, ME 30900, ME 31500, ME 32300,

ME 35200, ME 36500, ME 37500, ME 45200, ME 46300 and ME 47500. These courses must be taken on the West Lafayette campus.

1D. Advising and Career Guidance

Advising in the First-Year Engineering Program: The First-Year Engineering (FYE) program provides academic advising services and support for first-year engineering students in their transition from high school to the rigorous academic demands of the College of Engineering. The FYE's programs and services foster success by assisting students in exploring their educational, career and life goals. Integral to FYE's role is providing students with the resources within the College and the University's communities that can help them achieve their goals, and provide them with personal growth and leadership skills. The FYE promotes academic excellence, thus empowering students to strive for excellence at Purdue and beyond.

First-year student advisors, consisting of a group of well-qualified staff of professional advisors and upper-division peer advisors, work with first-year students to facilitate their transition and learning process. The School of Mechanical Engineering typically recommends candidates and provides support for two students to serve as part of the FYE advising staff to help guide students with interests in Mechanical Engineering. Interviews, selection, hiring, training, scheduling, supervision, and salaries for student advisors are coordinated through the ENE (Engineering Education) staff. The FYE advisors conduct student audits five times a year (mid- and final audits each regular semester and a final audit after summer).

During the fall and spring semesters, students are encouraged to explore their educational and career goals. As part of their ongoing support for students, the advisors assist students with personal issues and provide guidance in evaluation of attitudes, goals, values and academic priorities. Students also meet with an advisor to select courses and monitor their academic progress and explore engineering options. All first-year students are required to meet with an advisor, either individually or in a group, each semester.

Advising in the Mechanical Engineering Program: The Undergraduate Office (UGO) in the School of Mechanical Engineering houses the advising faculty and staff who oversee all aspects of the BSME degree program. UGO activities include, but are not limited to, student advising, admission to the ME program, maintenance of student records, time schedule of class offerings, room scheduling of classes, seminars and related events, grade sheets, special permission for closed courses, and course approval activity. The Undergraduate Staff is comprised of two faculty: the Associate Head for Undergraduate Education (a 50% appointment) and the Co-op Director (a 25% appointment); two academic advisors, and one administrative assistant. The governing body that establishes the policies and procedures for advising and reviews and special exceptions is the ME Curriculum Committee. This Committee is comprised of 6 faculty members, one from each Area Committee within the School: Combustion, Energy Utilization and Thermodynamics (CENUT), Design, Fluid Mechanics and Propulsion, Heat Transfer, Mechanics and Systems, Measurement and Controls (SMAC).

The services of the UGO staff are available to students on a walk-in basis Monday through Friday. Students meet with the advisors to discuss future term scheduling of classes, their plan-of-study (POS), internship or co-op possibilities, study-abroad interests, dual-degree interests, minors, and interpretation of policies and regulations pertaining to the curriculum. The advisors meet one-on-one with students who request appointments to discuss many facets of their academic careers and college life.

The academic advisors conduct most of the advising sessions. The Associate Head advises roughly 100 students per semester. Generally, these are students who have experienced academic difficulty (e.g., falling below the 2.0 Core GPA), who have complex POSs (due to study-abroad, double major, etc.), or who have requested to meet with the Associate Head for personal reasons. When a student falls below the 2.0 Core GPA, they receive a probation letter indicating that they are on probation and that they have one grace semester to bring their Core GPA back above the required 2.0 for graduation. Before the student can make changes in registration for the upcoming semester, they have to complete and submit to the Associate Head a revised POS and a Probation Memo. The memo requests information regarding four issues: 1) what were the problems that led to the academic difficulties, 2) what are the proposed solutions to these problems, 3) what are the proposed courses for the upcoming semester and 4) what target GPA has the student set for the upcoming semester. The Associate Head reviews the POS and probation memo, and discusses any needed changes with the student prior to any registration changes. If the student is able to improve his/her Core GPA to above a 2.0, then he/she is back in good standing with the School. If not, then the student is required to make plans to CODO into another academic program. A student that fails to meet the Core GPA requirement may petition the ME Curriculum Committee for a second grace semester. The petition may be approved if the student is very close to the 2.0 cut-off or if circumstances outside of the student's control prevented the student from having a fair chance to improve their grades.

Career counseling is also done by the UGO staff. In cases where a staff member cannot answer a career question, the student is directed to the appropriate faculty member who has expertise in that area. The School also has a full-time Director for Industrial Experience who, as an engineer, serves as the main link to our co-op and internship companies. He is readily available to advise students on co-op and internship opportunities as well as permanent positions. Again, if students have questions that the Director cannot answer, they are directed to the appropriate faculty member who has the expertise to assist the student.

All correspondence with or about students is kept in their file for reference. Students have access to these files in accordance with the Freedom of Educational Rights & Privacy Act (FERPA) regulations. All UGO staff has appropriate FERPA training to assure compliance with these federal privacy laws.

Currently, students have access to MyPurdue, an on-line data warehousing system, from which they can access unofficial academic records, their progress report and their financial aid data. This allows them to monitor their academic progress at any time.

All admitted ME undergraduate students are added to the ME undergraduate email group. Mechanical Engineering students are sent email messages from the UGO on many pertinent issues, such as approaching deadlines for scholarships, job opportunities, drop/add deadlines, events, and general correspondence.

1E. Work in Lieu of Courses

Purdue grants Advanced Placement credit. The score required to earn credit is set by the department that teaches the course. For example, the Department of Chemistry has decided that a 4 on the Advanced Placement test in Chemistry is required to earn credit in Chem 11500. Purdue also allows student to test out of many classes (the major exceptions are laboratory classes, classes requiring extensive teamwork, and classes requiring field trips). The department that offers the course develops the examination, grades the examination, and sets the passing level. Students are allowed only one attempt to test out, and they cannot take a test-out exam after they have taken the course.

Students participating in college-credit courses taught concurrently for high school and college credit during the regular school day by local high school teachers must validate the credit by submitting satisfactory results on the College Board Advanced Placement Examination or the Purdue advanced credit examination, as determined by the subject department.

1F. Graduate Requirements

Students are required to have a Cumulative GPA (including all courses taken at Purdue, both required and not required for their BSME degree) of 2.0 or better. In addition, all ME students are required to achieve a Core GPA (all sophomore and higher required core technical courses) of 2.0 to qualify for graduation. The courses that comprise the Core include: ME 20000, 26300, 27000, 27400, 29000, 30000, 30900, 31500, 32300, 35200, 36500, 37500, 45200, 46300, 47500; ECE 20100, 20700; MA 26100, 26200, 30300; MSE 23000; and PHYS 24100 (or any equivalent substitutes). Any lower-division courses for which a student may have transfer credit for do not calculate into the Core GPA unless it is from a Purdue regional campus. The Core GPA requirement was added to eliminate the possibility of students taking numerous easy electives (not required for graduation) in order to artificially inflate their academic performance.

Given these requirements, students with D's in sophomore-level ME courses are strongly advised to repeat these courses. Also, students cannot simultaneously repeat a course and take a follow-on course for which the course being repeated is a prerequisite, nor may students repeat a course once they have passed a subsequent course for which the course in question was a prerequisite. These rules are meant to ensure that students are as well prepared as possible for the upper-division ME courses, so as to make the best use of limited instructional resources.

As mentioned above, prior to the registration for the final semester, the academic advisors conduct a detailed audit of each candidate's POS. A Candidate Audit sheet (see Figure 1.2) is prepared for each candidate to ensure that the following are met: minimum of 128 credits toward program; all required and elective courses are complete; minimum 2.0 cumulative GPA; minimum 2.0 Core GPA; satisfactory final grades. The outstanding requirements that need to be completed in the final semester are identified and reviewed when the student registers for his/her final semester.

In rare instances, a student may petition the ME Curriculum Committee to make a substitution in his/her record, which falls outside the School Rules. These petitions are rarely granted. When these requests are approved, they are done so only when the spirit of the rules is met.

Date________________________

CANDIDATE AUDIT-Program 284
(For students entering ME in/after Fall 2009)

Name___________________________________I.D.__________________________________
Last First

______4	CHM 115_____________________	_______3	Sci. Sel.(CHM 116 or CS 159)_______
______3	ENGL 106/108________________	_______3	COM 114__________________
______4	MA 165_____________________	_______4	MA 166__________________
______2	ENGR 131___________________	_______4	PHYS 172_________________
______2	CGT 163____________________	_______2	ENGR 132_________________
_______	__________________________	________	__________________________

______4	MA 261_____________________	_______3	M E 274__________________
______4	MA 262_____________________	_______1	M E 290__________________
______3	MA 303_____________________	_______4	M E 309__________________
______3	PHYS 241___________________	_______4	M E 315__________________
______3	ECE 201____________________	_______3	M E 323__________________
______1	ECE 207____________________	_______4	M E 352__________________
______3	MSE 230____________________	_______3	M E 365__________________
______3	M E 200____________________	_______3	M E 375__________________
______3	M E 263____________________	_______3	M E 463__________________
______3	M E 270____________________		

RESTRICTED EL.	3________________________	FREE EL.	3________________________
	3________________________		
		ECON EL.	3________________________
		Wrld/Cult El.	3________________________
TECH EL.-1	3________________________	GEN ED – 1	3________________________
-2	3________________________	-2	3________________________
-3	3________________________	-3	3________________________
-4	3________________________	-4	3________________________

Extra Courses:____
Shortage:____
Remarks:____
Programs/Microsoft Word/Samba 3.0.5 (R)/Tarri's Office Forms/Candidate Audit Forms

Figure 1.2 Sample Candidate Audit Form.

1G. Transcripts of Recent Graduates

As requested, a transcript analysis of six recent graduates will be available. A detailed description of how the transcripts are to be interpreted is provided. All program options are designated on the transcripts.

CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

2A. Mission Statements

Purdue University: "Purdue University serves diverse populations of Indiana, the nation, and the world through **discovery** that expands the frontiers of knowledge, **learning** that nurtures the sharing of knowledge, and **engagement** that promotes the application of knowledge." (http://www.purdue.edu/strategic_plan/documents/StrategicPlanBrochure.pdf).

College of Engineering: The mission of the College of Engineering is "To advance engineering **learning**, **discovery**, and **engagement** in fulfillment of the Land Grant promise and the evolving responsibility of a global university."
(https://engineering.purdue.edu/Engr//AboutUs/StrategicPlan/2009-2014)

School of Mechanical Engineering: The School will serve its students, industry and society by fulfilling the missions of **discovery**, **learning**, and **engagement** through the creation, dissemination, and application of engineering methods, knowledge, and professional standards relevant to the practice of mechanical engineering in the many aspects of modern life where it plays a crucial role.

(https://engineering.purdue.edu/ME/Academics/Undergraduate/Mission_Prgm_Edu_Objs_Outcomes_2010.pdf).

2B. Program Educational Objectives

The **Program Educational Objectives** of the School of Mechanical Engineering are to matriculate graduates who conduct themselves in a responsible, professional and ethical manner (citizenship), and who upon the years following graduation, are committed to:

1. *Discovery* – (Professional Practice)

- actively embracing leadership roles in the practice of engineering in industry and government organizations (including both traditional and emerging technical areas),
- conducting research and development (via graduate study or industry) to advance technology and foster innovation, in order to compete successfully in the global economy,
- applying their engineering problem solving skills to less-traditional career paths (e.g., patent law, medicine, business, start-up ventures, engineering education, public policy, etc.).

2. *Learning* – (Professional Development)

- actively participating in on-going professional development opportunities (e.g., informal interactions with colleagues, formal conferences, workshops, short courses, graduate education, etc.),
- updating and adapting their core knowledge and abilities to compete in the ever changing global enterprise,
- developing new knowledge and skills to pursue new career opportunities.

3. *Engagement* – (Professional Outreach)

- serving as ambassadors for the engineering profession, inspiring others to develop a passion for engineering,
- exchanging and applying knowledge to create new opportunities that advance our society and solve a variety of technical and societal problems,
- advancing entrepreneurial ventures and fostering activities that support sustainable economic development to enhance the quality of life of people in the State, across the country, and around the world.

The program educational objectives and program outcomes of the School of Mechanical Engineering are formally published in the College of Engineering bulletin and are available to students and faculty on the School's Undergraduate home page. (see

https://engineering.purdue.edu/ME/Academics/Undergraduate/MissionObjectivesOutcomes.pdf).

2C. Consistency of the Program Educational Objectives with the Mission of the Institution

The Mechanical Engineering Program Educational Objectives are clearly consistent with the educational mission and goals of the College of Engineering and of Purdue University. The program Educational Objectives are aligned under the three primary stems of the University's mission, namely **Discovery**, **Learning** and **Engagement**.

2D. Program Constituents

We view the constituents of our program to be:

- **Students** The purpose of the undergraduate program is to educate and nurture our students. Our undergraduate program is committed to providing an environment where our students can learn formally in the classroom and informally through active and self-exploratory interactions with the faculty, the educational staff (including teaching assistants) and peers.

- **Alumni** We want our alumni, upon graduation from our program, to become responsible and productive members of society. We want our alumni to be proud Purdue University graduates and to share their knowledge and experiences with us to help shape both our educational objectives and our student outcomes for future generations.
- **Employers** Most of our graduates will enter industry. Our students work in virtually all segments of industry and many work in less traditional areas like patent law, medicine, business, start-up ventures, engineering education, public policy, etc. We believe that we have a responsibility and an obligation to provide students who are not only well educated in current technology but who also possess the fundamental knowledge that will let them grow intellectually as they work in industry and provide them the ability to adapt their problem solving skills to succeed in whatever career path they choose. We also intend to maintain a curriculum that will stay current with the needs of industry.
- **Faculty** The faculty are the backbone of our ME program. Every aspect of our Program is dependent on their commitment to excellence. Without their input and willingness to adapt and innovate our ME Program, it would be impossible to develop the educational experiences needed to become a leading ME Program. The faculty have been intimately involved in developing and adapting our ME Program Educational Objectives (PEOs) and Student Outcomes. They have also been critical to the development, assessment, and evaluation of numerous direct measures. Finally, faculty serve as the catalysts to continuous improvement and thus represent a key constituent of our ME Program.
- **MEAC** Our MEAC (Mechanical Engineering Advisory Council), though not all alumni of Purdue, are mostly alums as well as employers of our graduates. However, this small group of mostly industrialists and some academicians have perhaps made some of the greatest commitments to improving our ME Program (including funding several pilot projects). Furthermore, as shown in Figure 2.1, the MEAC is an integral part of our program review and improvement process.

The career paths of our graduates are broad and varied. They include not only the traditional areas of engineering (e.g., aerospace/defense, automotive, biotechnology/pharmaceutical, chemical/petroleum, computers/electronics, construction, consumer/food products, energy/nuclear, engineering consulting, heavy/off-road equipment, etc.) but also a broad array of non-traditional careers (e.g., medicine/healthcare, patent law/intellectual property, business/financial services, engineering and public policy, engineering education, entrepreneurial ventures, etc.). Consequently, the program educational objectives are developed to incorporate the diverse skills and abilities that graduates are utilizing in their varied careers.

2E. Process for Revision of the Program Educational Objectives

The program educational objectives were initially established in 1999 in consultation with our primary constituents as illustrated in Figure 2.1 below. This process, which has long been established, is identical to the process we use to implement curricular changes.

The objectives were reviewed and modified by the ME faculty during our annual faculty retreat (August 17, 2006), and the School's Mechanical Engineering Advisory Council (MEAC) on September 14-16, 2006. The essence of the change was to make our program educational objectives much broader and better aligned with the mission of the University and the College.

In fall 2011, we reviewed the ME program educational objectives (PEOs) again with the faculty at our annual faculty retreat. By in large faculty were satisfied with our current PEOs. Only minor editorial changes were recommended and adopted. These same PEOs were vetted with the ME Advisory Committee at our 2011 annual meeting. Again, the MEAC agreed that the PEOs broad emphasis effectively reflected the diverse career paths that graduates were pursuing. They approved the PEOs as presented.

The current program educational objectives are published in the College of Engineering bulletin and are available to students and faculty on the School of Mechanical Engineering undergraduate website at:
https://engineering.purdue.edu/ME/Academics/Undergraduate/Mission_Prgm_Edu_Objs_Outcomes.pdf.

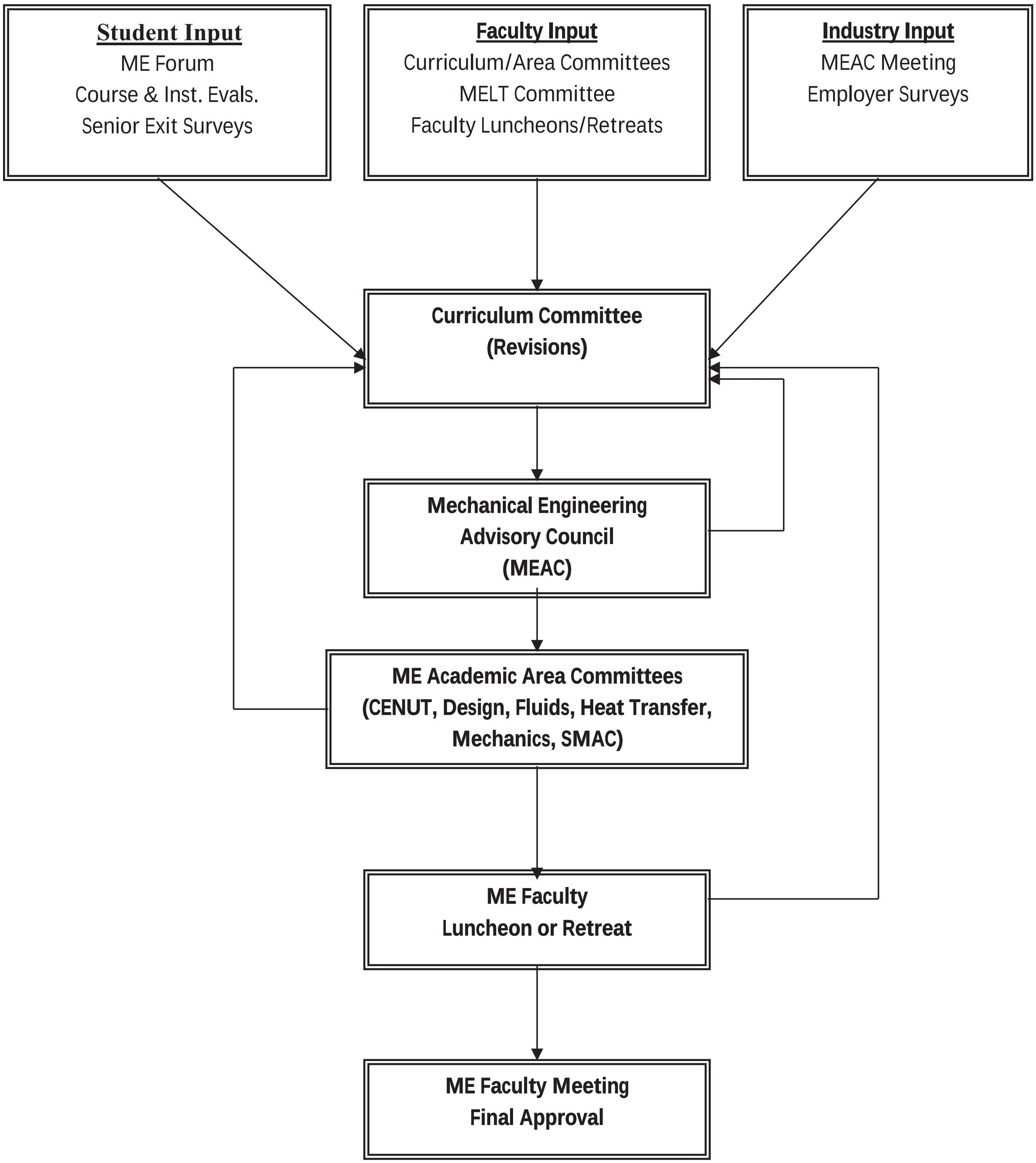


Figure 2.1. Process for Review and Improvement of the ME Program.

CRITERION 3. STUDENT OUTCOMES

3A. Student Outcomes

The student educational outcomes of Mechanical Engineering at Purdue University include the ABET (a) through (k) in Criterion 3 augmented by four additional outcomes (l-o). The student outcomes are logically organized into three categories as illustrated below in Figure 3.1.

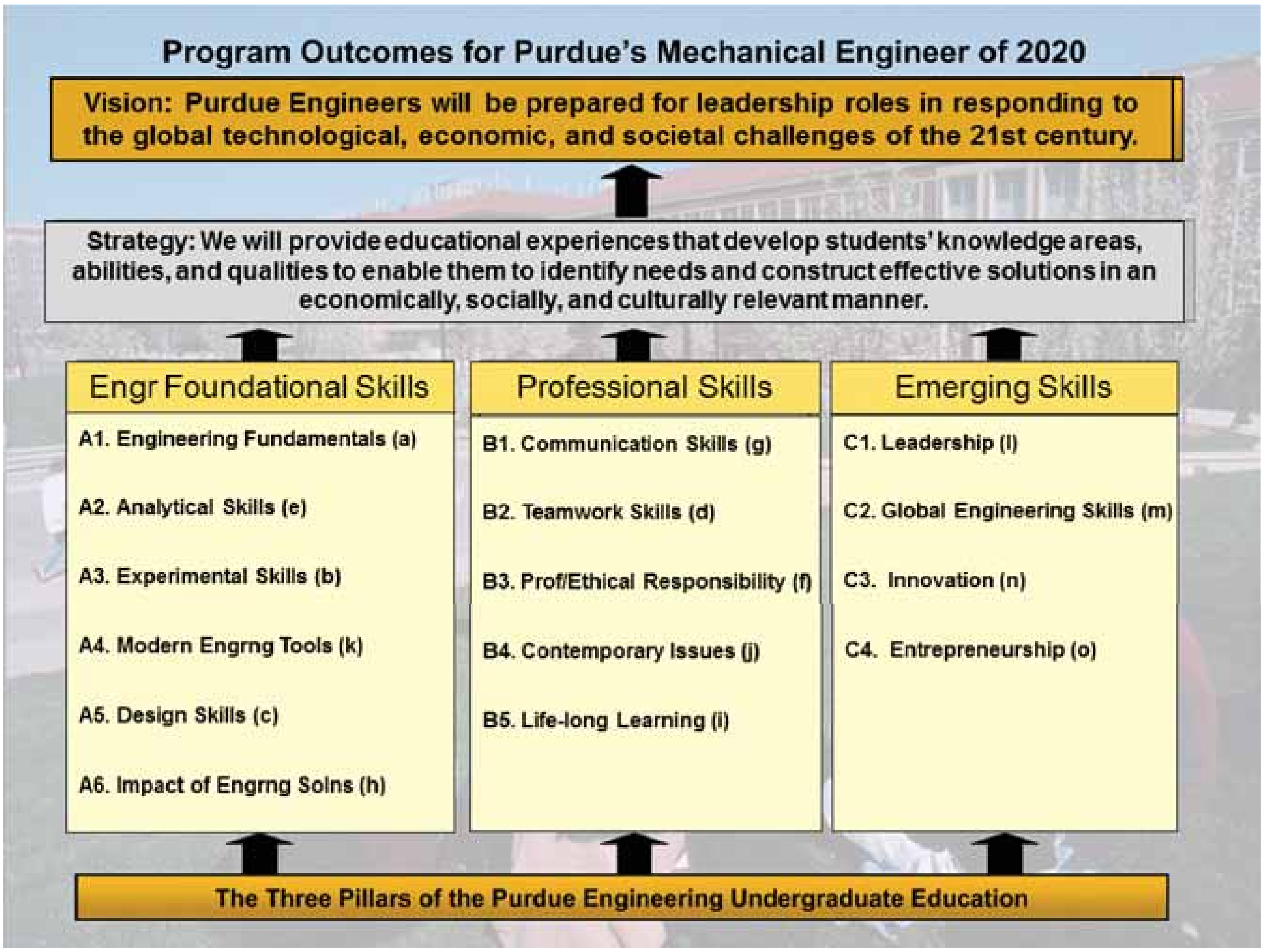


Figure 3.1 Mechanical Engineering Student Outcomes.

Operational Definitions of Program Outcomes (Letter designations represent the equivalent ABET outcome)
A. Engineering Fundamentals
A1. Engineering Fundamentals (a) - An ability to apply knowledge of math, science and engineering.
A2. Analytical Skills (e) - An ability to identify, formulate, and solve engineering problems.
A3. Experimental Skills (b) - An ability to design and conduct experiments, as well as to analyze and interpret data.
A4. Modern Engineering Tools (k) - An ability to use the techniques, skills and modern engineering tools necessary for engineering practice.
A5. Design Skills (c) - An ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
A6. Impact of Engineering Solutions (h) - The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
B. Professional Skills
B1. Communication Skills (g) - The ability to communicate effectively.
B2. Teamwork Skills (d) - An ability to function on multidisciplinary teams.
B3. Professional and Ethical Responsibility (f) - An understanding of professional and ethical responsibility.
B4. Contemporary Issues (j) - A knowledge of contemporary issues.
B5. Life-Long Learning (i) – A recognition of the need for and an ability to engage in life-long learning.
C. Emerging Skills
C1. Leadership (l) - An ability to apply effective leadership principles to formulate and articulate a shared vision, and lead an organization in the implementation of this vision.
C2. Global Engineering Skills (m) - An ability to work effectively in the global engineering profession.
C3. Innovation (n) - An ability to identify promising market opportunities and develop new, creative solutions which meet customer needs and desires.
C4. Entrepreneurship (o) - An ability to apply entrepreneurial skills both in new ventures (e.g., start ups) and within well-established organizations (intrapreneurship).

Table 3.1 Table of the Operational Definitions of the Student Outcomes.

3B. Relationship of Student Outcomes to Program Educational Objectives

Our process to ensure that the program educational objectives and student outcomes are met is to have a clear mapping between the student outcomes and the program objectives. While some outcomes could naturally fall under more than one program objective, we have chosen to align each outcome with the objective with which it most naturally fits. Students who achieve these program outcomes will naturally be well prepared to meet the Program Educational Objectives in their future engineering careers.

Table 3.2 Alignment of Program Educational Objectives with Student Outcomes.

ME Program Outcomes vs. Program Educational Objectives			
ME Program Outcomes	**ME Program Educational Objectives**		
Rev 2/13/13	**Discovery** (Professional Practice)	**Learning** (Professional Development)	**Engagement** (Professional Outreach)
Engineering Fundamentals			
A1. Engineering Fundamentals (a)	H	M	M
A2. Analytical Skills (e)	H	M	M
A3. Experimental Skills (b)	M	M	L
A4. Modern Engineering Tools (k)	H	M	M
A5. Design Skills (c)	M	M	M
A6. Impact of Engineering Solutions (h)	M	L	H
Professional Skills			
B1. Communication Skills (g)	H	M	H
B2. Teamwork Skills (d)	H	M	L
B3. Professional/Ethical Responsibility (f)	H	M	H
B4.Contemporary Issues (j)	H	M	H
B5. Life-long Learning (i)	M	H	M
Emerging Skills			
C1. Leadership (l)	H	M	H
C2. Global Engineering Skills (m).	M	M	H
C3. Innovation (n)	M	M	H
C4. Entrepreneurship (o)	M	M	H
H = High M = Medium L = Low			

CRITERION 4. CONTINUOUS IMPROVEMENT

4A. Student Outcomes

In section 4A, a summary of the assessment processes and a brief description of each process is presented. Following this, a summary of the assessment results for each outcome is provided.

4A.1 Listing and Description of Assessment Processes

Figure 4.1 below shows various indirect and direct assessment methods used to assess the program outcomes. For indirect measures, we used three different survey instruments to measure each of the 15 different program outcomes. These surveys included measures from each of our three constituents: 1) *graduating seniors*, 2) a*lumni*, and 3) *employers*. The common elements of each of these surveys included two questions regarding each outcome. At the time of graduation, please 1) "… indicate the **assessment of the level** to which the program was successful in meeting the stated outcome", and 2) "…indicate the anticipated **degree of importance** of each of the 15 *outcomes* to your organization." In addition to these quantitative questions, we asked each constituent for an overall grade for the Purdue ME education and invited an open response to four short essay questions: 1) "What are graduates primary strengths?", 2) "…primary weaknesses?", 3) "…recommendations for changes to the ME Program." and 4) "…recommendation for changes in the outcomes."

For direct measures we used a variety of assignments, rubrics, and assessment instruments to establish a direct measure of each of the 15 outcomes. At least one direct measure was used for each outcome. Thus, at least 4 different measures (including at least one direct measure) were utilized for each outcome to provide insight into graduates' performance in these areas.

Below is a brief description of each assessment method along with a listing of the outcome(s) the method is designed to measure.

<u>**Indirect Measures**</u>

Senior Exit Surveys (All Outcomes): The Senior Exit Survey is used to solicit input from engineering seniors in their last semester in the program. Since we have a captive audience, we solicit extensive feedback from graduating seniors. The survey, which is approximately eight pages in length, consists of nine sections: personal information, career plans, undergraduate professional work experience, global/international work experience, program outcomes, educational experience at Purdue University, mechanical engineering core curriculum, school climate, and qualitative evaluation of Purdue experience. Most of these sections involve check boxes or pull down menus, except for the last section which invites subjective comments on the program's strengths, weaknesses, and recommendations for changes. Graduates are told that their individual data is confidential, except for access to specific administrative and placement staff. Candidates are also told that the aggregate data will be used in our ABET report and other similar reports for the purpose of continuous improvement.

Rev. 6/3/13	Indirect Methods			Direct Methods																								
ME Program Outcomes	Senior Exit Surveys	Alumni Surveys	Employer Surveys	Fundamentals of Engineering (FE) Exam (All Subjects)	ME 26300 - Deliverable 6 Engrg Models	ME 31500 and 36500 Lab Grades	FE Exam - Engineering Probability & Statistics	FE Exam - Measurements, Instruments & Controls	FE Exam - Computers	ME 309 - Lab 9 Experiment using PIV	ME 35200 Projs. 2 and 3 on Analysis of 4-Bar Linkages	ME 26300/46300 Course Grades	FE Exam - Engineering Economics	ME 26300 - Grades on Progress Report 3: Detailed Design	ME 26300 Written Proress Reports 1, 2, 3	ME 26300 Oral Rpts 1, 2, 3 (Indiv. Grades)	ME 26300 Oral Rpts 1, 2, 3 (Team Grades)	Teamwork Rubric in ME 26300/46300	FE Exam - Ethics and Business Practices Subject	ME 29000-Global Professional Profile	ME 29000 Zakaria's Post-American World (Quizzes 1, 2, and 3)	Prof. Dev. Data from Sr Exit/Alum Survey	Leadership Rubric in ME 26300/ME 46300	Senior Exit Survey - Study Abroad Data	Collegiate Cultrual Dev. Inventory (CCDI)	ME 263 - Deliverable 3: House of Quality Deliverable	ME 263 - Deliverable 5: Functional Decomposition	ME 263 - Deliverable 11 Economic Analysis
A. Engineering Fundamentals																												
A1. Engineering Fundamentals (a)	P	P	P	P																								
A2. Analytical Skills (e)	P	P	P		P																							
A3. Experimental Skills (b)	P	P	P			P	P	P																				
A4. Modern Engineering Tools (k)	P	P	P						P	P	P																	
A5. Design Skills (c)	P	P	P									P																
A6. Impact of Engineering Solutions (h)	P	P	P										P	P														
B. Professional Skills																												
B1. Communication Skills (g)	P	P	P												P	P												
B2. Teamwork Skills (d)	P	P	P														P	P										
B3. Professional/Ethical Responsibility (f)	P	P	P																P	P								
B4. Contemporary Issues (j)	P	P	P																		P							
B5. Life-long Learning (i)	P	P	P																			P						
C. Emerging Skills																												
C1. Leadership (l)	P	P	P																				P					
C2. Global Skills (m)	P	P	P																					P	P			
C3. Inovation (n)	P	P	P																							P	P	
C4. Entrepreneruship (o)	P	P	P																									P
P = Primary Assessment Instrument																												

Figure 4.1 Direct and Indirect Assessment Methods used to assess the ME Program Outcomes.

To ensure full participation in the survey by graduating seniors, candidates are not cleared to receive their diploma until after they have completed their senior exit survey which is done via a web-based survey instrument. Nevertheless, several follow-up reminders are still required to get full compliance. This ensures 100 percent participation by the candidates prior to graduation. The survey takes approximately 45 minutes to complete, and almost all of the students write comments in addition to completing the check boxes and pull down windows. Because of the level of participation and the resulting quality of the data obtained, we view the senior exit survey to be the most reliable assessment instrument for our curriculum. It correlates very well with the alumni data that we have received, and it gives us very timely feedback on the changes that we have made to our curriculum and individual courses. The results of the senior exit survey data are summarized each semester for review, as well as on an annual basis (by calendar year). However, since the change of our outcomes in spring 2010, we have re-written this survey and currently have three semesters of data with the new instrument. We hope to build on this in the upcoming years to better anticipate future trends.

Alumni Surveys (All Outcomes): The alumni survey was recently revised and updated in spring 2010 to reflect our new student outcomes. The survey is mailed annually to the alumni of two graduating classes (2 years and 6 years past graduation). The graduates two years out provide more immediate feedback, while the graduates six years out give a longer-term perspective. An on-line version of the survey is also made available. This way alumnus can choose the method which is most convenient for them to provide feedback. The survey is two pages long and is made up of four sections: career/profession information, assessment of the student outcomes, qualitative assessment of their Purdue education and their overall grade for their Purdue education. Since we rely on alumni's goodwill for completion of the surveys, we designed it to be as short as possible to maximize our return rate.

The surveys are mailed to the graduates in September of each fall semester. With one additional follow up reminder, the return rate for mechanical engineering graduates is typically in the range of 25 percent. The surveys are administered by the School of Mechanical Engineering. Hardcopies of the survey are entered into a web-based site and the data is transferred into an excel spreadsheet for further data reduction.

Unlike the senior exit survey, the return rate on the alumni survey is limited, and there is no easy way to determine how representative the returned surveys are. However, we have found that the alumni surveys generally follow trends similar to the senior exit surveys, which suggests that the sample size is sufficiently large to be representative.

Employer Surveys (All Outcomes): The employer survey was recently revised and updated in fall 2010 to reflect our new student outcomes. As with the alumni survey, the employer survey is relatively short (two pages) and is typically made up of four sections: evaluator information, assessment of the program outcomes, qualitative assessment of Purdue education, and their overall grade for their Purdue education. We mailed out 250 surveys to our co-op and intern contacts and asked them to forward the survey to one of their engineering managers who worked closely with Purdue ME graduates. In addition, we handed out surveys at our annual Engineering Expo in February of 2013.

With the competitive and demanding nature of industry, it is difficult to achieve high participation rates from employers. Of the 335 surveys we mailed out and the numerous others we handed out at the Engineering Expo, we were only able to solicit 21 responses (roughly a 6% response rate). Nevertheless, we felt the number of responses was sufficient to analyze the data. Successfully soliciting an adequate response rate from our industrial partners is perhaps our greatest challenge in our indirect measures.

<u>Direct Measures</u>

Fundamentals of Engineering (FE) Exam (A1. Engineering Fundamentals, A3. Experimental Skills, A4. Modern Engineering Tools, B3. Professional/Ethical Responsibility): The fundamentals of engineering (FE) exam (sometimes also known as the EIT or engineer-in-training exam) is one of our primary direct measures. In this report the results of up to 15 separate exam offerings (April/October 2005-2012) is presented. For completeness we have included both the AM and PM topics for both the general exam and the ME exam. While our overall participation is roughly 50% (which indicates that the sample size would be large enough to make the data representative), the number of Purdue students taking the ME exam was low (in the single digits) in some offerings until 2012 when we began strongly urging our students to take the ME exam, since it covers advanced topics that are not addressed in the General exam.

For all of the FE data shown, we have conducted a gap analysis between Purdue MEs and the National ME averages. The gap values (Z) are determined as the difference in the Purdue ME scores and the national ME scores (for each topic), normalized by the national ME standard deviations

$$Z = (\text{Purdue ME Score} - \text{National ME Average}) / \sigma$$

Essentially the Z value is a measure of how many standard deviations above the national ME average Purdue MEs are scoring. Purdue student scores exceed Z = 1.28 (representing a confidence level of 90%) indicating they have met expectations. Purdue student scores which exceed Z = 3.10 (representing a confidence level of 99.9%) indicate they have exceeded expectations. The interpretation of these values is provided below.

Meets Expectations => 1.28σ => $p = 0.100$ (confidence interval of 90.0% or there is less than a 1 in 10 chance in obtaining this result by chance)

Exceeds Expectations => 3.1σ => $p = 0.001$ (confidence interval of 99.9% or there is less than a 1 in 1000 chance in obtaining this result by chance)

ME 26300 Introduction to Mechanical Engineering Design, Innovation and Entrepreneurship: ME 26300 *Introduction to Mechanical Engineering Design, Innovation, and Entrepreneurship* is a three-credit (2 credits lecture and 1 credit lab) sophomore-level cornerstone design course. This course is specifically designed to provide students early in their academic careers a mentored design experience in which they are guided through a typical design process and introduced to many of the common tools and instruments engineers use in professional practice to develop their designs. During the course of the semester, students are required to complete weekly deliverables, some individual and some team. The intent of these deliverables is to jump start student's efforts in specific areas to assist them in making steady progress on their projects and not waiting until just before the larger progress report are due. The course is divided into three phases: Phase 1- Problem Definition; Phase 2 – Concept Generation and Evaluation; and Phase 3 – Product Design and Economic Analysis. Because of the highly-structured nature of this course, there is a wealth of assignments that can be used for student assessment.

ME 26300 Deliverable 3. House of Quality (C3. Innovation): Deliverable 3 involves using the House of Quality to study the market of the proposed product area. Students use survey and interviews to determine key customer requirements. Benchmark products are used for comparison to aid in establishing the needed engineering requirements for a product to be successful in the market. As such, it is a good illustration of student's ability to identify promising market opportunities ripe for new innovative solutions.

ME 26300 Deliverable 5. Functional Decomposition (C3. Innovation): Deliverable 5 involves conducting a Functional Decomposition of their concept. Functional Decomposition is the process of taking a complex system and breaking it down into its smaller, simpler sub-parts, generating multiple options for each sub-part, and then mixing and matching the sub-part options in order to develop numerous unique solutions of a concept. As such this process fosters innovative and out-of-the-box thinking.

ME 26300 Deliverable 6 - Engineering Models (A2. Analytical Skills): One of the deliverables required in ME 26300 is devoted to engineering modeling. In this deliverable each student is asked individually to develop a model on some aspect of their project and conduct a parametric analysis to illustrate the effects of various parameters on their model. This deliverable is scored directly on each student's ability to develop an analytical model, parametrically exercise the model and draw conclusions from their analysis. As such, this deliverable represents an excellent direct measure of a student's analytical skills.

ME 26300 Deliverable 11 - Economic Analysis (C4. Entrepreneurship): Deliverable 11 in ME 26300 lab is one where students prepare a complete economic model for their product covering the development period and an initial production period of three years. As part of the deliverable, each team prepares an EXCEL-based financial analysis along with a cumulative net cash flow diagram. To assess the economic viability of their product, students evaluate the following economic performance measures: (1) break-even point, (2) profit (net present value), (3) percent annual return on investment (ROI), (4) rate of return (ROR), (5) the minimum annual production quantity to break even – i.e., zero profit at the end of the three year production cycle (excluding interest), and (6) the minimum annual production quantity to break even – i.e., zero profit at the end of the three year production cycle (including interest). As such, this deliverable represents an excellent direct measure for outcome C4. Entrepreneurship.

ME 26300 Progress Report 1- Problem Definition Phase (B1. Communication Skills): In phase I of their project, students are given a market area (like exercise equipment) and asked to identify an economically-viable market niche by conducting customer surveys, studying market trends, researching competitive products and analyzing relevant patents. The information they gather is to be analyzed using quality function deployment (QFD) methods and ultimately formulated into a concise problem definition that describes what attributes their product would need to possess in order to be marketable.

ME 26300 Progress Report 2 - Concept Generation and Evaluation Phase (B1. Communication Skills): In phase II of their project, students are to conduct a functional decomposition to help them to generate a large number of ideas to consider. They are then to proceed through a concept selection process to narrow down the most promising ideas. Next, they are to analyze their primary concept and use the analysis to improve their design. Finally, students are to benchmark their primary concept against other competitive products currently on the market.

ME 26300 Progress Report 3 - Product Design and Economic Analysis Phase (B1. Communication Skills): In phase III of their project, students conduct a detailed design of their product. They determine what parts should be purchased and what parts must be fabricated. As discussed above for Deliverable 11, students conduct a detailed economic analysis and evaluate the economic viability of the product based on six different economic indicators. Finally, students conduct a performance analysis and assembly analysis to make improvements to the final product.

ME 26300 Oral Reports 1, 2, 3 (B1. Communication Skills): At the end of each of the three phases of the project, student teams prepare and present a 15-20 minute oral presentation on their findings for that phase. With each presentation the faculty supervisor and teaching assistant provide feedback on the strengths and weaknesses of the presentation. They also make recommendations for changes that can be incorporated into future presentations. Comparison of student performance on these three presentations provides a measure of student progress on their oral communication skills. In this course, both an individual and a team grade are recorded for each presentation.

ME 26300 Course Grades (A5. Design Skills): In ENGR 13100 and ENGR 13200 students have some introduction to design processes. However, our sophomore-level cornerstone design course (ME 26300), provides a more comprehensive exposure to the design process that build upon the foundation from ENGR 13100/13200 and expands students' understanding of the design process, including exposure to many of the common tools engineers use today to facilitate this process. As such, the course grades from ME 26300 serve as an effective measure of students' ability in open-ended design and problem solving.

ME 29000 Global Professional Engineering Seminar: ME 290 *Global Engineering Professional Seminar* is a 1-credit sophomore-level seminar class designed as a forum on contemporary issues in the global profession of mechanical engineering. Like ME 26300, it has several individual writing and web assignments that are useful as direct measures.

ME 2900 Global Professional Profile (C3. Professional/Ethical Responsibility): In this assignment, students are expected to prepare a 1000 word profile about them, including a personal introduction as well as description of their credentials, experience and career plans. The document also includes a section on professional interests, professional ethics, global vision and future career goals. Regarding the ethics section, the students are expected to comment on an ethical dilemma they have faced; not a right/wrong issue, but a right/right issue. One of the more common issues students write about is quality vs. delivery. Many students in their internships are often pushed to complete project quickly. At times this can negatively affect the quality of the product. They discuss this tension in light of their circumstances and address how they resolved this dilemma.

ME 29000 Zakaria's Post-American World – Quiz 1, 2, and 3 (B4. Contemporary Issues): Every student in ME 29000 is required to read Fareed Zakaria's "Post-American World." Quiz 1 covers chapters 1-3 in the book and focuses on the diminishing power of the US and factors that led to the current balance of powers in the world. Quiz 2 covers chapters 4 and 5 of the Zakaria's book. These chapters focus on the emergence of China and India as economic powers and contrast the advantages and disadvantages of the top-down autocratic Chinese government versus the bottom-up democratic political system in India. How their different political systems impact their economic rise as compared with Western-style policies is addressed. Quiz 3 covers chapters 6 and 7 of the book and addresses the American rise to superpower status, its use of this power and provides guidelines for how the US should use it power in the future world envisioned by Zakaria. As such, these chapters provide students with a broad view of past and contemporary issues affecting the US in the context of a changing world.

ME 30900 Fluid Mechanics: ME 30900 *Fluid Mechanics* is a four credit (3 credits lecture and 1 credit lab) junior-level core course designed to introduce students to the fundamentals of fluid mechanics.

ME 30900 Lab Grades (A3. Experimental Skills): The lab component of ME 30900 is assigned a separate grade from the lecture. Since this course provides an extensive hands-on experience in measurement techniques related to fluid mechanics, the lab grade in ME 30900 provides an excellent direct measure of a student's experimental skills.

ME 30900 – Lab 9 PIV (A4. Modern Engineering Tools): Lab 9 in ME 309 Fluid Mechanics involves the use of Particle Image Velocimetry (PIV). Particle Image Velocimetry (PIV) is an optical technique to measure velocity fields in planar, two-dimensional domains using laser light sheets and two-dimensional imaging. In the lab, students not only learn the proper techniques to calibrate and operate a PIV, but also learn about common measurement errors that may be encountered. This lab offers a good illustration of exposure to modern engineering instrumentation.

ME 31500 Heat and Mass Transfer: ME 31500 *Heat and Mass Transfer* is a four credit (3 credits lecture and 1 credit lab) senior-level core course designed to introduce students to the fundamentals of heat and mass transfer (conduction, convection and radiation).

ME 31500 Lab Grades (A3. Experimental Skills): The lab component of ME 31500 is assigned a separate grade from the lecture and is divided into two parts. The first half of the lab involves traditional experiments on conduction, convection and radiation. The second half of the lab is devoted to an open-ended design experience on an experimental heat transfer-related project. Again, since this course provides an extensive hands-on experience in measurement techniques related to heat transfer, the lab grade in ME 31500 likewise provides an excellent direct measure of a student's experimental skills.

ME 35200 Machine Design I: ME 35200 is four-credit (3credit lecture and 1 credit lab) junior-level course designed to introduce the foundational principles of design and analysis of machines and machine components. Special emphasis is placed on design for functionality, motion, force, strength and reliability. A number of practical laboratory experiences provide open-ended projects to reinforce the design process.

ME 35200 Project II (A4. Modern Engineering Tools): Project II in ME 35200 involves a static analysis of a 4-bar linkage. The project is typically done in the context of a practical application such as a lift mechanism on a bulldozer. As such the analysis requires students to code the four-bar mechanism in MATLAB in order to evaluate the position of the various components and prepare a formal report documenting their analysis, including a discussion on the correctness of their results and comments pertaining to the function of the mechanism. As such this project is an excellent students' use of modern engineering tools.

ME 35200 Project III (A4. Modern Engineering Tools): Project II in ME 35200 involves a force analysis of a 4-bar linkage. The project is an extension of the lift mechanism on a bulldozer from project II. As such the analysis requires students to code the force analysis in MATLAB in order to evaluate the various loads on components and prepare a formal report documenting their analysis, including a discussion on the correctness of their results and comments pertaining to the function of the mechanism. As such this project is an excellent students' use of modern engineering tools.

ME 36500 Systems and Measurements: ME 365 *Systems and Measurements* is a three-credit (2 credit lecture and 1 credit lab) junior-level core course designed to introduce students to the basic principles of digital data analysis, the utilization of measurement instrumentation, and the application of a variety of different transducers commonly used in engineering practice.

ME 36500 Lab Grades (A4. Experimental Skills): Students earn a separate grade for the lab component of ME 36500. In the lab, students learn the basic operation of oscilloscopes, multi-meters, functions generators, timers/counters, and other basic digital data acquisition equipment (e.g., A/D & D/A Converters, Op Amps, and Quantization Filters). They also learn to calibrate, and analyze the static response and dynamic response of a variety of different transducers. Students are introduced to basic statistical analysis methods to analyze data. In addition, during the last two weeks of lab, students are asked to identify a transducer of interest and study its function, calibration, operation, etc. and prepare a presentation for the rest of the lab class describing its operation and use in engineering practice. This assignment introduces students to a broad array of additional transducers and compliments the in-depth experience with the transducers utilized in lab. Consequently, the hands-on nature of the lab component of ME 365 provides an excellent direct measure of student's ability in experimental skills.

ME 46300 Engineering Design: ME 46300 *Engineering Design* is our 3-credit, senior-level capstone design course. As such, the ME 26300/ME 46300 combination represents our cornerstone and capstone design courses, respectively. The primary differences in these two courses are three fold:

1) *Level of Mentorship* - ME 26300 is designed to provide students with a highly mentored introduction to the design process whereas ME 46300 is designed to provide students with an open-ended design experience with significant independence from faculty, with faculty mostly providing overall supervision.

2) *Project Complexity* - In ME 26300 the design projects by necessity tend to be simpler and smaller-scale mechanical systems whereas in ME 46300 the projects are much larger, more complex and multifaceted.

3) *Project Prototypes* - ME 26300 is primarily concerned with desings on paper alone, although some students do build small-scale physical models of their concepts. In contrast, in ME 46300 full-scale mock-ups of their projects are the norm. In essence, the ME 46300 experience requires a much greater knowledge and experience with the manufacturability and fabrication issues.

ME 46300 Course Grades (A5. Design Skills): In essence, ME 263 is designed to be student's introduction to the design process whereas ME 463 is designed to be their culminating experience in design. As such, the grades of both of these courses provide an excellent assessment of student's ability in open-ended design and problem solving.

Leadership/Teamwork Rubric in ME 26300 and ME 46300 (B2. Teamwork Skills, C1. Leadership Skills): The leadership/teamwork rubric is designed to provide an assessment of students' leadership and teamwork abilities. For leadership the rubric is designed to assess students' effectiveness in taking ownership of their project, identifying teammates' strengths, assisting teammates as needed, and advanced team planning. An overall ranking of each student's effectiveness in leadership is also determined.

In a similar manner, the teamwork rubric assesses students in four areas: degree of engagement, trust with team mates, degree of consensus, and team respect. An overall ranking of each student's effectiveness in teamwork is also determined.

In both cases, students are assessed on a 5 point Likert scale with 5 = Very Effective, 4 = Effective, 3 = Average, 2 = Ineffective, and 1 = Very Ineffective. Also, a Not Applicable option is also provided. In ME 26300 this assessment is performed by the lab coordinator of each section, who is typically a faculty member or senior TA. In ME 46300, this assessment is conducted by the assigned faculty instructor for each section.

Professional Development Data from the Senior Exit Survey and the Alumni Survey (B5. Life-long Learning): The best way to determine if students will be (or will likely be) continuous learners is to examine their extracurricular and post-graduate activities. In our senior exit survey we asked students if they participate in a range of extracurricular activities. Example activities include: participation in professional/honor societies, extracurricular projects or design contests, workshops, short courses, conferences, elected leadership roles, FE exam, etc. This enables us to determine not only their likelihood to continuing learning, but also provide insight into their most likely activities for future professional development. Likewise, by asking similar questions of alumni 2 years and 6 years out, we can determine the level of continuous learning that is actually occurring and the nature of this continuing learning. Example activities we asked about included: whether they had received or were working toward a second degree, were they a member of a professional organization, have they attended any conferences, workshops or short courses, whether they were a licensed professional engineer, etc. Again, the responses to these questions will provide insight about their degree of involvement in continuing learning and the most common types of professional development.

Collegiate Cultural Development Inventory (CCDI) (C2. Global Skills): This instrument is designed to inventory a students' high school and collegiate global experiences (both domestic and abroad). Most of the items are factual questions rather than opinion questions. As such most of the data represents a direct measure of students' experiences and can be used to demonstrate growth in global knowledge and experiences.

4A.2 Introduction of Student Outcome Assesment and Evaluation

Before a detailed review of the assessment and evaluation data of each student outcome is presented, a brief preview of what to expect is provided below. For each outcome, constituents (*seniors*, *alumn*i, and *employers*) are asked two questions on a 0 to 4 scale (like a GPA):

1) How **important** is the outcome to your business?

2) How **effective** are students prepared in this outcome area?

Figure 4.2 shows scatterplots of the **importance** (x-axis) versus **effectiveness** (y-axis) ratings for all 15 outcomes for each of our three constituents: *seniors*, *alumni*, and *employers* for 2012. The effectiveness score needs to be within half a letter grade of the importance score to meet expectations (i.e., within the white diagonal strip). Ideally, the effectiveness score would be at greater than or equal to the importance score. However, some outcomes are rated so high in importance (e.g., 3.9/4.0), that meeting this high of an expectation is unrealistic and nearly impossible.

The advantage of these plots is that it allows reviewers to visually see how each of the outcomes stack up comparatively in both importance and effectiveness and thus easily determine the areas where expectations are being met and those where improvements are needed. Also, when only limited resources are available, this approach will help to identify the areas of greatest need. In other words ultimately we generally have to make value judgments on where to focus our limited resources. Given that not all outcomes are equally important, identical effort in each outcome is not the goal.

Ultimately, the purpose of including these plots here is to provide readers with a preview of the most significant outliers with respect importance/effectiveness gap. Clearly, the single biggest concern is outcome B1. Communication Skills. It is consistently ranked among the highest in importance, especially for *alumni* and *employers*. Yet our effectiveness at meeting this high expectation was not achieved for any of the three constituents. Consequently, improvement in communication skills is our primary current focus.

Collectively for all constituents, outcomes which are the Greatest and Least on average in Importance and Effectiveness include:

<u>Greatest Importance</u>
A1. Engineering Fundamentals
A2. Analytical Skills
B1. Communication Skills
B2. Teamwork Skills

<u>Greatest Effectiveness</u>
A1. Engineering Fundamentals
A2. Analytical Skills

<u>Least Importance</u>
B4. Contemporary Issues
C4. Entrepreneurship
A6. Impact of Engineering Solutions

<u>Least Effectiveness</u>
C4. Entrepreneurship
B4. Contemporary Issues

In the following sections, we will present the assessment and evaluation data for each of the 15 outcomes individually, with special emphasis on outcome B1. Communication Skills. Several initiatives to address this deficiency have been developed. While these initiatives have helped (as will be shown), they have yet to resolve this deficiency. Additional future initiatives will also be discussed to address the changing student demographics and the impact of these changes.

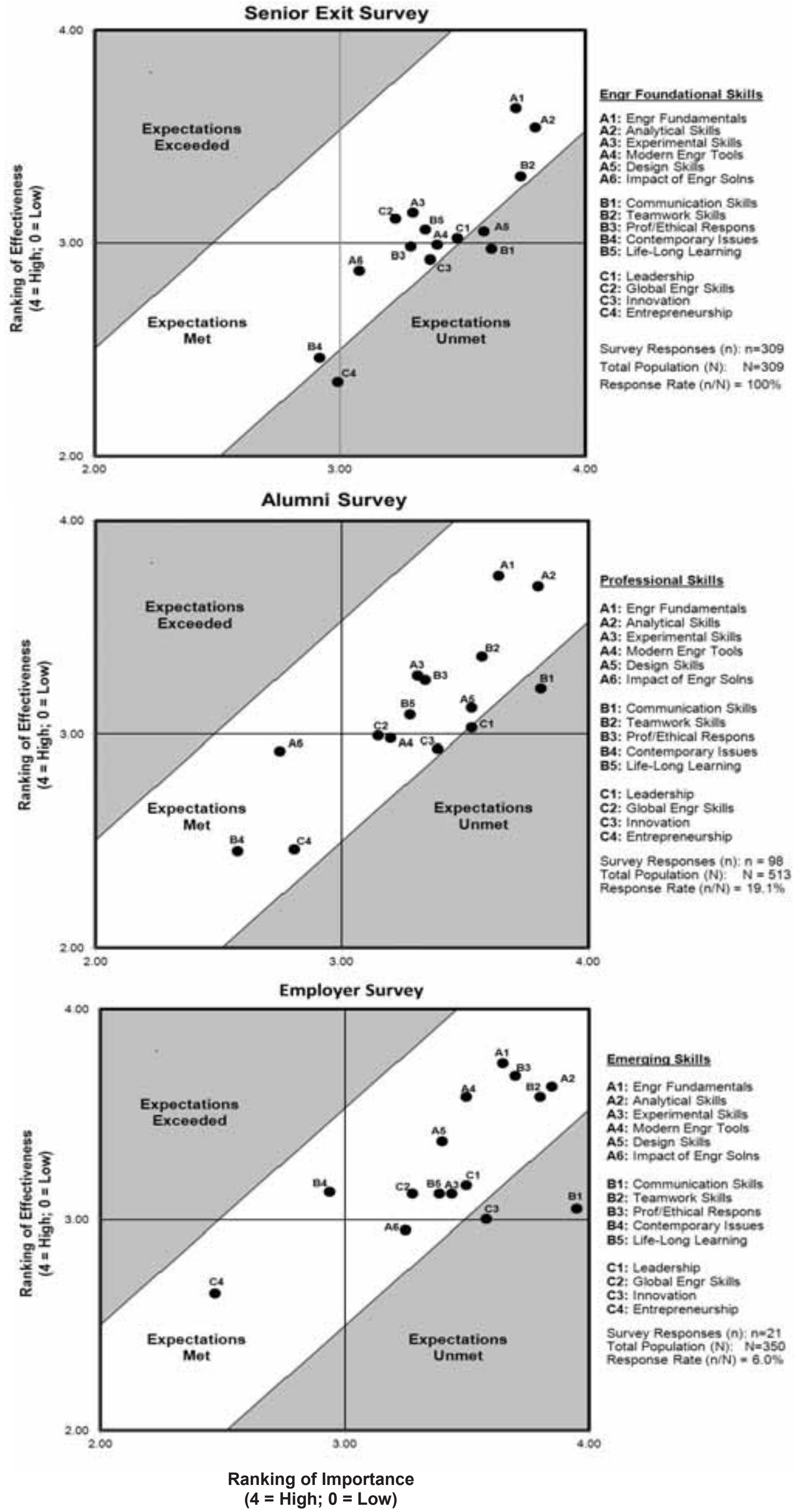


Figure 4.2 Scatterplots of Importance versus Effectiveness for all Outcomes for each of our Constituents: Seniors, Alumni, and Employers for 2012.

4A.3 Program Outcome A1. – Engineering Fundamentals (a)

Table 4.1 shows the performance criteria, assessment methods, and minimum level of achievement used to evaluate outcome A1. – Engineering Fundamentals (a). A brief discussion of each of the four assessment methods is presented below.

Table 4.1 Performance Criteria, Assessment Methods, and Minimum Level of Achievement used for Outcome A1. – Engineering Fundamentals.

A1. Engineering Fundamentals (a) An ability to apply knowledge of math, science and engineering					
Performance Criteria	• Demonstrates a foundational understanding of mathematics, basic science, and engineering principles. • Applies math, science, and engineering principles to solve engineering problems.				
Assessment Method	**Minimum Level of Achievement**	**Date of Data Collection**	**Faculty/Course Assessment Took Place**	**Date of Results Evaluation**	**Evaluation Performed By**
Senior Exit Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec 2007-2012	Curriculum Committee
Alumni Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	Fall 2007-2012	N/A	Dec. 2007-2012	Curriculum Committee
Employer Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	Fall 2012	N/A	Dec. 2012	Curriculum Committee
Fundamentals of Engineering Exam (Direct)	1.28σ above ME National Comparator Group	April/Oct 2007-2012	N/A	May 2008-2013	Curriculum Committee

Senior, Alumni, and Employer Surveys: Figure 4.3 shows the results of a longitudinal gap analysis for outcome A1. Engineering Fundamentals (a). For each outcome, constituents (seniors, alumni, and employers) are asked two questions on a 0 to 4 scale (like a GPA):

3) How **important** is the outcome to your business?

4) How **effective** are students prepared in this outcome area?

The gap is determined as the difference in the **effectiveness score** and the **importance score.** The results of figure 4.3 shows that expectations are consistently met (i.e., the gap is within ± half a letter grade of the target level of importance), based on seniors, alumni, and employer perspectives. Seniors and alumni are surveyed annually, and employers are surveyed only once every 7 years, because there is a continuous turnover of seniors and alumni, but the employers we survey don't change on a regular basis. Seniors, alumni and employers all consistently rank our Engineering Fundamentals as meeting expectations.

Interestingly, seniors consistently rank their Engineering Fundamentals preparations lower than the alumni and employers. This is not surprising because anecdotally we frequently have alumni tell us how they were surprised the level of preparation they had compared to peers from other institutions. Only after starting their professional careers did they realize their better preparation in comparison to peers from other institutions.

There appears to be a downward trend in the gap values over the past six years, yet all constituents rated students as meeting expectations in the area of Engineering Fundamentals. We plan to continue monitoring this data to see if it relay's a trend or just a natural variation due to other factors. For example, this trend seems to coincide with the downturn in the economy, and could this just be a subconscious mood that is influencing "constituents'' opinions. Certainly, the FE results don't reflect this trend. Another potential factor is the increased emphasis on broader skills like innovation, entrepreneurship and global skills. Also, perhaps the recent growth in ME, which has resulted in larger class sizes, could be a factor. We are working hard to hire several new faculty to address this significant growth. The bottom line is that while graduates are still meeting expectations, we plan to monitor this trend and see if it continues or self corrects.

In addition to this longitudinal analysis, a snapshot of just the 2012 data is provided in Figure 4.4 in a scatterplot format. In this case, the data is plotted on an **importance** (x-axis) versus **effectiveness** (y-axis) scale similar to Figure 4.2, except that only the Engineering Fundamentals data is shown for each of the three constituents. Ideally the effectiveness score would be within half a letter grade of the importance score to meet expectations (i.e., within the white diagonal strip). The advantage of this plot is that it allows reviewers to see the actual level of importance and effectiveness for each constituent. As might be expected, all constituents rank the importance of Engineering Fundamentals very high. Nevertheless, for all constituents the level of effectiveness is equally high. Seniors tended to rate the importance of fundamentals higher than employers and alums. As discussed above, seniors also tend to underestimate the effectiveness of their preparation. Finally, since this outcome is ranked so high in importance, there is limited opportunity to improve further and exceeding expectations is impossible.

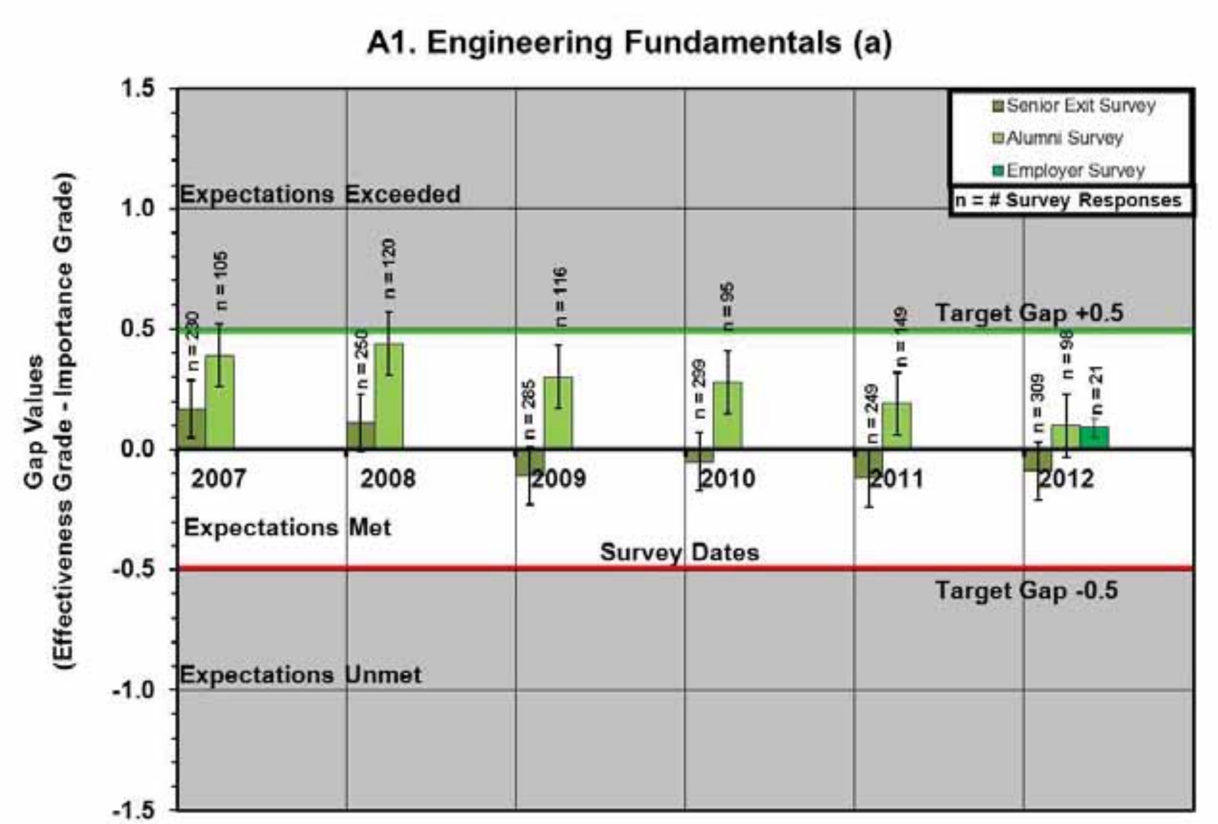


Figure 4.3 Longitudinal Gap Analysis for Outcome A1. Engineering Fundamentals from 2007-2012.

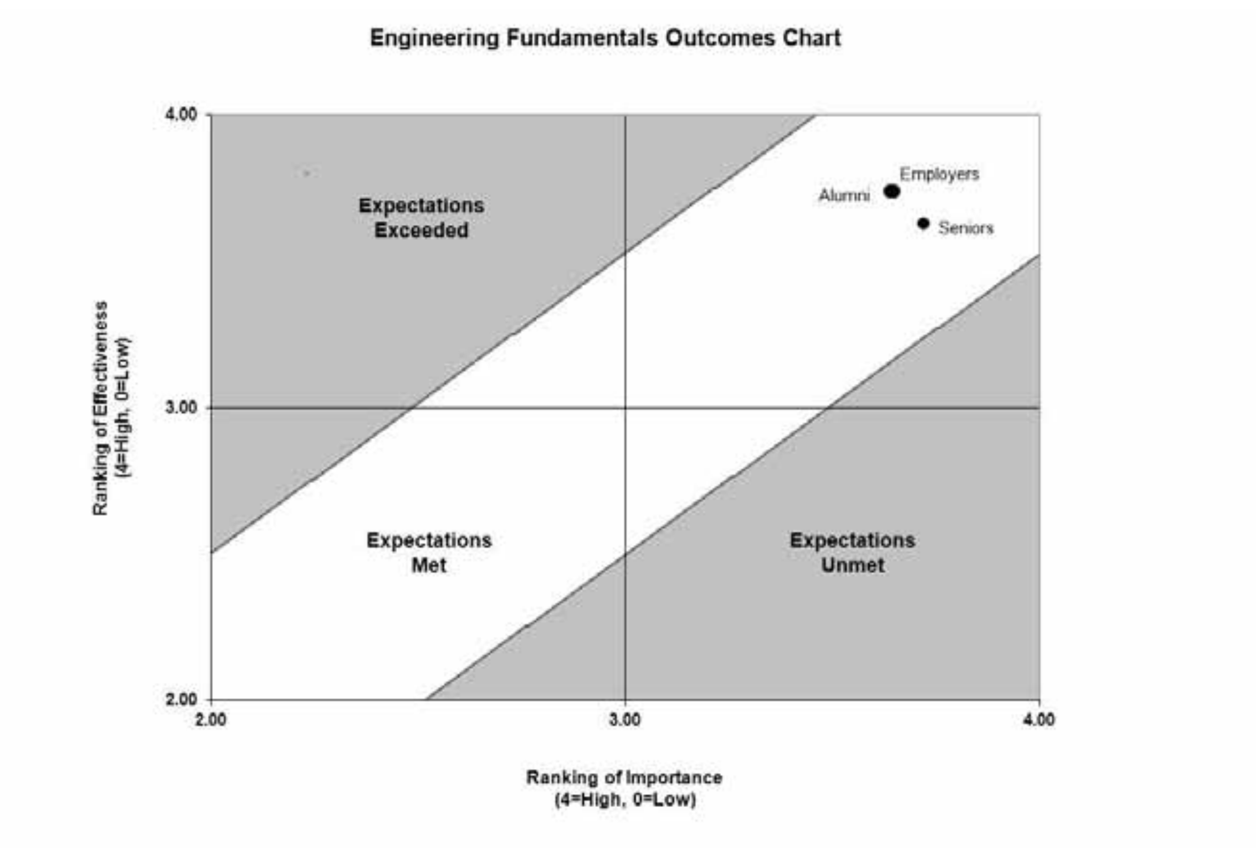


Figure 4.4 Scatterplot of Importance versus Effectiveness for Outcome A1. Engineering Fundamentals for 2012.

FE Exam (Math, Science and Engineering Subjects): Figures 4.5-4.6 illustrate the overall percent of correct solutions on the FE Exam and the number of standard deviations above the ME National Average (Z-values). During the 2007/2008 time-frame, most of our students chose to take the General Exam, but more recently, at our urging, most students have taken the ME Exam. Since these exams are different we have presented a weighted average of their scores in these plots.

The gap values (Z) are determined as the difference in the Purdue ME scores and the national ME scores (for each topic), normalized by the national ME standard deviations. To meet expectation, Purdue students need to exceed 1.28σ (representing a confidence level of 90%). To exceed expectations, Purdue students need to exceed 3.10σ (representing a confidence level of 99.9%). The "n" values represent the number of Purdue ME students who participated at each offering of the FE exam.

Purdue ME students consistently outperformed the national average, exceeding expectations in all FE Exam offerings between 2007-2012. In every case, except one, Purdue students scored over four standard deviations above the national average. The exam offerings with lower gap values were all October offerings, in which the number of participants was substantially lower. Limited participation in the October (off-sequence) offerings causes more variations in the data, some of which may not be statistically significant. Nevertheless, it is clear that Purdue students consistently exceeded expectations in all FE Exam offerings between 2007-2012.

In Appendix E, a longitudinal gap analysis was conducted from 2007-2012 for each individual topic offered in the FE Exam, including both the General Exam and the ME Exam (since they differ in the afternoon topics). In virtually every subject area, Purdue seniors met expectations and in most cases exceeded expectations. These individual topic results (not included here for conciseness) reinforce the conclusion that Purdue graduates are well prepared in all major topical areas. Again, the few cases where students didn't meet expectations were mostly cases when there were a low number of participants (which inevitably causes more variations and undermines the statistical significance of the data).

Conclusions: The results of the constituent surveys and the FE data clearly illustrate that Purdue ME students have a strong foundation in all of the mathematics, basic sciences, and engineering topics.

Future Actions: While these results show that Purdue ME seniors have a strong foundation in the mathematics, basic sciences, and engineering fundamentals, we continue to seek ways to improve these fundamentals. Below is a list of potential curricular changes that are currently under discussion. Item 3 has already been implemented, but the remaining options are still under review.

1. *Advanced Analysis* - There is a new course in advanced analysis (primarily finite element analysis) that is currently being offered to students on an annual basis. It has started as a technical elective; however, it is planned to offer this course as one of our restricted electives, providing more restricted elective options for the students. Ultimately, we hope to make this course as a part of our ME core curriculum, since computational tools have become essentials for design of complex systems.

2. *Enhanced Manufacturing Emphasis* - We plan to incorporate an expanded manufacturing course (ME 36300) to provide more opportunity for students to gain these valuable skills.

3. *Mechanics Sequence* - We have modified ME 27000 Basic Mechanics I to incorporate several mechanics of materials topics (e.g., stress/strain, axial stress, torsional stress, bending stress, shear/moment diagrams, etc.) in place of the longstanding topics in

dynamics of a particle. We believe that this provides a better integrated mechanics sequence for our students.

4. *Systems, Measurement, and Controls Sequence* - We are currently in the process of evaluating our systems, measurements and controls sequence (ME 36500, ME 37500 and ME 47500). The intent of this review is to restructure some of the topics based on faculty and student feedback. The current plan is to continue with a required two-course sequence (ME 36500/ME 37500) that incorporates a healthy balance of systems modeling, instrumentation and control theory across both courses. ME 47500 would continue as a restricted elective offering including more advanced topics not covered in the ME 36500/ME 37500 sequence. We feel this integrated approach of including lab experiences across both courses in the sequence will further enhance the educational experience of the students.

5. *Machine Design Sequence* - We are currently evaluating our machine design sequence (ME 35200 and ME 45200). Currently, ME 35200 (a course on machine kinematics and kinetics of machines) is a required course and ME 45200 (which is a traditional machine design course with stress and reliability) is one of three restricted electives, but not required of all students. Many of our Mechanics and Design faculty (as well as students) have concluded that we should rearrange the topics or possibly morph them together because the traditional machine design topics are much more relevant and useful for capstone senior design and to most engineering positions.

6. *Lab Component in ME 32300* - Finally, we are considering incorporating a small laboratory component into ME 32300 Mechanics of Materials. Currently, none of the mechanics courses have a laboratory component. Adding a hands-on laboratory component should greatly enhance students understanding of deformation of materials and stress analysis principles for machine components.

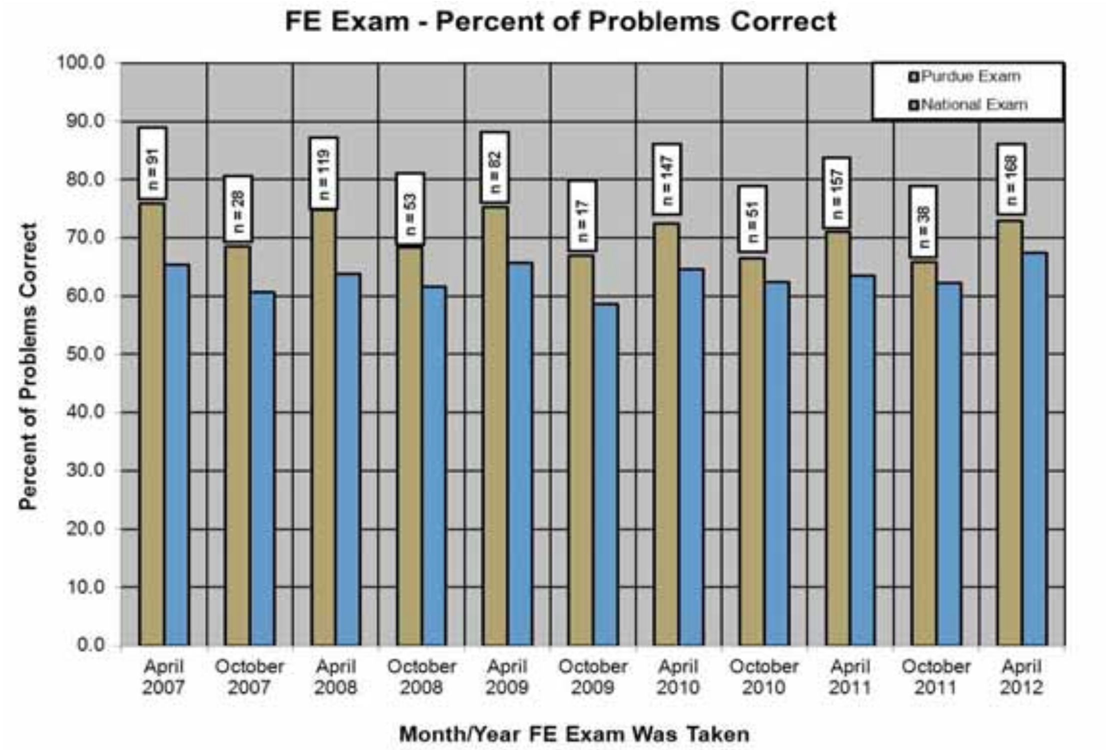


Figure 4.5 FE Exam Percent of Problems Correct between 2007 – 2012.

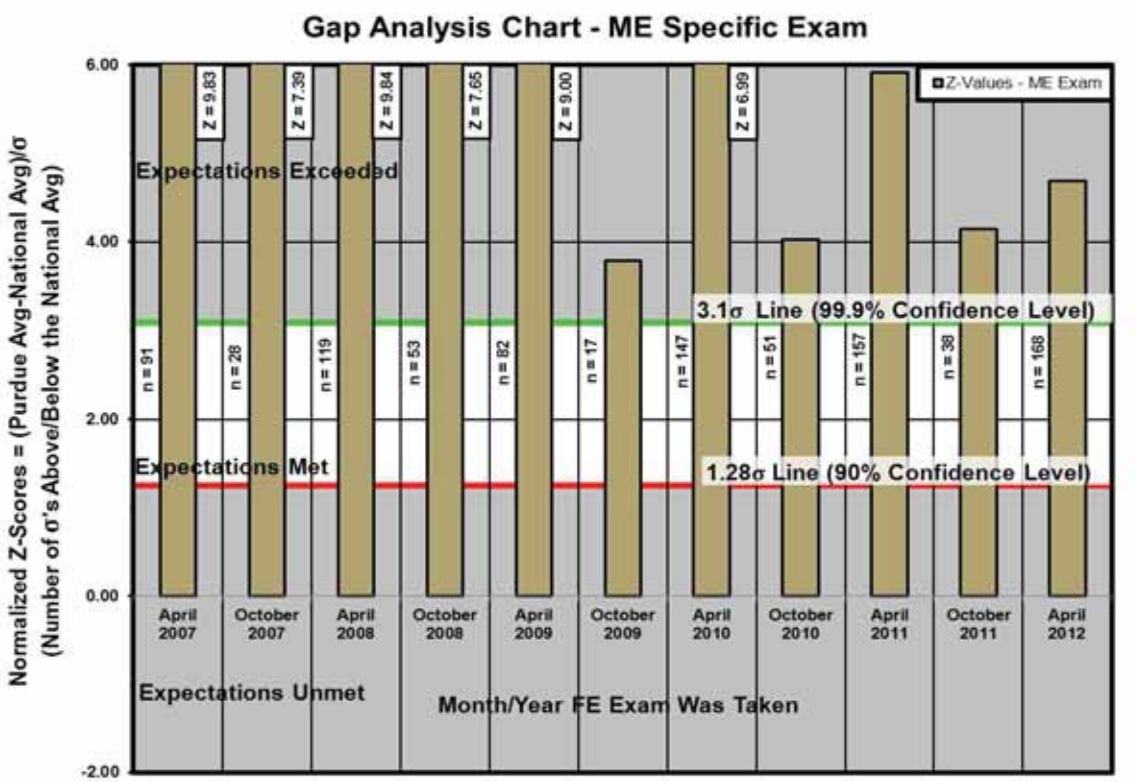


Figure 4.6 Gap Analysis for the FE Exam between 2007 – 2012.

4A.4 Program Outcome A2. – Analytical Skills (e)

Table 4.1 shows the performance criteria, assessment methods, and minimum level of achievement used to evaluate outcome A2. – Analytical Skills (e). A brief discussion of each of the four assessment methods is presented below.

Table 4.2 Performance Criteria, Assessment Methods, and Minimum Level of Achievement used for Outcome A2. – Analytical Skills.

A2. Analytical Skills (e) An ability to identify, formulate, and solve engineering problems.					
Performance Criteria	• Simplifies complex systems into representative analytical models. • Exercises models to understand the relationship between various parameters. • Interprets physical significance of model predictions.				
Assessment Method	**Minimum Level of Achievement**	**Date of Data Collection**	**Faculty/Course Assessment Took Place**	**Date of Results Evaluation**	**Evaluation Performed By**
Senior Exit Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec 2007-2012	Curriculum Committee
Alumni Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	Fall 2007-2012	N/A	Dec. 2007-2012	Curriculum Committee
Employer Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	Fall 2012	N/A	Dec. 2012	Curriculum Committee
ME 26300 Deliverable 6 Engineering Models (Direct)	80% of students earn a grade of 8/10 or higher	Fall 2012 Spring 2013	Anderson/ME 26300 (Fall) Reed/ME 26300 (Spring)	Dec. 2012 May 2013	Anderson Reed

Senior, Alumni, and Employer Surveys: Figure 4.7 shows the results of a longitudinal gap analysis for outcome A2. Analytical Skills (e) similar to that presented for Outcome A1. Seniors, alumni and employers all consistently rank our students' Analytical Skills as meeting expectations. Similar to Outcome A1, seniors consistently rank their Analytical Skill preparation lower than alumni and employers.

In addition to this longitudinal analysis, a scatterplot of the importance versus the effectiveness data for the year 2012 is presented in Figure 4.8 This plot illustrates that Analytical Skills are ranked high (around 3.8/4.0) by all constituents, with employers ranking it the highest. All three constituents ranked students' effectiveness in Analytical Skills as meeting expectations; however, alumni and employers generally ranked students Analytical Skills slightly higher than seniors. With such skills so highly ranked in importance, it can be challenging to meet such a high expectations (and impossible to exceed them), and explains why the gap values hover near zero.

ME 26300 – Deliverable 6 – Analytical Models: Figure 4.9 shows the frequency histogram for deliverable 6 – Analytical Models from ME 26300. As discussed above, deliverable 6 represents students' first experience in developing simplified analytical models of complex engineering systems, parametrically exercising their models and interpreting the physical implications of their results. The minimum level of achievement to meet expectations requires 80% of students consistently earning an 8/10 (or 80%) or higher on deliverable 6. To exceed expectations requires 90% of students consistently earning 8/10 or higher on deliverable 6. As shown in Figure 4.9, students in both fall 2012 and spring 2013 not only met expectations but exceeded expectations (though only bearly).

Conclusions: The constituent surveys and direct measures provided support the conclusion that seniors are adequately prepared in analytical skills.

Future Actions: No future actions are planned at this time.

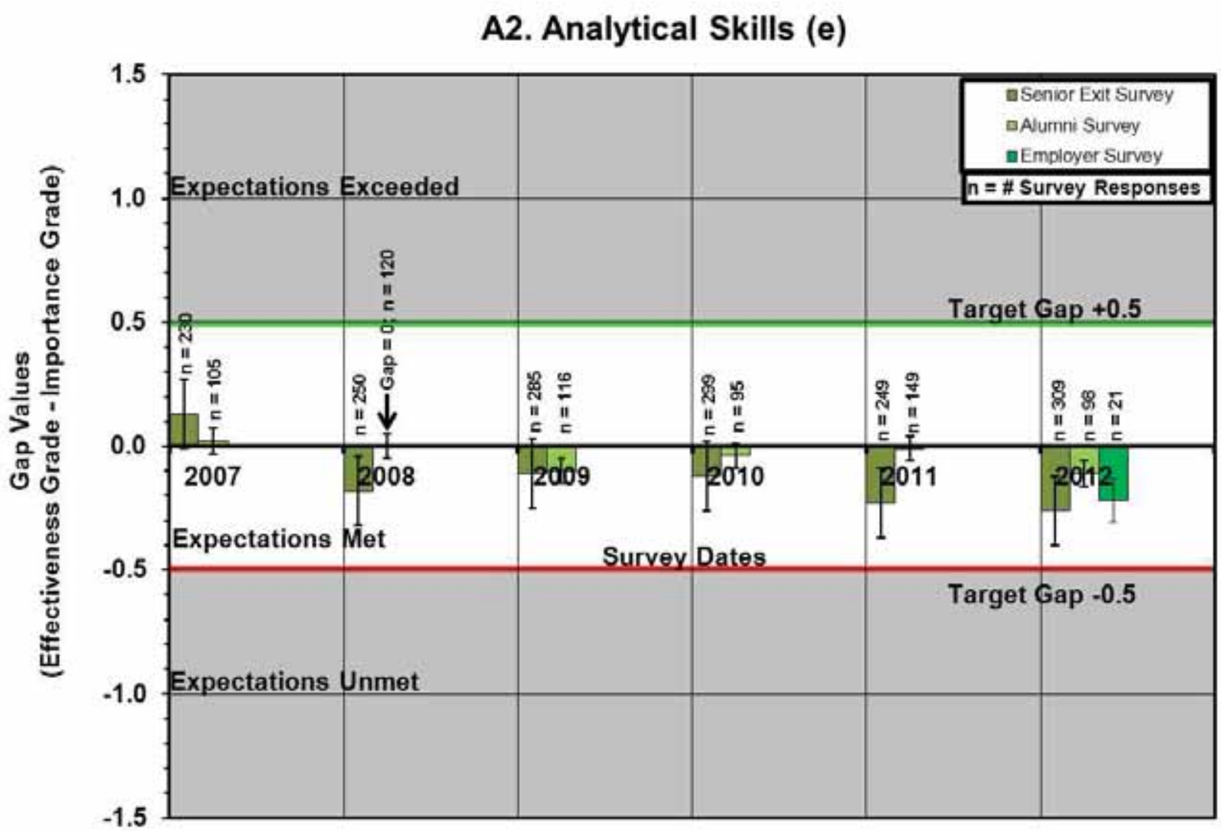


Figure 4.7 Longitudinal Gap Analysis for Outcome A2. Analytical Skills for 2007-2012.

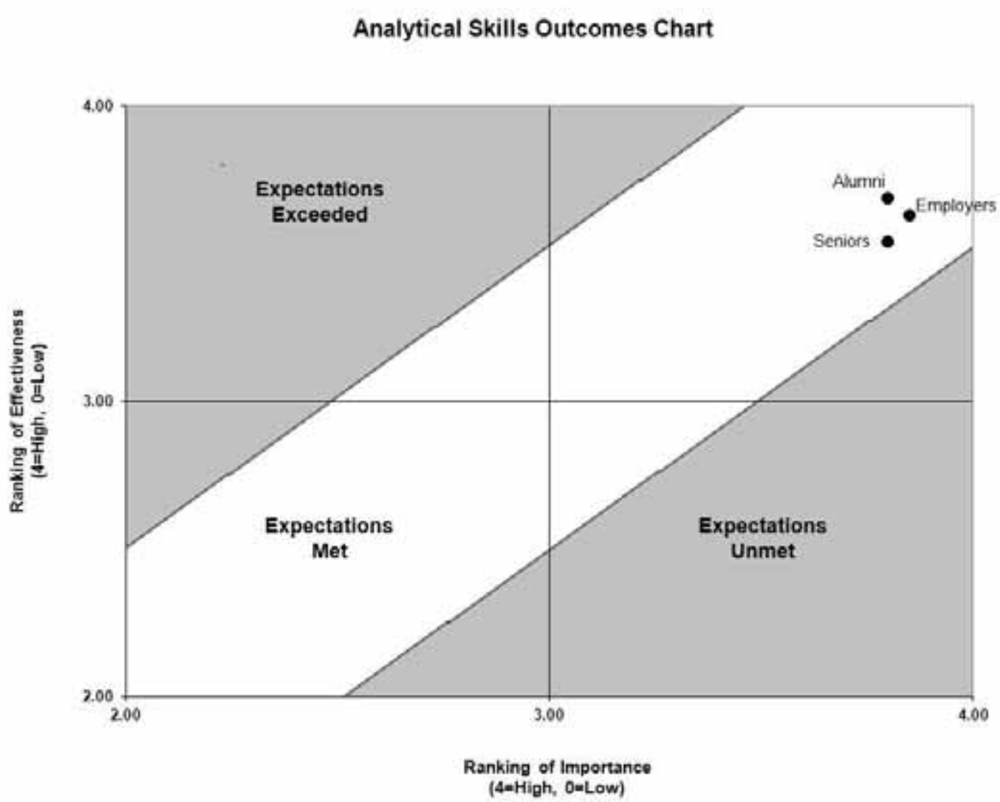


Figure 4.8 Ranking of Effectiveness versus Importance for Outcome A2. Analytical Skills for all constituents for 2012.

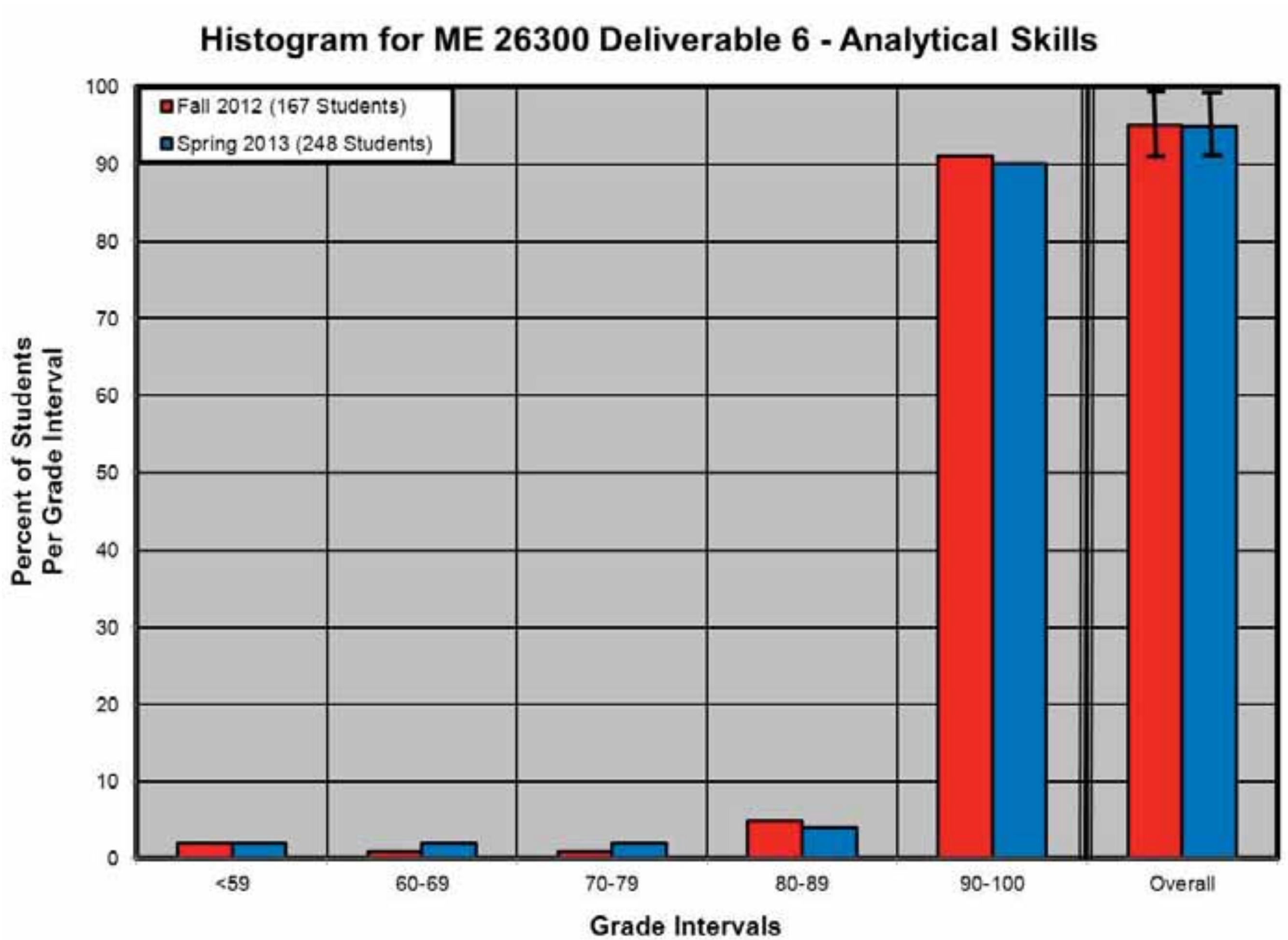


Figure 4.9 Histogram of ME 26300 Deliverable 6 – Analytical Modeling for fall 2012 and spring 2013.

4A.5 Program Outcome A3. – Experimental Skills (b)

Table 4.3 shows the performance criteria, assessment methods, and minimum level of achievement used to evaluate outcome A3. - Experimental Skills (b). A brief discussion of each of the six assessment methods is presented below.

Table 4.3 Performance Criteria, Assessment Methods, and Minimum Level of Achievement used for Outcome A3. – Experimental Skills.

A3. Experimental Skills (b) An ability to design and conduct experiments, as well as to analyze and interpret data.					
Performance Criteria	• Designs and constructs experimental studies using modern measurement equipment. • Draws appropriate inferences and conclusions from the data using statistical methods.				
Assessment Method	**Minimum Level of Achievement**	**Date of Data Collection**	**Faculty/Course Assessment Took Place**	**Date of Results Evaluation**	**Evaluation Performed By**
Senior Exit Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec 2007-2012	Curriculum Committee
Alumni Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	Fall 2007-2012	N/A	Dec. 2007-2012	Curriculum Committee
Employer Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	Fall 2012	N/A	Dec. 2012	Curriculum Committee
Lab Grade in ME 30900 Fluid Mechanics (Dir)	80% of Students Score 80 or above	Fall 2012 Spring 2013	Wereley/ME 30900 Wereley/ME 30900	Dec 2012 May 2013	Wereley Wereley
Lab Grade in ME 31500 Heat & Mass Transfer (Direct)	80% of Students Score 80 or above	Fall 2012 Spring 2013	Mudawar/ME 31500 Mudawarl/ME 31500	Dec 2012 May 2013	Mudawar Mudawar
Lab Grade in ME 36500 Systems and Measuremt (Direct)	80% of Students Score 80 or above	Fall 2012 Spring 2013	Savran/ME 36500 Meckl/ME 36500	Dec 2012 May 2013	Savran Meckl
FE Exam – Engrg. Prob. & Statistics (Direct)	1.28σ above National Comparator Group	April/Oct 2007-2012	N/A	May 2008-2013	Curriculum Committee
FE Exam – Measuremts, Instru & Cntls (Direct)	1.28σ above National Comparator Group	April/Oct 2007-2012	N/A	May 2008-2013	Curriculum Committee

Senior, Alumni, and Employer Surveys: Figure 4.10 shows longitudinal gap analysis for the three constituents for outcome A3. Experimental Skills (b). All constituents consistently ranked our students as meeting the expected level of achievement. Alumni ranked seniors the highest while seniors and employers ranked this skill somewhat lower, but still within the acceptable range.

Figure 4.11 shows the ranking of importance versus effectiveness of each of our three constituents for outcome A3. Experimental Skills. All constituents consistently ranked our students as meeting the expected level of achievement. Employers ranked the importance of experimental skills marginally higher than seniors or alumni. However, alumni ranked students effectiveness marginally higher than seniors or employers. In all cases, the ranking of A3. Experimental Skills both in the importance and effectiveness is significantly lower than those of outcomes A1. Engineering Fundamentals and A2. Analytical Skills. This is likely due to the fact that most employers regularly utilize engineering fundamentals and analytical skills, but notably fewer utilize experimental skills.

FE Exam: One measure of a student's ability in experimental skills is knowledge of and ability to apply statistical methods. Figure 4.12 shows the normalized gap analysis of the fundamentals of engineering (FE) exam for the Probability and Statistics topic. While the ME Exam Data may not be statistically significant in every offering, all of the data is included for completeness. Students met or exceeded expectations in Probability and Statistics in every case where the number of students is sufficiently large to make the data statistically significant.

Likewise, we have also included the performance of students on the Measurement, Instruments, and Controls section of the ME Fundamentals Exam (see Figure 4.13). In many of these years between 2007-2012, the number of Purdue ME students taking the ME version of the Fundamentals Exam was low, making the statistical significance of the data questionable. However, in the last three April offerings, the number of Purdue ME students taking the ME version of the FE exam is substantially larger, to the extent that the results are statistically significant. In the latter years, Purdue ME students performed well above the national average, exceeding expectations in this subject area.

ME 30900, ME 31500 and ME 36500 Lab Grades: Figures 4.14, 4.15, and 4.16 show the frequency histograms for ME 30900 Fluid Dynamics, ME 31500 Heat and Mass Transfer, and ME 36500 Systems and Measurements for fall 2012 and spring 2013. The level of achievement to meet expectations requires 80% of students consistently earning an 8/10 (or 80%) or higher on deliverable 6. To exceed expectations requires 90% of students consistently earning 80 or higher on deliverable 6. In all three lab courses, students either met or exceeded expectations every fall and spring in these three lab courses.

Conclusions: The constituent survey results coupled with the FE data and lab grades for three core ME lab courses clearly supports the conclusion that students meet the expected level of achievement of for outcome A3. Experimental Skills.

Future Actions: We plan to continue updating the instrumentation and equipment in the ME 30900 Fluid Mechanics, ME 31500 Heat and Mass Transfer, ME 36500 Systems and Measurements, and ME 47500 Automatic Controls labs to keep the labs current and running effectively.

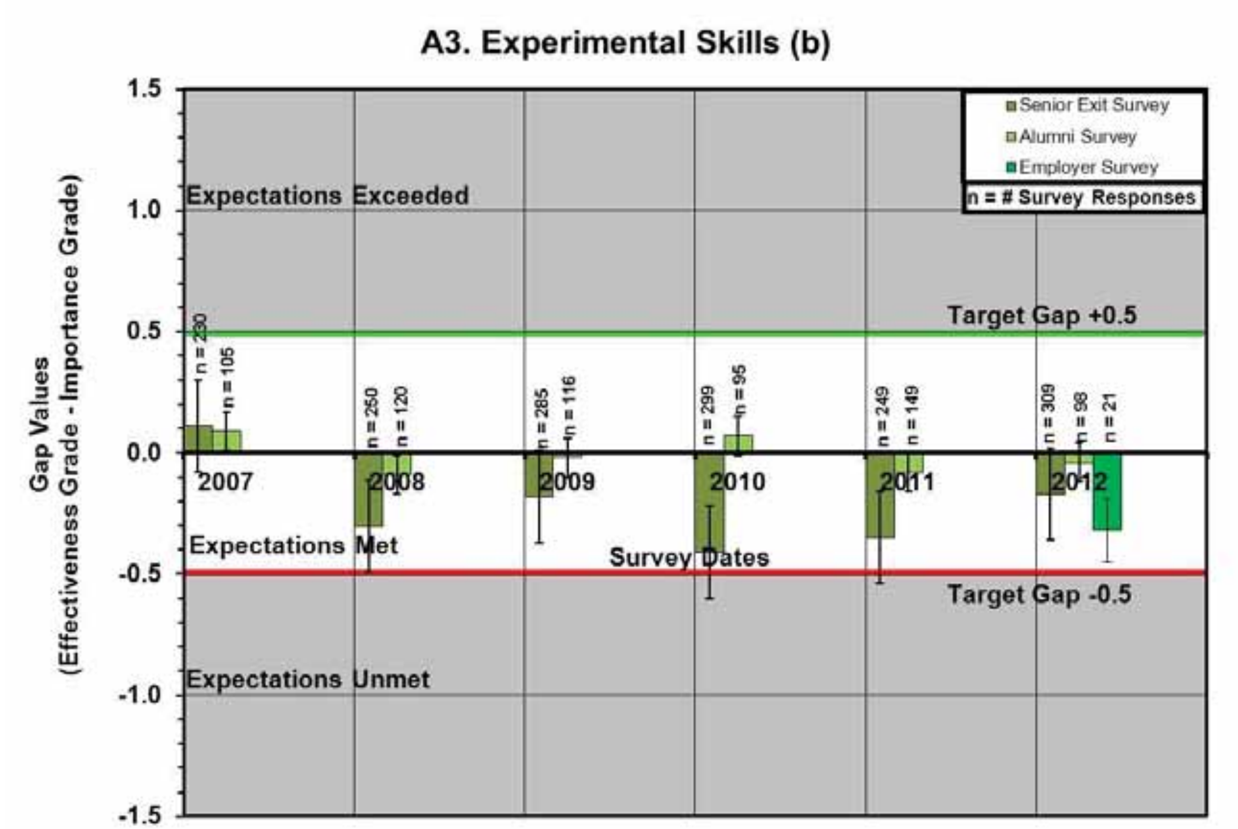


Figure 4.10 Longitudinal Gap Analysis for Outcome A3. Experimental Skills for 2007-2012.

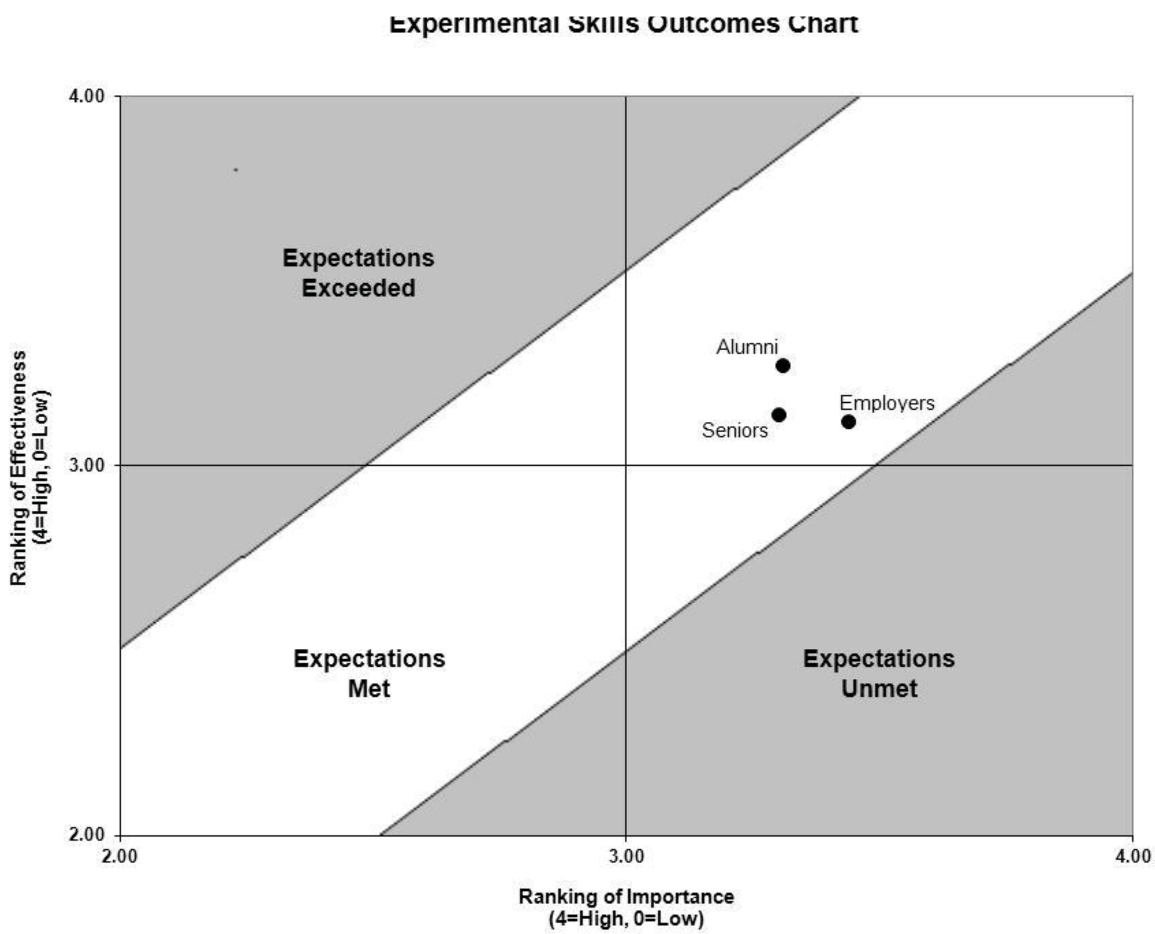
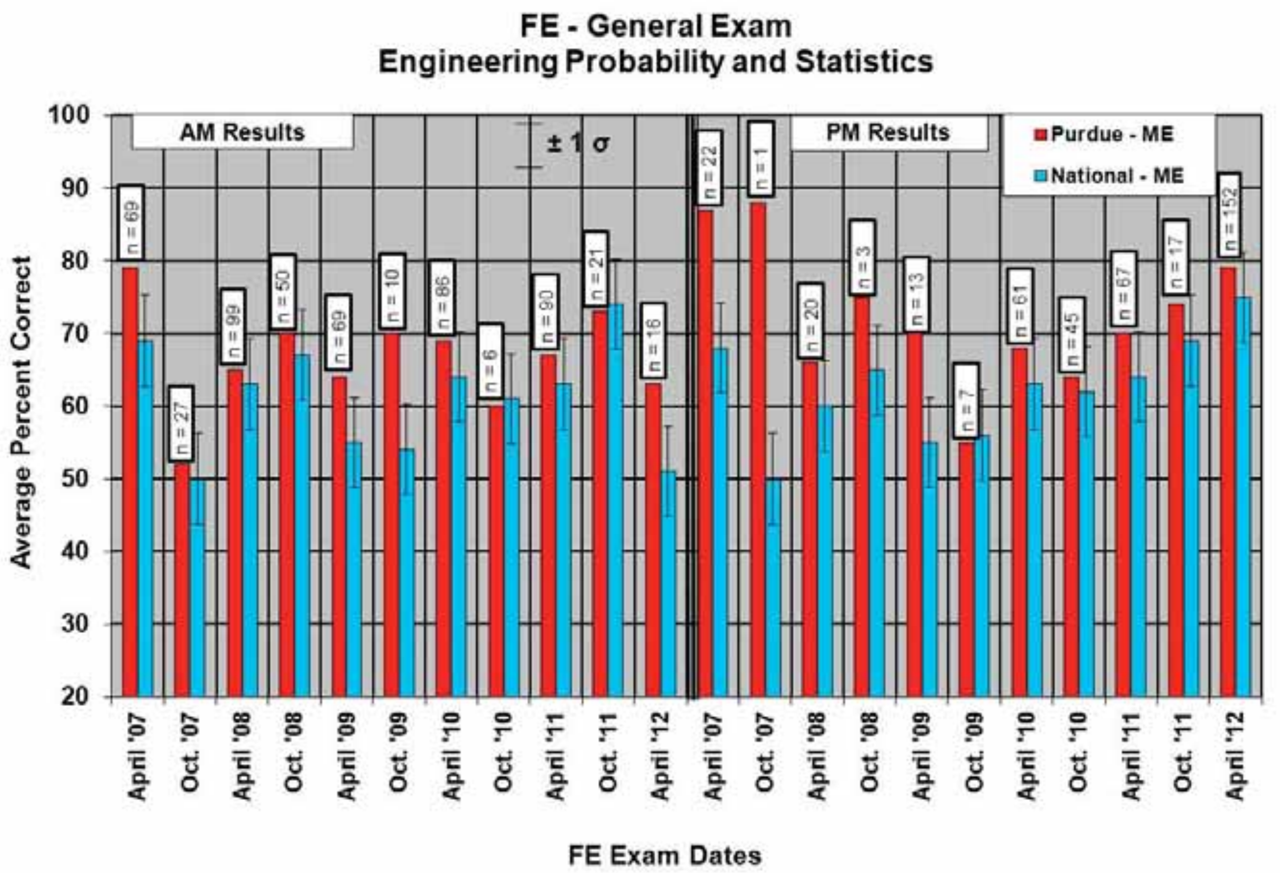


Figure 4.11 Ranking of Effectiveness versus Importance for Outcome A3. Experimental Skills for all constituents for 2012.



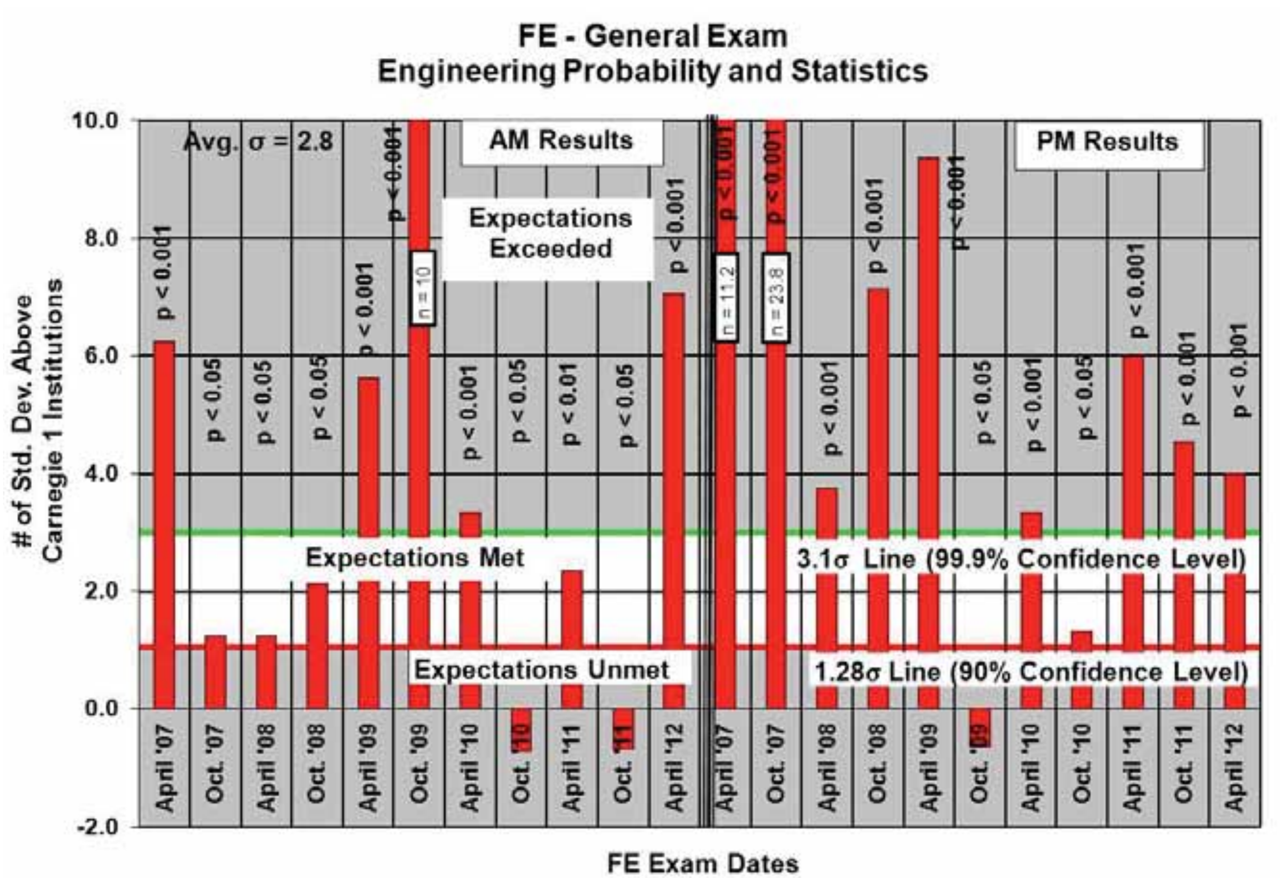
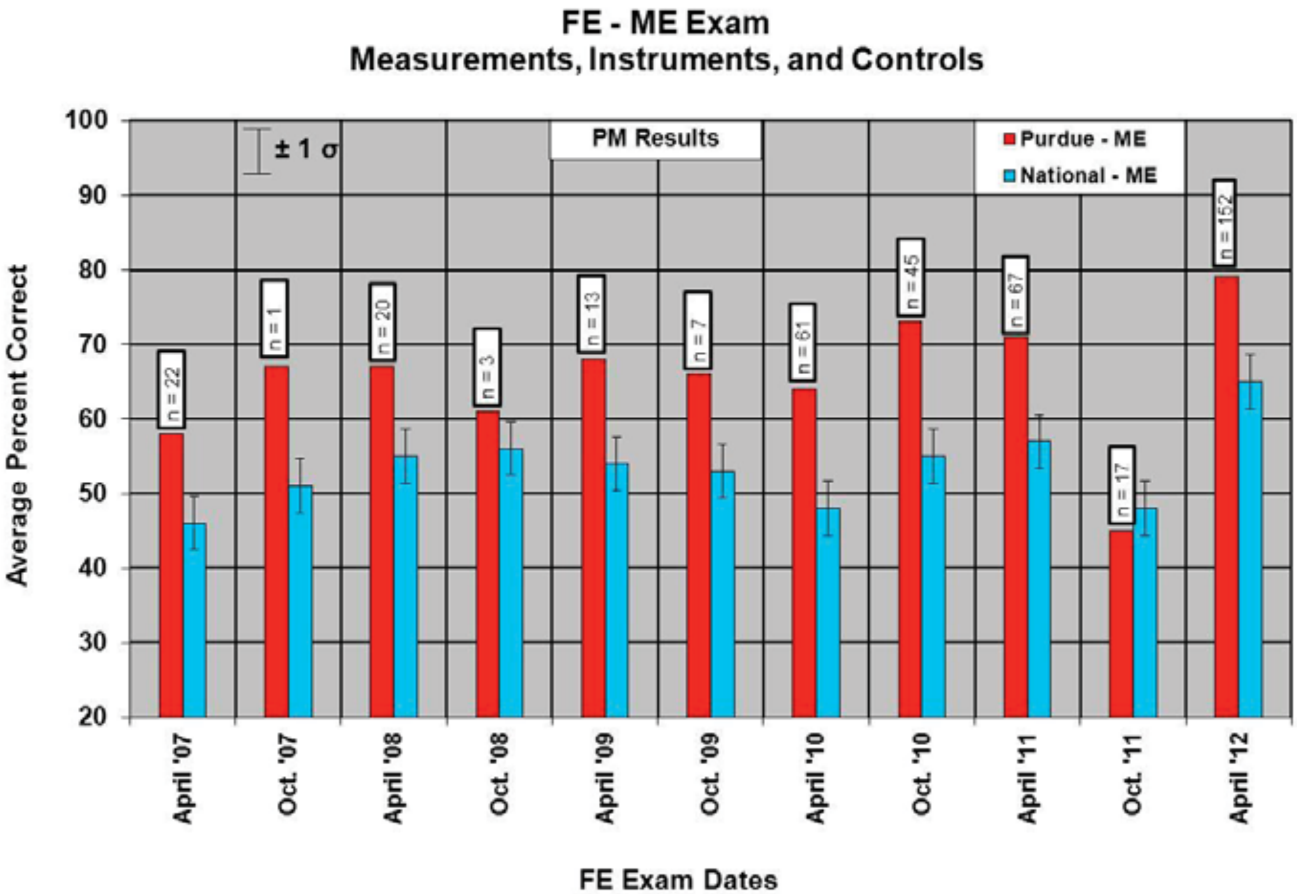


Figure 4.12 FE Exam Results for General Exam – Engineering Probability and Statistics Subject (2007-2012).



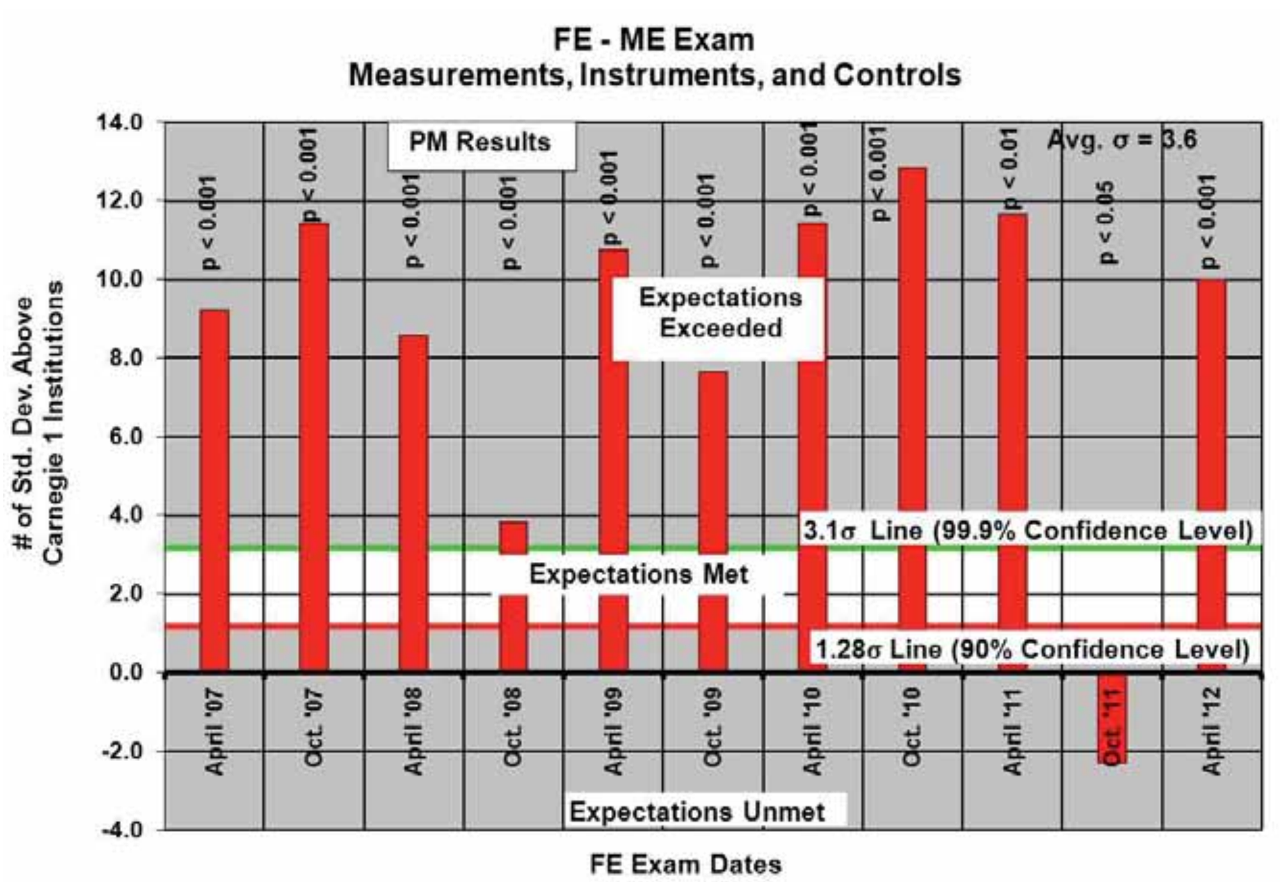


Figure 4.13 FE Exam Results for Mechanical Exam – Measurements, Instruments, and Controls (2007-2012).

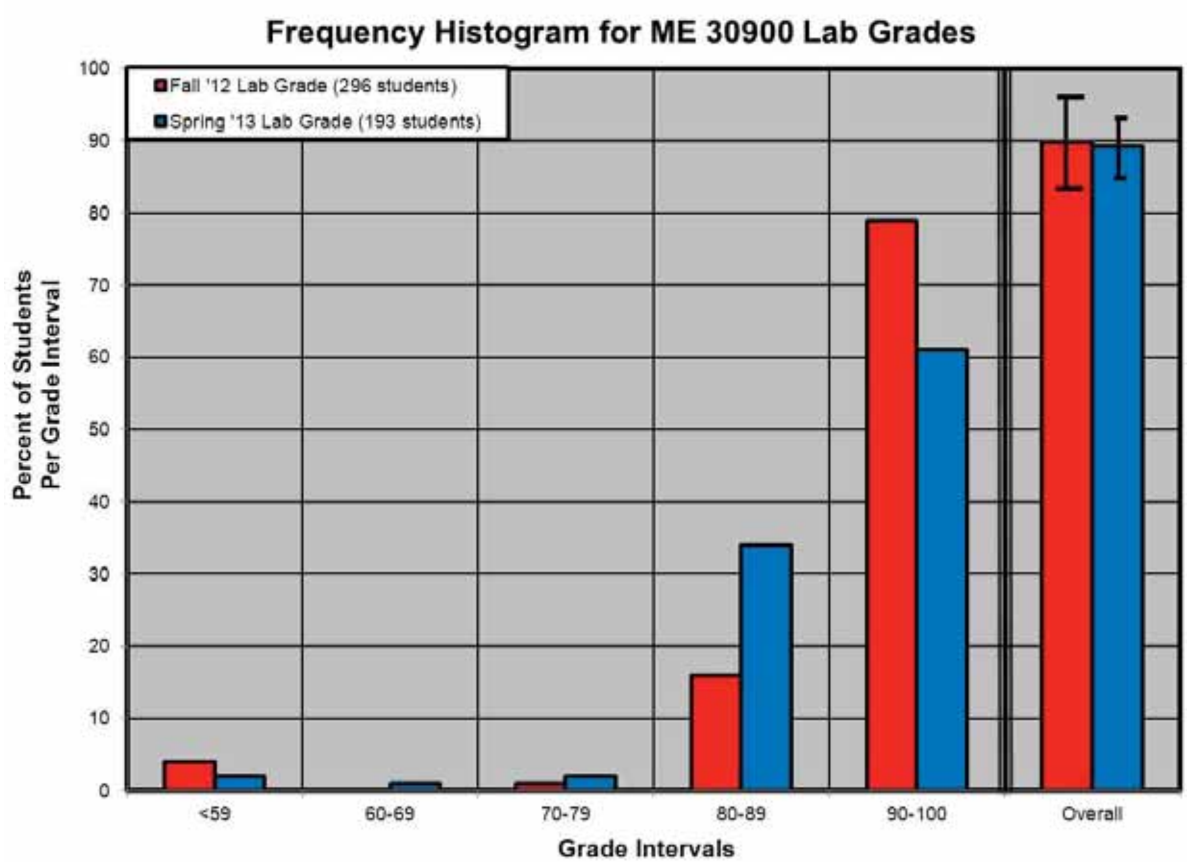


Figure 4.14 Frequency histogram for ME 30900 Fluid Mechanics lab grades for fall 2012 and spring 2013.

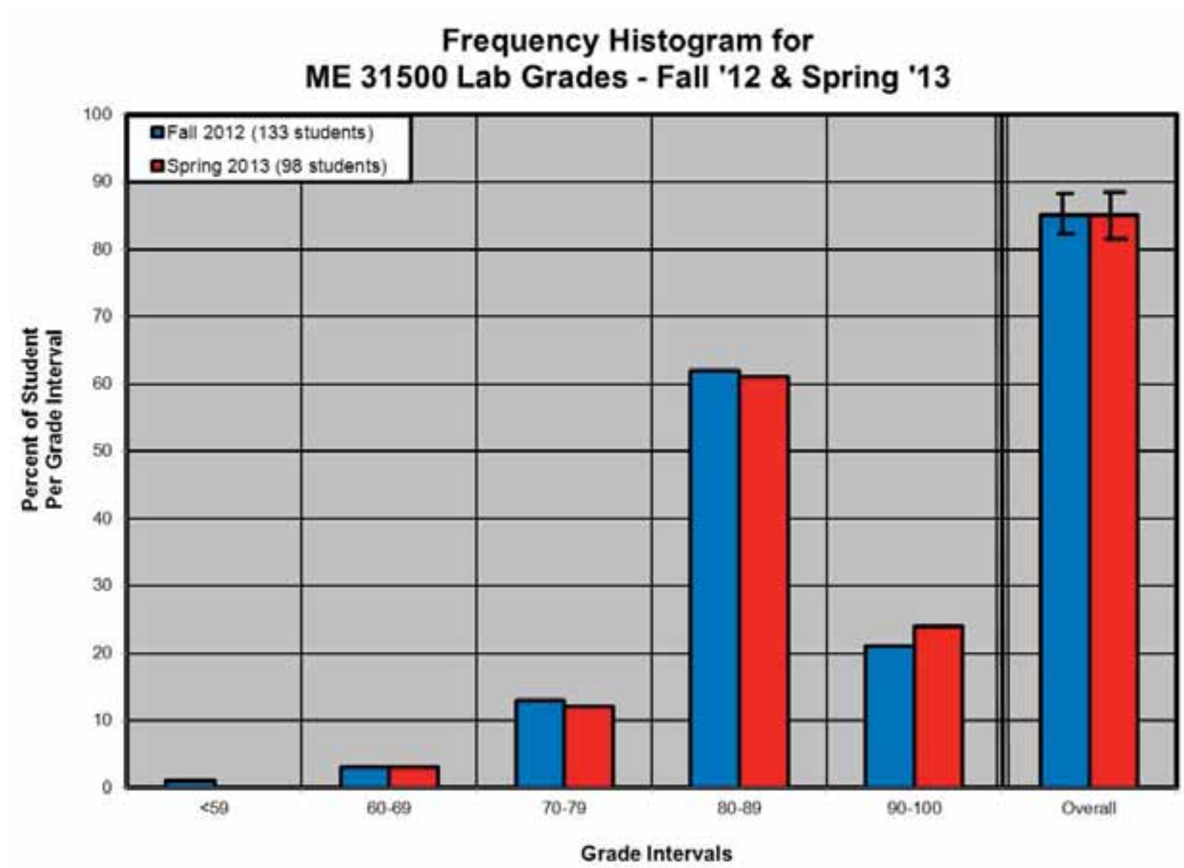


Figure 4.15 Frequency histogram for 31500 Heat and Mass Transfer lab grades for fall 2012 and spring 2013.

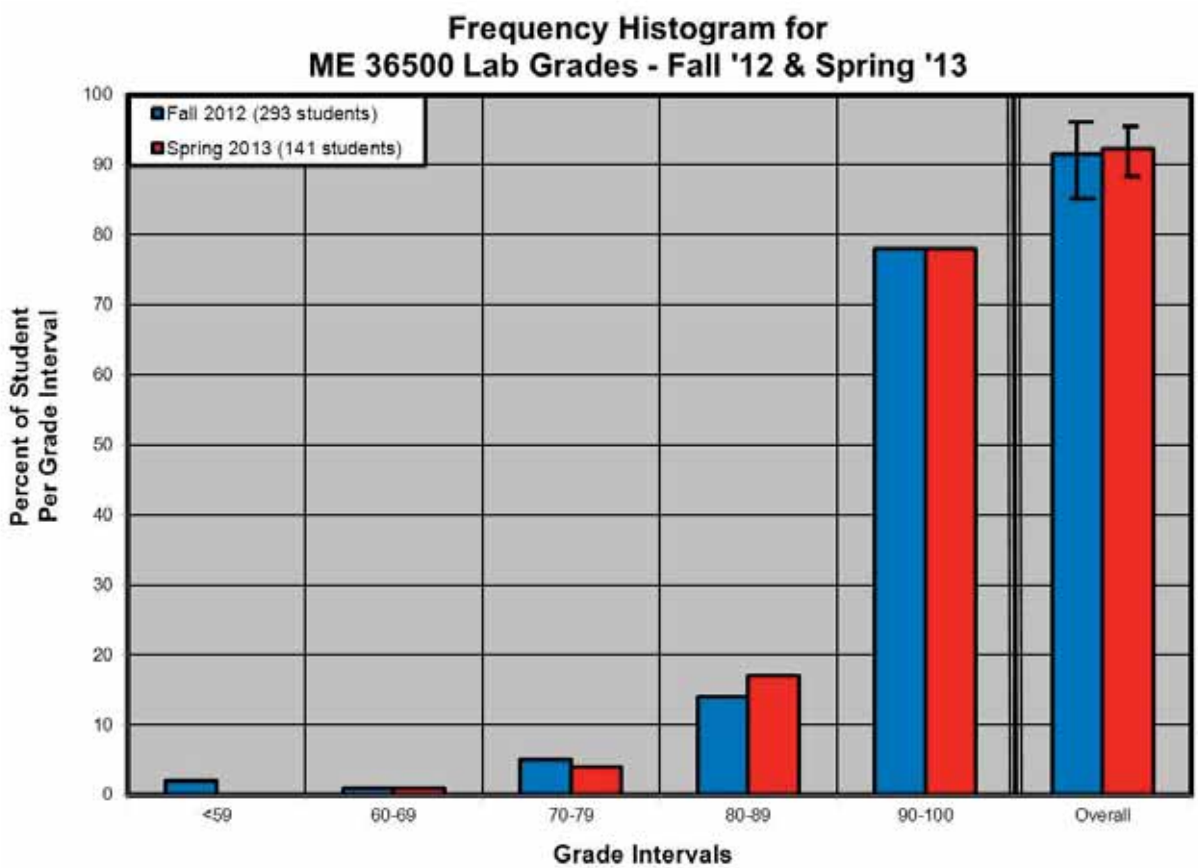


Figure 4.16 Frequency histogram for 36500 Systems and Measurements lab grades for fall 2012 and spring 2013.

4A.6 Program Outcome A4. – Modern Engineering Tools (k)

Table 4.4 shows the performance criteria, assessment methods, and minimum level of achievement used to evaluate outcome A4. – Modern Engineering Tools (k). A brief discussion of each of the six assessment methods is presented below.

Table 4.4 Performance Criteria, Assessment Methods and Minimum Level of Achievement used for Outcome A4. – Modern Engineering Tools.

A4. Modern Engineering Tools (k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice					
Performance Criteria	• Ability calibrate and properly use modern instrumentation equipment • Ability to analyze systems using modern computational tools				
Assessment Method	**Minimum Level of Achievement**	**Date of Data Collection**	**Faculty/Course Assessment Took Place**	**Date of Results Evaluation**	**Evaluation Performed By**
Senior Exit Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Alumni Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Employer Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
FE Exam – Computers Subject (Direct)	80% correct or 1.28σ above National Average	April/Oct 2007-2012	N/A	May 2008-2013	Curriculum Committee
ME 30900 – Lab 9 (Direct)	80% of student earn a grade of 70% or higher	Fall 2012 Spring 2013	Wereley(ME 30900) Wereley (ME 30900)	Dec 2012 May 2012	Wereley Wereley
ME 35200 – Projs 2 & 3 (Direct)	80% of student earn a grade of 70% or higher	Fall 2012 Spring 2013	Pennock(ME 35200) Cipra (ME 35200)	Dec 2012 May 2012	Pennock Cipra

Senior, Alumni, and Employer Surveys: Figure 4.16 shows longitudinal gap analysis for the three constituents for outcome A4. Modern Engineering Tools (k). In 2010, we made a decision to adopt the ABET a-k outcomes explicitly. Previous to this, we had developed our own outcomes and mapped them into the ABET a-k. In this transition, none of our past outcomes aligned one-to-one with Modern Engineering Tools. This is why we did not show any data before 2011. In the limited results we have, all constituents consistently ranked our students as meeting the expected level of achievement except for seniors in 2011. Employers ranked students with the highest gap value (+0.1) while alumni and seniors ranked this skill somewhat lower.

Figure 4.17 shows the ranking of importance versus effectiveness of each of our three constituents for outcome A4. Modern Engineering Tools for 2012. All constituents consistently ranked our students as meeting the expected level of achievement. Interestingly, employers ranked the effectiveness of this outcome significantly higher that seniors or alumni. However, the importance ranking was similar for employers and seniors while the alumni ranked the importance of skills in modern engineering tools moderately lower.

FE Exam: One measure of a student's ability in the use of Modern Engineering Tools is knowledge of computers. Figure 4.18 shows the normalized gap analysis of the fundamentals of engineering (FE) exam for the Computers topic for every offering of the FE Exam from 2007-2012. The gap values (Z) are determined as the difference in the Purdue ME scores and the national ME scores (for each topic), normalized by the national ME standard deviations. To meet expectation, Purdue students need to exceed 1.28σ (representing a confidence level of 90%). To exceed expectations, Purdue students need to exceed 3.10σ (representing a confidence level of 99.9%). The "n" values represent the number of Purdue ME students who participated at each offering of the FE exam. The results indicate that students not only met, but exceeded expectations in the subject area of Computers in every offering of the FE Exam for the past 6 years.

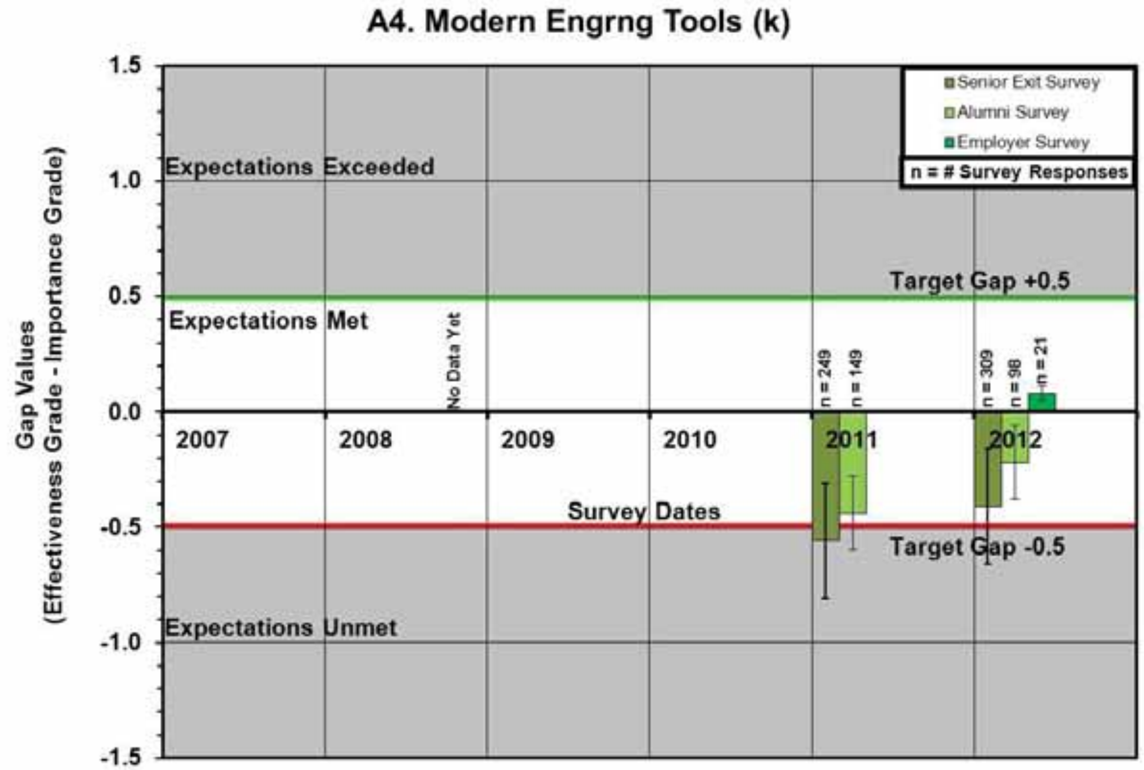


Figure 4.16 Longitudinal Gap Analysis for Outcome A4. Modern Engineering Tools (k) from 2007-2012.

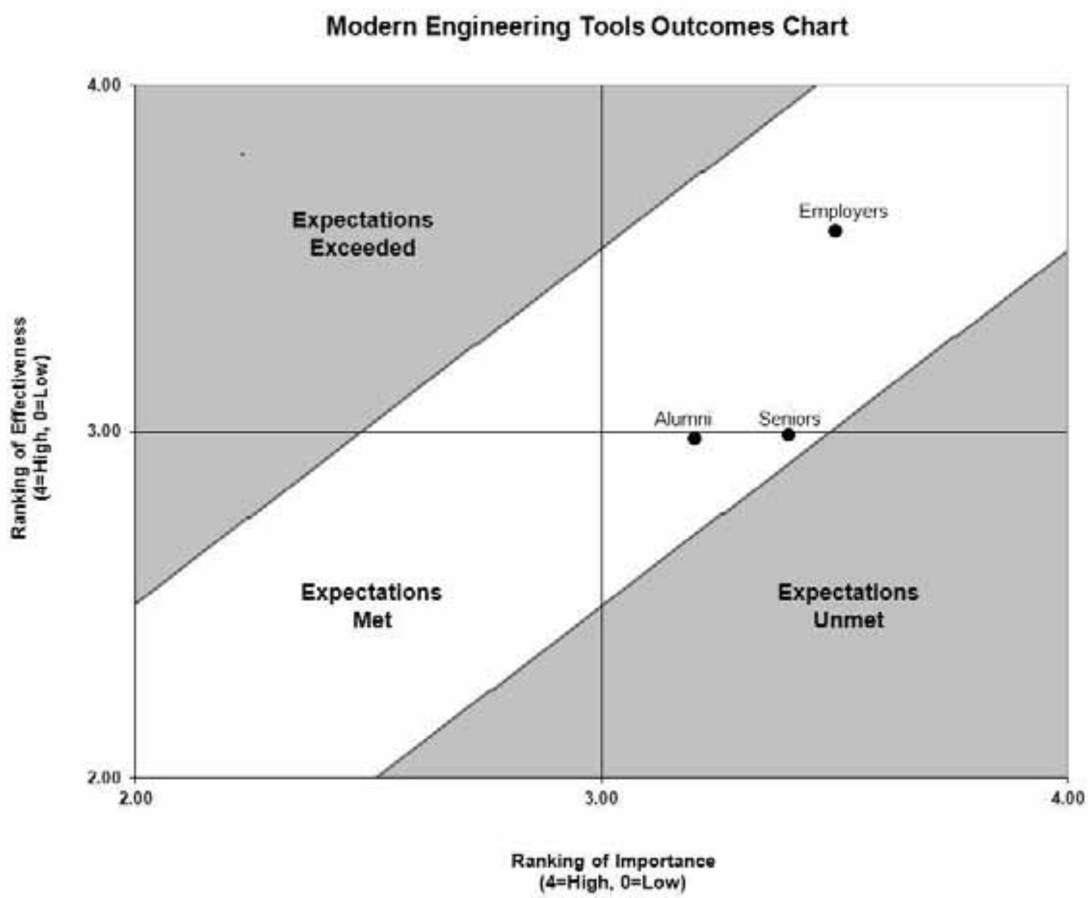
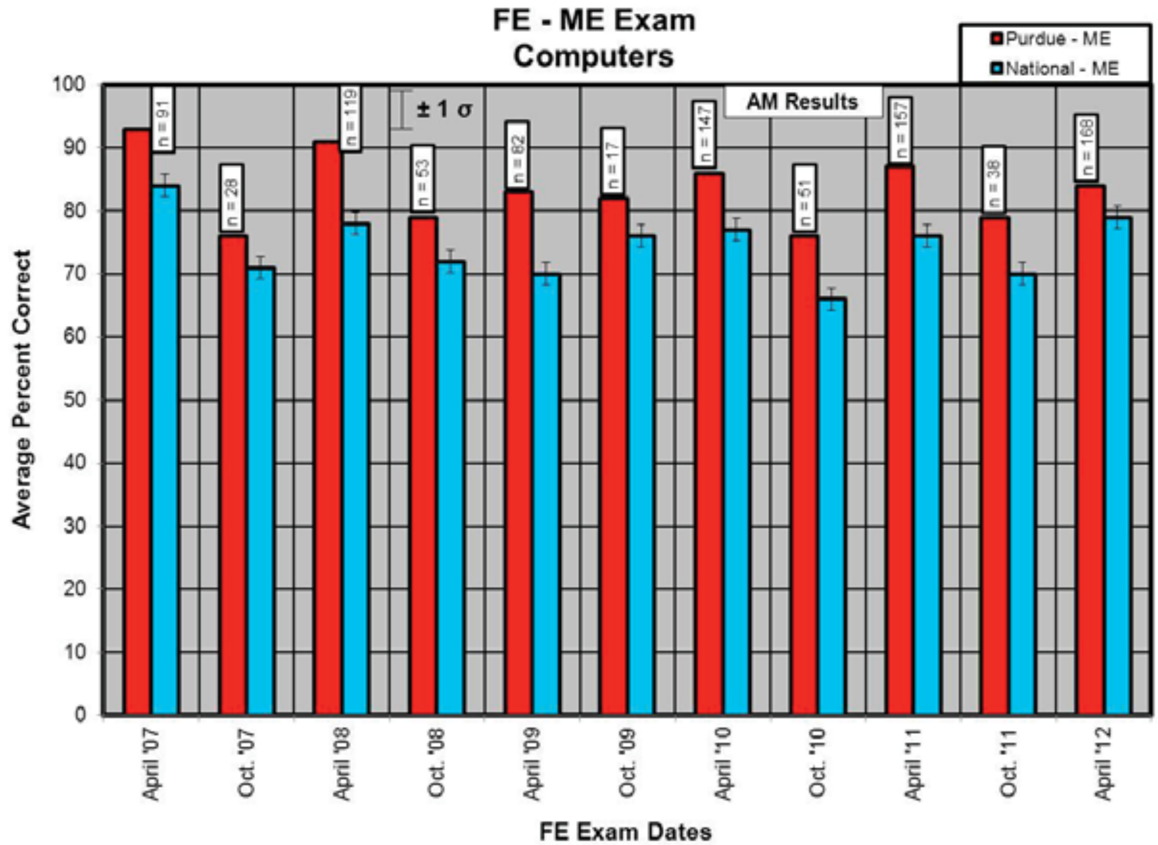


Figure 4.17 Ranking of Effectiveness versus Importance for Outcome A4. Modern Engineering Tools for all constituents for 2012.



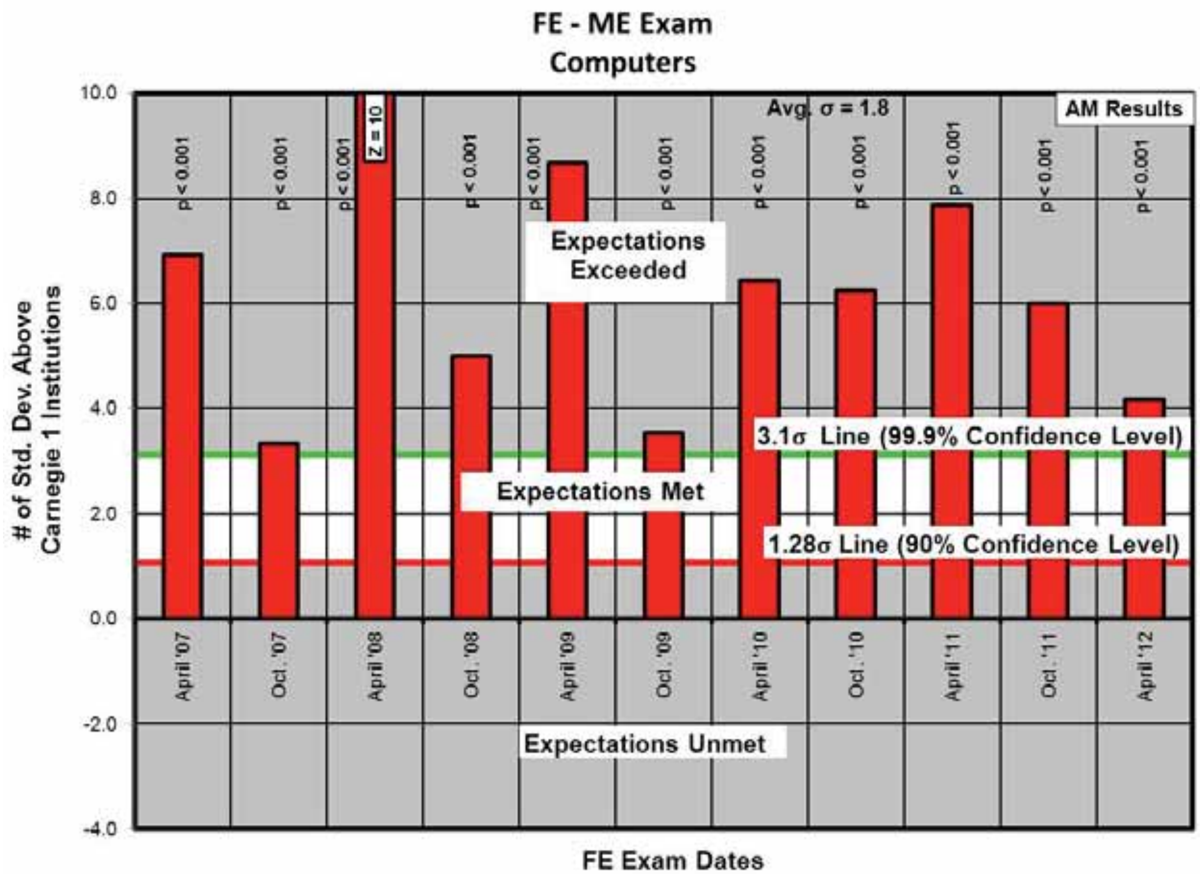


Figure 4.18 FE Exam Results for Computers for 2007-2012.

ME Students are exposed to an array of various modern engineering tools during the course of their curriculum. Some of these include MATLAB, LabView, a variety of transducers (e.g., accelerometers, thermocouples, LVDTs, strain gages, PIV, RTDs, etc.), Digital Data Analysis, Finite Element Analysis, EES (Engineering Equation Solver), FLUENT, etc. Three direct measures were selected to illustrate students' abilities in the use of two Modern Engineering Tools, MATLAB and PIV (Particle Image Velocimetry). Details of these three direct measures are presented below.

ME 30900 Lab on PIV Measurements: Lab 9 in ME 30900 Fluid Mechanics, involves the use of Particle Image Velocimetry (PIV). Particle Image Velocimetry (PIV) is an optical technique to measure velocity fields in planar, two-dimensional domains using laser light sheets and two-dimensional imaging. In the lab, students not only learn the proper techniques to calibrate and operate a PIV, but also learn about common measurement errors that may be encountered. Figure 4.19 shows the frequency histogram of the grades from ME 30900 Lab 9 on PIV Measurements. In both fall and spring of 2012-13 students exceeded the expected minimum level of performance to demonstrate competency in the use of this sophisticated instrumentation.

ME 35200 Project 2 on Kinematic Analysis of a 4-Bar Mechanism: Project 2 in ME 35200 for spring 2013 involved conducting a kinematic analysis of a bucket lifting mechanism through a vertical linear motion. Specifically this involved finding: i) the height from the ground level through which the construction vehicle can lift a load in an approximate straight line path with a minimal rotation of the bucket, and (ii) determine the actual stroke (position) of the hydraulic cylinder necessary to lift the bucket through that height. The project entails developing the symbolic equations required to solve for the position variables and generating a computer program (using MATLAB) to solve all position variables using the hydraulic cylinder as the input. Figure 4.20 shows the frequency histogram of the grades from ME 35200 Project 2 on a kinematic analysis of the bucket lifting mechanism. In fall and spring 2012-2013, students met the expectation that 80% of students would earn a 70% or higher on this lab.

ME 35200 Project 3 on Kinetic Analysis of a 4-Bar Mechanism: Project 3 in ME 35200 for spring 2013 involved conducting a kinetic force analysis of the same bucket lifting mechanism through a vertical linear motion. Specifically this involved: i) evaluating the internal reaction forces in the mechanism and computing the required driving force in the hydraulic cylinder, in order to lift the bucket and given load; and (ii) determining an optimal location of the ground attachment pivot of the hydraulic cylinder to maximize mechanical advantage. The project entails expanding their computer program (using MATLAB) to a complete static force analysis including computing the driving force in the hydraulic cylinder using the power equation and determining the mechanical advantage of the mechanism throughout the range of motion. Figure 4.21 shows the frequency histogram of the grades from ME 35200 Project 3 on a kinetic analysis of the bucket lifting mechanism. In fall and spring 2012-2013, students met the expectation that 80% of students would earn a 70% or higher on this project.

Conclusions: The constituent survey results coupled with the FE data on Computers, the ME 309 PIV results, and the ME 35200 Project results support the conclusion that students meet the expected level of achievement for outcome A4. Modern Engineering Tools.

Future Actions: It is our assessment that our students need more exposure to the fundamentals of finite element analysis since this analysis method is so common place. We have begun taking steps in this direction by developing a new course ME 49700 Finite Element Analysis that is currently offered as a technical elective. Our plan is to eventually offer this course as a Restricted Elective (one of only 4 options) and eventually possibly even as a required course.

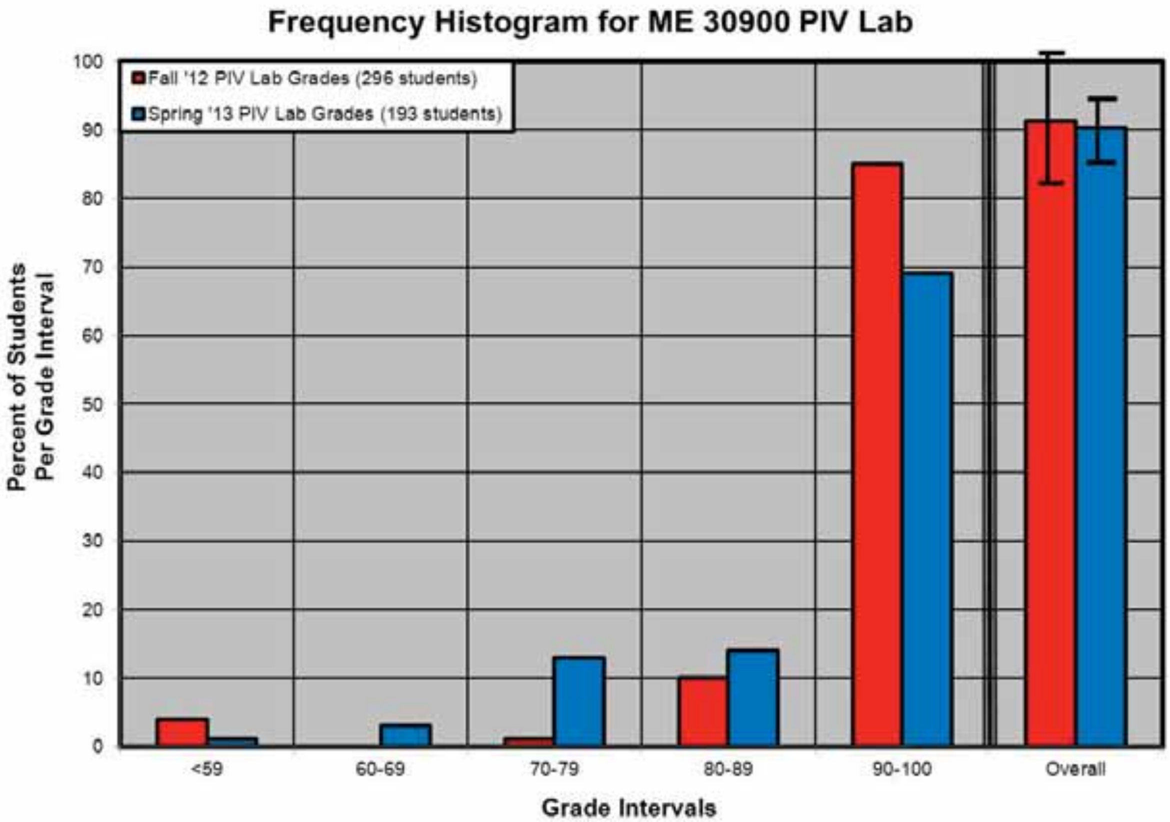


Figure 4.19 Frequency histogram for ME 30900, Lab #9 Grades on Particle Imagining Velocimetry in fall 2012 and spring 2013.

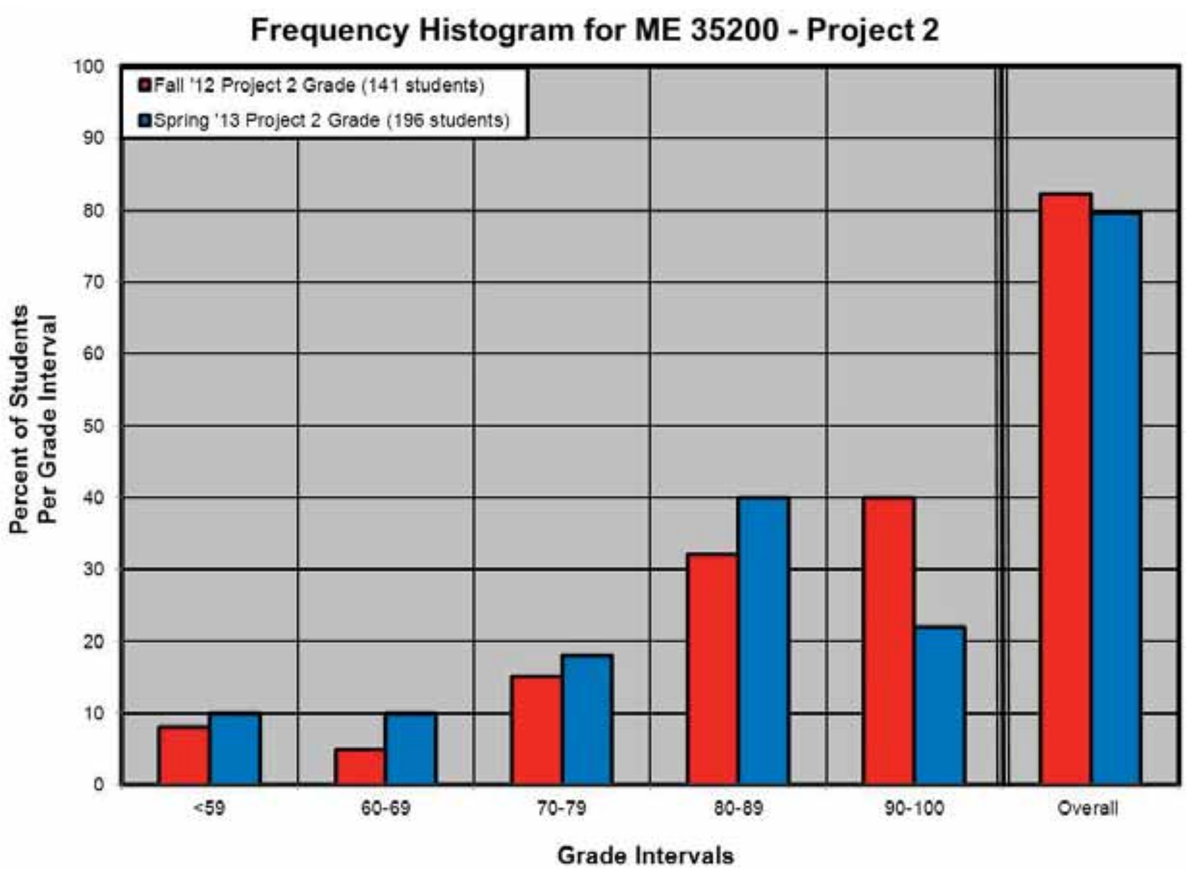


Figure 4.20 Frequency histogram for ME 35200, Project 2 Grades on a Static Analysis of a 4-Bar Mechanism in fall 2012 and spring 2013.

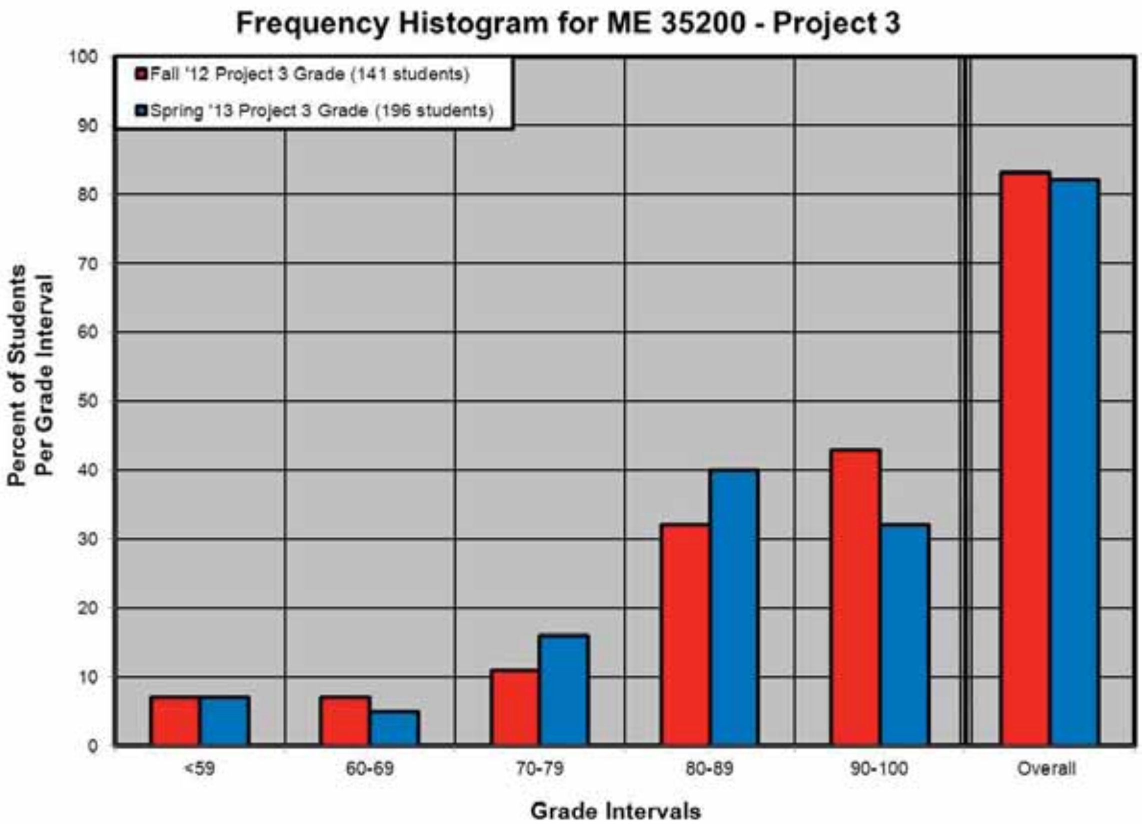


Figure 4.21 Frequency histogram for ME 35200, Project 3 Grades on a Kinetic Analysis of a 4-Bar Mechanism in fall 2012 and spring 2013.

4A.7 Program Outcome A5. – Design Skills (c)

Table 4.5 shows the performance criteria, assessment methods, and minimum level of achievement used to evaluate outcomes A5. – Design Skills. A brief discussion of each of the five assessment methods is presented below.

Table 4.5 Performance Criteria, Assessment Methods, and Minimum Level of Achievement used for Outcome A5. – Design Skills (c).

<table>
<tr><td colspan="6">A5. Design Skills (c)
an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability</td></tr>
<tr><td>Performance Criteria</td><td colspan="5">• Creatively apply engineering fundamentals and problem solving skills to ill-posed, open-ended problems.
• Applies formal design tools and procedures throughout the design process.</td></tr>
<tr><td>Assessment Method</td><td>Minimum Level of Achievement</td><td>Date of Data Collection</td><td>Faculty/Course Assessment Took Place</td><td>Date of Results Evaluation</td><td>Evaluation Performed By</td></tr>
<tr><td>Senior Exit Survey (Indirect)</td><td>Effectiveness Score within ½ Letter Grade of Importance Score</td><td>May/Aug/ Dec 2007-2012</td><td>N/A</td><td>Dec. 2007-2013</td><td>Curriculum Committee</td></tr>
<tr><td>Alumni Survey (Indirect)</td><td>Effectiveness Score within ½ Letter Grade of Importance Score</td><td>May/Aug/ Dec 2007-2012</td><td>N/A</td><td>Dec. 2007-2013</td><td>Curriculum Committee</td></tr>
<tr><td>Employer Survey (Indirect)</td><td>Effectiveness Score within ½ Letter Grade of Importance Score</td><td>May/Aug/ Dec 2007-2012</td><td>N/A</td><td>Dec. 2007-2013</td><td>Curriculum Committee</td></tr>
<tr><td>ME 26300 Grades (Direct)</td><td>80% of Students earn a Grade of “B” or higher</td><td>Dec 2012
Apr 2013</td><td>Anderson/ME 26300
Reid/ME 26300</td><td>Dec 2012
May 2013</td><td>Anderson
Reid</td></tr>
<tr><td>ME 46300 Grades (Direct)</td><td>80% of Students earn a Grade of “B” or higher</td><td>Dec 2012
Apr 2013</td><td>Starkey/ME 46300
Starkey/ME 46300</td><td>Dec 2012
May 2013</td><td>Starkey</td></tr>
</table>

Senior, Alumni, and Employer Surveys: Figure 4.22 shows longitudinal gap analysis for the three constituents for outcome A5. Design Skills (c). Although in some years seniors rated themselves below expectation, alumni and employers rated seniors as consistently meeting expectations in design skills in all years between 2007-2012. Employers rated students notably higher in design skills than either seniors or alumni. As with several other outcomes, seniors often underestimate their preparation in areas like design skills until they are actually in professional practice for a while. They often ultimately, come to the realization that they are much better prepared than they thought when comparing themselves to their peers in the company.

Figure 4.23 shows the ranking of importance versus effectiveness of each of our three constituents for outcome A5. Design Skills for 2012. Alumni and employers rank our seniors as meeting the expected level of achievement while seniors ranked their effectiveness as marginally below expectations. However, seniors and alumni tended to rank our level of achievement lower than others. Also, alumni ranked the importance of this outcome notably lower than the other constituents, which is a little surprising.

ME 26300 and ME 46300 Course Grades: Figures 4.24 and 4.25 show the frequency histograms for course grades in ME 26300 and ME 46300 for fall 2012 and spring 2013. As discussed earlier, ME 26300 serves as the cornerstone design course in our ME curriculum while ME 46300 serves as the capstone design course. Overall grades in these courses reflect students' performance in open-ended design experiences. As can be seen in these plots, students exceed the minimum expectation of 80% receiving a grade of B or better in these courses. In both courses, grades in spring tend to be higher because this is the "on-semester" for these courses. Students taking ME 26300 or ME 46300 in the "off-semester" on average don't perform as well because most top students are on track to finish in 4 years. Students who are behind are often off schedule due to a need to repeat some courses.

Conclusions: The results from constituent surveys and the design course grades are generally consistent and support the conclusion that students meet the expected level of achievement of for outcome A5. Design Skills. The primary action taken to improve performance in this outcome is the opening of the Gatewood Wing, and specifically the Product Realization and Laboratory (PEARL) facilities. In addition, the ME Student Shop has also roughly doubled in size. Details of these new and expanded facilities are provided in section 4B of this chapter.

Design inherently is a very sophisticated and complex activity that requires maturity and experience in many different areas (marketing, sales, manufacturing, etc.) to be able to synthesize the complex pieces needed to be an effective designer. While we feel we have provided a solid foundation, graduates will need to continue to build this maturity throughout their careers.

Future Actions: Because of the significant growth in the ME Program enrollment (over 50%), we are considering adding a third full-time staff for the ME Student Shop. This is a significant need, especially in light of the fact that the President's Office is asking College of Engineering to grow yet another 10%. The other significant issue that we will be addressing is to make the shop a more student friendly environment. Many students feel very inadequate going into the shop because of their lack of experience. A more student centric learning environment will help create a magnetic effect drawing more students into the shop.

Due to the dramatic increase in our international student population, we are also discussing how to best assist these students cultivate effective design skills. Inherently international students view design differently. From a cultural perspective, many international students are excellent at solving well-defined problems, better in many cases than our domestic students. However, due to the strongly rote educational systems they grew up in, many of these same students are very uncomfortable with more open-ended type problems found in design activities. How best to help these students cultivate critically important design skills is a current focus of discussion. Also, it is important to note that this is not solely an international student issue. There are also a number of domestic students who likewise struggle with the uncertainty of design activities. However, it seems to be more pronounced concern for the population of international students.

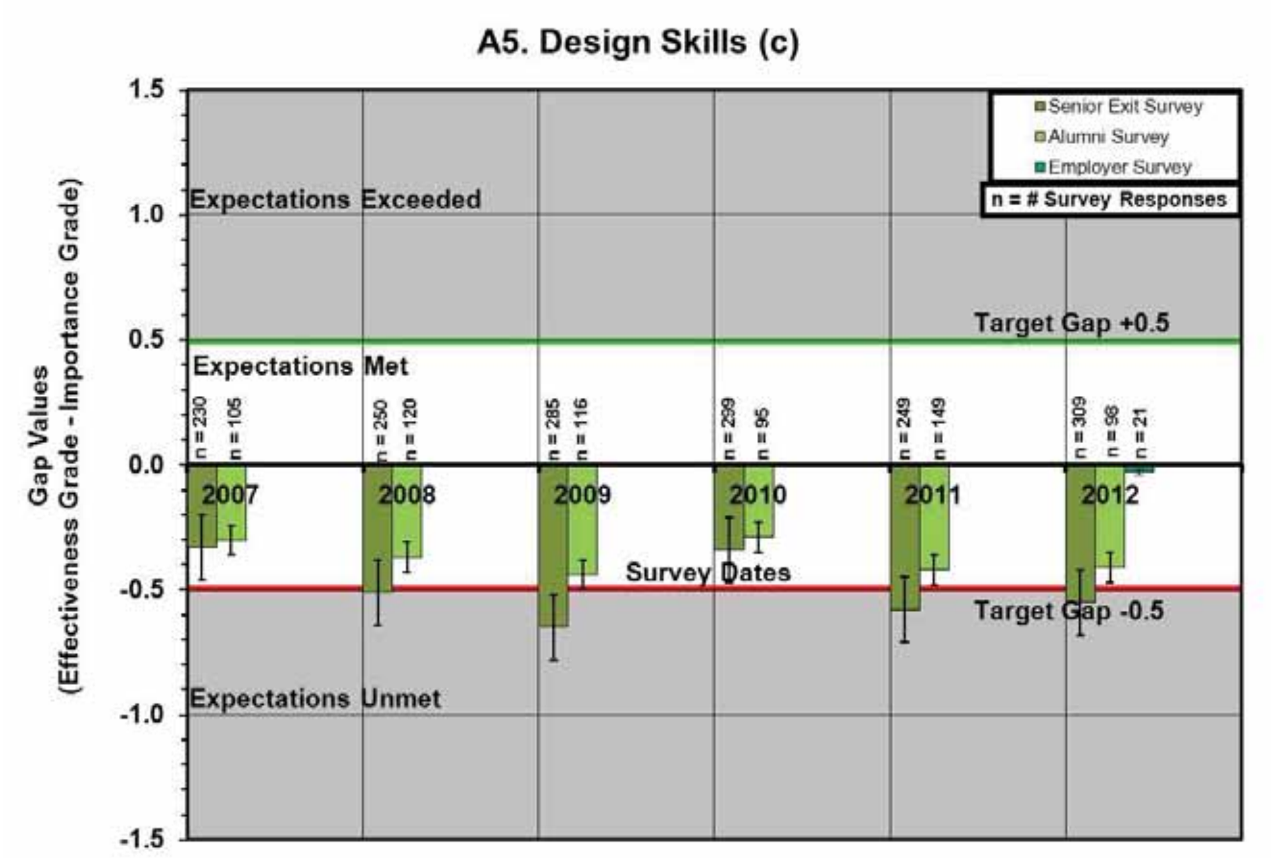


Figure 4.22 Longitudinal Gap Analysis for Outcome A5. Design Skills (c) from 2007-2012.

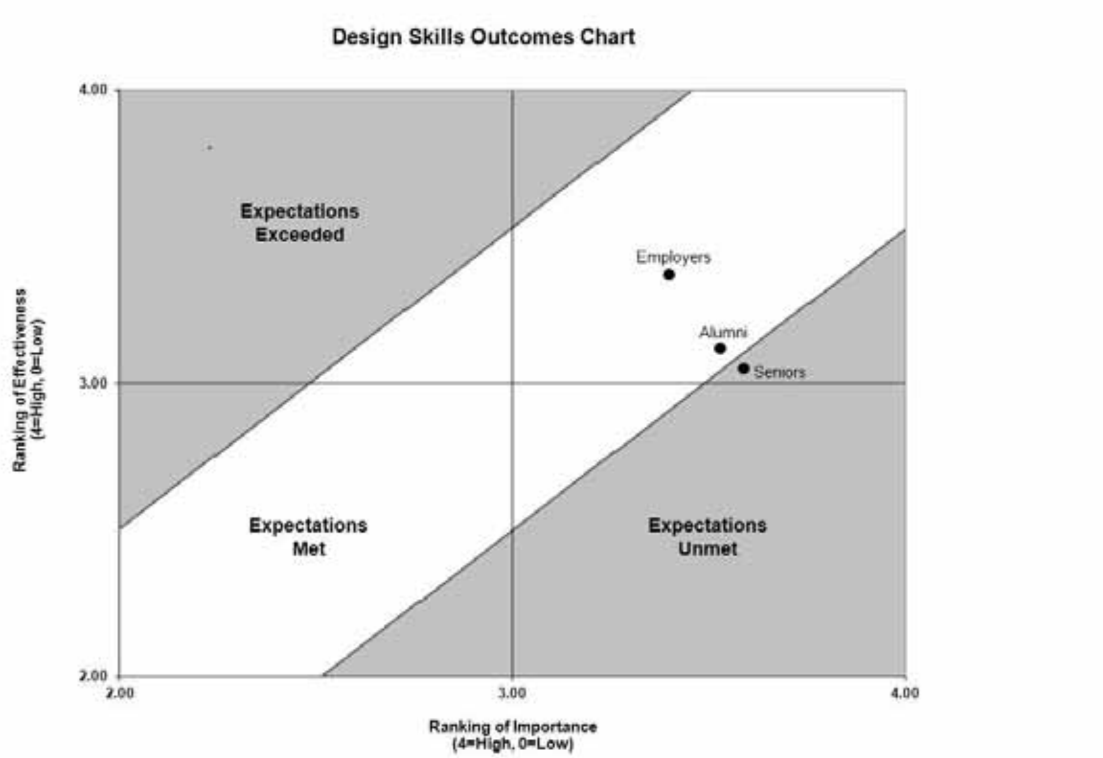


Figure 4.23 Ranking of Effectiveness versus Importance for Outcome A5. Design Skills for all constituents in 2012.

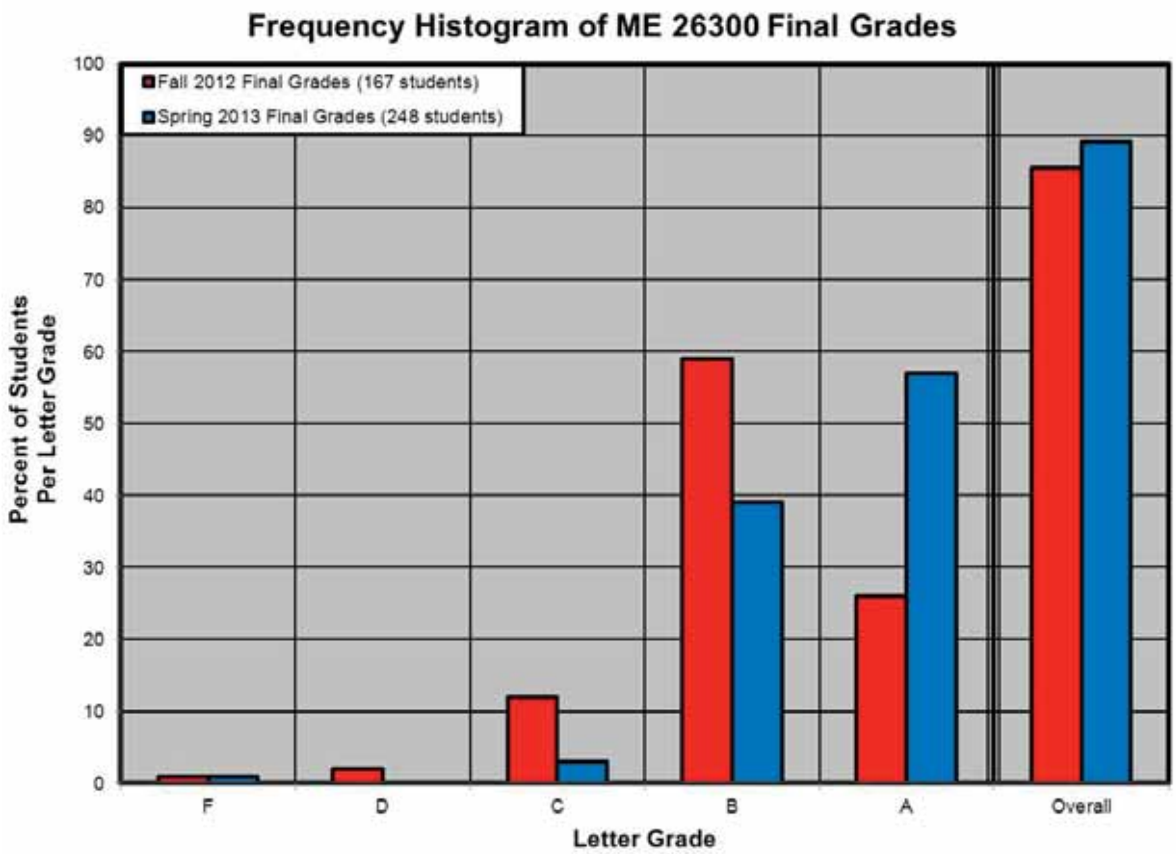


Figure 4.24 Frequency histogram for ME 26300 Introduction to Mechanical Engineering Design, Innovation and Entrepreneurship final grades for fall 2012 and spring 2013.

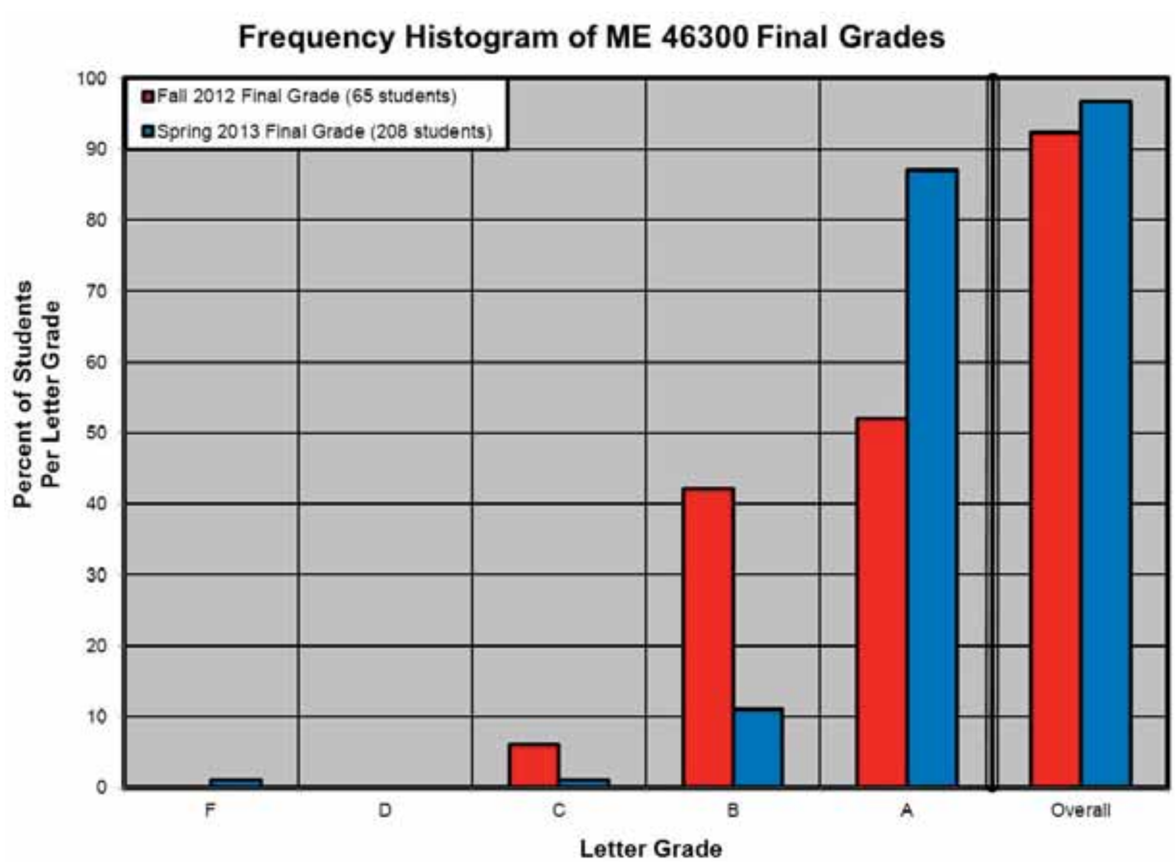


Figure 4.25 Frequency histogram for ME 46300 Engineering Design final grades for fall 2012 and spring 2013.

4A.8 Program Outcome A6. – Impact of Engineering Solutions (h)

Table 4.6 shows the performance criteria, assessment methods, and level of achievement used to evaluate outcome A6. – Impact of Engineering Solutions. A brief discussion of each of the five assessment methods is presented below.

Table 4.6 Performance Criteria, Assessment Methods, and Minimum Level of Achievement used for Outcome A6. – Impact of Engineering Solutions (h).

A6. Impact of Engineering Solutions The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.					
Performance Criteria	• Impact of engineering solutions in a global, economic, environmental and societal context.				
Assessment Method	**Minimum Level of Achievement**	**Date of Data Collection**	**Faculty/Course Assessment Took Place**	**Date of Results Evaluation**	**Evaluation Performed By**
Senior Exit Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Alumni Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Employer Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
FE Exam – Engr. Economics Subject (Direct)	80% correct or 1.28σ above National Average	April 2011 Oct 2011 April 2012	N/A	May 2013	Curriculum Committee
ME 26300 Grades in Progress Report 3 (Direct)	80% of Student Teams earn a Grade of "B" or better	Dec 2012 April 2013	Anderson/ME 263 King/ ME 263	May 2013	Anderson King

Senior, Alumni, and Employer Surveys: Figure 4.26 shows the longitudinal gap analysis for the three constituents for outcome A6. Impact of Engineering Solutions (h). Over the past six years there has been a significant increase in the gap value, especially for alumni (going from -1 to +0.2). It is difficult to know precisely the reasons for this dramatic improvement, however, we believe it is in large part due to our emphasis on our global programs coupled with a growing number of opportunities for students to pursue business related options (e.g., 5 Yr BSME/MBA Program, MGMT minor, ECON minor, Innovation and Entrepreneurship Certificate Program, and most recently, our 5 Yr BSME/ MS Econ Program). Similar dramatic increase in survey results are noted in the global skills section of this chapter.

Figure 4.27 shows the ranking of importance versus effectiveness of each of our three constituents for outcome A6. Impact of Engineering Solutions. All constituents ranked seniors as meeting expectations. The effectiveness rankings by the constituents were all consistently just below 3.0. However, the importance ranking of these skills varied notably with employers ranking these skills as more important as compared with seniors and alumni. This is not surprising since higher ranking employers generally have more experience with these broader issues.

FE Exam (Engineering Economics Subject): One measure of a student's ability to synthesize engineering, business and societal perspectives is a basic knowledge of engineering economics. Figure 4.28 shows Purdue students' performance on the Engineering Economics subject from the FE exam for the April 2011, October 2011, and April 2012 offerings. These data are the averaged values of the AM results of both the FE General and FE ME exams because students only recently started transitioning to the ME Exam. Only the AM results are presented here because the ME exam has no PM Engineering Economics section. These results indicate that Purdue ME graduates performed well above the national average in the April 2011 and April 2012 offerings (when most Purdue ME students took the exam). However, the Purdue ME students were slightly below the national average for October 2011. Nevertheless, given the strong performance in April 2011 and April 2012 and the large number of student participating in these semesters, it is clear that these students have met expectations.

ME 263 – Progress Report 3 (Product Design and Economic Analysis): Figure 4.29 shows the frequency histograms for progress report 3 (product design and economic analysis) from ME 263 for fall 2011 and spring 2012. Progress report 3 (PR3 – Product Design and Economic Analysis) is focused on completing the detailed design of their product including determining what parts to purchase and what parts to fabricate. As discussed previously, students then conduct a detailed economic analysis and evaluate the economic viability of the product based on six different economic indicators. This represents students' first experience in developing simplified economic analysis models. Finally, students conduct a performance analysis and assembly analysis to make improvements to the final product.

The level of achievement to meet expectations requires 80% of students consistently earning a grade of "B" or higher on PR3. To exceed expectations requires 90% of students consistently earning a grade of "B" or higher on PR3. As shown in Figure 4.28, students met expectations in fall 2011 and exceeded expectations in spring 2012. As in other areas, student performance was stronger in spring 2012 because it is the "on-semester" for ME 263 and typically has academically stronger students.

Conclusions: The results of the constituent surveys, the FE data on Engineering Economics and the ME 263 Progress Report 3 are generally consistent and support the conclusion that students meet the expected level of achievement for outcome A6. Impact of Engineering Solutions. Our efforts in expanding our global experiences, transitioning ME 29000 to emphasize global competency and expanding efforts for students to learn about business practices has made a significant impact in this outcome.

Future Actions: No future actions are planned at this time.

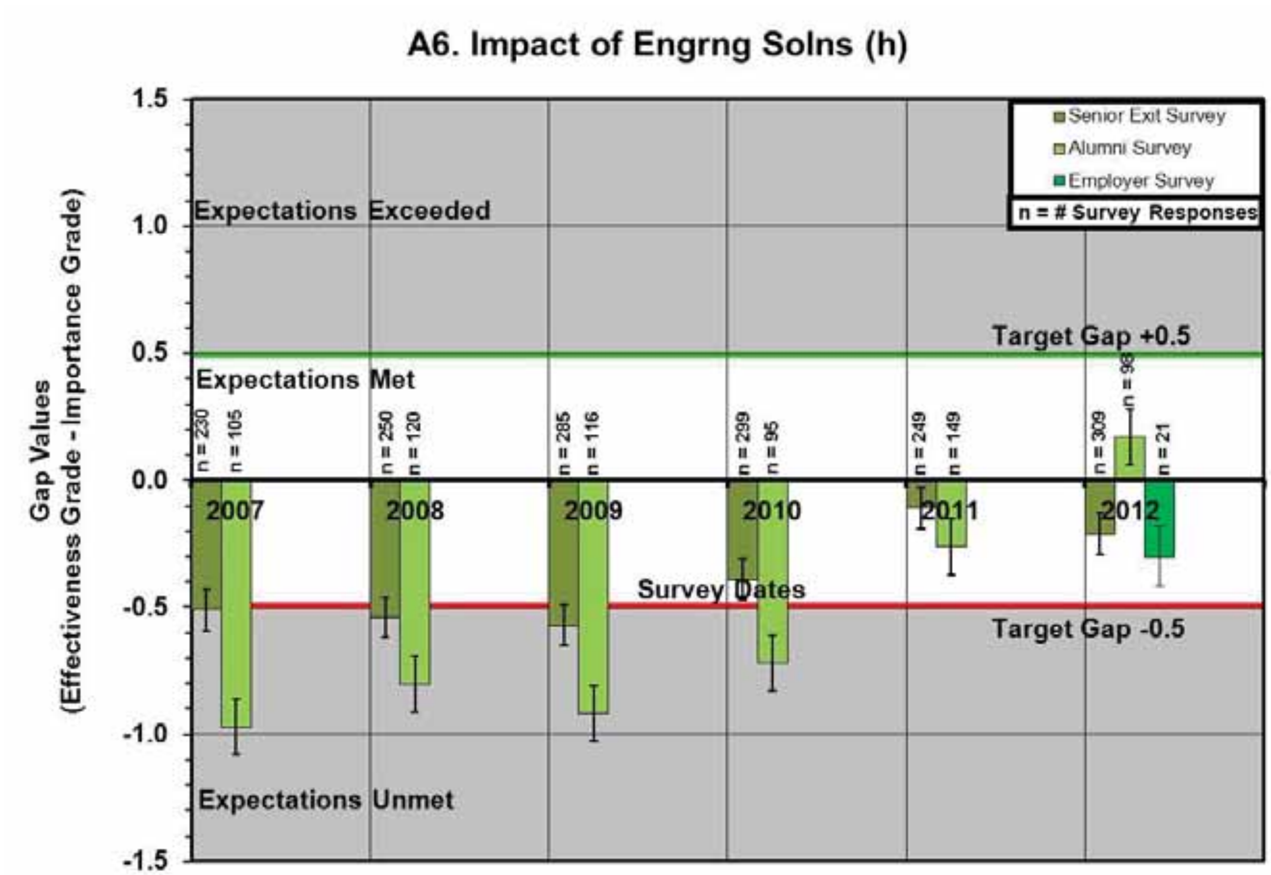


Figure 4.26 Longitudinal Gap Analysis for Outcome A6. Impact of Engineering Solutions (h) from 2007-2012.

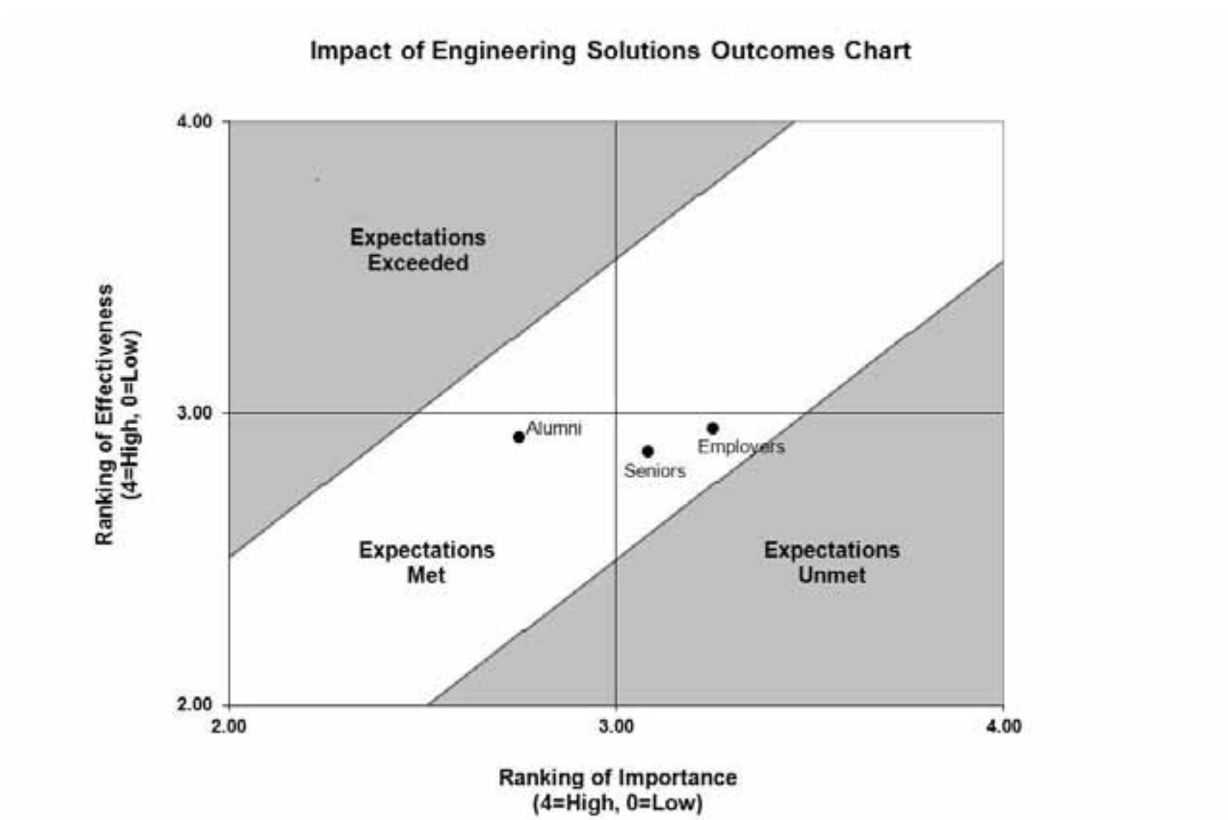
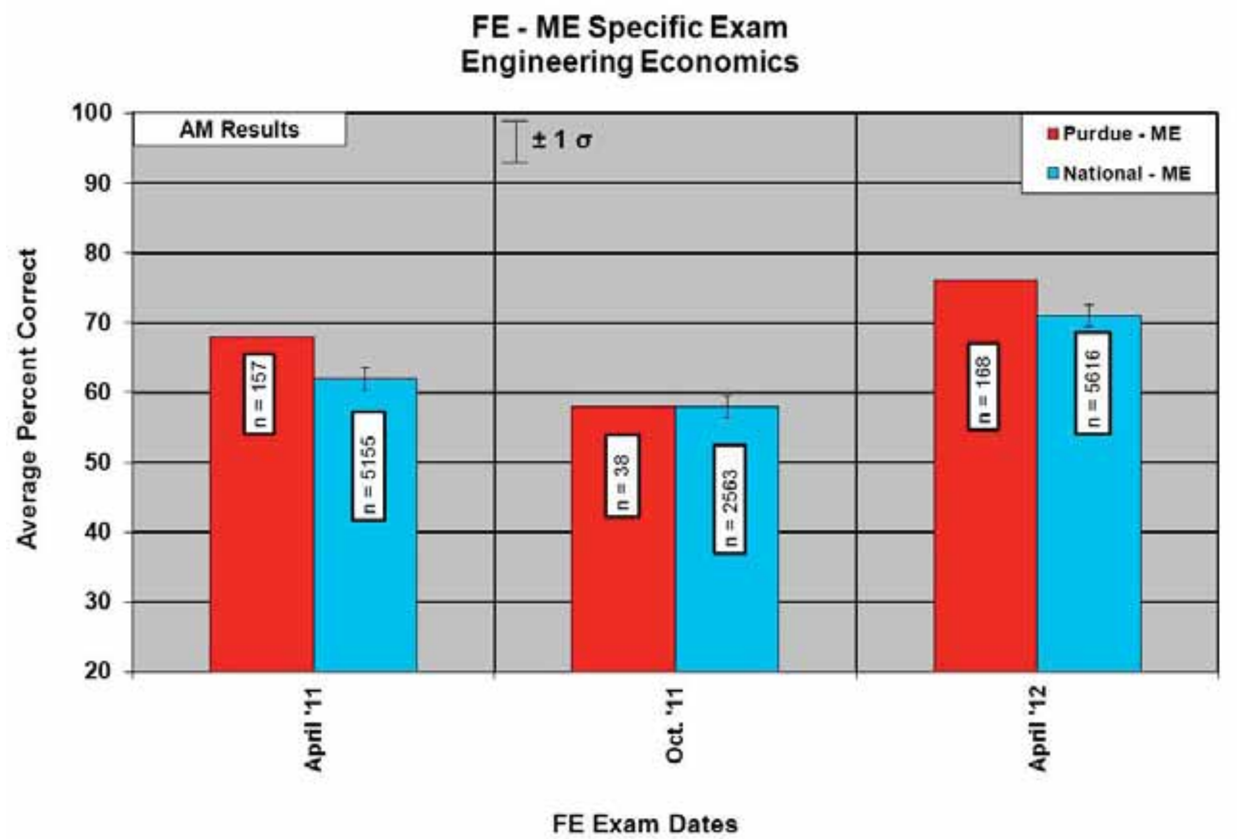


Figure 4.27 Ranking of Effectiveness versus Importance for Outcome A6. Impact of Engineering Solutions for all constituents.



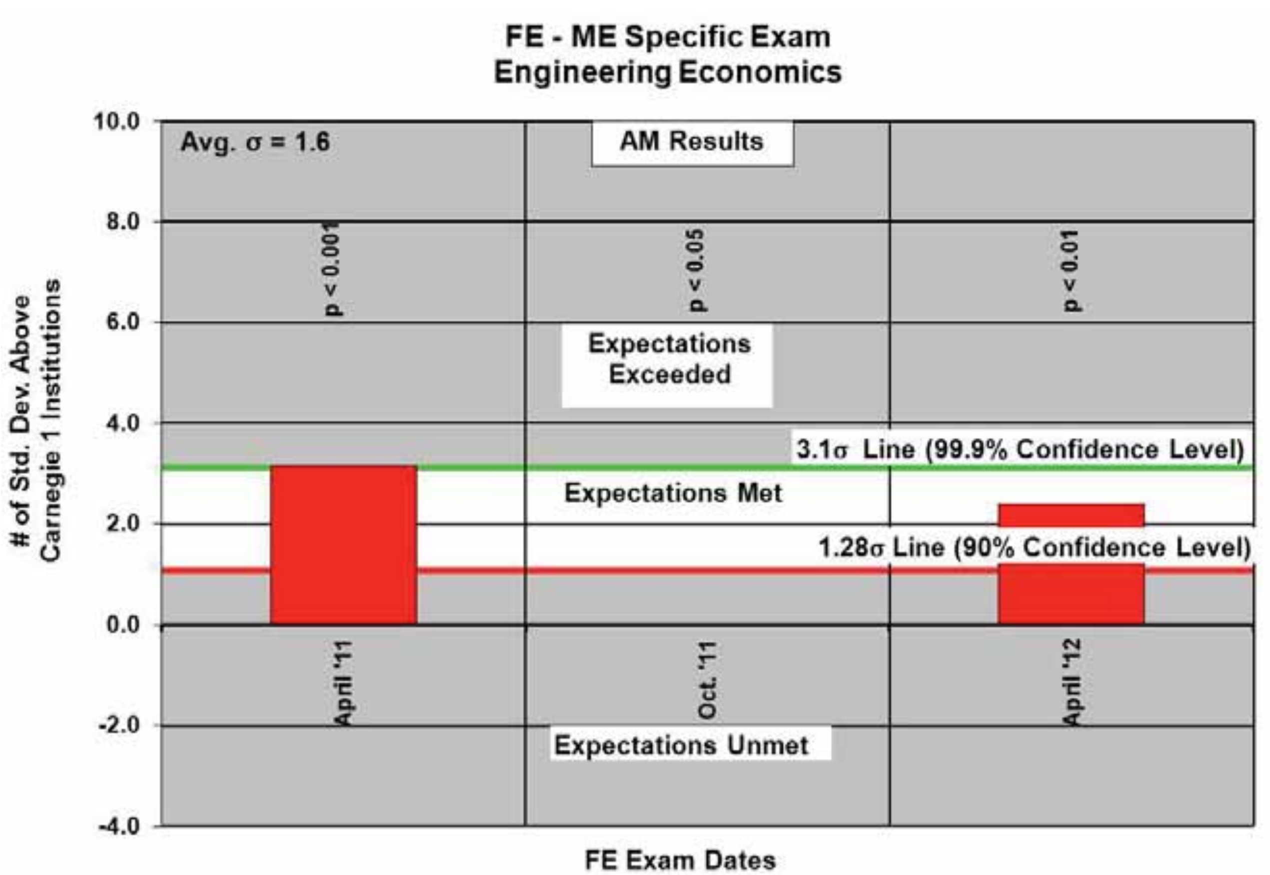


Figure 4.28 FE Exam Results for General Exam – Engineering Economics Subject (2011-2012).

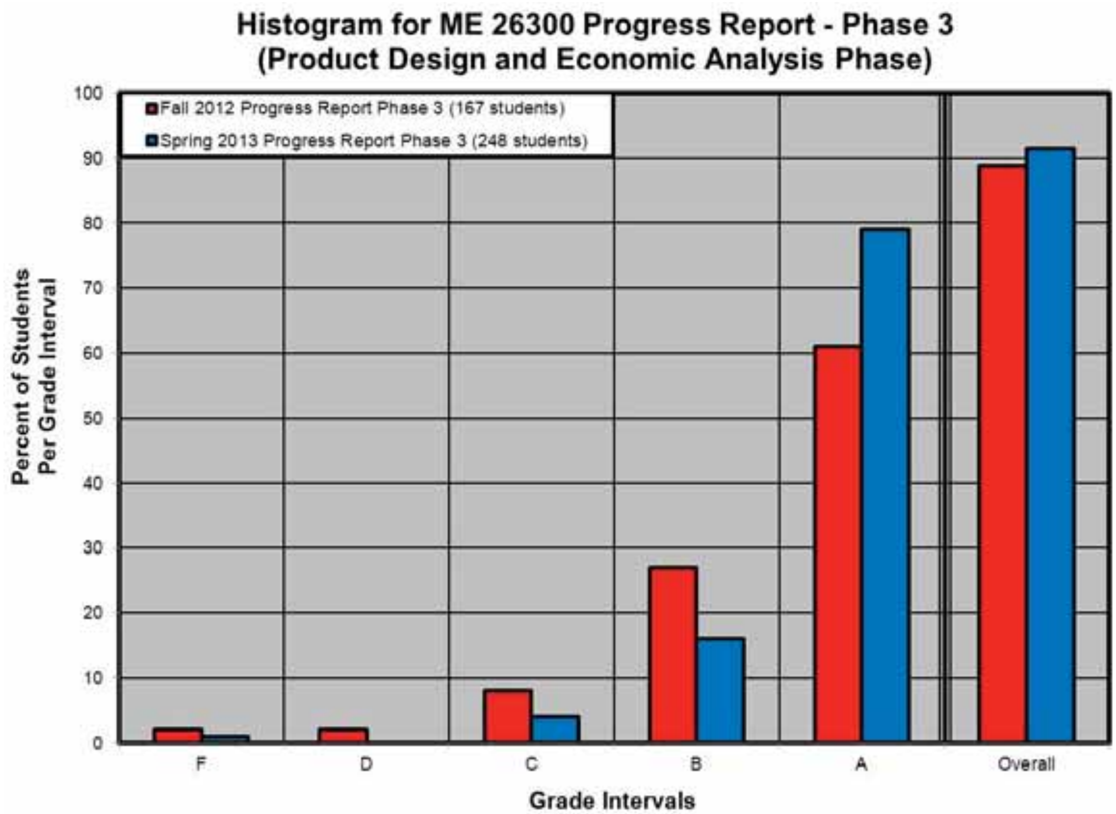


Figure 4.29 Histogram of ME 26300 progress report 3 grades (Product Design and Economic Analysis Phase) for fall 2012 and spring 2013.

4A.9 Program Outcome B1. – Communication Skills (g)

Table 4.7 shows the performance criteria, assessment methods, and level of achievement used to evaluate outcome B1. – Communication Skills. A brief discussion of each of the six assessment methods is presented below.

Table 4.7 Performance Criteria, Assessment Methods, and Minimum Level of Achievement used for Outcome B1. – Communication Skills (g).

B1. Communication Skills (g) Ability to communicate effectively					
Performance Criteria	• Succinctly communicate ideas using oral, written or graphical methods • Organized, persuasive and attuned to the intended audience.				
Assessment Method	**Level of Achievement**	**Date of Data Collection**	**Faculty/Course Assessment Took Place**	**Date of Results Evaluation**	**Evaluation Performed By**
Senior Exit Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/ Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Alumni Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/ Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Employer Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/ Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
ME 26300 Ind. Grades on Oral Reports 1, 2, & 3 (Direct)	80% of Student Teams earn a Grade of "80" or higher	Dec 2012 Apr 2013	Anderson/ME 26300 King/ME 26300	Dec 2012 May 2013	Anderson King
ME 26300 Team Grades on Written Progress Rpts 1, 2, & 3 (Direct)	80% of the Student Teams earn a Grade of "80" or higher	Dec 2012 Apr 2013	Anderson/ME 26300 King/ME 26300	Dec 2012 May 2013	Anderson King

Senior, Alumni, and Employer Surveys: Figure 4.30 shows the longitudinal gap analysis for the three constituents for outcome B1. Communication Skills. Over the past six years the ranking of the communication skills has consistently fallen below expectations despite our best efforts to improve student competency in this important skill set.

Figure 4.31 shows the ranking of importance versus effectiveness of each of our three constituents for outcome B1. Communication Skills for 2012. As expected, each of the constituents ranking fell below the expected performance level. However, this plot illustrates part of the challenge we face in trying to meet expectations. Note that employers, alumni and seniors rank this skill very high in importance. In fact, employers' ranking exceeds the 3.9/4.0 level. This illustrates the high degree of importance that practicing engineers place on communication skills. However, it is impossible for us to exceed expectations and very difficult to meet expectations when an outcome is ranked so high.

On a related note, the ASME Vision 2030 Project has shown some similar results concerning Communication Skills. In their surveys, industrial supervisors and early career Mechanical Engineers rated the strength of graduating BSMEs' Communication Skills as follows:

Supervisors	**Early Career MEs**
43% Sufficient/Strong	75% Sufficient/Strong
52% Weak	17% Weak

In essence, 52% of supervisors ranked BSME graduates' communication skills as weak whereas only 17% of early career practicing ME's ranked their own communications skills as weak. The dissatisfaction with communication skills of BSME graduates by industrial supervisors seems to be a national trend. Communication Skills was the second highest ranked perceived weakness by industrial supervisors, just below practical experience (how devices are made/work).

It is also important to recognize that our best efforts have not been without success. While there is no measureable improvement in the ranking of communication skills, there is a stable performance in this skill over the past six years. This is significant because over the past six years, there has been a 350% jump in international student population (see Figure 4.32). Currently, international students make up over 25% of the ME student body. Of these international students, over 60% are from China. These Chinese students historically experience the greatest cultural delta of any of our international students and experience the greatest difficulty with mastering the English language. The average TOEFL score of the 2013 incoming Chinese students is 95.2. The second largest group of international students is from India and make up about 18% of the international student population on average. As a group these students have much more experience with the English language and thus can more easily benefit directly from the communication opportunities available in the ME Program. This experience is reflected in the 2013 average TOEFL score of 105.1 for the incoming India students. The third largest group of international students is from South Korea and make up about 6% of the international student population. These students are more experienced than the Chinese students, but are not up to par with the students from India. The average TOEFL score for the 2013 incoming Korean students is 98.5. In any case, we have yet to see the full impact of this international student growth.

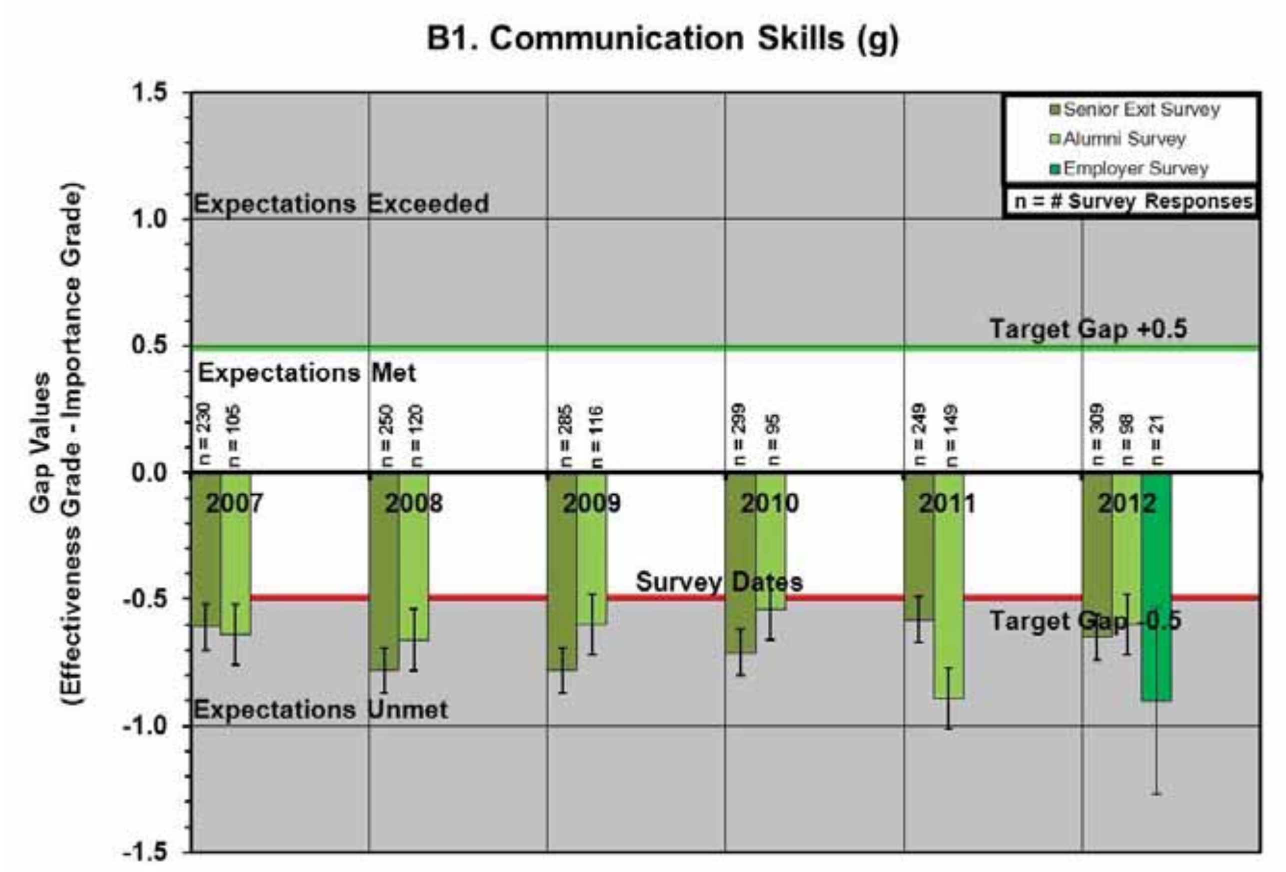


Figure 4.30 Longitudinal Gap Analysis for Outcome B1. Communication Skills (g) from 2007-2012.

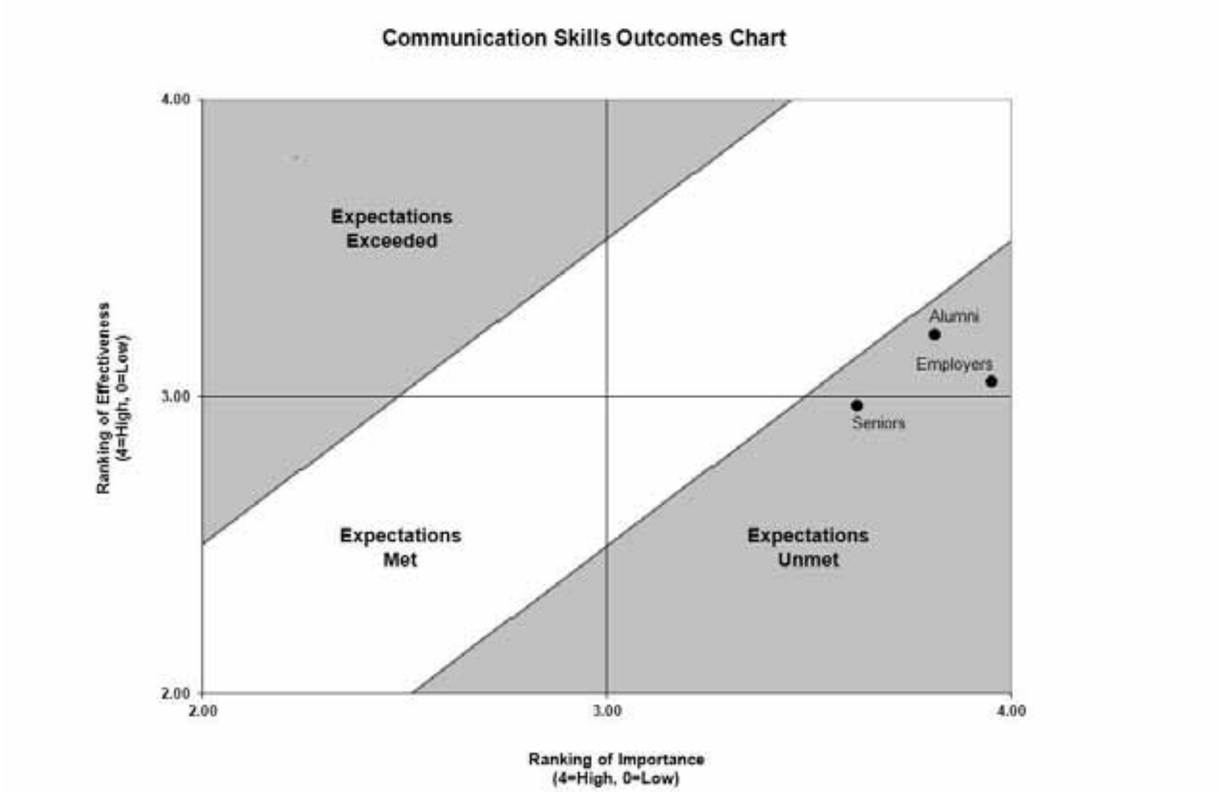


Figure 4.31 Ranking of Effectiveness versus Importance for Outcome B1. Communication Skills for all constituents for 2012.

To provide you with a sense of the communication opportunities made available to students in ME, figure 4.33 shows the ME Communication Experience Matrix, which is essentially a one page summary of the major communication experiences students complete during their BSME degree. As illustrated by this matrix, the communication experiences are numerous and varied, and are integrated across the curriculum. The point of this diagram is to illustrate that there is not a lack of opportunity for students to develop these skills. However, at times students may not be taking full advantage of these opportunities to improve their communication skills. More details of these concerns are presented in the conclusions section.

ME 26300 – Individual Grades on Oral Reports (OR) 1, 2 and 3: Figures 4.34 and 4.35 show the histograms for the ME 263 team grades for oral reports 1, 2 and 3 for fall 2012 and spring 2013. The minimum level of achievement to meet expectations requires 80% of students consistently earning a score of 80 or higher on OR1, OR2, and OR3. To exceed expectations requires 90% of students consistently earning a score of 80 or higher on OR 1, OR2, and OR3. These figures show that the individual performance of the large majority of ME 263 students show consistent improvement over the course of the semester in the area of oral communication. For all three oral reports, students' level of achievement has exceeded expectations in both fall 2012 and spring 2013. These results suggest that the large majority of the students are meeting expectations in the area of oral communication.

ME 26300 Team Grades on Written Progress Reports 1, 2 and 3

Figures 4.36-4.37 show the histograms for the ME 26300 team grades for written progress reports (PR) 1, 2 and 3 for fall 2012 and spring 2013. The level of achievement to meet expectations requires 80% of students consistently earning a grade of "B" or higher on PR1, 2, and 3. To exceed expectations requires 90% of students consistently earning a grade of "B" or higher on PR 1, 2, and 3. These figures show that the team performance of the large majority of ME 26300 groups show consistent improvement over the course of the semester in the area of written communication. In both fall 2012 and spring 2013, the performance on the first written progress report met the expected level of achievement. However, the vast majority of teams showed considerable improvement and exceeded expectations for reports 2 and 3. These results suggest that for the large majority of the students, their written communication skills are improving and meeting expectations.

Conclusions: Given the number of communication assignments in the ME curriculum, it is surprising that communication skills continue to be our lowest ranked outcome from our constituent surveys. The results from ME 26300 illustrate a mixed message that suggests students are meeting expectations in ME 26300, but are below expectations in senior, alumni and employer surveys. After studying this issue over a protracted amount of time, we have arrived at the conclusion that because much of the communication experiences are team oriented, domestic students are often doing a majority of this work, effectively compensating for the weaker skills of the non-native students (as well as weaker domestic student writers) and thus limiting the benefit to these students. The fundamental problem is that many of these non-native students are sufficiently weak in their communicating skills and that it is difficult for them to make meaningful contributions to group reports. While some ME 26300 weekly deliverables are individual deliverables, this in and of itself is not sufficient to bring these students up to the expected level.

On a related note, starting in the fall of 2010, we initiated the Mechanical Engineering Writing Enhancement Program (WEP) as collaboration between the Purdue Writing Lab (run by the English Department) and the Purdue School of Mechanical Engineering to assess and track undergraduate student writing in ME 29000 and ME 26300. Using a combination of error counting, holistic rubrics, analytic rubrics, and interviews with ME faculty, the WEP developed and refined the two analytic rubrics currently being used and twelve custom video-tutorial available online through the Purdue Online Writing Lab. Each semester, writing samples from ME 29000 and memos from ME 26300 have been assessed by the WEP using the various rubrics. The assessment determined that over 30% of the errors made by ME 26300 students were more complex than surface-level errors (basic grammar and mechanics), and the WEP work with the Purdue School of Mechanical Engineering resulted in an 8% reduction in these more complex errors when the error counting was discontinued in the Spring of 2011. In addition, a minimum of 69% of the students in ME 26300 for each semester have displayed improved writing over the course of each semester. Because ME 29000 students only submitted one writing sample, it was not possible to accurately track writing development—instead, the assessment of the ME 29000 writing samples was used to recommend additional writing instruction for weak writers. Further development of the analytic rubric and the video-tutorials is ongoing. One of the main benefits of this effort beyond the rubrics to assess student writing weaknesses has been the on-line video-tutorials. The advantage of this approach is that students can view these tutorials (typically 5 minutes long) as many times as desired. In addition, the TAs (and faculty) can likewise use the videos to learn subtleties of the English language, since many of them are also non-native students. It helps all students develop a solid foundation in writing skills. Nevertheless, students are still not meeting expectations. In the following section, some planned future actions are highlighted.

Future Actions: Several steps have been taken or are in the process of being taken to improve student communication skills. First, the minimum TOEFL score to be admitted to Purdue has been increased from 79 to 88. Second, a new General Studies (GS 490) course on Reading, Writing, and Speaking Skills for International Students is under development. Our hope is that this effort will be expanded to include two such 3 credit courses, one of Reading/Writing and one on Listening/Speaking. Third, there is a proposal to initiate a new summer boot camp for international students to give them a jump start prior to their starting at Purdue. Fourth, there are efforts to initiate special ENGL 106 (English Composition) and COM 114 (Speech) classes designed just for the special needs of non-native students. Finally, a new assessment instrument is being designed to help determine the students with the greatest needs since the integrity of the TOEFL scores are often in question. It is our hope that such efforts can lead to meaningful progress in light of the significant challenges non-native student face in the communication skills area.

This discussion is not to imply that challenges with communication skills are solely a concern for international students. While the magnitude of the concern is smaller, there are still a significant number of domestic students who also struggle with their communication skills. To improve writing skills, the best thing we could do is have them write more (with effective feedback). Our plan is to review SAT Writing score to identify the students who have the greatest need and require them to take ENGL 42100 Technical Writing to gain more practice at writing. This course counts as a technical elective and this this requirement will not require any additional credits of the student to graduate.

Beyond the options discussed above, we are also considering whether it would be helpful in ME 26300 to provide students with good/bad samples of various deliverables from previous semesters to help them better understand what constitutes an effective writing sample. Also, we are contemplating requiring students to prepare outlines of their larger progress reports to help them frame out their reports and prepare topic sentences for each of the paragraphs as a mechanism to help them improve their writing skills (i.e., writing with a purpose and not just writing whatever come to mind) and to learn how to become more effective in collaborative writing. Ultimately, what students need to understand and appreciate is that a good report effectively communicates the key information while minimizing the burden on the reader (not the writer)!

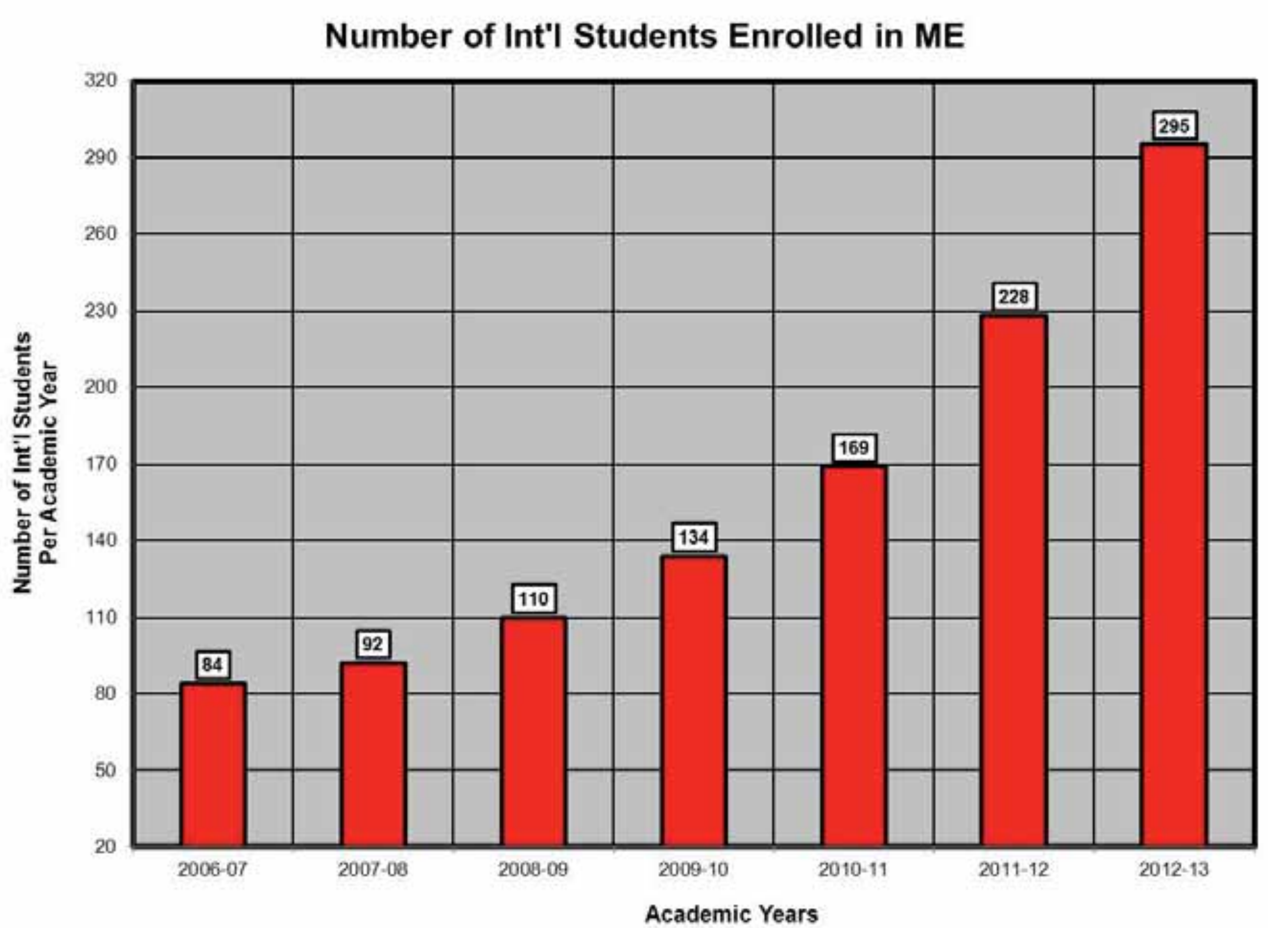


Figure 4.32 Six year longitudinal trends in international student growth in ME.

	Fall Semester	Spring Semester
Fresh. Year	**ENGL 106 First-Year Composition** *Experiential Writing*: In-class Writing; Personal Essay; Argument-Driven Essay; Short Exploratory Essays; Rhetorical Analysis Essay; Proposal; 4-6 Essays 1500-3000 words each (7,500-11,500 words of polished writing) or (15,000-22,000 words including drafts); and at least one multimedia project (podcast, video, website, or photo essay)	**COM 114 Fund. of Speech Communication** *Oral Communications*: Two Informative Speeches; Persuasive speech; Group Persuasive Presentation (6-8 Students/Team);
	CGT 163 Intro. To Graphics for Mfg. *Graphical Communication*: 3-D Basic Models; Hand Sketching; Solid Modeling; Orthographic Projs; Dimensioning and Tolerancing.	**CHM 116 General Chemistry (Science Selective)** *Laboratory Reports*: Two page written reports summarize laboratory work. 12 reports per semester. Teamwork: completed in 4-student teams.
	ENGR 131 Ideas to Innovation I *Memo*: To fictitious client on Open-Ended Problem (2 pp); Two drafts and one final response. *Peer Review*: Critically evaluate others work. Two calibration exercises and then one team review (0.5pp)	**ENGR 132 Ideas to Innovation II** *Executive Summary*: MATLAB GUI Design Proj. (2pp) with peer feedback. *Peer Feedback*: Critically evaluate others work. Score and give written feedback on the Team's solution to the design project.
	CHM 115 General Chemistry *Laboratory reports*: work completed in pairs, written in the laboratory. 12 reports per semester.	**PHYS 172 Modern Mechanics** *Oral Communications:* In laboratory, students work in small groups and each group must make an acceptable oral report to the TA in each of 14 sessions.
Soph Year	**ME 290 Global Engineering Professional Seminar** *Professional Documents and Correspondence*: Professional Correspondence; Persuasive Resume; Short Digital "Distance" Interview; Formal Memo – Ethics Analysis and Response; Professional website (Internet site with navigation, site cover, resume, digital video and technical exhibit); Cultural Values Mapping Assignment (for self and selected peer); Professional Portfolio (with informative, structured peer feedback on individual assignments).	**ME 263 Intro. To ME Design, Innov & Entre.** *Design Project Documentation*: Teamwork (3 to 5 Students/Team), Design Notebook, Customer Survey, weekly memo reports for assigned deliverables, Patent Summary, Benchmarking, Marketing Study, QFD, Problem Definition, Functional Decomposition, Brainstorming, Concept Evaluation, Modeling, Product Design, Selection Design, Bill of Materials, Assembly/Parts Drawings, Performance Analysis, Assembly Analysis, Economic Analysis, Progress Reports, (10 pp. + App.), Final Report (10 pp. + App.), Design Review (15 min).
Junior Year	**ME 309 Fluid Mechanics** *Laboratory Reports*: (approx. 9 @ 4-6 pp. Each) Brief Narrative of Procedure, Measured Data, Reduced and Analyzed Data, Plotted Results with Discussion and Conclusions.	(ME 263 continued)
	ME 365 Systems and Measurements *Focused Technical Communications and Summaries:* Executive Summaries, Memos, Letters, Informal Team Presentations, Short Project (Formal Presentation, Memo), Short Answer Communications.	**ME 352 Machine Design I** *Design Project Documentation:* Informal Reports –1 (ind.). Design a working model of a mechanism & 5-10 page report plus App.; Formal Reports – 2 (ind.) 15-20 pages plus App.; Memo Reports in lab; Oral reports in lab; Typically no group projects.
Senior Year	**ME 315 Heat and Mass Transfer** *Laboratory and Project Reports*: Laboratory Experiment Written Reports (5-6 Reports, Individual); Team Project Activities – One Progress Report (oral and/or written); Final Report (oral and written).	**ME 463 Engineering Design** *Design Project Documentation*: Teamwork (3-5 Students/Team), Students document on their own design process; design notebooks, 3 Project Reports (10 pp. + App.); 3 Project Presentations (15-20 min.), CAD drawings, Final Poster Show
	ME 452 Machine Design II* *Design Project Documentation*: Teamwork (2 students/Team on 2nd project), Formal Design Reports (2 @ 15 pp. + App., 1 Individual, 1 Team (2 students/team), CAD Drawings.	**ME 475 Automatic Control Systems*** *Laboratory and Projects Reports*: Laboratory reports (9 @ 3-5 pp, Individual): Summary of laboratory objectives, results, and conclusions, supported by graphical output. Project Report (1 @ 10 pp., Individual): Detailed description of design approach, results, and conclusions, with supporting documentation.
*Restricted Electives (i.e., students required to take 2 of these 3 courses and may elect to take all 3.)		

Figure 4.33 ME Communication Experience Matrix.

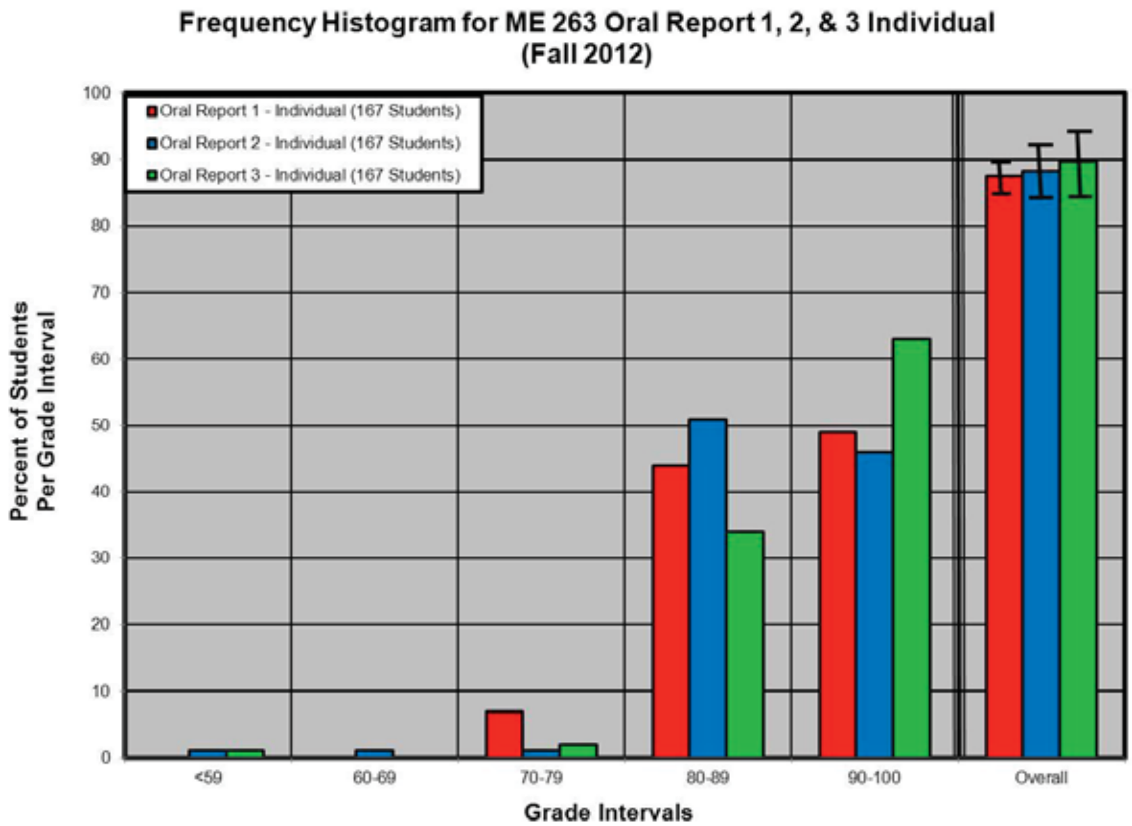


Figure 4.34 Histogram for ME 26300 individual oral reports 1, 2 and 3 grades for fall 2012.

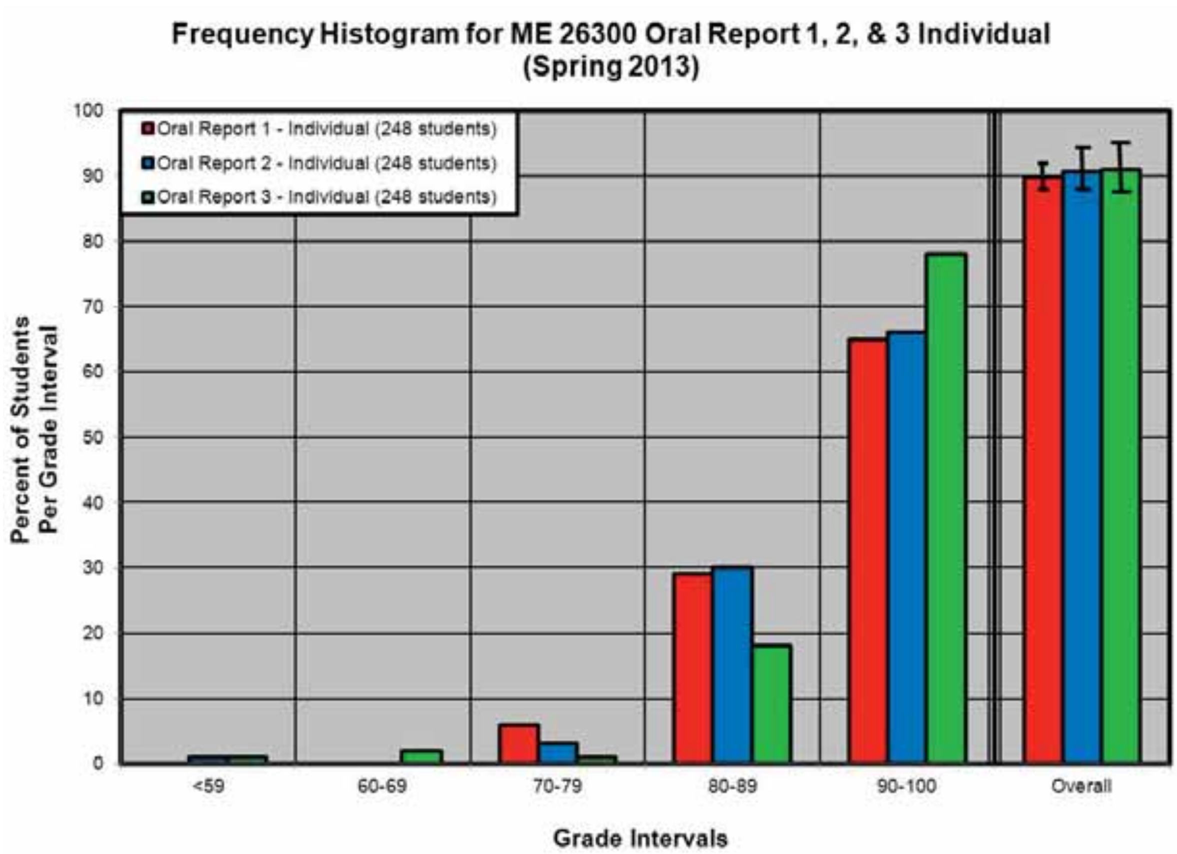


Figure 4.34 Histogram for ME 26300 individual oral reports 1, 2 and 3 grades for spring 2013.

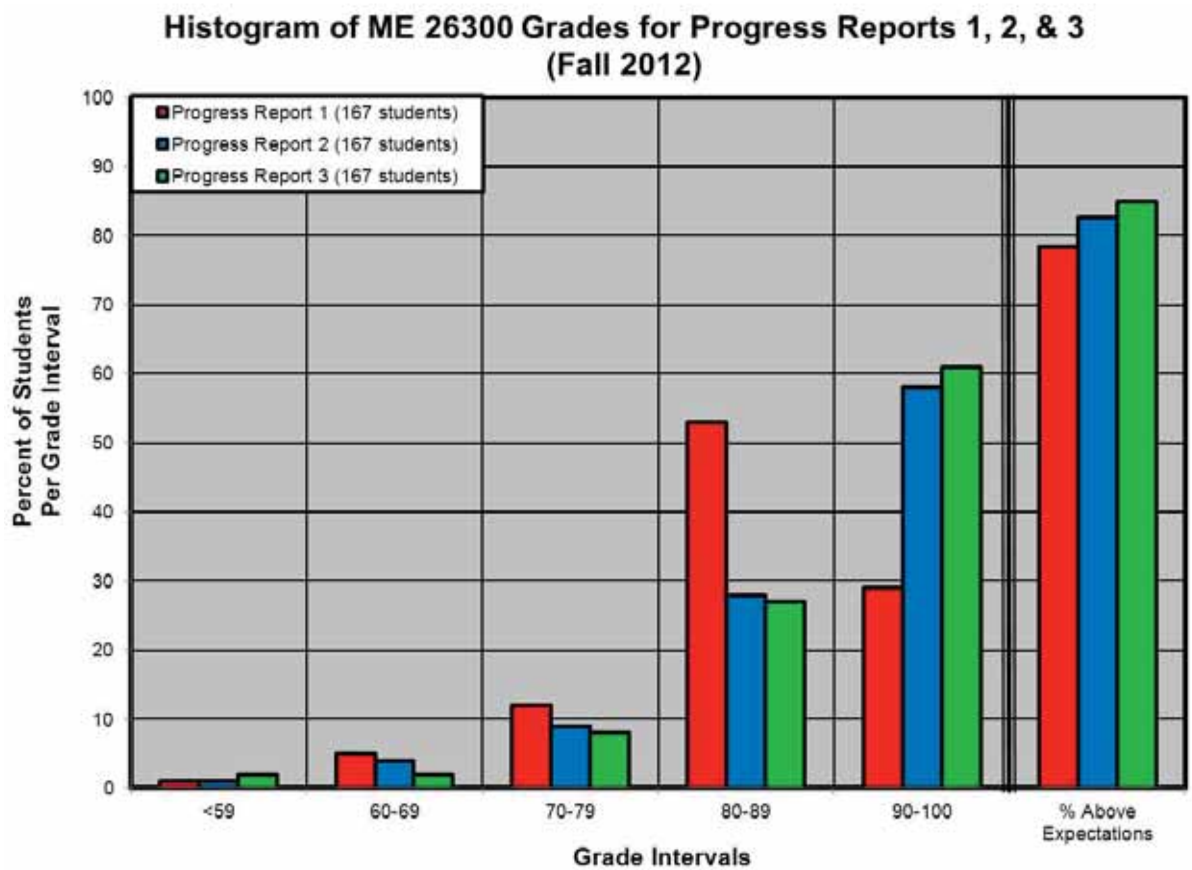


Figure 4.36 Histogram of ME 26300 grades for progress reports 1, 2 and 3 for fall 2012.

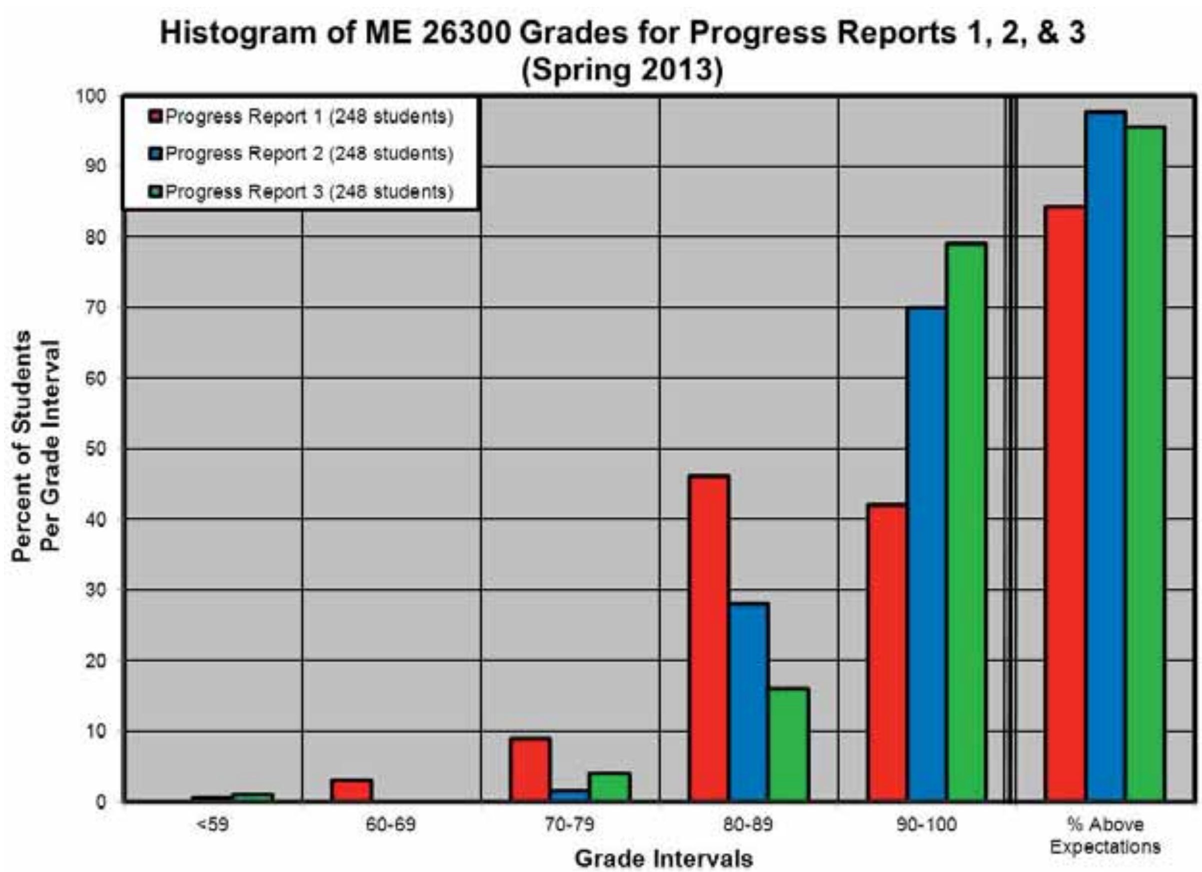


Figure 4.37 Histogram of ME 26300 grades for progress reports 1, 2 and 3 for spring 2013.

4A.10 Program Outcome B2. – Teamwork Skills (d)

Table 4.8 shows the performance criteria, assessment methods, and level of achievement used to evaluate outcome B2. – Teamwork Skills (d). A brief discussion of each of the five assessment methods is presented below.

Table 4.8 Performance Criteria, Assessment Methods, and Minimum Level of Achievement used for Outcome B2. – Teamwork Skills (d).

B2. Teamwork Skills (d) Ability to function on multidisciplinary teams					
Performance Criteria	• Constructively collaborate with culturally diverse members of a team to achieve an assigned goal in a timely manner. • Constructively collaborate with professionally diverse members of a team to achieve an assigned goal in a timely manner.				
Assessment Method	**Minimum Level of Achievement**	**Date of Data Collection**	**Faculty/Course Assessment Took Place**	**Date of Results Evaluation**	**Evaluation Performed By**
Senior Exit Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/ Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Alumni Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/ Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Employer Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/ Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
ME 26300 Team Grades in Oral Pres 1, 2, & 3 (Direct)	80% of Student Teams earn a Grade of "80" or higher	Dec 2012 Apr 2013	Anderson/ME 26300 Reid/ME 26300	Dec 2012 May 2013	Anderson King
Teamwork Rubric (Direct)	80% of students score at the "acceptable" level or higher	Apr 2013 Apr 2013	Reid/ME 26300 Starkey/ME 46300	May 2013	Jim Jones

Constituent Surveys: Figure 4.38 shows the longitudinal gap analysis for the three constituents for outcome B2. Teamwork Skills (d). Over the past six years the ranking of the teamwork skills has consistently met expectations for all three constituents.

Figure 4.39 shows the ranking of importance versus effectiveness of each of our three constituents for outcome B2. Teamwork Skills (d) for 2012. As with communication skills, this plot illustrates that constituents rank this skill as very important (roughly 3.8/4.0 for employers), again making it impossible to exceed expectations and difficult to meet expectation. This illustrates the high degree of importance that practicing engineers place on teamwork skills.

ME 26300 Team Grades on Oral Reports (Presentations) 1, 2 and 3 (Teamwork Comp.)
Figures 4.40 and 4.41 show the histograms for the ME 26300 team grades for oral reports 1, 2 and 3 teamwork component for fall 2012 and spring 2013. The level of achievement to meet expectations requires 80% of students consistently earning a grade of 80/100 or higher on the teamwork component of the Oral Reports (OR) 1, 2, and 3. To exceed expectations requires 90% of students consistently earning a grade of 80/100 or higher on OR 1, 2, and 3. These figures show that the team performance of the large majority of ME 263 groups show clear and consistent improvement in their teamwork skills over the course of the semester. For all three oral reports, student teams' level of achievement have met or exceeded expectations in all three reports in fall 2012 and spring 2013. These results suggest that for the large majority of the students, their teamwork skills are improving to the level of either meeting or exceeding expectations.

ME 26300/ME 46300 Teamwork Rubrics: Figures 4.42-4.44 show the frequency histograms for the ME 26300 teamwork rubric for spring 2013 for phase 1, phase2, and phase 3 respectively. The level of achievement to meet expectations requires 80% of students consistently earning an "acceptable" score of higher by the rater. To exceed expectations requires 90% of students consistently earning an "acceptable" score or higher by the rater. Students met or exceeded expectations for ME 26300 in all phases of the course. Comparing the three phases of the course, a notable improvement in the teamwork ratings, while not dramatic, is apparent. Also, student seemed to do better than average in earning the trust of their teammates, but worse than average in respecting their teammates. The new trend toward having a large international student population further complicates the team dynamics because of the cross-cultural differences between students..

Figure 4.45 shows the frequency histograms for the ME 46300 teamwork rubric for spring 2013. Students exceeded expectations on their teamwork ratings in all categories. In this case, students did better than average in being actively engaged and worse than average in respecting their teammates. The notable increase in being actively engaged is likely due to the ability to select the project they want to work on (in contrast to ME 26300, where the project is defined for them). Comparing the ME 26300 and ME 46300 results, the obvious difference is the dramatic increase in the number of students rated as very effective. On a related note, there are notably fewer students in the ineffective or very ineffective categories.

Conclusions: The results from the constituent surveys, the ME 26300 oral reports (teamwork component), and the ME 26300/ME 46300 teamwork rubric, illustrate that students consistently meet or exceed the expected level of achievement of for outcome B2. Teamwork.

Future Actions: No future actions are planned at this time.

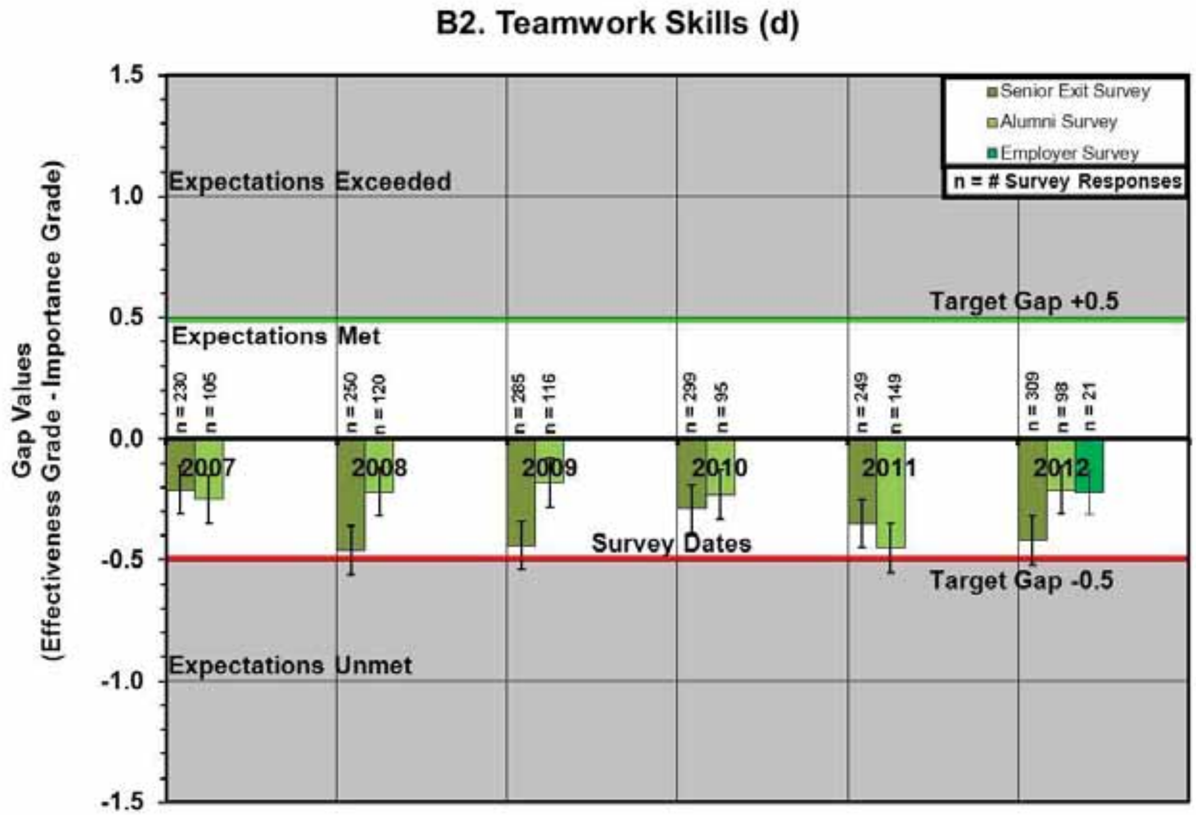


Figure 4.38 Longitudinal Gap Analysis for Outcome B2. Teamwork Skills (d) from 2007-2012.

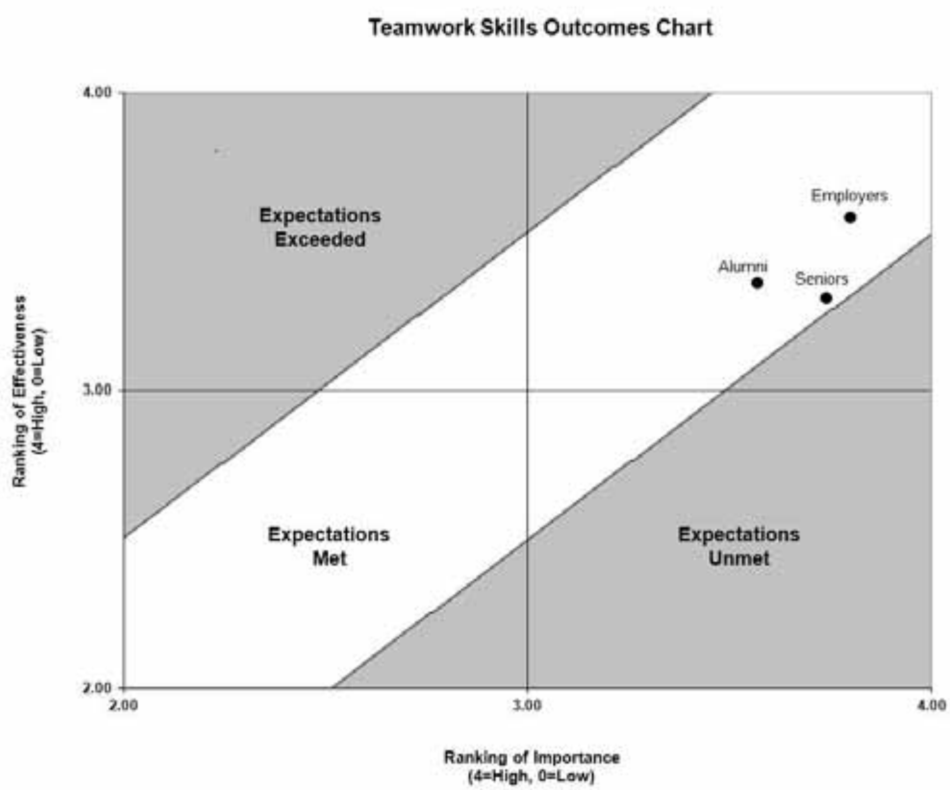


Figure 4.39 Ranking of Effectiveness versus Importance for Outcome B2. Teamwork for all constituents for 2012.

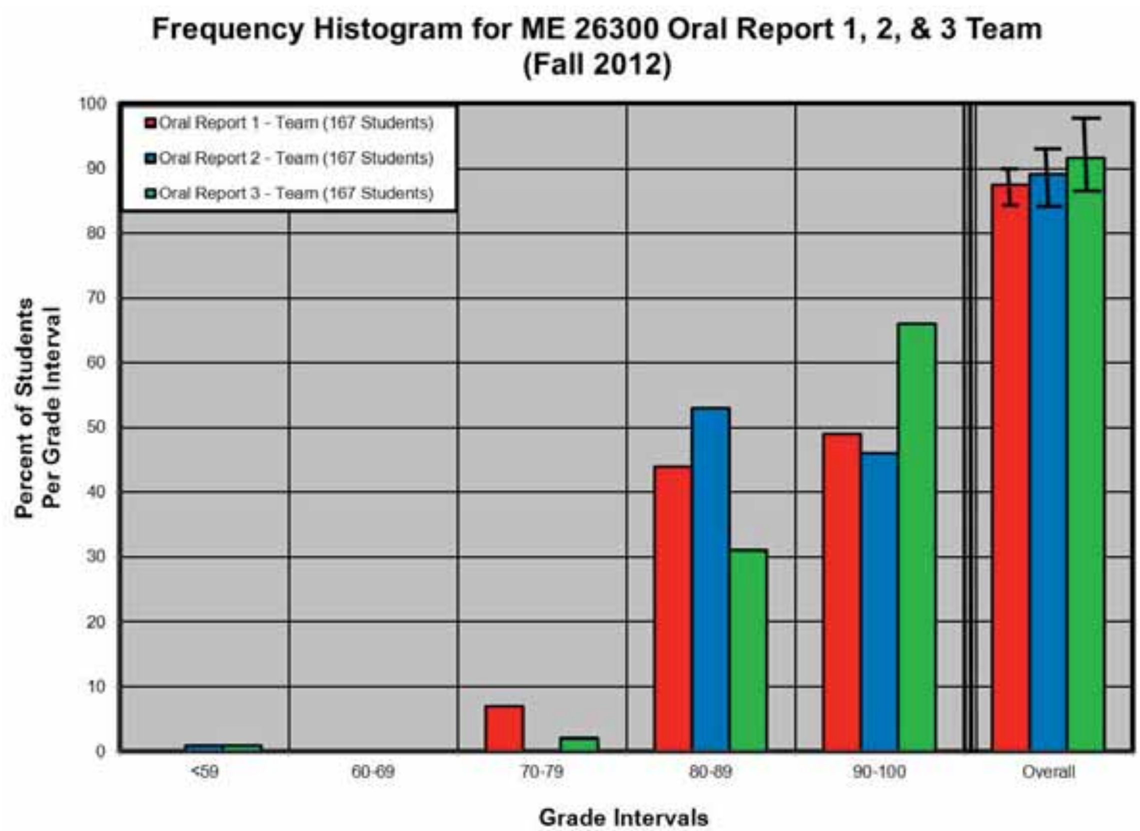


Figure 4.40 Histogram of ME 26300 team oral reports 1, 2, and 3 for fall 2012.

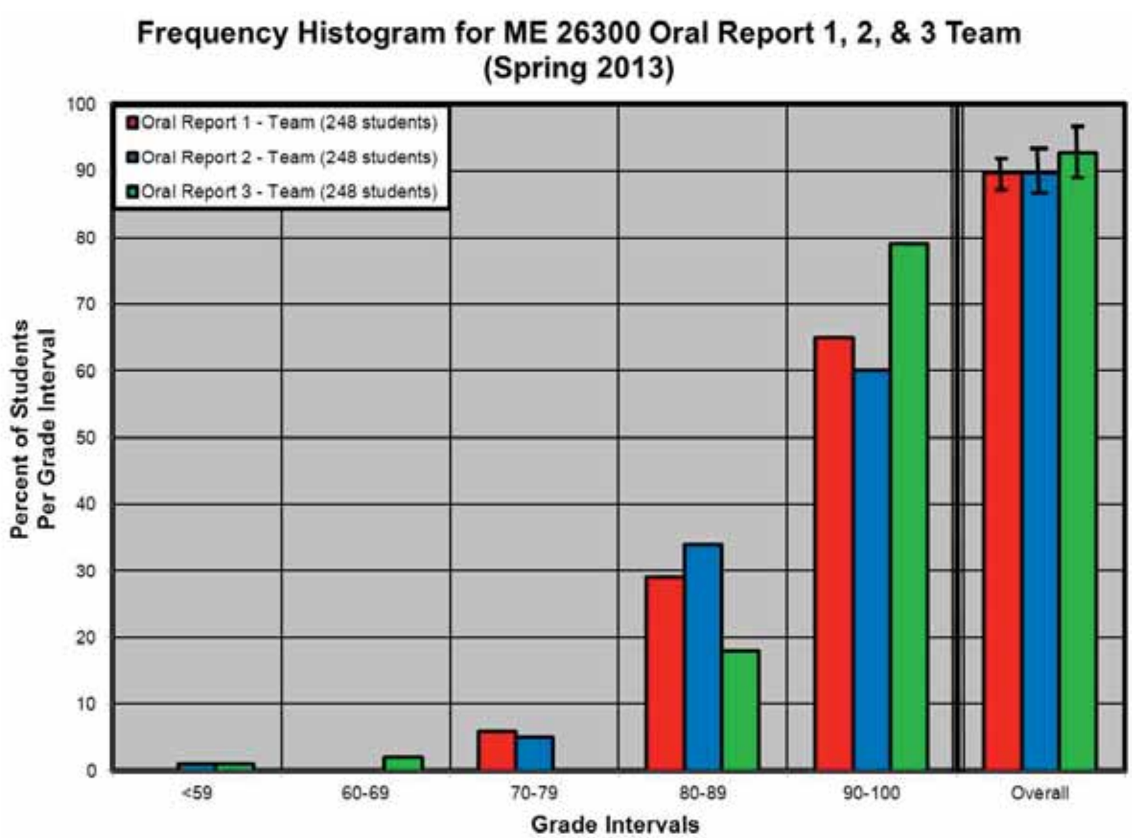


Figure 4.41 Histogram of ME 26300 Team Oral Reports 1, 2 and 3 for spring 2013.

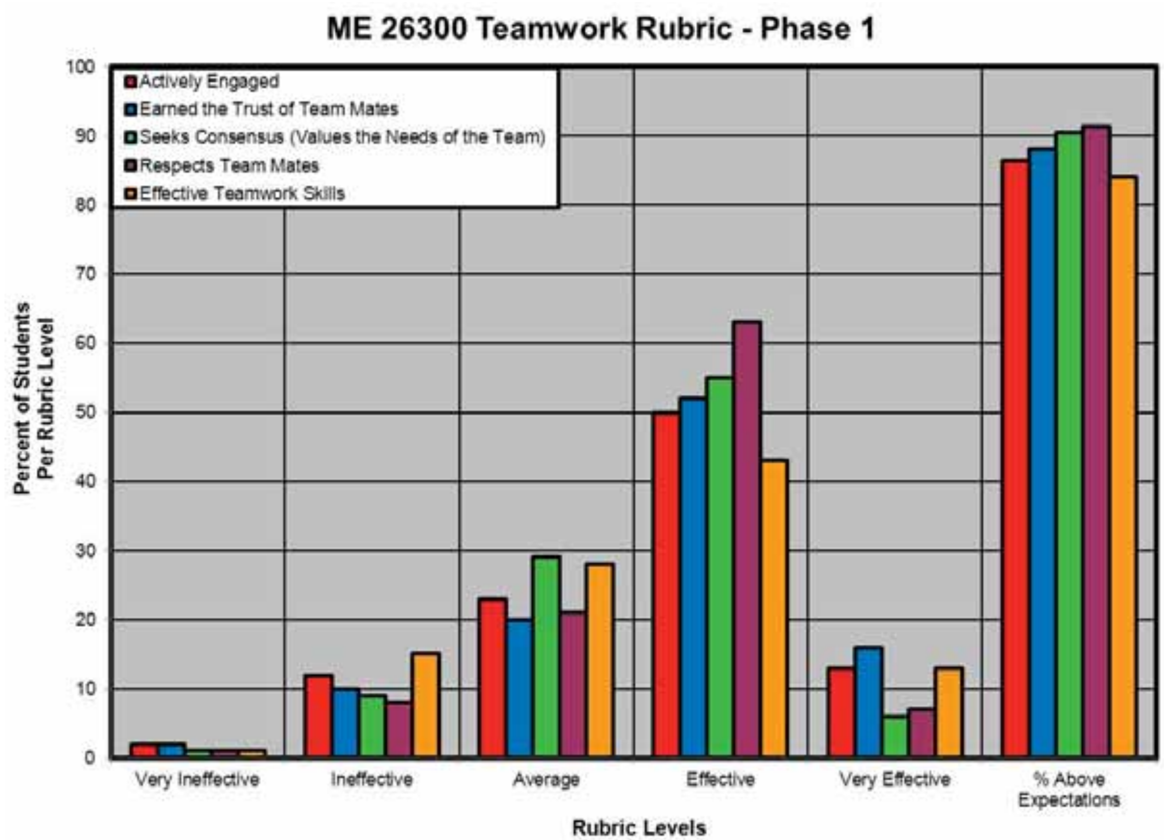


Figure 4.42 Histogram of ME 26300 Teamwork Rubic Results for Phase One in spring 2013.

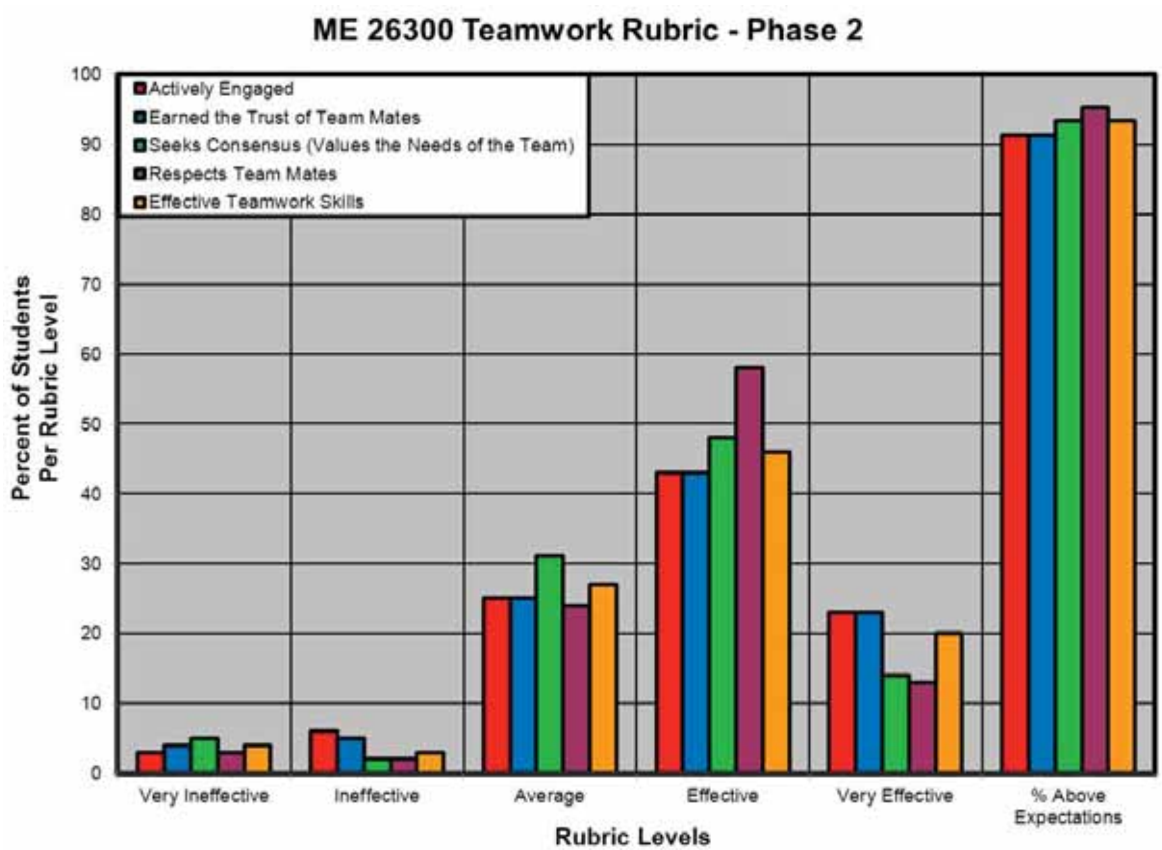


Figure 4.43 Histogram of ME 26300 Teamwork Rubic Results for Phase Two in spring 2013.

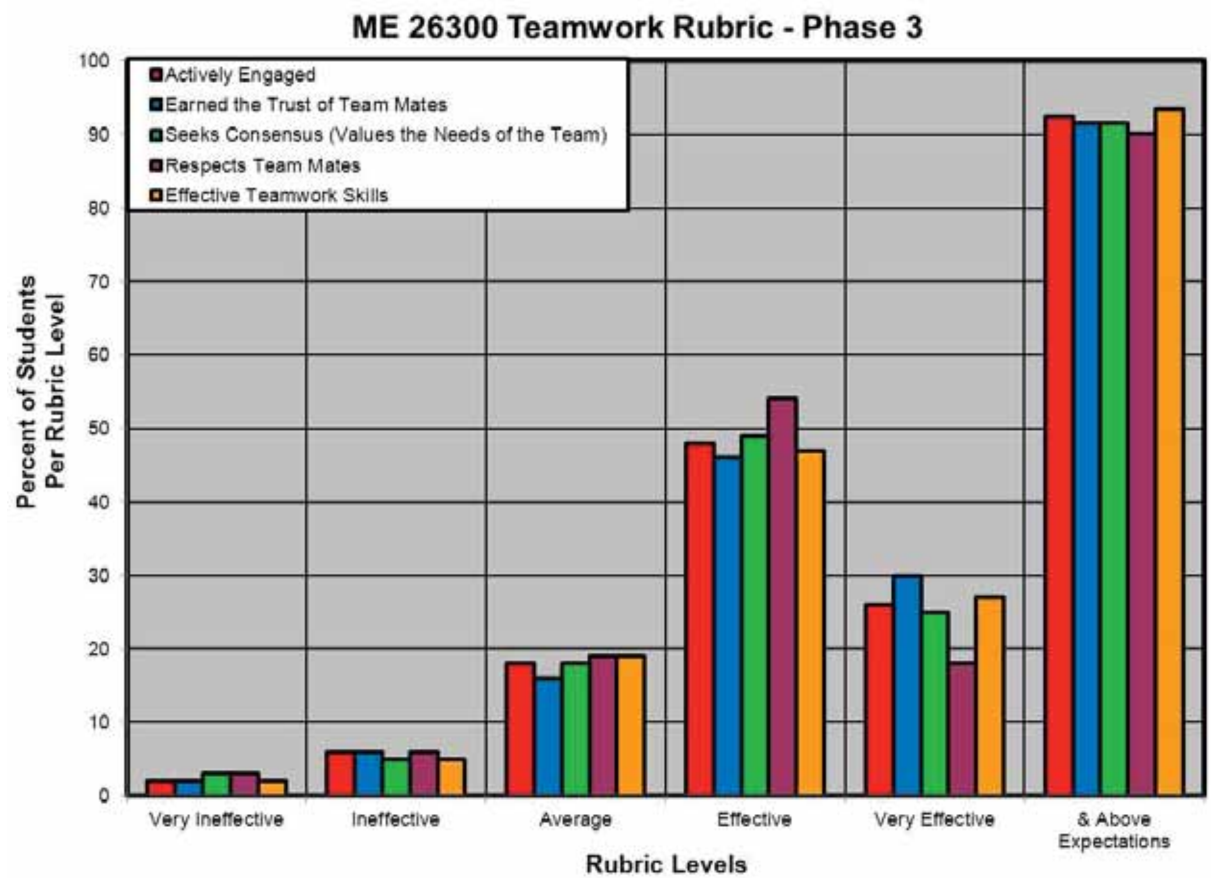


Figure 4.44 Histogram of ME 26300 Teamwork Rubric Results for Phase Three in spring 2013.

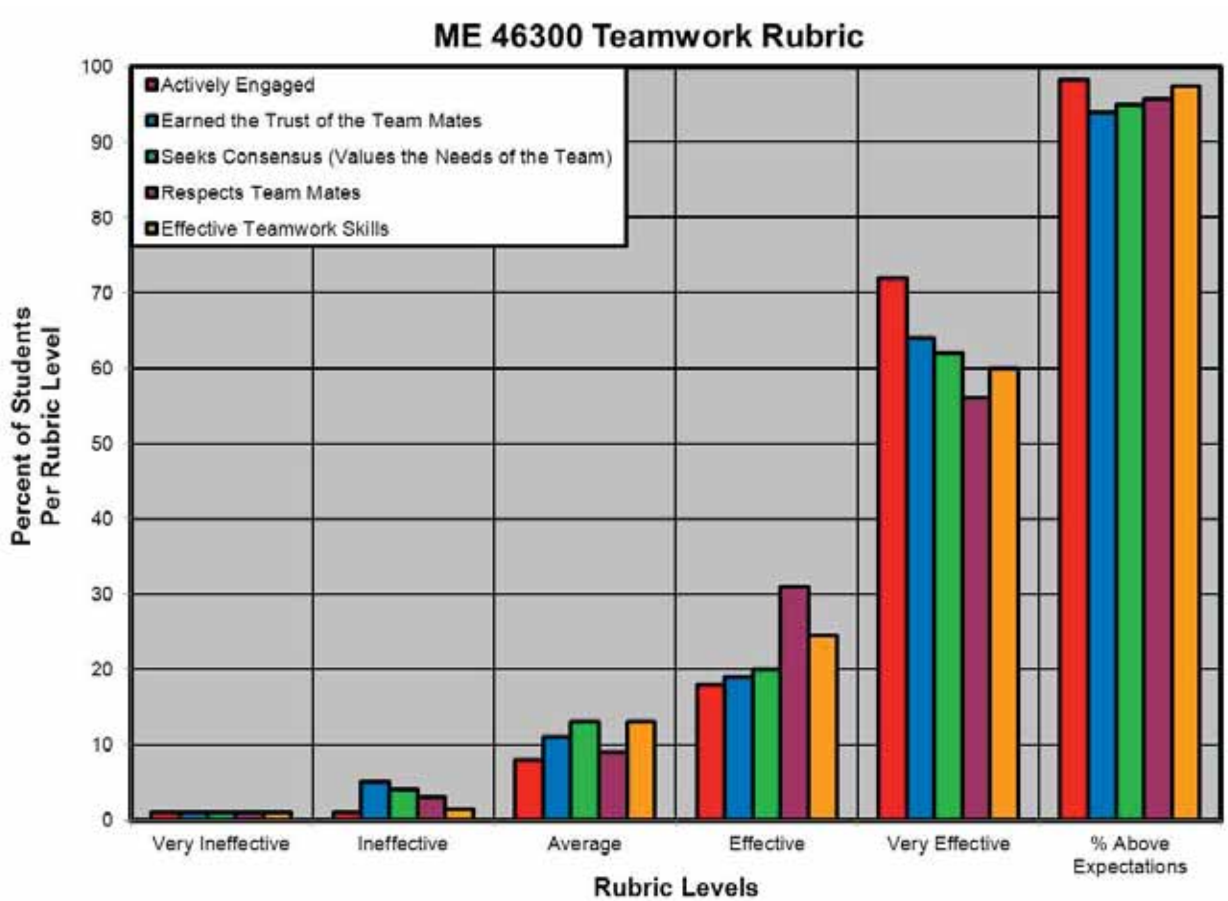


Figure 4.45 Histogram of ME 46300 Teamwork Rubic Results for spring 2013.

4A.11 Program Outcome B3. – Professional/Ethical Responsibility (f)

Table 4.9 shows the performance criteria, assessment methods, and level of achievement used to evaluate outcome B3. – Professional/Ethical Responsibility. A brief discussion of each of the five assessment methods is presented below.

Table 4.9 Performance Criteria, Assessment Methods, and Minimum Level of Achievement used for Outcome B3. – Professional/Ethical Responsibility (f).

B3. Professional and Ethical Responsibility (f) Understanding of professional and ethical responsibility.					
Performance Criteria	• Able to apply an ethical framework in global, social, intellectual and technical contexts. • Recognizes the importance of cross-cultural differences on engineering solutions.				
Assessment Method	**Minimum Level of Achievement**	**Date of Data Collection**	**Faculty/Course Assessment Took Place**	**Date of Results Evaluation**	**Evaluation Performed By**
Senior Exit Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Alumni Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Employer Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
FE Exam – Ethics and Bus. Practices (Direct)	80% correct or 1.28σ above National Avg.	April 2011 Oct 2011 April 2012	N/A	Jan 2013	Curriculum Committee
ME 29000 Global Professional Profile (Direct)	80% of Students earn a Score of 80 or higher	Dec 2012 May 2013	Atkinson/ME 29000 Atkinson/ME 29000	Dec 2012 May 2013	Atkinson Atkinson

Senior, Alumni, and Employer Surveys: Figure 4.46 shows the longitudinal gap analysis for the three constituents for outcome B3. Professional and Ethical Responsibility (f). Over the past six years the ranking of the professional and ethical responsibility outcome has consistently met expectations for all three constituents.

Figure 4.47 shows the ranking of importance versus effectiveness of each of our three constituents for outcome B3. Professional and Ethical Responsibility (f) for 2012. Interestingly, employers rated the importance of this outcome significantly higher than seniors or alumni, but also rated seniors' effectiveness in this outcome significantly higher than either seniors or alumni. While we strongly emphasize the importance of ethical and professional conduct throughout the ME Program, it seems to take time for seniors and alumni to fully appreciate the gravity and significance of this in their careers. As alumni advance in their careers, they gain a greater appreciation for the importance of professional and ethical responsibility. As we often remind students, the decisions we make as engineers can have life and death implications.

FE Exam – Ethics and Business Practices: One direct measure we have of this outcome is students' performance on the Ethics and Business Practices section of the FE exam. Figure 4.48 shows Purdue students' performance on the Ethics and Business Practices subject from the FE exam for the April 2011, October 2011 and April 2012 offerings. The results from the FE exam were mixed. In the October 2011 and April 2012 offerings, Purdue ME students met expectations. In April 2011, they did not meet expectations. This unusual fluctuation seemed to merit further study. We purchased a copy of the FE Review Manual, 2nd edition by Michael Lindeburg. We copied the ethics diagnostic exam and gave it to our ME Curriculum Committee. We then scored our exams together and discussed the results. Interestingly, our ME faculty scored lower on the ethics diagnostics exam than our students did on the FE exam. We proceeded to go through the "correct answers" one-by-one and discuss them to understand the discrepancies. We came to the conclusion that the majority of the questions were well posed and had clear "correct" solutions. However, there were a small number of ethics questions that were ill-posed and our faculty disagreed with the "correct answer," even after reading the authors rational for their solution. In other cases, faculty not only disagreed with the "correct solution", but also each other. From this experience, it was not surprising to see our student's performance fluctuate on this Ethics and Business Practices section. We would expect our students to (in most cases) correctly answer 70-75% or more of the questions "correctly." However, on the other (ambiguous) questions, student responses will depend on their interpretation of the problem. Hence, we would expect students to sometimes perform slightly above the norm and sometimes slightly below the norm. Our data seems to support this hypothesis. Hence, based on this greater insight, we feel students' performance on the Ethics and Business Practices section of the FE exam does meet our expected level of achievement.

ME 29000 – Global Professional Profile Assignment: Figures 4.49 shows the frequency histograms for the ME 29000 Global Professional Profile assignment. In this assignment, students are expected to prepare a 1000 word profile about them, including a personal introduction as well as description of their credentials, experience and career plans. The document also includes a section on professional interests, professional ethics, global vision and future career goals. Regarding the ethics section, the students are expected to comment on an ethical dilemma they have faced; not a right/wrong issue, but a right/right issue. One of the more common issues students write about is quality vs. delivery. Many students in their internships are often pushed to complete projects quickly. At times this can negatively affect the quality of the product. They discuss this tension in light of their circumstances and address how they resolved this dilemma.

The level of achievement to meet expectations requires 80% of students consistently earning an 80 or higher on this assignment. To exceed expectations requires 90% of students consistently earning 80 or higher on the assignment. In fall 2012 and spring 2013 students exceeded expectations on this assignment in fall 2012, but were below expectations in spring 2013. Performance in the fall tends to be stronger because this is the “on-semester” for ME 29000 and thus generally has academically stronger students in the course. Nevertheless, overall, ME students as a group meet expectations on this outcome.

Conclusions: Based on the collective results from the constituent surveys, the FE exam (Ethics and Business Practices section), and the ME 29000 – Global Professional Profile assignment, this data consistently support the conclusion that students meet the expected level of achievement for outcome B3. Professional and Ethical Responsibility. The primary recent change that we have made in this area is to adapt our ethics assignment in ME 29000 to have a global emphasis, which fits with our newly changed emphasis in ME 29000.

Actions Taken: No future actions are being planned at this time.

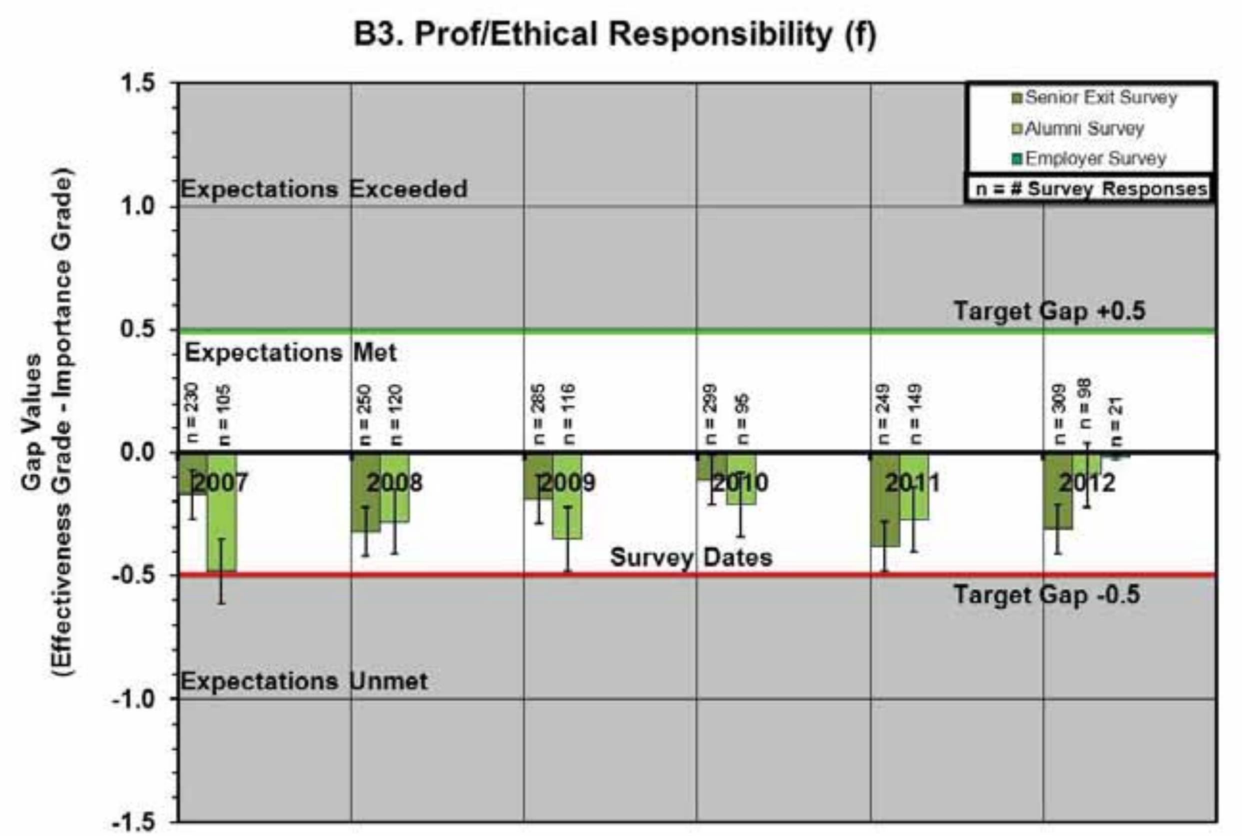
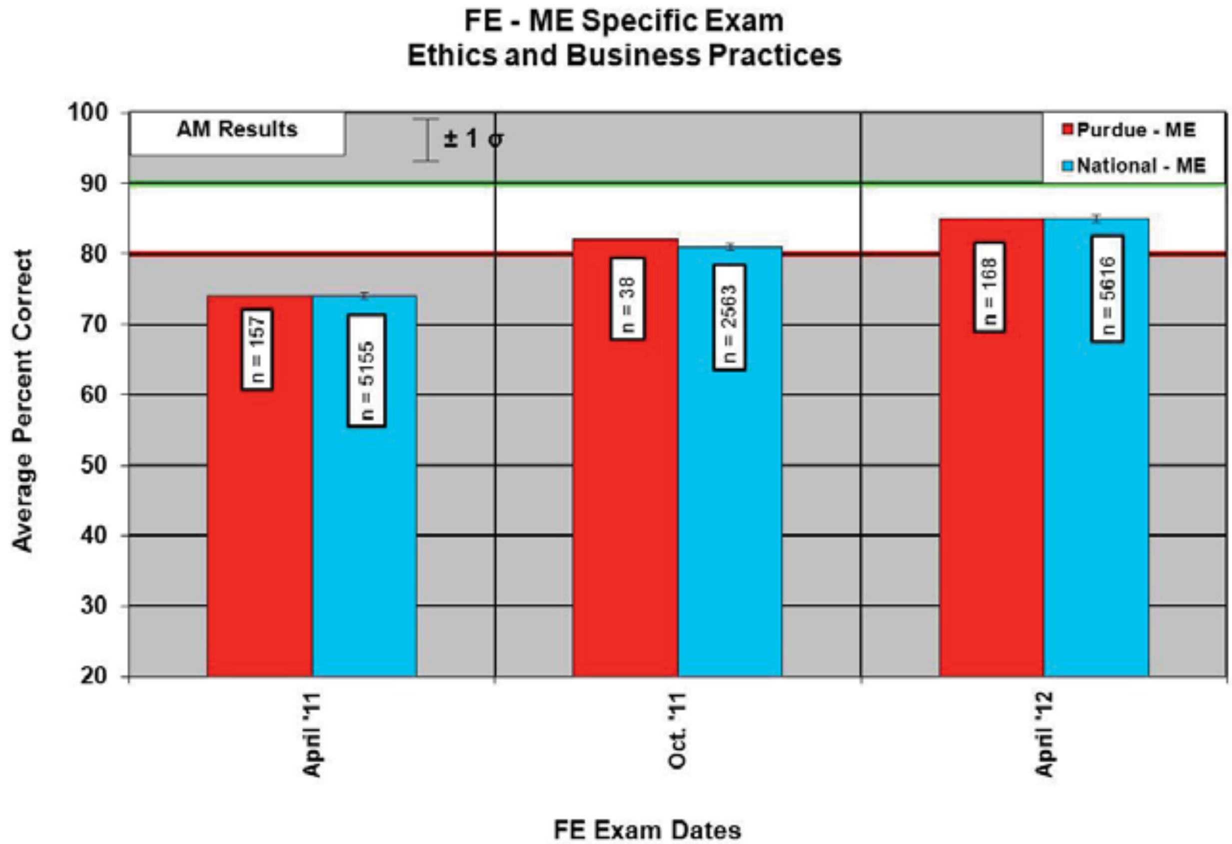


Figure 4.46 Longitudinal Gap Analysis for Outcome B3. Professional and Ethical Responsibility (f) from 2007-2012.

Figure 4.47 Ranking of Effectiveness versus Importance for Outcome B3. Professional and Ethical Responsibility (f) for all constituents for 2012.



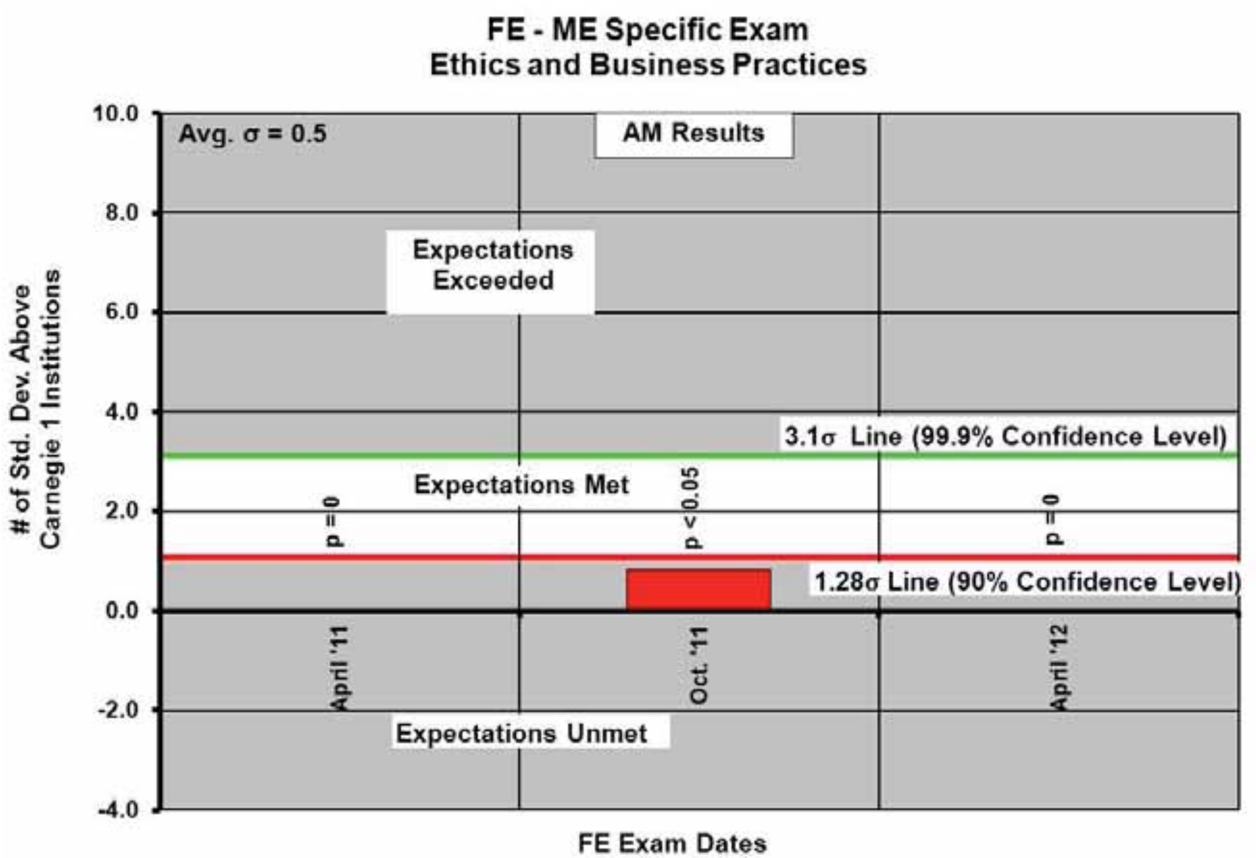


Figure 4.48 FE Exam Results for General Exam – Ethics and Business Practices Subject (2011-2012).

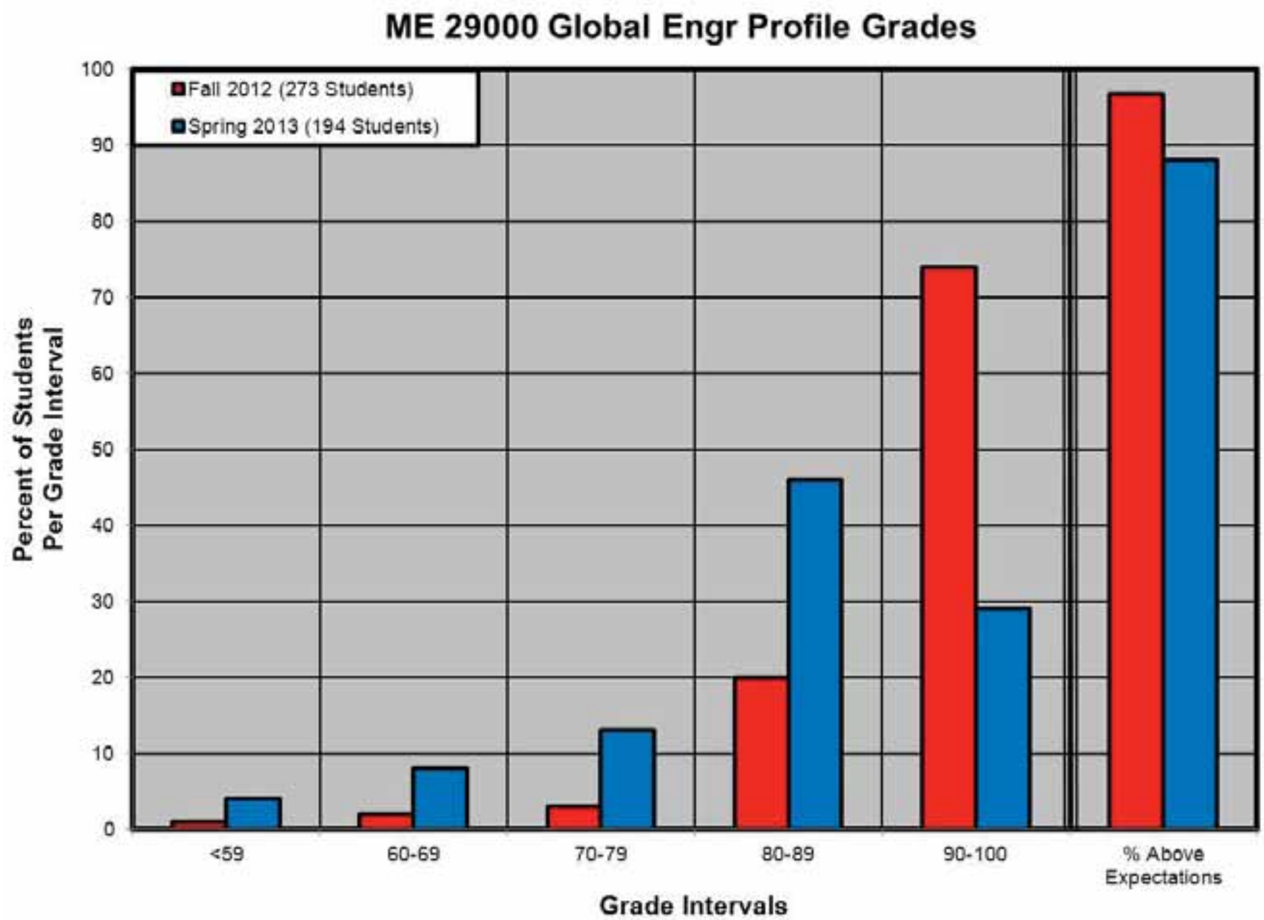


Figure 4.49 Histogram of Global Engineering Profile Assignment in ME 29000 for fall 2012 and spring 2013.

4A.12 Program Outcome B4. – Contemporary Issues (j)

Table 4.10 shows the performance criteria, assessment methods, and level of achievement used to evaluate outcome B4. – Contemporary Issues (j). A brief discussion of each of the six assessment methods is presented below.

Table 3.21 Performance Criteria, Assessment Methods, and Level of Achievement used for Outcome B4. – Contemporary Issues (j).

B4. Contemporary Issues (j) Knowledge of contemporary issues.					
Performance Criteria	• Recognizes the need to be informed about contemporary issues. • Exhibits a desire and ability to stay informed about contemporary issues.				
Assessment Method	**Level of Achievement**	**Date of Data Collection**	**Faculty/Course Assessment Took Place**	**Date of Results Evaluation**	**Evaluation Performed By**
Senior Exit Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Alumni Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Employer Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
ME 29000 Quizzes 1, 2, and 3 on Zakaria book (Direct)	70% of Students earn a Score of 70 or higher	Dec 2012 April 2013	N/A	Jan 2013 May 2013	Jones Jones

Senior, Alumni, and Employer Surveys: Figure 4.50 shows the longitudinal gap analysis for the three constituents for outcome B4. Contemporary Issues (j). In 2010, we made a decision to adopt the ABET a-k outcomes explicitly. Previous to this, we had developed our own outcomes and mapped them into the ABET a-k. In this transition, none of our past outcomes aligned one-to-one with Contemporary Issues. This is why we did not show any data before 2011. In the limited results we have, all constituents ranked our students as meeting the expected level of achievement with employers rating us the highest followed by alumni and then seniors.

Figure 4.51 shows the ranking of importance versus effectiveness of each of our three constituents for outcome B4. Contemporary Issues (j) for 2012. Interestingly, all three constituents rated the importance of contemporary issues as less important than most other outcomes, with alumni rating the importance of this outcome the lowest. Alumni and seniors rated our effectiveness in this outcome as about the same, but employers rated our effectiveness as significantly higher than the other constituents. Nevertheless, all ratings for all constituents met expectations.

ME 29000 Quiz 1, 2, and 3 on Zakaria Text on "Post-American World"

Figures 4.52 and 4.53 show the histograms for the ME 29000 quiz grades for fall 2012 and spring 2013. Quiz 1 covers chapters 1-3 in the book and focuses on the diminishing power of the US and factors that led to the current balance of powers in the world. Quiz 2 covers chapters 4 and 5 of Zakaria's book. These chapters focus on the emergence of China and India as economic powers and contrast the advantages and disadvantages of the top-down autocratic Chinese government versus the bottom-up democratic political system in India. How their different political systems impact their economic rise as compared with Western-style policies is addressed. Quiz 3 covers chapters 6 and 7 of the book and addresses the American rise to superpower status, its use of this power and provides guidelines for how the US should use it power in the future world envisioned by Zakaria. As such, these chapters provide students with a broad view of past and contemporary issues affecting the US in the context of a changing world.

The level of achievement to meet expectations requires 70% of students consistently earning a grade of 70 or higher on Quiz 1, 2, and 3. To exceed expectations requires 80% or more of students consistently earning a grade of 70 or higher on Quiz 1, 2, and 3. Figure 4.51 shows that students in fall 2012 meet expectations on quiz 1, exceed expectations on quiz 3, but fall slightly below expectations on quiz 2. Figure 4.52 shows that students in spring 2013 meet expectations for Quiz 3, fall just below expectations on quiz 1 and are notably below expectations on quiz 2. Note that since the fall 2012 semester is the "on-semester" for ME 29000 (see enrollment number in Figures 4.51 and 4.52), it is not surprising that the fall performance on these quizzes is generally stronger than the spring 2013 performance. Based on this data, the quiz 2 questions appear to be somewhat more challenging.

Conclusions: Based on the constituent surveys and the quizzes on Zakaria's book on "Post-American World", students overall seem to meet expectations, albeit marginally. The recent change we made to focus ME 29000 on contemporary global issues has had a significant impact on this outcome. Students have become keenly aware of key issues related to the global economy and the impact these have in the engineering domain not only in the US, but also around the world. While we are not satisfied with students' current performance, we believe that students' knowledge of contemporary issues will continue to grow with this foundation in place.

Future Actions: No future actions are planned at this time.

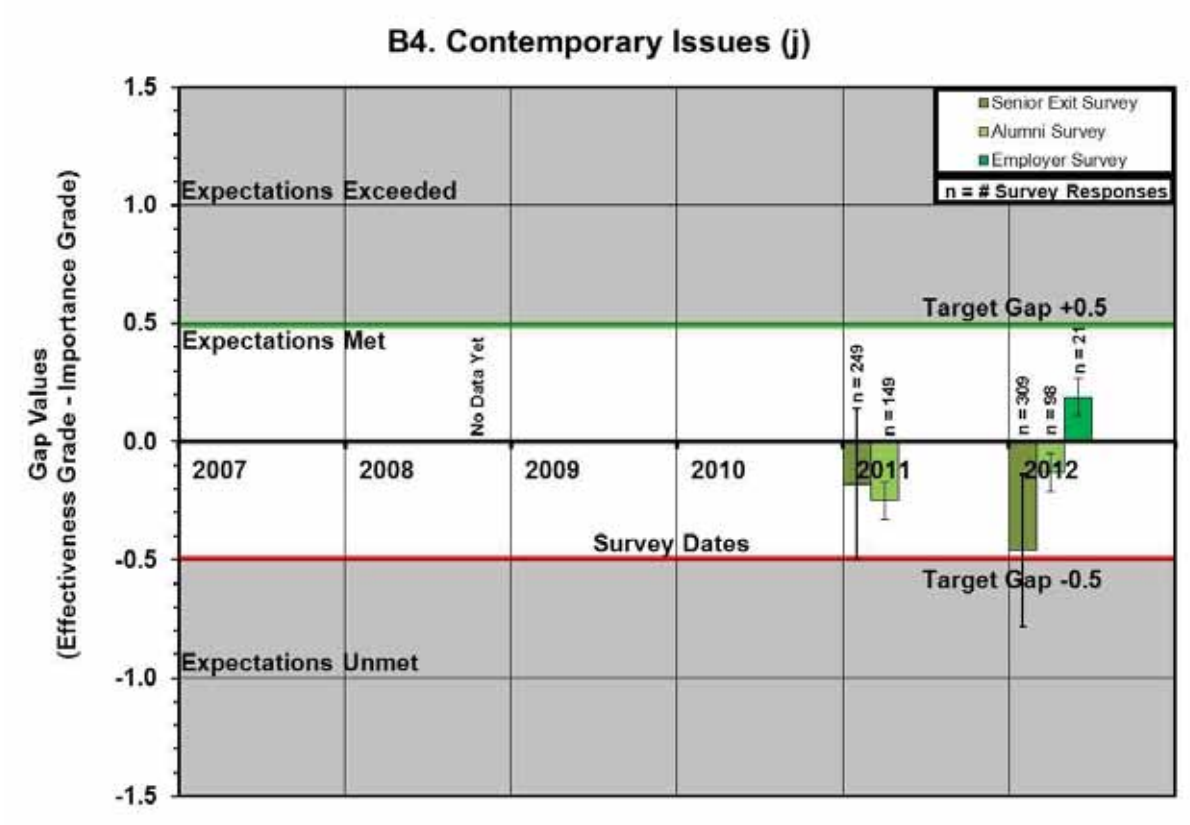


Figure 4.50 Longitudinal Gap Analysis for Outcome B4. Contemporary Issues (j) from 2007-2012.

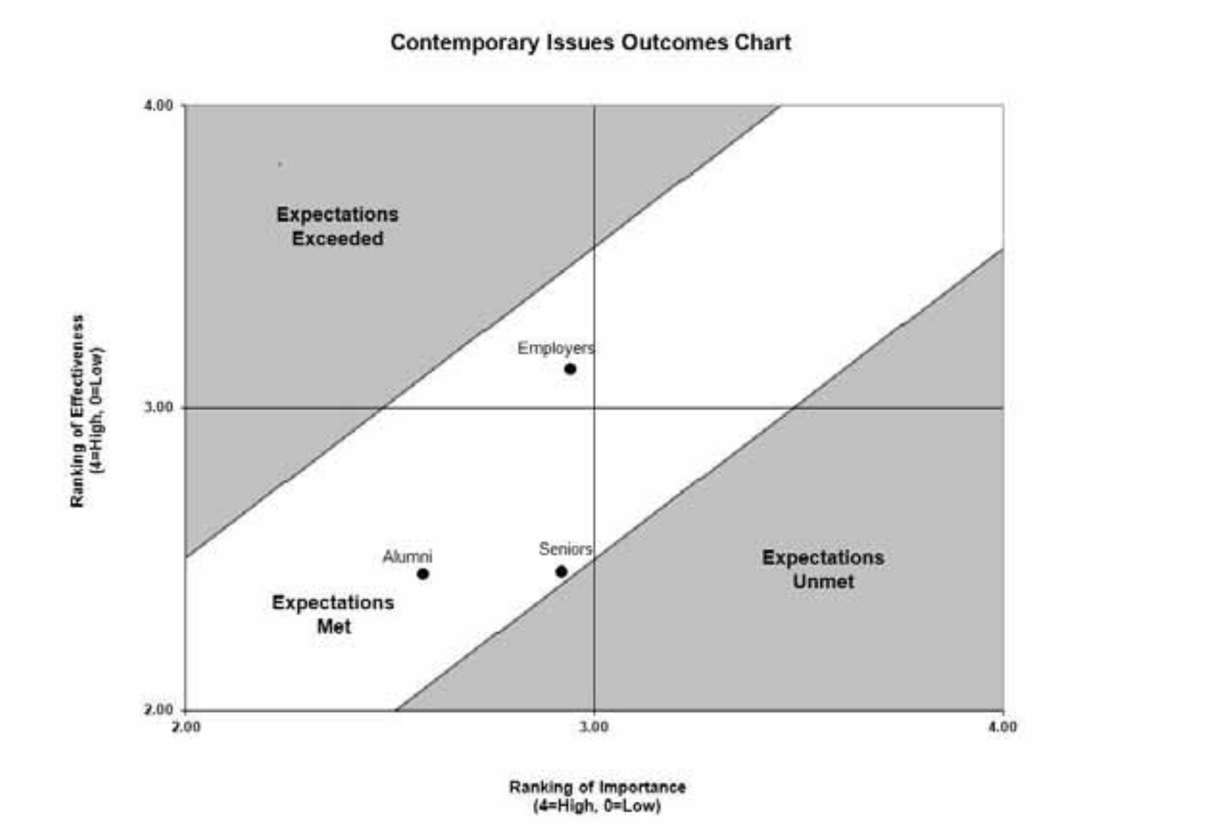


Figure 4.51 Ranking of Effectiveness versus Importance for Outcome B4. Contemporary Issues (j) for all constituents for 2012.

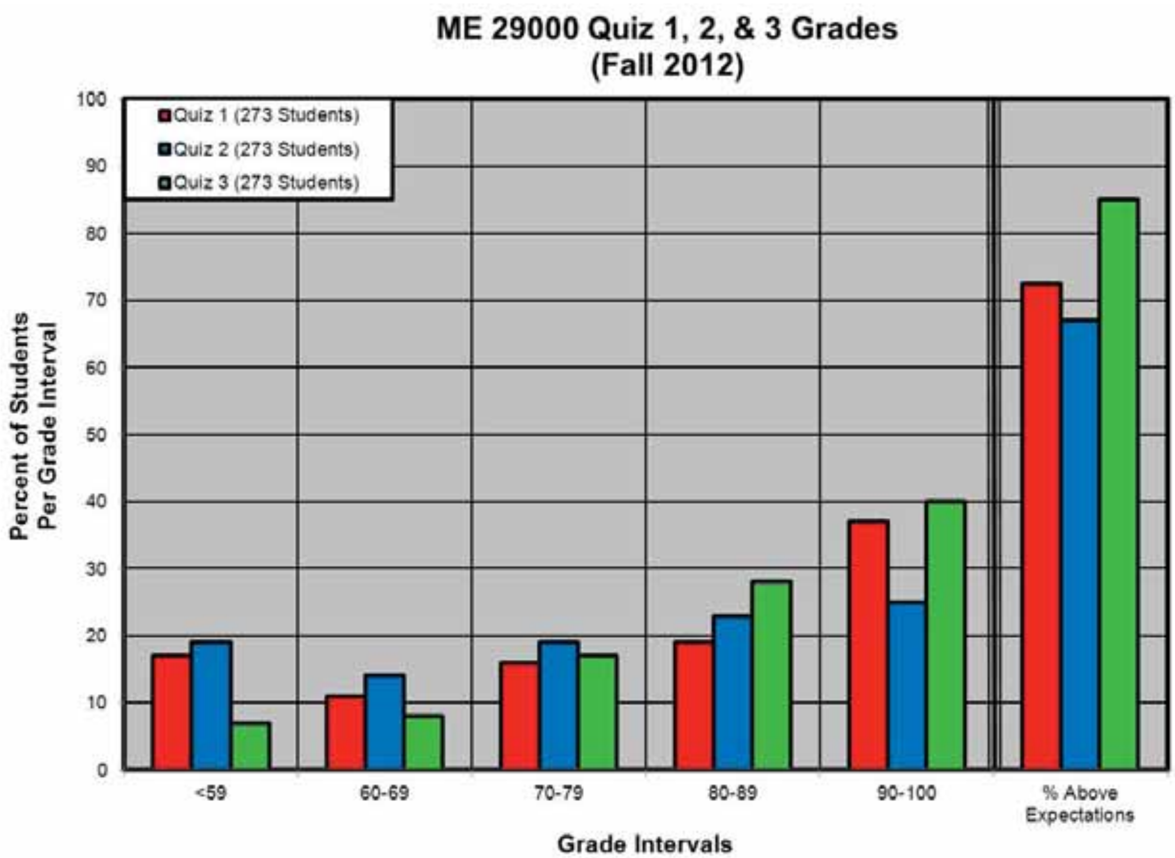


Figure 4.52 Histogram of ME 29000 grades for Quiz 1, 2 and 3 for fall 2012.

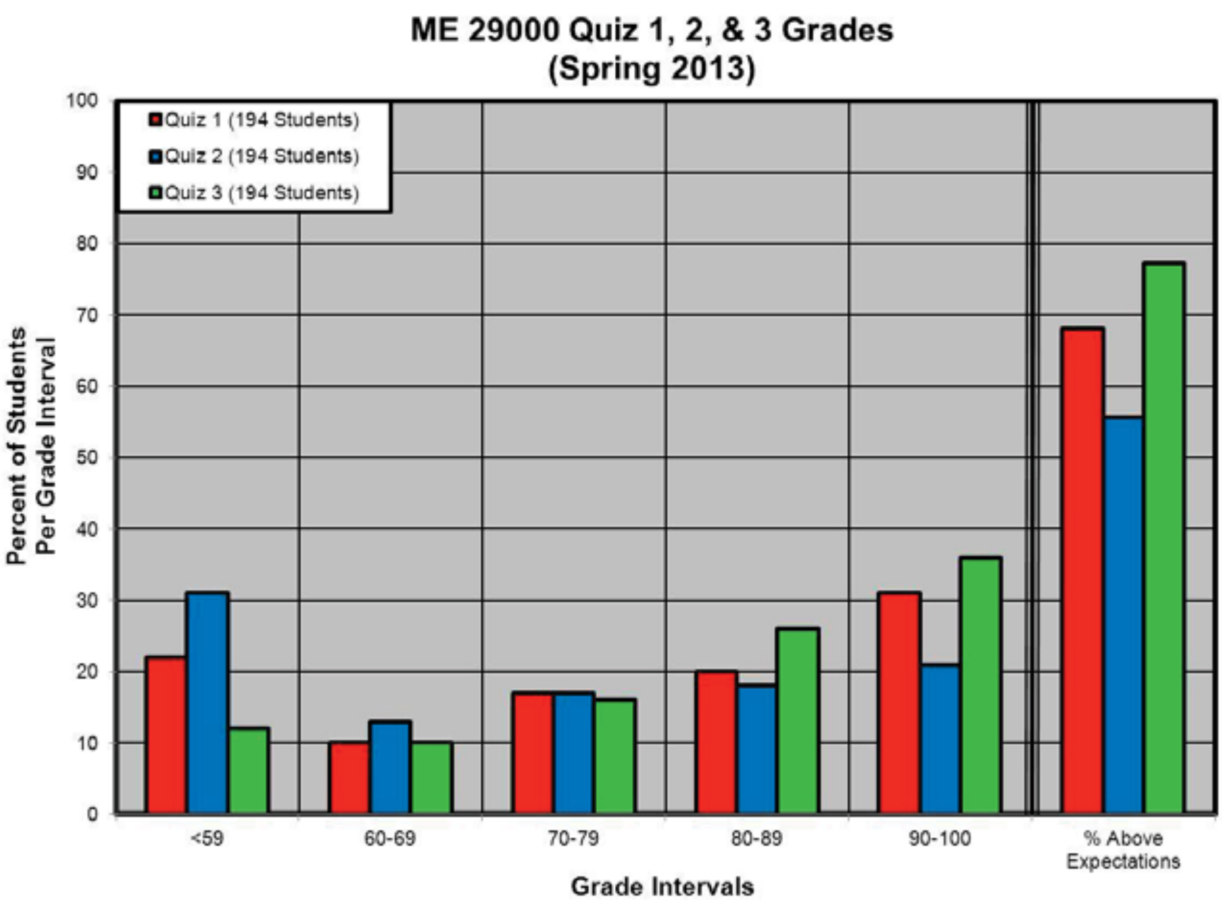


Figure 4.53 Histogram of ME 29000 grades for Quiz 1, 2 and 3 for spring 2013.

4A.13 Program Outcome B5. – Life-Long Learning (i)

Table 4.11 shows the performance criteria, assessment methods, and level of achievement used to evaluate outcome B5. – Life-Long Learning. A brief discussion of each of the five assessment methods is presented below.

Table 4.11 Performance Criteria, Assessment Methods, and Level of Achievement used for Outcome B5. – Life-Long Learning (i).

B5. Life-long Learning (i) Recognition of the need for and an ability to engage in life-long learning.					
Performance Criteria	• Recognizes the need to continuously upgrade their knowledge and skills. • Exhibits a desire and ability to pursue professional development.				
Assessment Method	**Level of Achievement**	**Date of Data Collection**	**Faculty/Course Assessment Took Place**	**Date of Results Evaluation**	**Evaluation Performed By**
Senior Exit Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Alumni Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Employer Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Professional Dev. Data from Senior Exit Survey (Direct)	80% of graduates involved in some type of Prof. Dev.	Aug 2012 Dec 2012 April 2013	N/A	May 2013 May 2013 May 2013	Jones Jones Jones
Professional Dev. Data from Alumni Survey (Direct)	80% of graduates involved in some type of Prof. Dev.	Aug 2012 Dec 2012 April 2013	N/A	May 2013 May 2013 May 2013	Jones Jones Jones

Senior, Alumni, and Employer Surveys: Figure 4.54 shows the longitudinal gap analysis for the three constituents for outcome B5. Life-long Learning (i). Over the past six years the ranking of the life-long learning outcome has consistently met expectations for all three constituents with little or no change.

Figure 4.55 shows the ranking of importance versus effectiveness of each of our three constituents for outcome B5. Life-long Learning (i) for 2012. As noted in the previous figure, all constituents rated the life-long learning skills of seniors as meeting expectations. This outcome is ranked generally in the middle on the importance scale. All three seniors, alumni and employers rated both the importance and effectiveness in a consistent fashion. There are no outliers in this case.

2012-13 Senior Exit Survey on Professional Development: Figure 4.56 shows the results of the 2012-13 professional development survey. The level of achievement to meet expectations requires 80% of seniors to be involved in some form of professional development. To exceed expectations requires 90% of seniors to be involved of some form of professional development. Six categories of professional development were explicitly identified as well as one generic "other" category. Overall over 90% of seniors were involved in some form of professional development while at Purdue, exceeding our expected level of achievement. The highest categories were those who passed the FE exam (70%), membership in professional and/or honors organizations (38%), and external project or design contest (32%).

2012 Alumni Survey on Professional Development: Figure 4.57 shows the results of the 2012 alumni survey on professional development. The results are parsed out by graduating class to illustrate the individual and combined responses of the 2006 and 2010 alums. The level of achievement to meet expectations requires 80% of alumni to be involved in some form of professional development. To exceed expectations requires 90% of alumni to be involved in some form of professional development. Seven categories of professional development were explicitly identified as well as one generic "other" category. For both 2006 and 2010 alums, graduates exceeded expectations with a surprising 95% of alums being involved in some form of professional development for both 2006 and 2010 alums. The highest categories included graduates that have passed the FE exam, graduates that have participated in continuing education, and those who have attended professional conferences. The most significant findings are:

- Over 40% of 2006 alums have earned a 2^{nd} undergraduate degree or an advanced degree and over 20% are seeking another degree.
- Almost 8% of 2010 graduates have earned a 2^{nd} undergraduate degree or an advanced degree and an additional plus 20% are seeking another degree.
- Over 10% of 2006 alums have earned a professional engineering (PE) license. As expected none of the 2010 alums have earned a PE license since most states required at least four years of engineering practice to be eligible to sit for the PE exam.

Conclusions: Based on the collective results from the constituent surveys and the senior and alumni professional development surveys, this data consistently supports the conclusion that students not only meet, but exceed the expected level of achievement of for outcome B5. Life-long Learners.

Future Actions: No future actions are planned at this time.

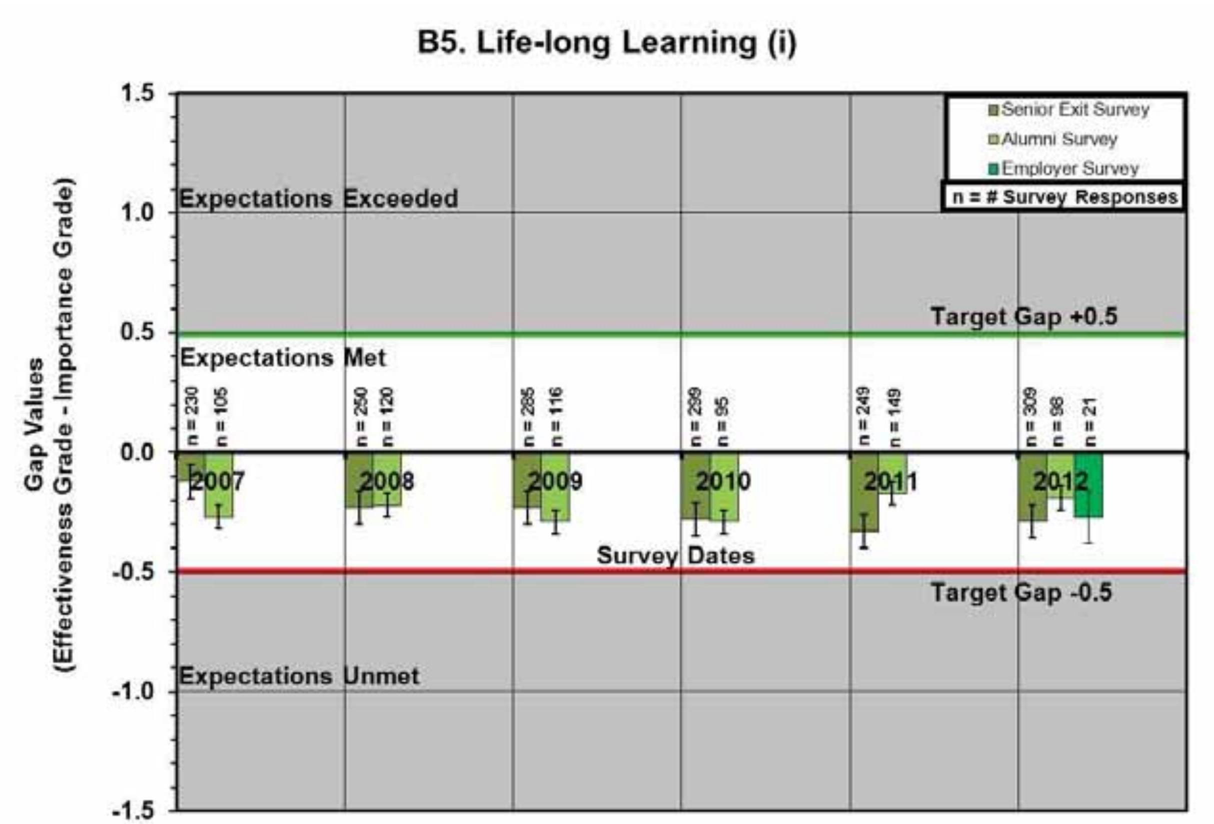


Figure 4.54 Longitudinal Gap Analysis for Outcome B5. Life-long Learning (i) from 2007-2012.

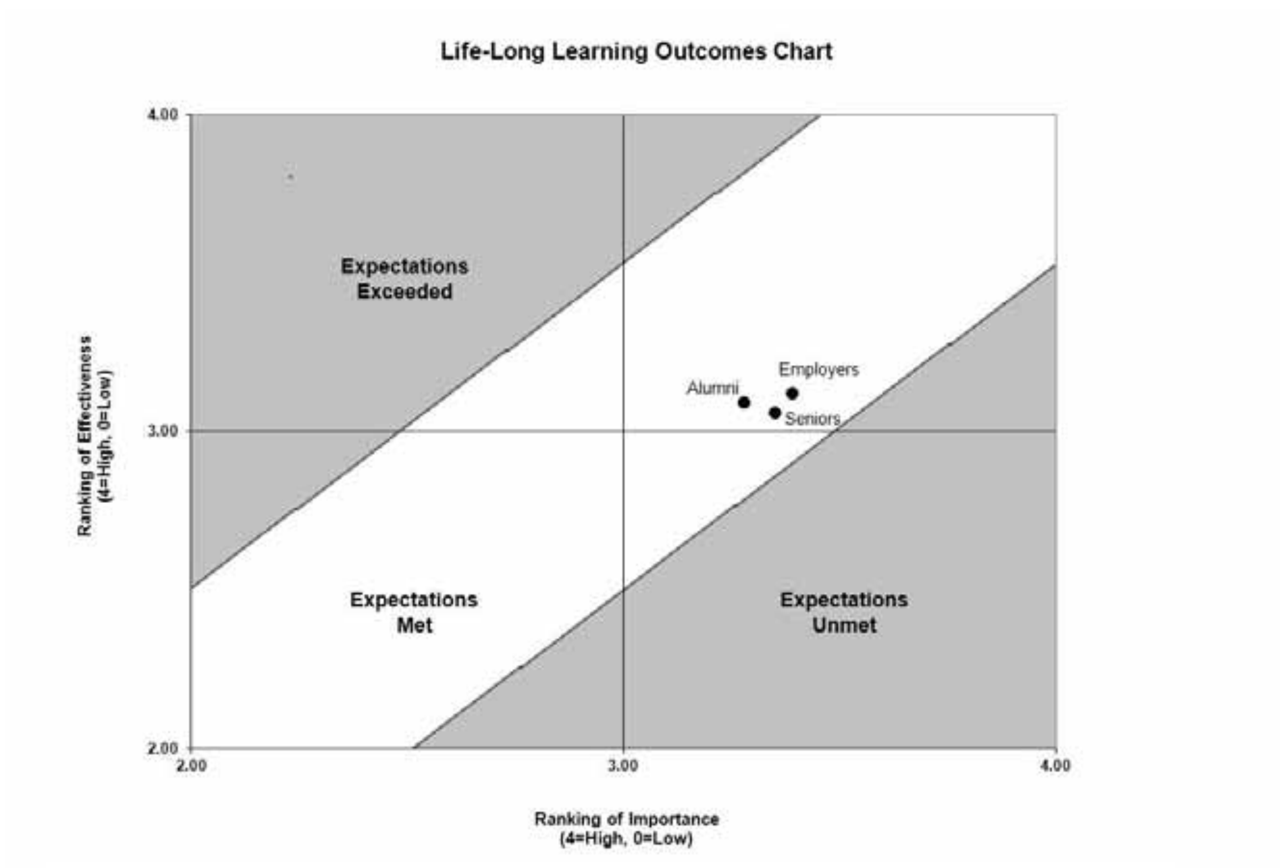


Figure 4.55 Ranking of Importance versus Effectiveness for Outcome B5. Life-long Learners for all constituents for 2012.

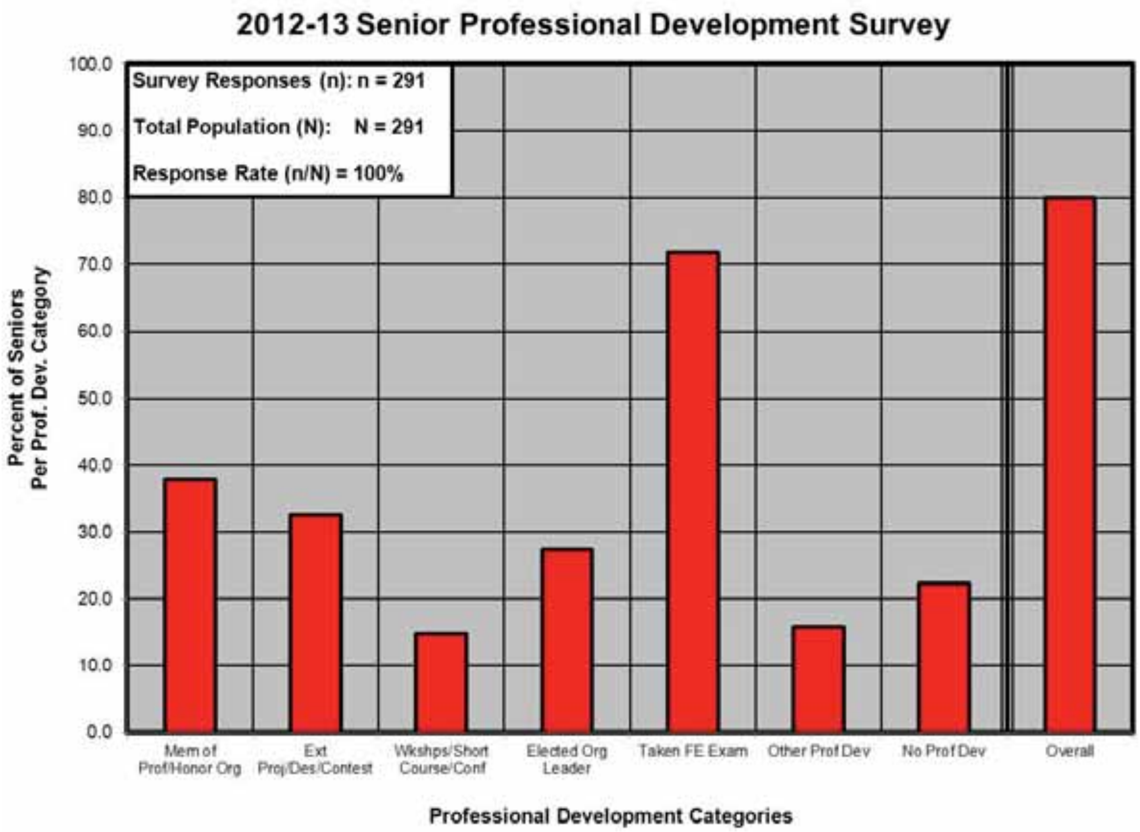


Figure 4.56 2012-13 Senior Exit Survey on Professional Development.

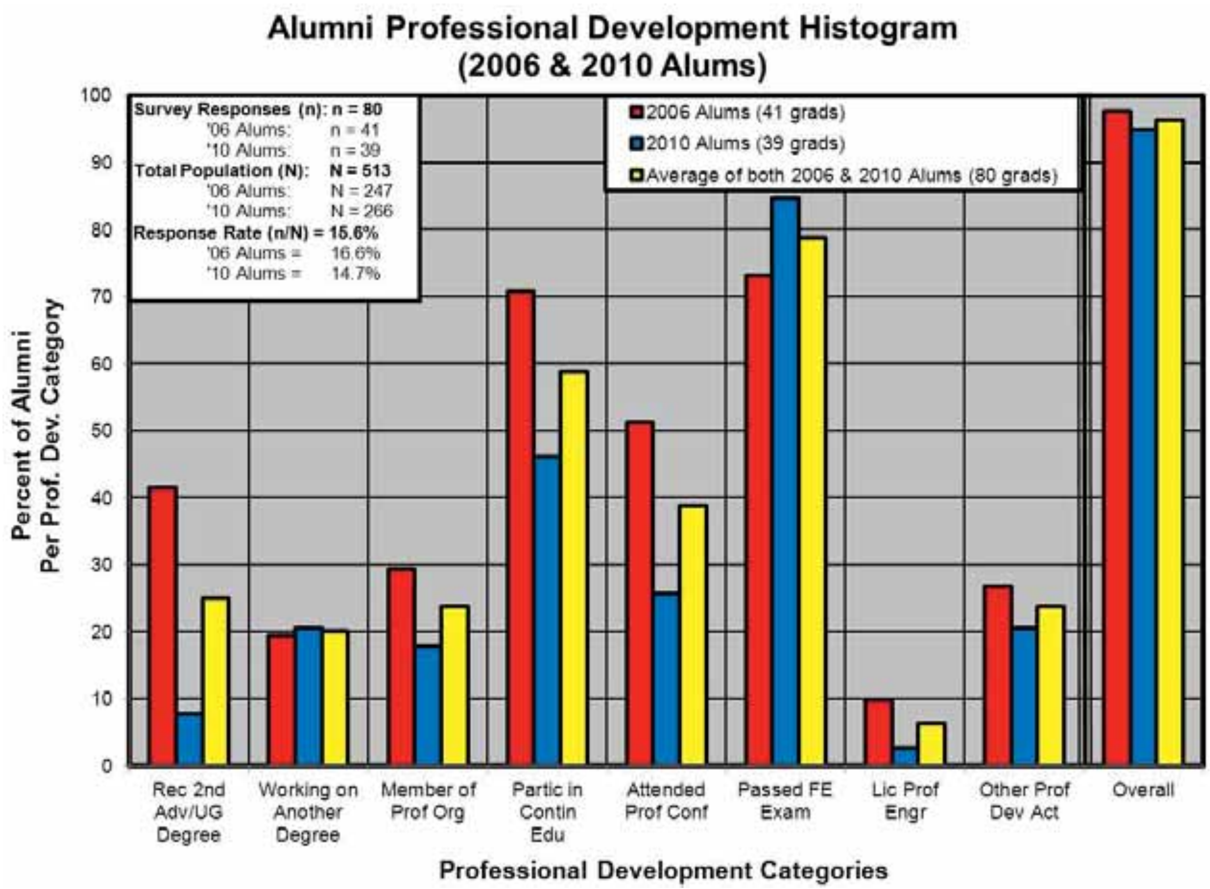


Figure 4.57 2012 Alumni survey on professional development for the graduating classes of 2006 (6 years out) and 2010 (2 years out) both individually and combined.

4A.14 Program Outcome C1. – Leadership (l)

Table 4.12 shows the performance criteria, assessment methods, and levels of achievement used to evaluate outcome C1. – Leadership (l). A brief discussion of each of the four assessment methods is presented below.

Table 4.12 Performance Criteria, Assessment Methods, and Level of Achievement used for Outcome C1. – Leadership (l).

C1. Leadership (l) An ability to apply effective leadership principles to formulate and articulate a shared vision, and lead an organization in the implementation of this vision.					
Performance Criteria	• Applies effective leadership principles to formulate and articulate a shared vision • Prepared to assume leadership roles in their organizations				
Assessment Method	**Level of Achievement**	**Date of Data Collection**	**Faculty/Course Assessment Took Place**	**Date of Results Evaluation**	**Evaluation Performed By**
Senior Exit Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Alumni Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Employer Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Leadership Rubric (Direct)	80% of students score at an "acceptable" level or higher	Jan/Mar/April 2013 April 2013	King/ME 26300 Cipra/ME 46300	May 2013 May 2013	Jim Jones

Senior, Alumni, and Employer Surveys: Figure 4.58 shows the longitudinal gap analysis for the three constituents for outcome C1. Leadership. Over the past six years the gap value of the leadership outcome has steadily improved to where all three constituents rate this outcome as meeting expectations, albeit marginally. Given this is a newly added outcome, it is not surprising that additional effort is still required to further develop students' leadership skills. Nevertheless, the upward trend demonstrates positive improvement.

Figure 4.59 shows the ranking of importance versus effectiveness of each of our three constituents for outcome C1. Leadership for 2012. As noted in the previous figure, all constituents rated the leadership skills of seniors as meeting expectations. This outcome is ranked generally in the middle on the importance scale (as compared to the other outcomes). All three seniors, alumni and employers rated both the importance and effectiveness in a consistent fashion, with employers rating our effectiveness slightly higher than seniors or alumni..

Leadership Rubric in ME 26300/ME 46300: Figures 4.60-4.62 show the frequency histograms for the ME 26300 leadership rubric for spring 2013 for phase 1, phase 2, and phase 3 respectively. The level of achievement to meet expectations requires 80% of students consistently earning an "acceptable" score of higher by the rater. To exceed expectations requires 90% of students consistently earning an "acceptable" score or higher by the rater. Students fell below expectations in some categories in phase 1, but met or exceeded expectations for ME 26300 in all phases 2 and 3. However, there were a few students that regressed in Phase 3. Comparing the three phases of the course, a notable improvement in the leadership ratings, while not dramatic, is apparent. Also, students seemed to do reasonable well in all categories (i.e., there were no obvious outliers).

Figure 4.63 shows the frequency histograms for the ME 46300 leadership rubric for spring 2013. Students exceeded expectations on their leadership ratings in all categories. In this case, students did better than average in ownership of their project and worse than average in planning ahead and identifying team members' strengths. The notable increase in project ownership is likely due the opportunity for students to select the project they want to work on (in contrast to ME 26300, where the project is defined for them). Comparing the ME 26300 and ME 46300 results, the obvious difference is the dramatic increase in the number of students rated as very effective. On a related note, there are notably fewer students in the ineffective or very ineffective categories. Ideally, we would have no one in the ineffective or very ineffective categories by senior year, but at least fewer students seem to fall into these scoring levels. One factor for some of the low scoring is the problem of "senioritis." Unfortunately, there is a small population of students who develop a sense of entitlement in their last semester (especially in spring semester when the weather is nice outside). They feel they deserve their degree, even without working hard on their senior design project. This is frustrating for other hard-working students, and can create division among some team members.

Conclusions: The results from the leadership rubric in constituent surveys and the ME 26300 and ME 46300 leadership rubric results are generally consistent and support the conclusion that students meet the expected level of achievement of for outcome B1. Leadership. However, there is clearly room for improvement in this area, especially in helping students develop confidence in their leadership skills. In addition, we have approved several leadership courses as part of our approved general education courses to make these topics more readily available to students. Finally, we have recently, approved a new Engineering Leadership Development minor. This enables student who want to make leadership a focal point of their curriculum a credential to work towards.

Future Actions: Our goal is to integrate more explicit leadership development in the curriculum, especially in ME 26300 and ME 46300 (our cornerstone and capstone design courses). In the past we have mostly focused on educating students on a top-down type of leadership. However, we are now evaluating how to prepare students to understand situational leadership similar to the Hershey-Blanchard situational model. In other words, how best to lead a group depends directly on: 1) how able (or unable) is the team to do the job, as well as, 2) how willing (or unwilling) they are to follow. In this way students will learn how to first assess their team's abilities and willingness to follow and then utilize an appropriate leadership model that fits the individuals on the team. This will also likely involve revising our leadership rubric to better address some of the unique issues related to situational leadership strategies.

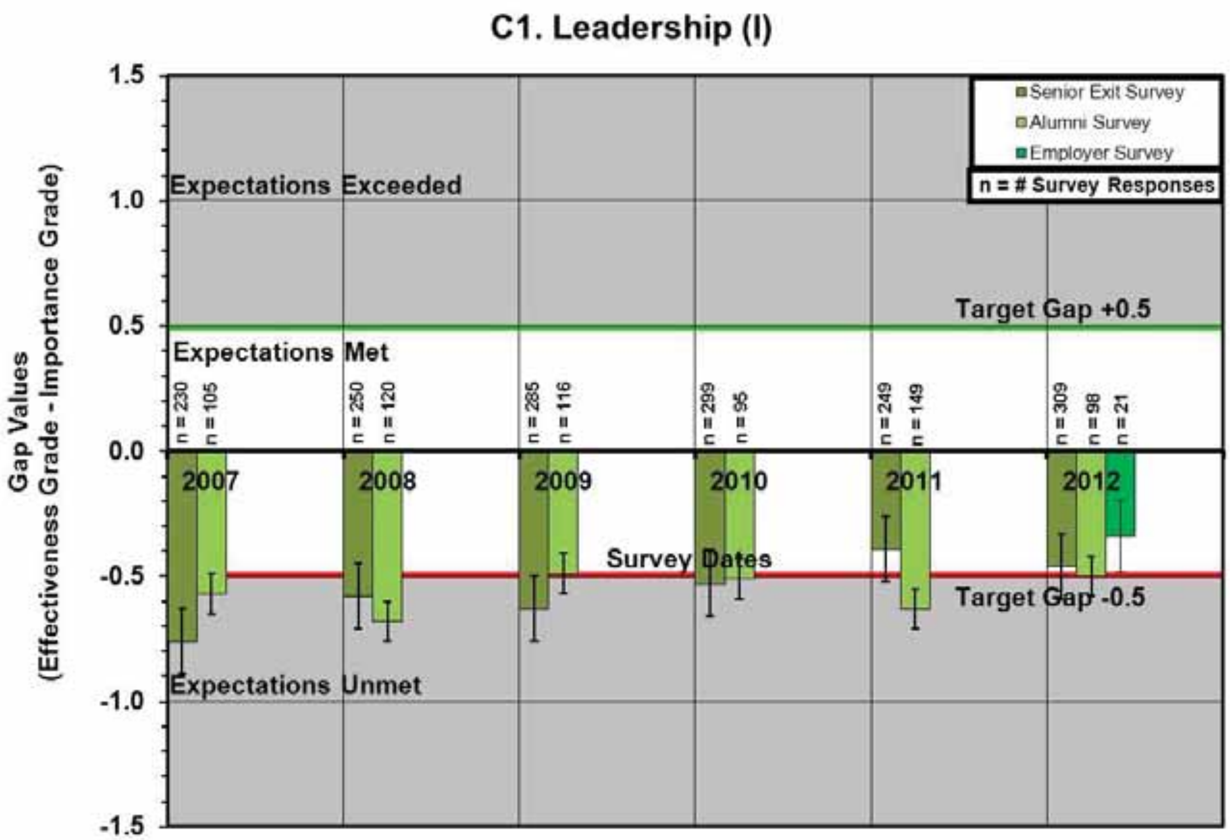


Figure 4.58 Longitudinal Gap Analysis for Outcome C1. Leadership from 2007-2012.

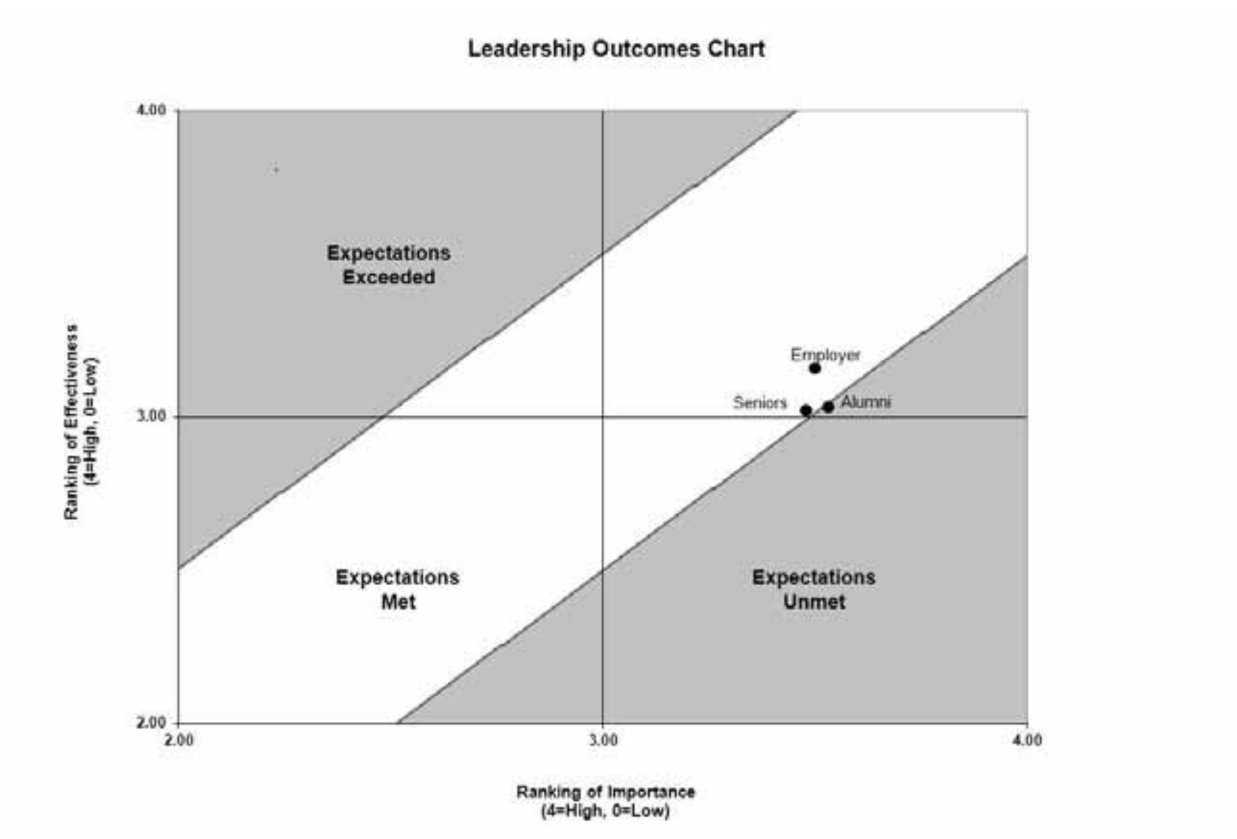


Figure 4.59 Ranking of Importance versus Effectiveness for Outcome C1. Leadership for all constituents for 2012.

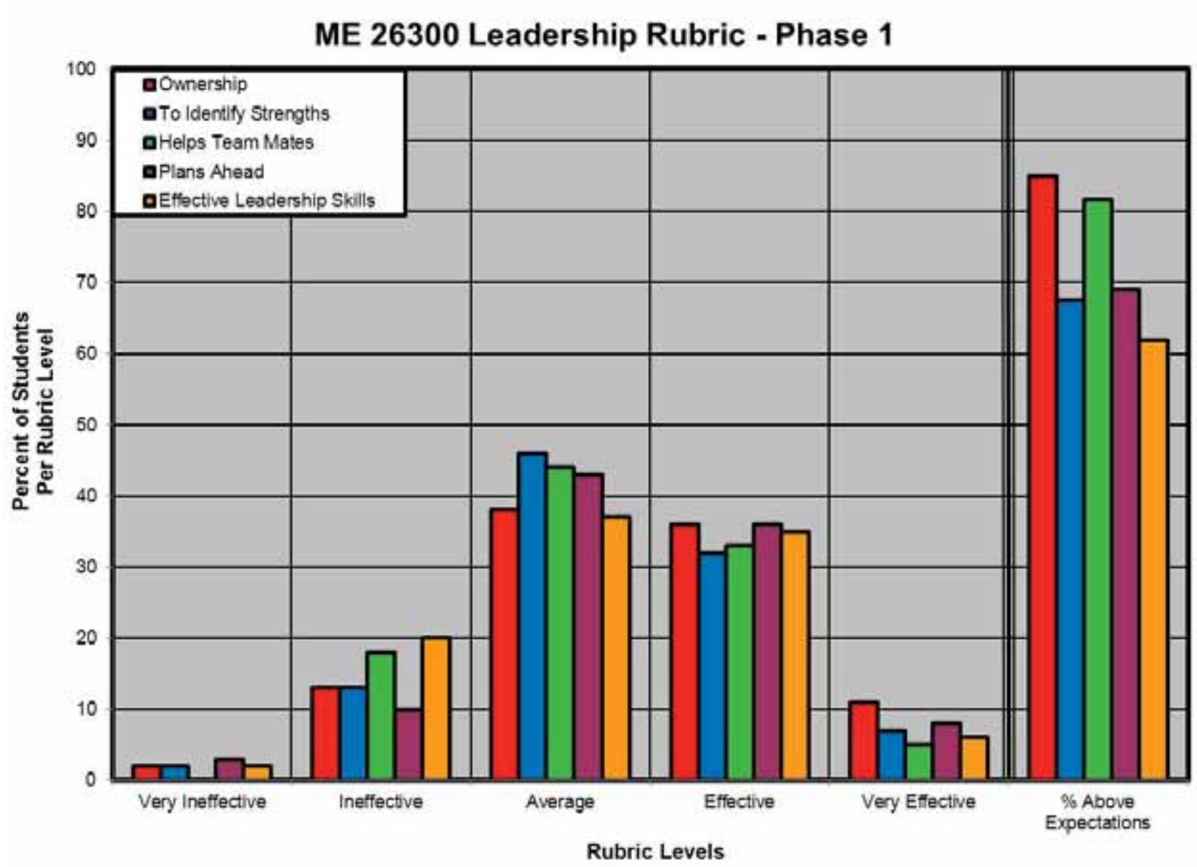


Figure 4.60 Histogram of ME 26300 Leadership Rubric for Phase 1 for spring 2013.

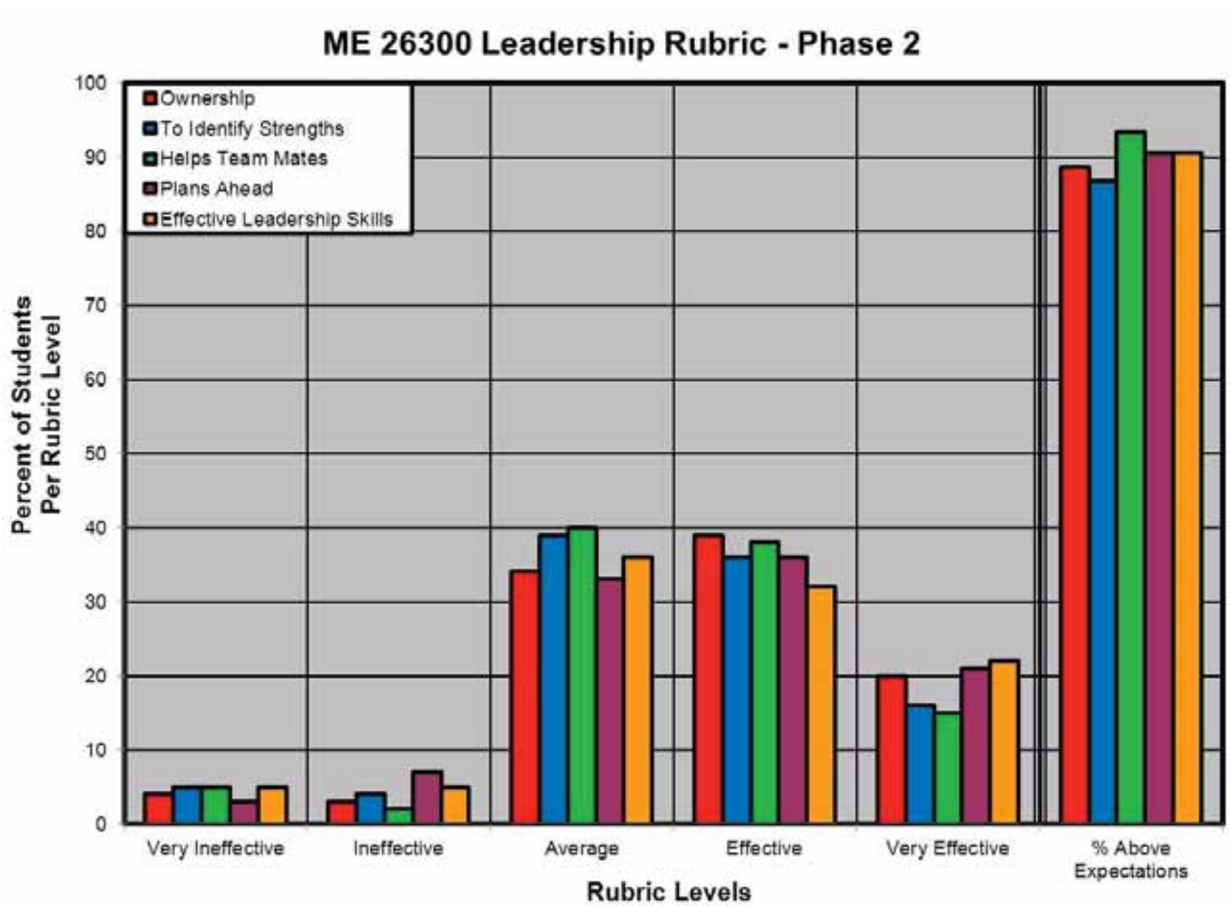


Figure 4.61 Histogram of ME 26300 Leadership Rubric for Phase 2 for spring 2013.

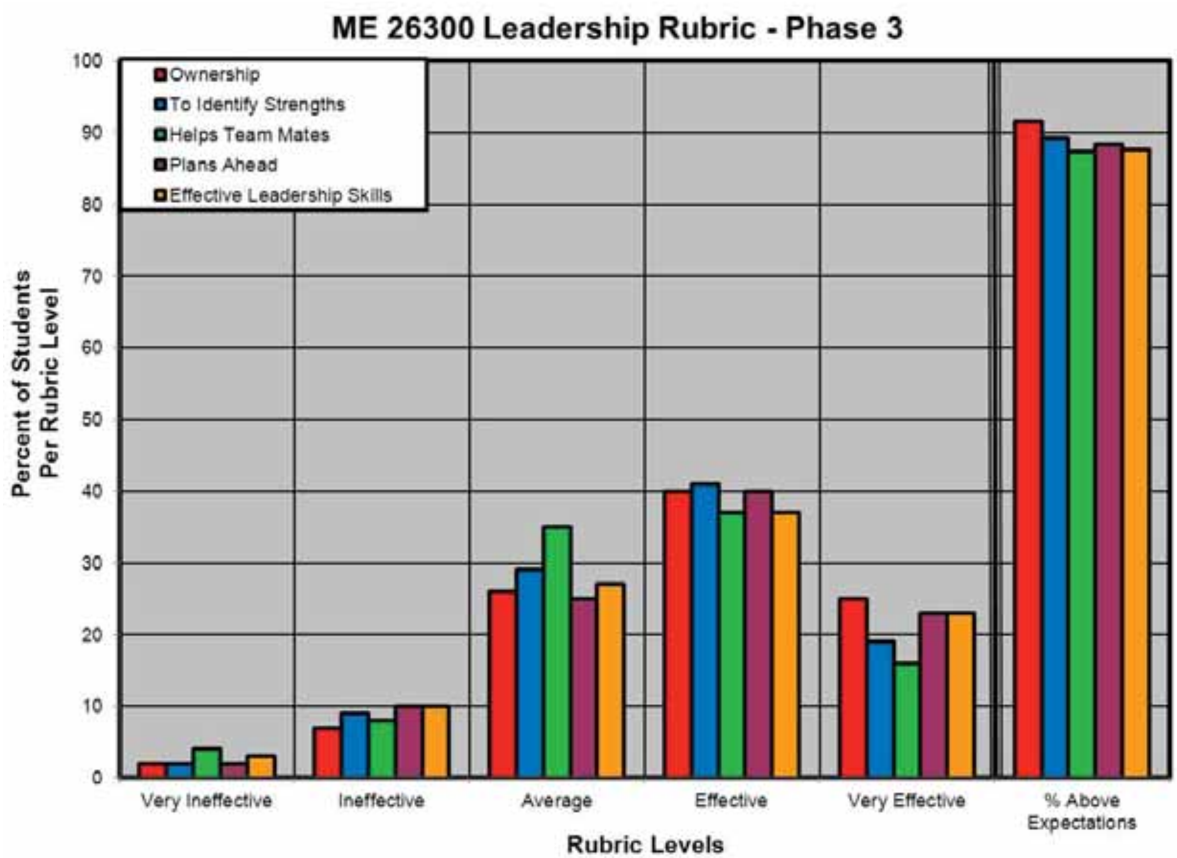


Figure 4.62 Histogram of ME 26300 Leadership Rubric for Phase 3 for spring 2013.

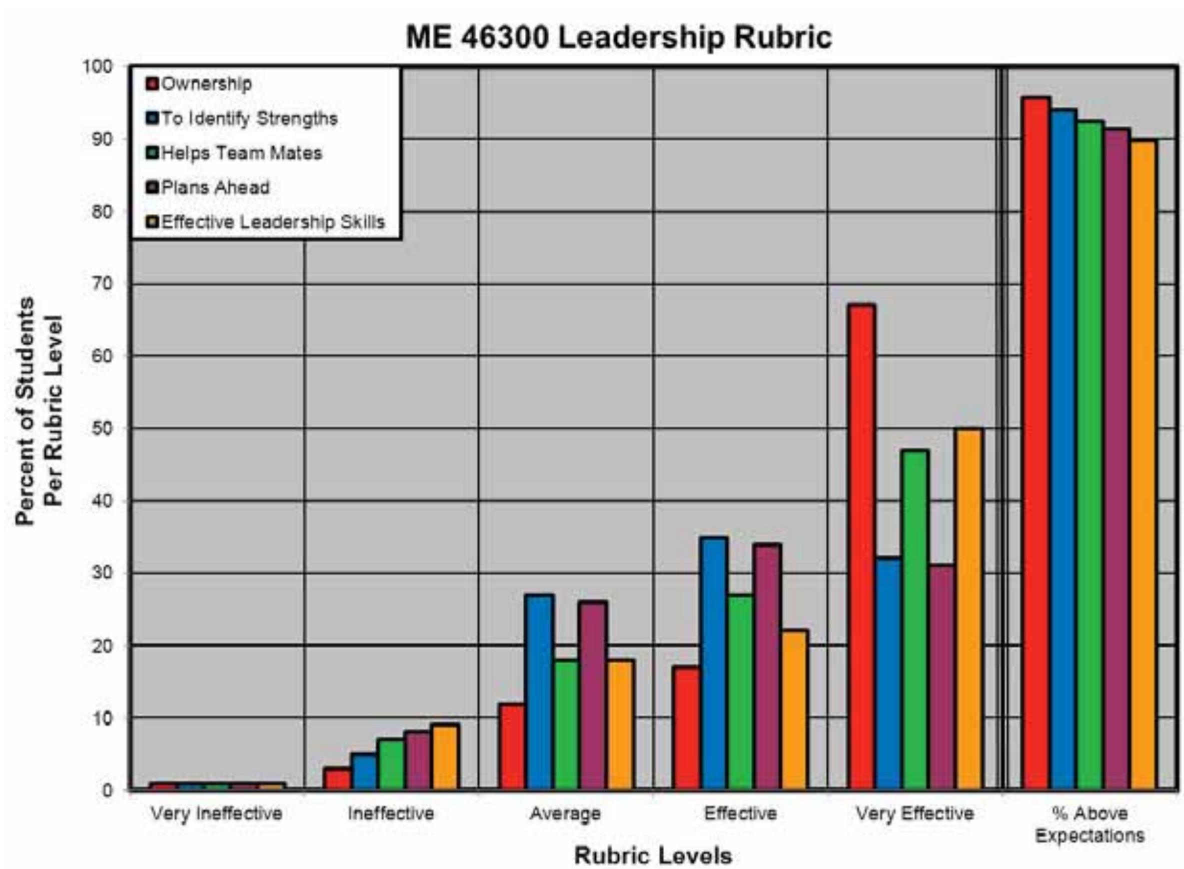


Figure 4.63 Histogram of ME 46300 Leadership Rubric for spring 2013.

4A.15 Program Outcome C2. – Global Engineering Skills (m)

Table 4.13 shows the performance criteria, assessment methods, and level of achievement used to evaluate outcome C2. – Global Engineering Skills (m). A brief discussion of each of the four assessment methods is presented below.

Table 4.13 Performance Criteria, Assessment Methods, and Minimum Level of Achievement used for Outcome C2. – Global Engineering Skills (m).

C2. Global Skills (m) An ability to work effectively in the global engineering profession.					
Performance Criteria	• Understand the impact of the global economy on competitiveness. • Able to work across time zones, cultures, and languages.				
Assessment Method	**Minimum Level of Achievement**	**Date of Data Collection**	**Faculty/Course Assessment Took Place**	**Date of Results Evaluation**	**Evaluation Performed By**
Senior Exit Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007 - 2013	Curriculum Committee
Alumni Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007 - 2013	Curriculum Committee
Employer Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007 - 2013	Curriculum Committee
Collegiate Cultural Development Inventory (Direct)	90% Participation in some form of Cultural Development while at Purdue	April 1013	Atkinson/ME 29000 Starkey/ME 46300	May 2013 May 2013	Jim Jones

Senior, Alumni, and Employer Surveys: Figure 4.64 shows the longitudinal gap analysis for the three constituents for outcome C2. Global Skills (m). Over the past six years there has been a significant increase in the gap value, especially for alumni (going from -0.7 to -0.2). We attribute this significant improvement to our unique strategy on our global programs. Details of this strategy are provided below.

Figure 4.65 shows the ranking of importance versus effectiveness of each of our three constituents for outcome C2. Global Skills. All constituents ranked seniors as meeting expectations. Both the importance and effectiveness rankings by the constituents were consistently around 3.0, with employers and seniors ranking this outcome slightly higher in both importance and effectiveness as compared to alumni. While global skills are not the highest rated outcome, it is the outcome that has grown in importance more than any other over the past 10-12 years. Nevertheless, we have been able to keep pace with this quickly changing expectation.

Collegiate Cultural Development Inventory (CCDI): In the past we have attempted to use the Intercultural Development Inventory (IDI) as a way to measure student progress in cultural development. Unfortunately, the IDI instrument is a life-long development measure that is insensitive to smaller cultural changes that occur over a typical 4-year college career. Consequently, we decided to develop our own Collegiate Cultural Development Inventory that would be more directly applicable to college student experiences. This inventory is specifically designed to capture cultural growth in the college years. The questions are almost all designed as factual in nature concerning college experiences (including curricular, co-curricular, and extra-curricular activities). As such these responses can largely be used as direct measures because we are not asking students opinions, but rather factual questions that have a specific answer (e.g., the number of foreign language classes taken while at Purdue). However, a small number of opinion questions are included related to typical barriers students experience that prevents them from studying abroad.

We encourage study abroad as a means of enhancing cultural development in our students. To help us understand barriers to study abroad we surveyed the students. Figure 4.66 shows opinions regarding nine perceived barriers to studying abroad. As you can see in the plot, cost and concern over language skills top the list. Our strategy has focused on gaining insight to the primary barriers via surveys and anecdotal data for the purpose of developing strategies to overcome these barriers. A brief summary of some of these strategies are provided below:

1. *Cost* – For students on a tight budget, cost can be a significant barrier to studying abroad. Certainly studying in places like Europe can add significantly to the cost due to the high cost of living. However, there are several other options that can be practically cost-neutral like China, India, and Turkey.
2. *Language Skills* – For student wanting to study abroad, the prospect of taking courses in a foreign language is frightening. In our case, we have been able to identify a sufficient number of courses taught in English to allow students to only take courses in English.
3. *Time -To -Graduation* – Similar to item 1, if studying abroad adds to a student's time-to-graduation, it adds cost to their education, which many students today cannot afford. This added time is often a result of most students taking only non-engineering courses abroad, making it difficult to stay on track to graduate. To combat this, we have permitted student to take select upper-level core engineering courses abroad so that they can more easily stay on track to graduate in 4 years and still have a transformational international experience.

4. *“Engineering” Abroad* – Our focus has been to develop true Engineering Terms Abroad for students in which they are taking core engineering courses. This is an important distinction because it allows students to see how “engineering” is different in other cultures. Ultimately, this is one of the most valuable aspect of the experience.
5. *Grades* – Many students are hesitant to go abroad because of the uncertainty of the educational experience and how their grades will be handled. Many students want to protect their Purdue GPA for good reasons (e.g., to maintain a scholarship, to get into graduate school, to open up more intern/co-op or permanent engineering opportunities, etc.). Over the years, we have experienced several unexpected grade issues that could have been devastating to students. However, we made a strategic decision to transfer all courses for credit only on a Pass/No Pass basis. This eliminates the concern over grades. Many study abroad purists adhere rigorously to the gold standard tradition of transferring courses with credit and grades. It took over 10 years for us to finally get formal approval to transfer courses for credit only.
6. *Proximity to Family and Friends* – Many students are afraid to be away from family and friends for a protracted 3-4 month period. In our case, we combat this barrier by sending over “a cohort” or “groups” of students to study abroad. We encourage students to bring their friends along on the study abroad with them. This alleviates the concern about studying abroad alone while increasing our participation rate. Also, many students have parents that fly over to visit them while they are abroad. This allows the student to showcase all they have learned for their parents.
7. *Acceptance/Making Friends* – Many students are concerned about whether they will be accepted and able to make friends while abroad. The cohort or group approach also addresses this concern because it gives students some built in friends to go with. Also, in some of our programs, students take a 1 credit study abroad orientation course in the semester prior to going abroad. This allows them to get to know their peers better and learn some basic cultural knowledge prior to leaving.
8. *Public Health Concerns and Safety* – These can be legitimate concerns. However, we are very careful to make sure that the students are placed into safe and healthy environments. One of the best ways to combat these concerns is to the have past participants speak about their experiences abroad. They often show pictures and/or videos of the accommodations and address any student questions concerning safety or health concerns.

Figure 4.67 shows a plot of the overall participation in global programs and the breakdown in the percentages of students participating in the various types of programs available. While the percent of students hasn’t really increased in recent years (due to the significant growth in our ME Program enrollment), the number of students participating has continued to grow steadily. We believe this shows that our efforts to encourage cultural development of this outcome through study abroad are fruitful.

Conclusions: Philosophically, we are taking a distinctly different and strategic approach to our global programs as compared to most traditional programs. Most programs see study abroad and other global programs as special opportunities for their elite students. In essence, they are seeking only a few opportunities for a select group of high performing students. In our case, we view global skills essential for all of our students. Our strategy is to encourage all of our students to pursue global opportunities, not just the elite students. Our goal is to make study abroad and other international opportunities as common as internships and co-ops are today. While we have a long way to go, we continue to make significant progress. With over 30% of our undergraduates studying abroad and 25% of our student body being international students, it is safe to say that roughly half of our students have international experience. Also, since all ME students are required to take a World Affairs and Cultures elective, essentially 100% of ME students are participating in some form of cultural development. However, the impact of traveling, studying and working abroad is so transformational; our aspiration is to seek such opportunities for all of our students. Essentially, we seek to make such experiences as common as internship and co-op experiences are today.

Based on the constituent surveys and CCDI and Senior Exit Survey data, we are meeting the current expectations for this outcome. However, it is important for us to remain diligent in this area, because given the nature of the global economy; this outcome will likely continue to grow in importance.

Future Actions: Current plans are to continue expanding our study abroad opportunities. To further encourage more participation in study abroad, we continue to expand our partner universities. Specifically, we are now attempting to identify some institutions in South America. As we open up more sites, we will entice more students to seriously consider these opportunities. On a related note, we are also in the process of revising our Global Engineering Minor. In the past this minor was mainly for students completing our flagship global program called GEARE. However, to provide more to recognize students for their varied international experiences (study abroad, international internships, research abroad, language skill development, cultural skill development, etc.), we are in the process of making the Global Engineering Minor more flexible so that more students can pursue this minor.

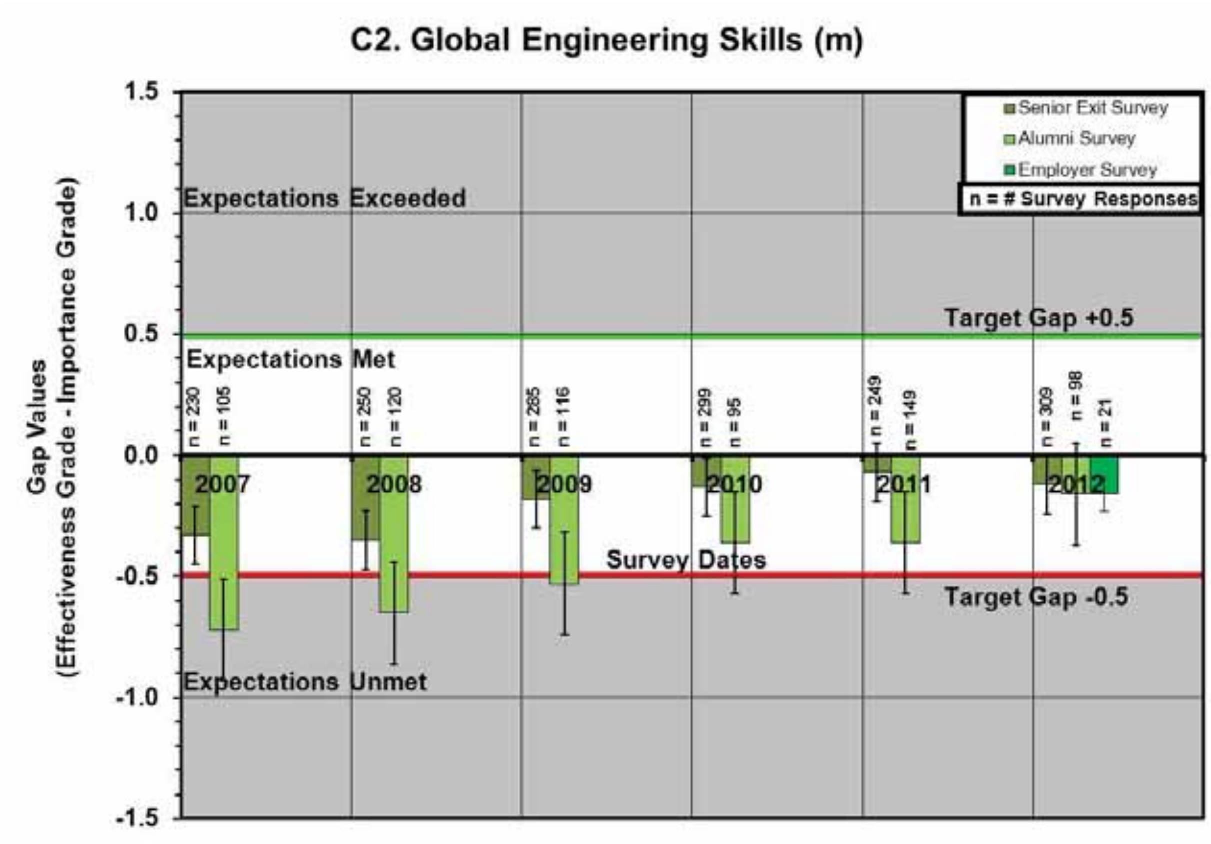


Figure 4.64 Longitudinal Gap Analysis for Outcome C2. Global Skills from 2007-2012.

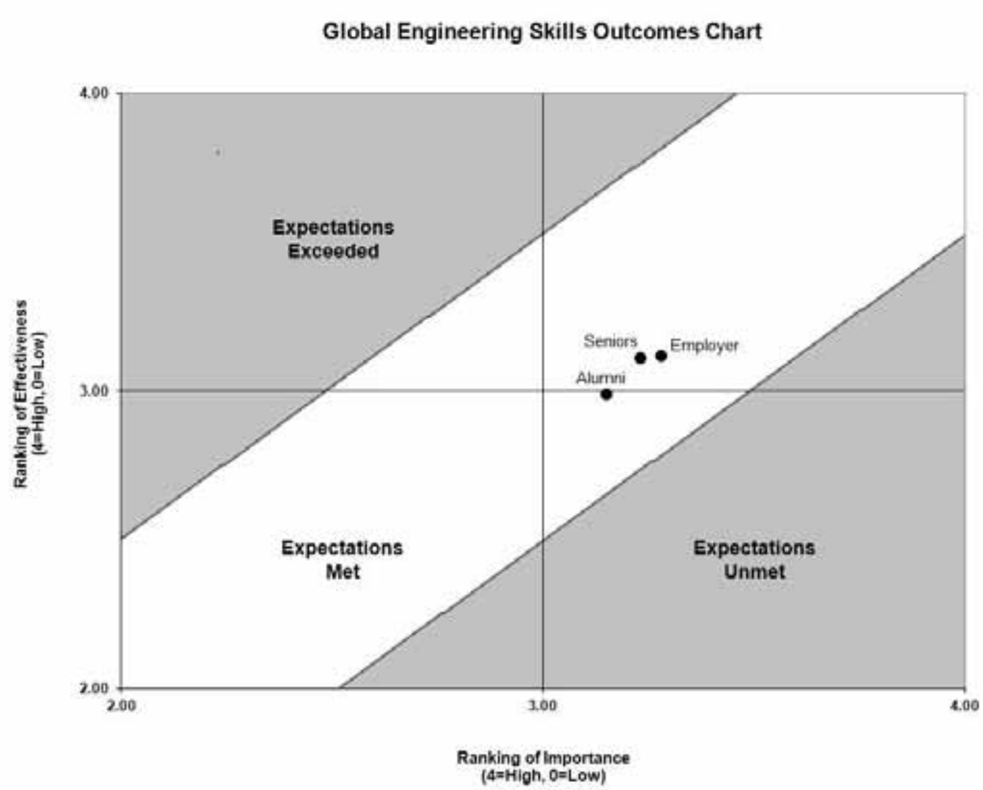


Figure 4.65 Ranking of Effectiveness versus Importance for Outcome C2. Global Skills for all constituents for 2012.

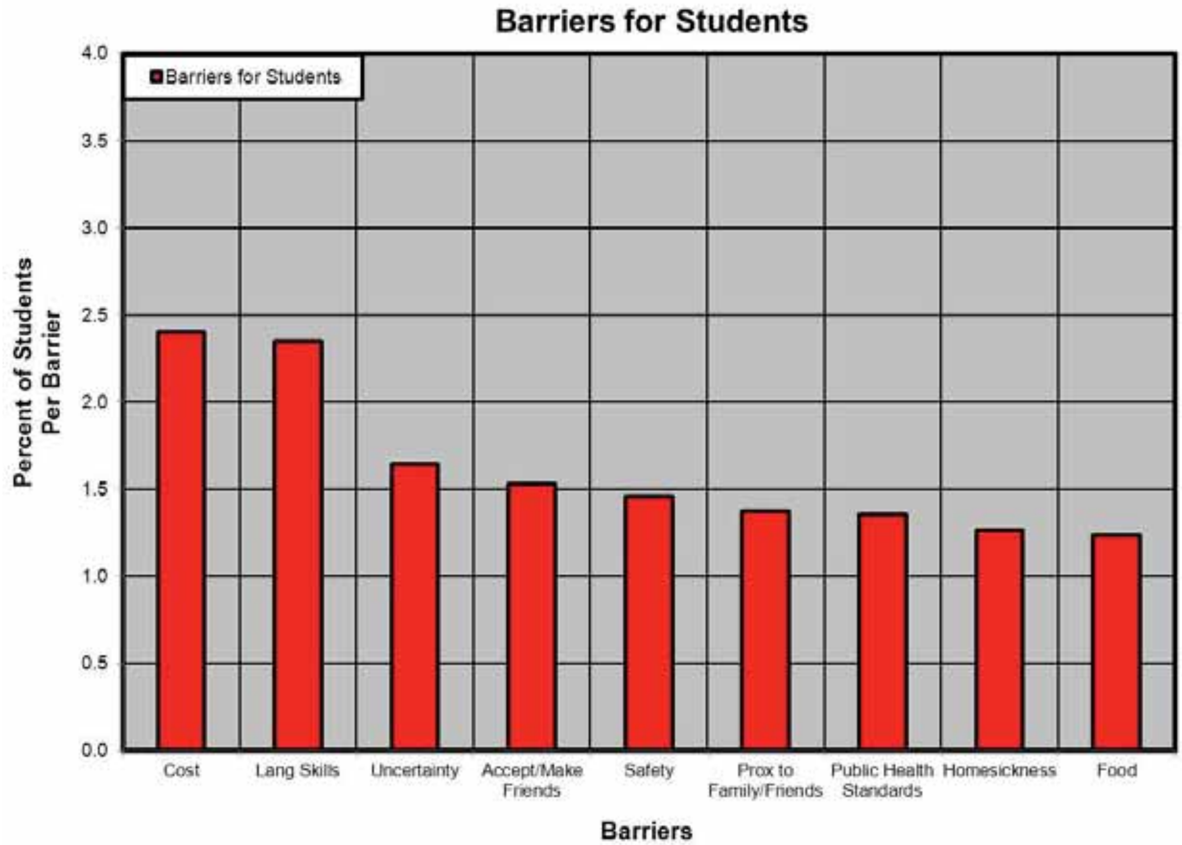


Figure 4.66 Ranking of Significant Barriers to Students Studying Abroad.

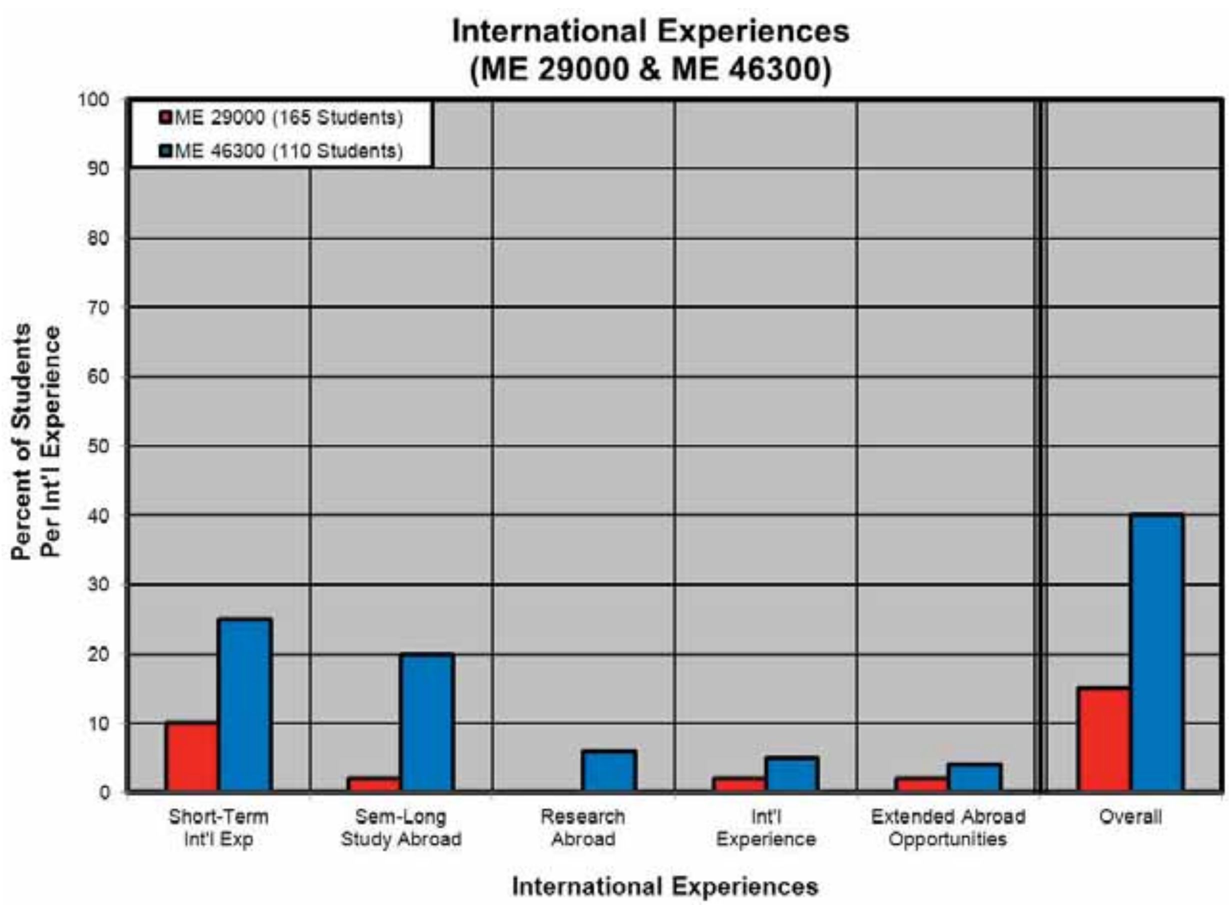


Figure 4.67 Participation rate for Various International Opportunities.

4A.16 Program Outcome C3. – Innovation (n)

Table 4.14 shows the performance criteria, assessment methods, and level of achievement used to evaluate outcome C3. – Innovation (n). A brief discussion of each four assessment methods is presented below.

Table 4.14 Performance Criteria, Assessment Methods, and Level of Achievement used for Outcome C3. – Innovation (n).

C3. Innovation An ability to identify promising market opportunities and develop new, creative solutions which meet customer needs and desires.					
Performance Criteria	• Identifies market opportunities. • Develops creative solutions which meet customer needs more effectively than current products.				
Assessment Method	**Level of Achievement**	**Date of Data Collection**	**Faculty/Course Assessment Took Place**	**Date of Results Evaluatio n**	**Evaluation Performed By**
Senior Exit Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Alumni Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Employer Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
ME 26300 Deliverable 3: House of Quality	90% of students score an 80 or higher	Dec 2012 April 2013	Anderson/ME 26300 Reid/ME 26300	Jan 2013 May 2013	Anderson Reid
ME 26300 Deliverable 5: Functional Decomposition	90% of students score an 80 or higher	Dec 2012 April 2013	Anderson/ME 26300 Reid/ME 26300	Jan 2013 May 2013	Anderson Reid

Senior, Alumni, and Employer Surveys: Figure 4.68 shows the longitudinal gap analysis for the three constituents for outcome C3. Innovation. All constituents consistently rated the gap values as marginally meeting or slightly below expectations. Given this is a relatively new outcome; it is not surprising that we still have work to do to improve students competency in this outcome.

Figure 4.69 shows the ranking of importance versus effectiveness of each of our three constituents for outcome C3. Innovation. In 2012, seniors and alumni rated this outcome as meeting expectations, but employer this outcome as just below expectation. All constituents rated this outcome as about average in comparison to the other outcome. However, continued improvement in the effectiveness of this outcome is needed.

ME 26300 – Deliverable 3 (House of Quality): Figure 4.70 show the histogram for the ME 26300 Deliverable 3 grades for fall 2012 and spring 2013. The level of achievement to meet expectations requires 90% of students consistently earning a grade of 80 or higher on the deliverable. To exceed expectations requires 95% of students consistently earning a grade of 80 or higher on the deliverable.

Deliverable 3 involves students developing a House of Quality for their semester project for the purpose of identifying specific engineering requirements and establishing a problem definition of what their product needs to be able to do to compete on the current market. As such the House of Quality serves an important function to determine the potential of a given market for new innovative ideas. Given this represents students' first experience in identifying an economically-viable market niche by conducting customer surveys, studying market trends, researching competitive products and analyzing relevant patents as well as their first exposure to using quality function deployment (QFD) methods, this deliverable is a useful direct measure for this outcome. Figure 4.70 shows that students in fall 2012 met expectations and in spring 2013 exceeded expectations.

ME 26300 – Deliverable 5 (Functional Decomposition): Figures 4.71 show the histogram for the ME 26300 Deliverable 5 grades for fall 2012 and spring 2013. The level of achievement to meet expectations requires 90% of students consistently earning a grade of 80 or higher on the deliverable. To exceed expectations requires 95% of students consistently earning a grade of 80 or higher on the deliverable.

Deliverable 5 involves students developing a Functional Decomposition for their product concept. The purpose of this functional decomposition is to help students to develop numerous potential solutions that address and meet the engineering requirements defined from the House of Quality. Such tools help foster broader and more innovative concepts that hopefully leads to a more novel solution that best meets the needs of the customer. Figure 4.71 shows that students in fall 2012 meet expectations and in spring 2013 exceed expectations.

Conclusions: The results from the constituent surveys are generally consistent and the House of Quality and Functional Decomposition deliverable support the conclusion that the students expected level of achievement for outcome C3. Innovation, albeit marginally. This result again is not surprising considering this is one of our new outcomes and we have had little time to develop curricular methods to foster innovation.

Three recent changes have helped to foster development of innovation skills. First, at the end of every ME 46300 Engineering Design course, there is an Innovation Competition in which faculty and several outside judges evaluate all of the projects and select top project for monetary awards. Mr. Thomas J. Malott, is the benefactor of this innovation competition and also a judge at the competition. While it is difficult to measure and quantify progress in innovation, Mr. Malott has noted anecdotally that he feels that students have shown improvement and that "we are on the right track." Similarly, the faculty concur that student awareness of the importance of innovation is on the rise. Second, in recent semesters, we have offered students the opportunity to develop their own student-sponsored project idea, assuming the scope of the project is appropriate and there are a group of students committed to the project. Having the opportunity to select your own ME 46300 project both fosters student innovation and ownership of the project. Many of the most innovative ME 46300 projects have come from student-sponsored projects. We are currently formalizing the process of initiating student-sponsored projects. Third, we recently received approval to permit students who initiate their own projects, to retain the intellectual property (IP) rights of their project. Although the University provides some modest resources, students will still be able to feel free to bring their best ideas to the table without the worry that the University will seek to own their ideas. In addition to these changes, students also have the option to pursue a Certificate in Innovation and Entrepreneurship at the University level.

Future Actions: We are currently in discussion with colleagues in Technology**,** Management, Technology Transfer, to seek ways to better prepare students to develop the array of skills needed to pursue start-up opportunities immediate after graduation.

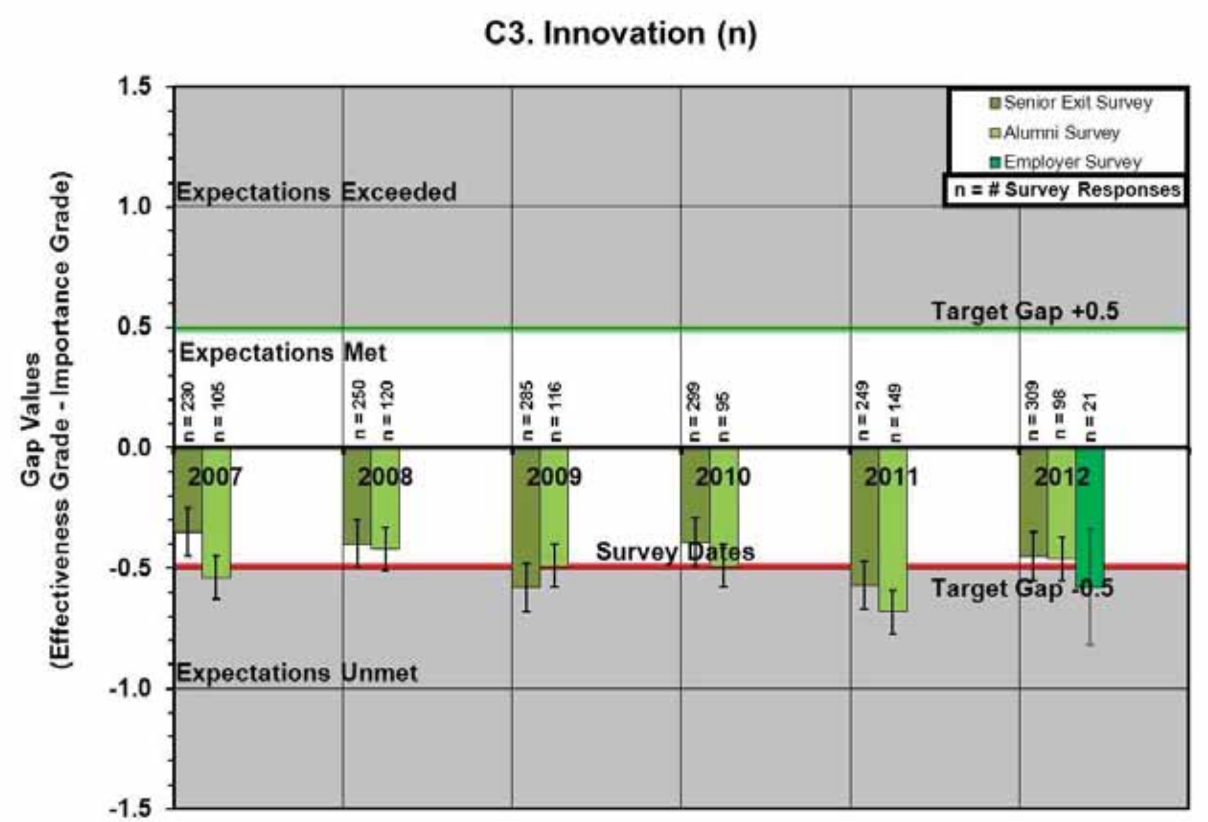


Figure 4.68 Longitudinal Gap Analysis for Outcome C3. Innovation from 2007-2012.

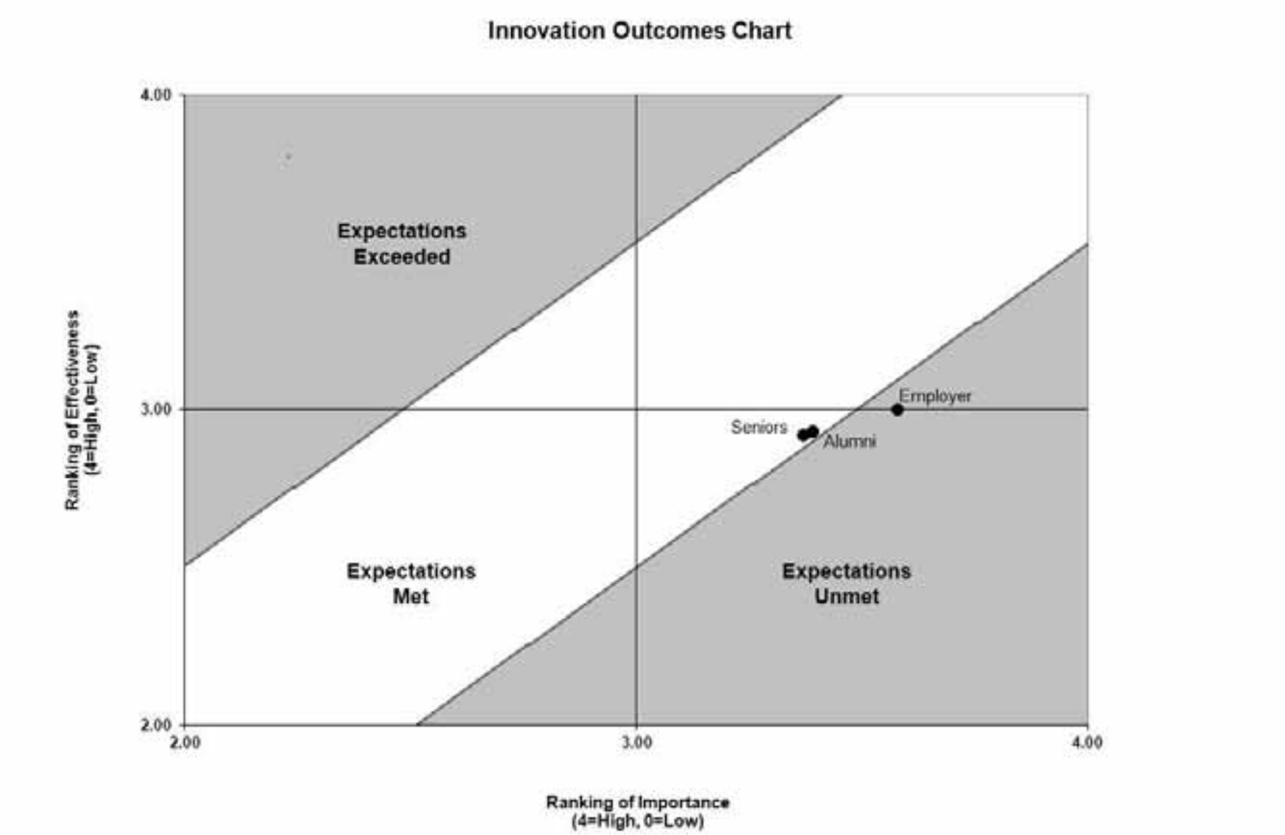


Figure 4.69 Ranking of Effectiveness versus Importance for Outcome C3. Innovation for all constituents for 2012.

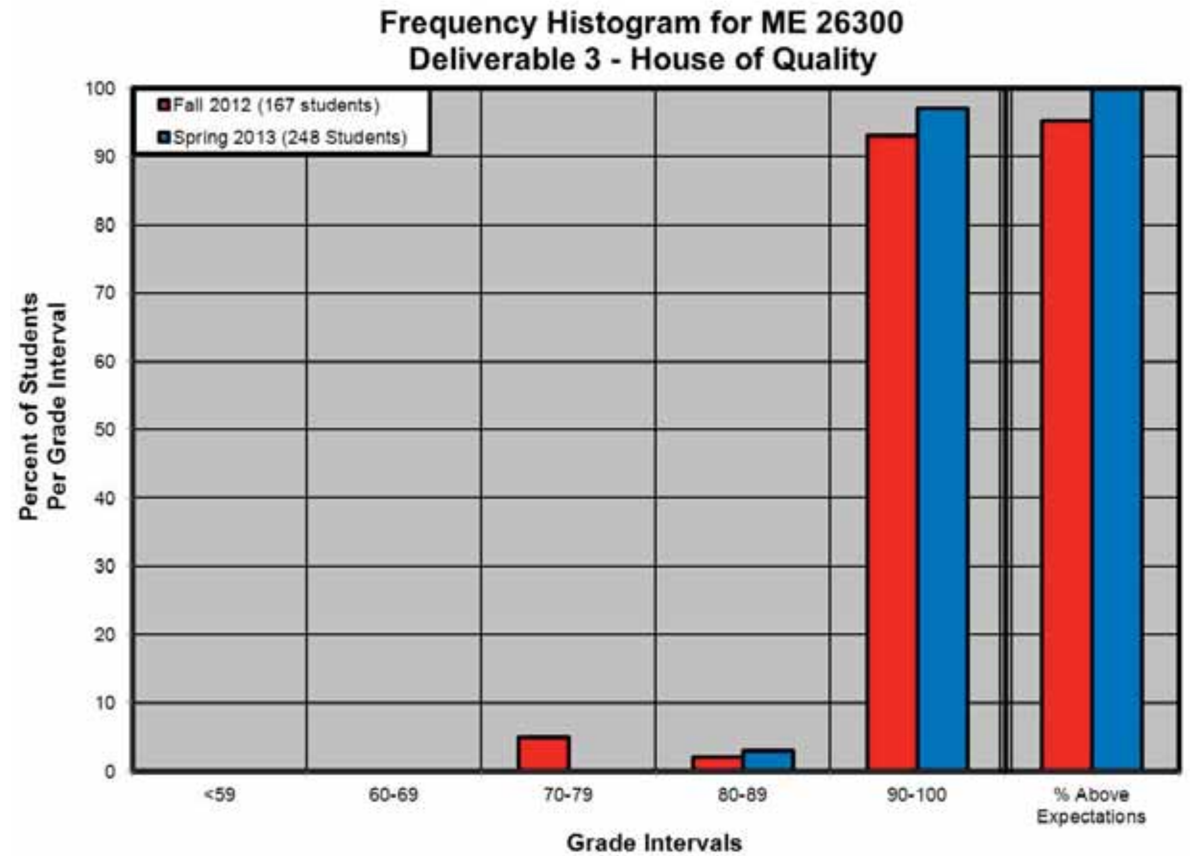


Figure 4.70 Histogram of ME 26300 Deliverable 3 (House of Quality) for fall 2012 and spring 2013.

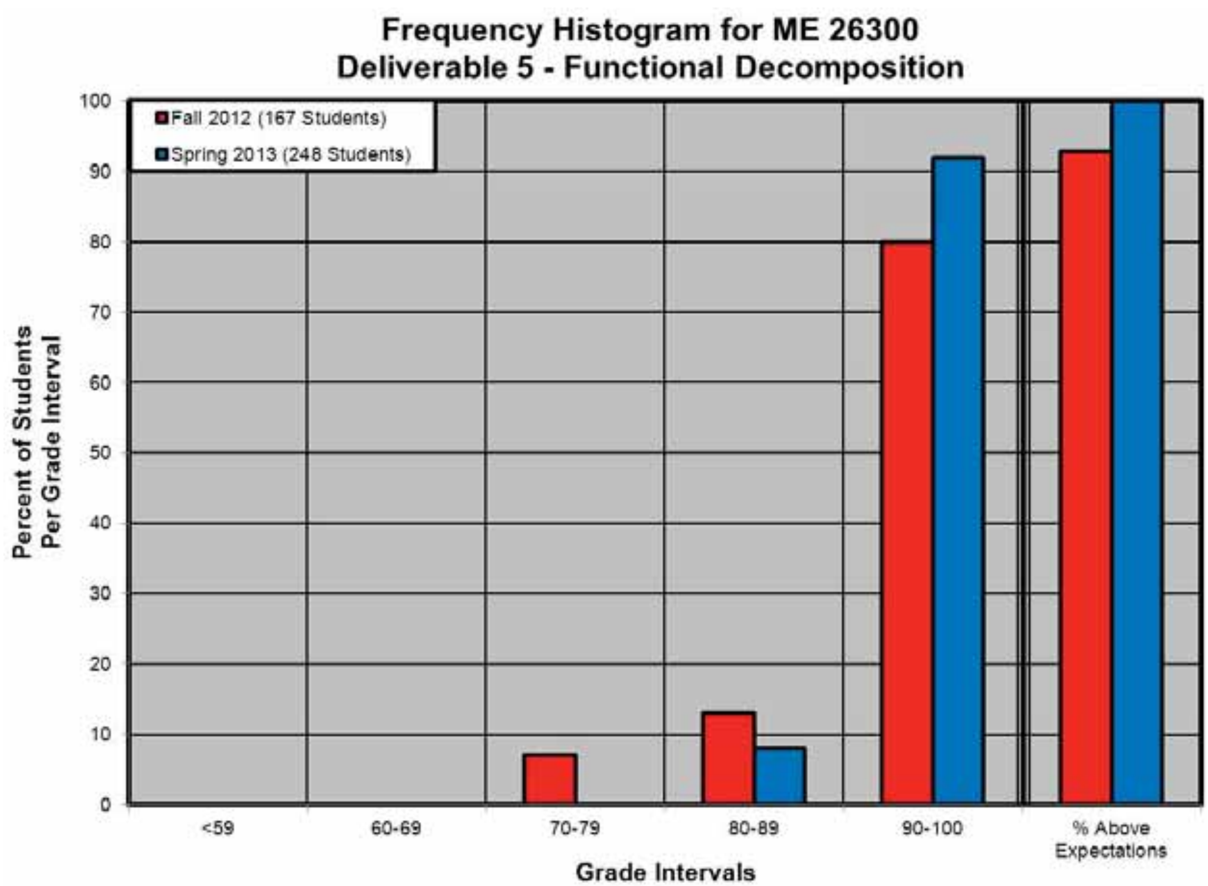


Figure 4.71 Histogram of ME 26300 Deliverable 5 (Functional Decomposition) for fall 2012 and spring 2013.

4A.17 Program Outcome C4. – Entrepreneurship (o)

Table 4.15 shows the performance criteria, assessment methods, and level of achievement used to evaluate outcome C4. – Entrepreneurship (o). A brief discussion of each of the four assessment methods is presented below.

Table 4.15 Performance Criteria, Assessment Methods, and Level of Achievement used for Outcome C4. – Entrepreneurship (o).

C4. Entrepreneurship (o) An ability to apply entrepreneurial skills both in new ventures (e.g., start ups) And within well-established organizations (intrapreneurship).					
Performance Criteria	• Performs studies on product development, risk assessment, market studies, and finance. • Able to interface with professionals in each of the above areas.				
Assessment Method	**Level of Achievement**	**Date of Data Collection**	**Faculty/Course Assessment Took Place**	**Date of Results Evaluation**	**Evaluation Performed By**
Senior Exit Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Alumni Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
Employer Survey (Indirect)	Effectiveness Score within ½ Letter Grade of Importance Score	May/Aug/Dec 2007-2012	N/A	Dec. 2007-2013	Curriculum Committee
ME 26300 Deliverable 11 Economic Analysis	90% of students score an 80 or higher	Dec 2012 April 2013	Anderson/ME 26300 Reid/ME 26300	May 2013 May 2013	Anderson Reid

Senior, Alumni, and Employer Surveys: Figure 4.72 shows the longitudinal gap analysis for the three constituents for outcome C4. Entrepreneurship. All constituents consistently rated the gap values as marginally meeting or slightly below expectations. Given this is a relatively new outcome; it is not surprising that we still have work to do to improve students competency in this outcome.

Figure 4.73 shows the ranking of importance versus effectiveness of each of our three constituents for outcome C4. Entrepreneurship. In 2012, employers and alumni rated this outcome as meeting expectations, but seniors rated this outcome as just below expectations. Interestingly this Entrepreneurship was one of the lowest rated outcomes, especially by employers. However, given that a significant fraction of job growth occurs in smaller start-up companies coupled with the highly competitive nature of the global economy, the importance of this skill may be underestimated.

ME 26300 – Deliverable 3 (Economic Analysis): Figures 4.74 show the histograms for the ME 26300 Deliverable 3 grades for fall 2012 and spring 2013. The level of achievement to meet expectations requires 90% of students consistently earning a grade of 80 or higher on the deliverable. To exceed expectations requires 95% of students consistently earning a grade of 80 or higher on the deliverable.

Deliverable 3 involves students developing an Economic Analysis of their product concept for the purpose of validating the economic viability of their idea. The Economic Analysis requires students to make a number of basic assumptions in order to develop their economic model. In their final presentation they are expected to defend the validity of their assumptions based on factual information regarding the market. Figure 4.74 shows those students in fall 2012 and spring 2013 exceeded expectations on this deliverable. Surprisingly, the students in fall 2012 scored higher than those in spring 2013 in this deliverable. Given that the fall 2012 is the "off-semester" for ME 26300, it is somewhat surprising that the fall 2012 students performed better on this deliverable.

Conclusions: The results from the constituent surveys and the ME 26300 Economic Analysis support the conclusion that students meet the expected level of achievement of for outcome C4. Entrepreneurship. While this is a newer outcome, some progress has already been made in this area. We have approved changes to the Innovation and Entrepreneurship Certificate Program for our ME program. Currently, students can complete the Innovation and Entrepreneurship Certificate program with only one extra course beyond their BSME degree by utilizing their electives properly.

Future Actions: We are currently in discussion with colleagues in Technology**,** Management, Technology Transfer, to seek ways to better prepare students to develop the array of skills needed to pursue start-up opportunities immediately after graduation. This certainly involves entrepreneurial skills among many others. Ultimately, the goal is to help students start the process of initiating a start-up, even while they are still at Purdue. While the Innovation and Entrepreneurship Certificate Program partly accomplishes this goal, a broader set of skills are needed by students for them to be effective. The proposed collaboration between Engineering, Technology Management and Technology Transfer shows potential for developing other critical skills needed to accomplish this goal.

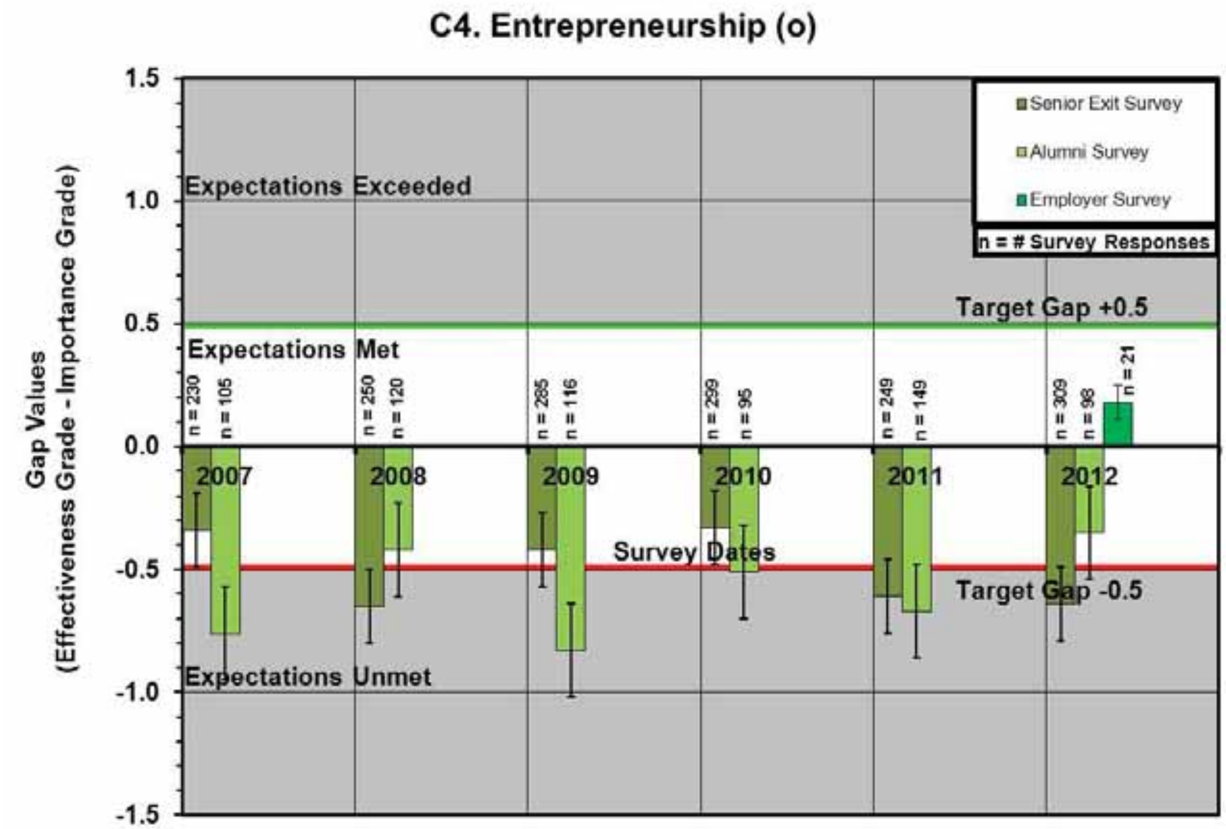


Figure 4.72 Longitudinal Gap Analysis for Outcome C4. Entrepreneurship from 2007-2012.

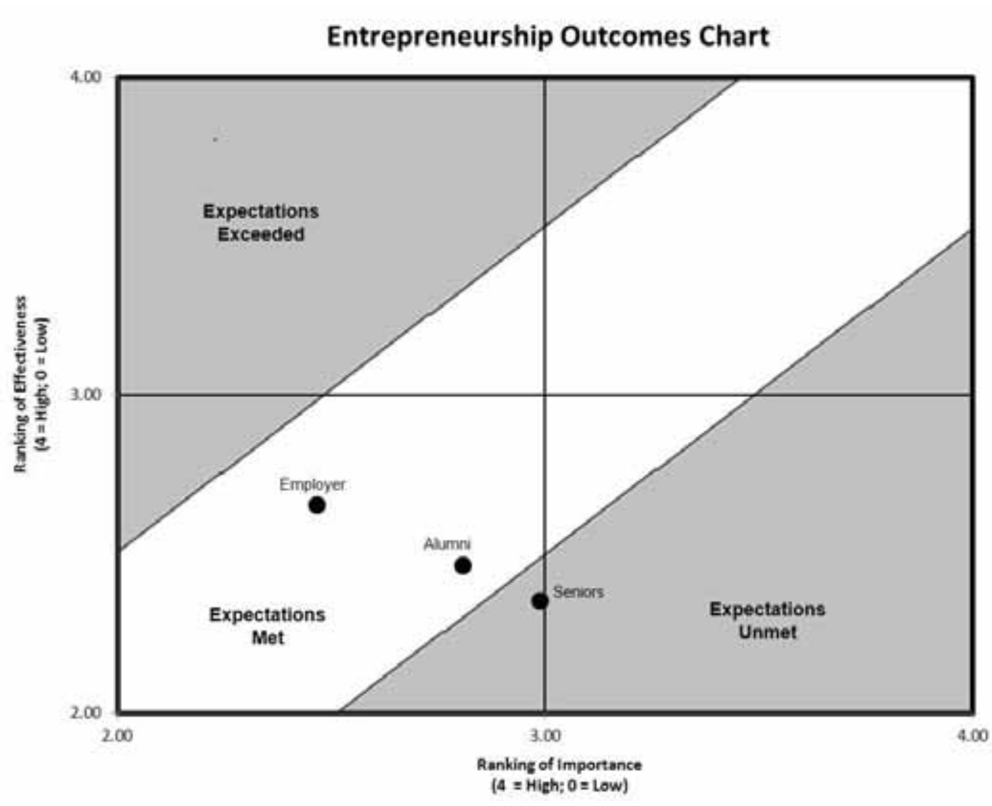


Figure 4.73 Ranking of Effectiveness versus Importance for Outcome C4. Entrepreneurship for all constituents for 2012.

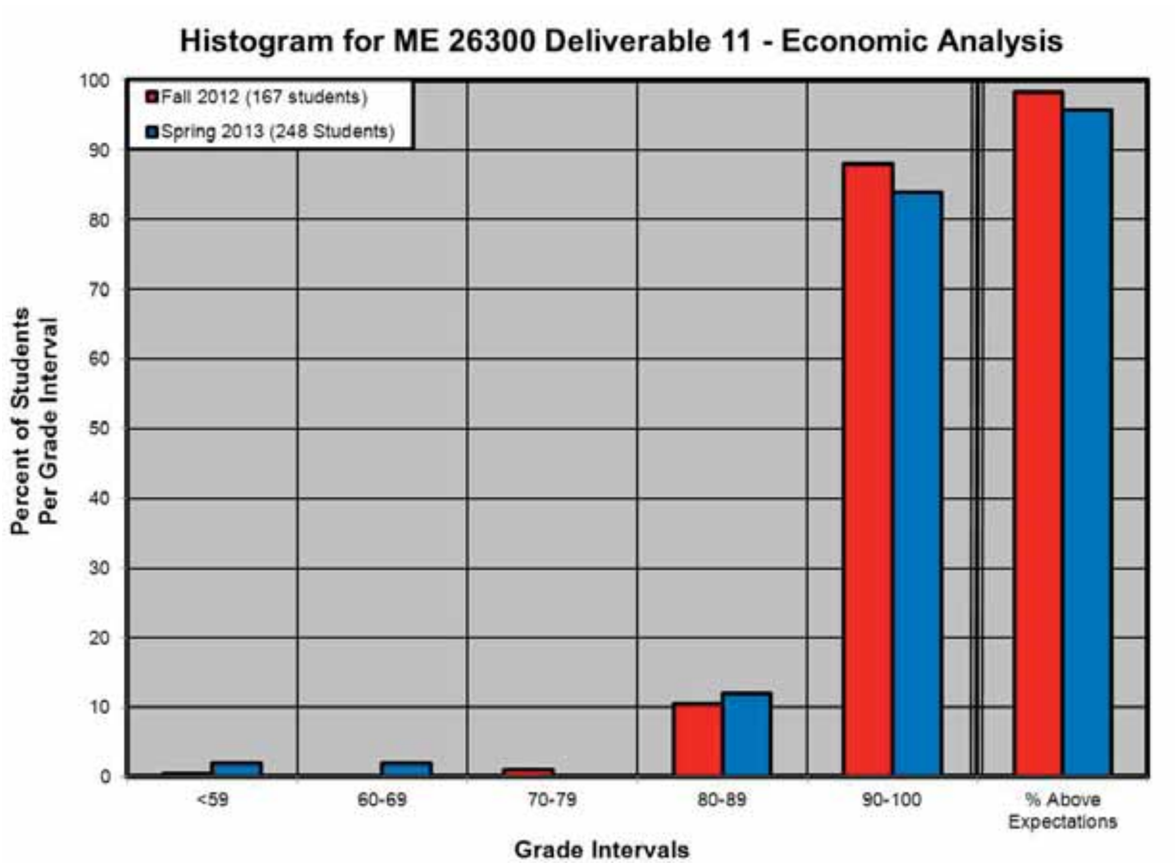


Figure 4.74 Histogram of ME 26300 Deliverable 11 (Economic Analysis) for spring 2013.

4B. Continuous Improvement

During the past six years, we have made numerous changes in response to our assessment process. In this section, we will summarize these changes.

4B.1 Changes in Outcome A1. Engineering Fundamentals (a)

The primary change under outcome A1. Engineering Fundamentals has been a modification of ME 27000 Basic Mechanics I. Historically, ME 27000 has had roughly 10 weeks of statics and 5 weeks of particle dynamics. The topics covered in particle dynamics were repeated in ME 27400 Basics Mechanics II, though at an accelerated pace. However, over time we have determined that this level of overlap is not essential. We have decided to replace 5 weeks of particle dynamics, with 5 weeks of introductory mechanics of materials including basic axial, torsional, and bending as well as shear-force and bending-moment diagrams. This will ultimately allow us to replace some fundamental material in ME 323 Mechanics of Materials with some more advanced topics that we currently are not able to cover. The other main advantage of this change is that students are exposed to some basic mechanics of materials principles early in their curriculum which they can take advantage of in the sophomore design course ME 26300 Introduction to Mechanical Engineering Design, Innovation, and Entrepreneurship. Since their experience at the sophomore level is greater in the mechanics area, the ME 26300 projects tend to mostly involve structural projects. Having some background in mechanics of materials gives students more options to develop basic analytical models of their systems.

Beyond ME 27000, we are also considering how to incorporate more manufacturing experience into our undergraduate curriculum. Currently we have a ME 36300 Manufacturing course as a professional elective offered every fall semester. We are considering making this a restricted elective or possibly part of the core curriculum. Again, this is also one of the more common suggestions for improvement from our senior exit survey.

We are also working on possibly modifying our Machine Design sequence (ME 35200 and ME 45200). ME 35200 Machine Design I is a kinematic and kinetic analysis and synthesis class while ME 45200 is more of a traditional design of machine elements class. The first class is required, but the second course is only a restricted elective. Because of the importance of strength and durability considerations, we are considering a reorganization of the topical contents in the two courses so that the first course in a two-course sequence has more balanced coverage of mechanisms and machine elements. This effort is on-going.

Finally, we have also added in our new Gatewood Wing a new 120 seat collaborative learning classroom. This classroom is especially designed to facilitate a conventional lecture environment being instantly transformed to a cooperative learning environment. This enables students to instantly form cooperative learning groups for interactive group activities. With this new facility, many faculty are now implementing cooperative learning techniques as well as experimenting with flipped classrooms.

4B.2 Changes in Outcome A2. Analytical Skills (e)

We see a need to add more experience with complex analysis and simulation tools (like finite element analysis) in our undergraduate core program. We have added a new FEA class as a professional elective as a start. However, in the future, we may consider making this course either a restricted elective (currently there are only 3 options) or possibly even part of our core curriculum. The need for such a course is one of the more common suggestions for improvement from our senior exit survey.

4B.3 Changes in Outcome A3. Experimental Skills (b)

Our ME 47500 Automatic Controls course has a lab that has been upgraded to all digital controllers. If needed the digital equipment can be used to simulate analog systems for illustrative purposes. Beyond this, ME 36500 lab has expanded to 13 stations to accommodate more students in each lab.

In addition to these upgrades, we have upgraded the lab equipment in ME 31500 Heat and Mass Transfer and expanded to 10 stations. A greater emphasis on energy and the environment, including global warming, has been incorporated in the class. Also, state-of-the-art infrared camera technology has been purchased for the lab. This helps provide students with experience using the latest modern thermal technology instrumentation.

4B.4 Changes in Outcome A4. Modern Engineering Tools (k)

There are no specific changes related to this outcome beyond the regular updating of our computer equipment and beginning efforts to seek greater emphasis in advanced modeling (like finite element modeling) discussed above under outcome A2, Analytical Skills.

4B.5 Changes in Outcome A5. Design Skills (c)

The major change to the design experience is the addition of our PEARL (Product Engineering and Realization Laboratory) facility in the Gatewood Wing. The Product Engineering and Realization Laboratory (PEARL) is a 6000 sq. ft. complex of several facilities located on the ground floor of the Gatewood Wing adjacent to the Atrium. These facilities all support the senior design experience and include an innovation instructional facility, a rapid prototyping facility, three fabrication and assembly facilities, and seven breakout rooms for team deliberations/consultations.

The Charlie and Louise Springer Innovation Instructional Facility (ME 1185) provides 800 sq.ft. of space for the weekly meetings of the ME 46300 design sections. Typically each of these sections have approximately 24 students. The instructional facility has a furniture arrangement that can be easily adapted to group work or modified for preliminary, critical or final design reviews. The room is equipped with a dedicated computer and large projection system for presentations.

The 600 sq. ft. Rapid Prototype Laboratory (ME 1191) is equipped with two laser stereo Lithography rapid prototyping machines (Model SLA 250/30), a ProJet 5000 3-D Printer, a 3-D Curing Oven, a Pro-Jet Finisher XL, a LABCONCO Protector Laboratory Hood and a sink and cabinet space. It also houses several display cases to showcase a variety of prototype projects.

Three 1200 sq. ft. Fabrication and Assembly rooms (ME 1178, 1202, and 1203) are each equipped with a protector hood, storage space and lockers, work benches, ample overhead power, an industrial sink, an Emergency Shower and Eye Wash Station, a first aid kit and an assortment of hand tools. These spaces are intended for fabrication and assembly of student projects.

Seven Breakout rooms (ME 1186, 1188, 1192, 1194, 1196, 1198, 1200) of roughly 132-216 sq. ft. each are available for student teams to meet individually with their teammates. Three of these rooms are also equipped with a 60 in monitor on the wall for projection of project documents for discussion.

In addition to the new PEARL Laboratory, the addition of the Gatewood Wing has enabled us to roughly double the size of our machine shop. This greatly improves out service to our students who frequent the machine shop to fabricate their senior design projects.

Finally, the Head has created a new position of Director of Senior Design and Prof. John Starkey has been serving in this role for the past 2 years. As the Director, Prof. Starkey serves as a point of contact for all issues related to senior design. These include reviewing student-sponsored project proposals, coordinating industry-sponsored projects, managing the PEARL facilities, coordinating projects and faculty instructors, organizing the Malott Innovation competition every semester, coordinating efforts with the student machine shops, managing safety reviews and other safety issues, among others.

4B.6 Changes in Outcome A6. Impact of Engineering Solutions (h)

This continued growth in our global programs has a direct impact on this outcome. As students get more exposure to other cultures, they gain a valuable perspective of how different cultures may value the impact of various engineering solutions very differently.

4B.7 Changes in Outcome B1. Communication Skills (g)

Communication skill currently is our number one concern with respect to students meeting expectations on outcomes. Ironically, there are a large number of communication experiences integrated across the ME core curriculum as demonstrated by the Communications Matrix discussed in the Communication Skills section.

Starting in the fall of 2010, we initiated the Mechanical Engineering Writing Enhancement Program (WEP) as a collaboration between the Purdue Writing Lab (run by the English Department) and the Purdue School of Mechanical Engineering to assess and track undergraduate student writing in ME 29000 and ME 26300. Using a combination of error counting, holistic rubrics, analytic rubrics, and interviews with ME faculty, the WEP developed and refined the two analytic rubrics currently being used and twelve custom video-tutorials available online through the Purdue Online Writing Lab. Each semester, writing samples from ME 29000 and memos from ME 26300 have been assessed by the WEP using the various rubrics. The assessment determined that over 30% of the errors made by ME 26300 students were more complex than surface-level errors (basic grammar and mechanics), and the WEP work with Purdue School of Mechanical Engineering resulted in an 8% reduction in these more complex errors when the error counting was discontinued in the Spring of 2011. In addition, a minimum of 69% of the students in ME 26300 for each semester have displayed improved writing over the course of each semester. Because ME 29000 students only submitted one writing sample, it was not possible to accurately track writing development—instead, the assessment of the ME 29000 writing samples was used to recommend additional writing instruction for weak writers. Further development of the analytic rubric and the video-tutorials is ongoing. One of the main benefits of this effort beyond the rubrics to assess student writing weaknesses has been the on-line video-tutorials. The advantage of this approach is that students can view these tutorials (typically 5 minutes long) as many times as desired. In addition, the TAs (and faculty) can likewise use the videos to learn subtleties of the English language, since many of them are also non-native students. It helps all students develop a solid foundation in writing skills. Nevertheless, students are still not meeting expectations. As highlighted in the "Future Actions" section of Section B1, we have planned a number of new initiatives to help us improve our effectiveness in communication skills.

4B.8 Changes in Outcome B2. Teamwork Skills (d)

While we haven't solved all of our concerns with respect to teaming, we have been studying how best to mix students for project teams. This is particularly important now since our international student population has grown so dramatically. The dynamics of how best to manage multi-cultural teams is a key question we are investigating.

4B.9 Changes in Outcome B3. Professional and Ethical Responsibility (f)

We continue strongly encouraging our seniors to take the FE exam as the first step in becoming a licensed engineer. This continues to be an uphill battle since professional licensure is not common in many ME dominated industries. Nevertheless, we typically, have 50-75% of our graduating seniors take the FE exam.

4B.10 Changes in Outcome B4. Contemporary Issues (j)

The most significant change is having students read a text like Zakaria's book on "Post American World" in ME 29000 and discuss the trends. Having this foundation gives stduents an informed perspective of many important issues that we as a community and nation are facing in a global economy.

4B.11 Changes in Outcome B5. Life-long Learning (i)

We have begun offering a small number of our core courses on-line for internship/co-op students and for students who are studying abroad and need an extra core course. Our plans are to expand this effort to offer most of our non-lab courses in an on-line format. By providing more opportunities to learn on-line, we are better preparing our students for life-ling learning, since many continuing education courses are offered in an on-line format.

4B.12 Changes in Outcome C1. Leadership (l)

We have recently approved an Engineering Leadership Development Minor for students. This enables students who want to make leadership a focal point of their academic career at Purdue can work toward this credential. We have also approved several leadership courses as part of our approved general education program to make these topics more readily available to students.

We have also piloted a rotating leadership approach with our project teams. The purpose of this it to require every student to serve as a leader at some stage of their project instead of letting the most naturally gifted leader maintain the leadership role all semester long. We haven't resolved all of the pros and cons of this approach as yet, but it is something we are testing.

4B.13 Changes in Outcome C2. Global Engineering Skills (m)

Philosophically, we are taking a distinctly different and strategic approach to our global programs as compared to most traditional programs. Most programs see study abroad and other global programs as special opportunities for their elite students. In essence, they are seeking only a few opportunities for a select group of high performing students. In our case, we view global skills essential for all of our students. Our strategy is to encourage all of our students to pursue global opportunities, not just the elite students. Our goal is to make study abroad and other international opportunities as common as internships and co-ops are today. While we have a long way to go, we continue to make significant progress. With over 30% of our undergraduates studying abroad and 25% of our student body being international students, it is safe to say that roughly half of our students have international experience.

We continue to expand the number of our Engineering Terms Abroad sites. New sites include Turkey, India, Australia, and Spain. One of our main areas of focus now is in South America. As we open up more sites, we will entice more students to seriously consider these opportunities. On a related note, we are also in the process of revising our Global Engineering Minor. In the past this minor was mainly for students completing our flagship global program called GEARE. However, to provide more to recognize students for their varied international experiences (study abroad, international internships, research abroad, language skill development, cultural skill development, etc.), we are in the process of making the Global Engineering Minor more flexible so more students can pursue this minor.

Since out last ABET visit, the Dean of the College of Engineering has created a Global Engineering Program (GEP) at the College to serve as an integrated, model program for engineering schools across the world, offering the tools and opportunities for global engineering discovery, education of engineers who exhibit scientific initiative and cultural sensitivity as they step into roles of international leadership, engaging and positively impacting communities both at home and abroad. As such the GEP program serves as a catalyst to promote global opportunities and foster cultural skill development among our students. As such, the GEP Program regularly sponsor global design projects, help facilitate international travel among faculty, staff and students, encourage joint research projects, among many other activities.

4B.14 Changes in Outcome C3. Innovation (n)

Three recent changes have helped to foster development of innovation skills. First, at the end of every ME 46300 Engineering Design course, there is an Innovation Competition in which faculty and several outside judges evaluate all of the projects and select the most innovative projects for monetary awards. Second, in recent semester, we have offered students the opportunity to develop their own student-sponsored project ideas, assuming the scope of the project is appropriate and there are a group of students committed to the project. We are currently formalizing this process. Third, we recently received approval to permit student who initiate their own projects, to retain the intellectual property of their project. Although the University provides some modest resources, students will still be able to feel free to bring their best ideas to the table without the worry that the University will seek to own their ideas. In addition to these changes, students also have the option to pursue a Certificate in Innovation and Entrepreneurship at the University level.

4B.15 Changes in Outcome C4. Entrepreneurship (o)

We have approved changes to the Innovation and Entrepreneurship Certificate Program for our ME program. Currently, students can complete the Innovation and Entrepreneurship Certificate program with only one extra course beyond their BSME degree by utilizing their electives properly.

C. Additional Information

In addition to the course material for all required ME courses, the following information will be provided in folders for the reviewer.

1) Data and results from senior exit surveys.
2) Data and results from alumni surveys.
3) Data and results from FE exams
4) Minutes from ME Curriculum Committee meetings
5) Data and results from direct assessments for required courses
6) Minutes for Mechanical Engineering Advisory Council (MEAC) meetings

CRITERION 5. CURRICULUM

5A. Program Curriculum

5A.1 Curriculum Plan of Study

Table 5.1 contains all of the required mathematics, science and core engineering courses in the program as well as placeholders for the appropriate number of courses for the Professional Electives, the General Education Electives, and the Free Elective. The rules and pre-approved courses for the Professional Elective Program (categorized by topical area) can be found at:

https://engineering.purdue.edu/ME/Academics/Undergraduate/METechElects.html

At Purdue, we have adopted a broad interpretation for the definition of Professional Electives which includes not only upper-level engineering courses, but also upper-level mathematics, hard science, and management courses. This broad interpretation fosters an increasing array of career paths that include not only all industrial sectors of engineering, but also many non-traditional career paths including law, medicine, education, business, politics, etc. Students may choose to diversify these electives by trying different topical areas or concentrate their technical electives in a single topical area, perhaps even pursuing a minor.

Likewise, the General Education Program is defined in broad terms. The rules and pre-approved courses for the General Education Program (categorized by department) can be found at:

https://engineering.purdue.edu/ME/Academics/Undergraduate/GenEds.html

As with the Technical Elective Program, students may pursue courses in many different areas or concentrate most of their General Education courses in a single, perhaps even pursuing a minor.

5A.2 Curriculum and Program Educational Objectives

The program curriculum supports the Program Educational Objectives (PEOs) by providing a strong technical preparation in the mechanical engineering sciences, while fostering skill development in mechanical engineering design, innovation and entrepreneurship, analytical and open-ended problem solving, modeling and computation/simulation, written and oral communication, global skills, and leadership. This along with an extensive general education experience allows our graduates to be successful in a broad array of traditional professional practice careers as well as many non-traditional careers enumerated in PEO #1 Discovery (Professional Practice). In addition there are a number of experiences, especially throughout the curriculum where students are responsible for determining what information they need and where to find reliable information. This skill is probably the single most important tool in their future professional development which is PEO #2 Learning (Professional Development). Wherever possible, current critical world-wide technological challenges and problems, such as sustainability, are woven directly into the appropriate core courses along with a dose of societal, global, and economic issues. These are a critical part of our students' experience and we believe they leave the program with a passion for engineering and a distinctive innovative and entrepreneurial spirit needed to serve as ambassadors for profession, and a willingness to advance new ventures and activities to enhance the quality of life of people as outlined in PEO #3 Engagement (Professional Outreach).

Table 5.1 Curriculum
B.S. in Mechanical Engineering - Purdue University - Semester System

Course (Department, Number, Title)			Course is Required, Elective or a Selected Elective by an R, an E or an SE.[2]	Curricular Area (Credit Hours)				Last Two Terms the Course was Offered: Quarter and Year	Average Section Enrollment for the Last Two Terms the Course was Offered[1]
				Math & Basic Sciences	Check if Contains Significant Design (√)	General Education	Other		
Year 1									
MA 16500	Calculus and Analytic Geometry I	(F - Year 1)	R	4				F ‘12 Sp ‘13	L 453, R 38 L 353, R 37
CHM 11500	General Chemistry	(F - Year 1)	R	4				F ‘12 Sp ‘13	L 465, R 24, LB 24 L 304, R 24, LB 24
ENGR 13100	Ideas to Innovation I	(F - Year 1)	R		2(√)			F ‘12 Sp ‘13	L 118, S 118 L 114, S 114
ENGL 10600/10800	English Composition	(F - Year 1)	R			3		F ‘12, Sp ‘13	L 20 L 21
CGT 16300	Graphical Communication and Spatial Analysis	(F - Year 1)	R				2	F ‘12 Sp ‘13	L 386, LB 37 L 353, LB 22
Math 16600	Calculus and Analytic Geometry II	(Sp - Year 1)	R	4				F ‘12 Sp ‘13	L 457, R 39 L 453, R 36
PHYS 17200	Modern Physics	(Sp - Year 1)	R	4				F ‘12 Sp ‘13	L 222, R 44, LB 44 L 260, R 46, LB 44
ENGR 13200	Ideas to Innovation II	(Sp - Year 1)	R		2(√)			F ‘12 Sp ‘13	L 117, S 117 L 118, S 118
COM 11400	Fundamentals of Speech Communication	(Sp - Year 1)	R			3		F ‘12 Sp ‘13	L 27 L 25
<u>Science Selective</u>		(Sp - Year 1)	SE						
CHM 11600	General Chemistry II			4 4				F ‘12 Sp ‘13	L 245, R 24, LB 24 L 352, R 24, LB 24
CS 15900	Programming Applications for Engineers			3 3				F “12 Sp ‘13	L 79, LB 27 L 247, LB 26

Course (Department, Number, Title)	Course is Required, Elective or a Selected Elective by an R, an E or an SE.[2]	Curricular Area (Credit Hours) Math & Basic Sciences	Check if Contains Significant Design (√)	General Education	Other	Last Two Terms the Course was Offered: Quarter and Year	Average Section Enrollment for the Last Two Terms the Course was Offered[1]
Year 2							
MA 26100 Multivariate Calculus (F - Year 2)	R	4				F '12 Sp '13	L 425, R 40 L 451, R 36
ME 20000 Thermodynamics I (F - Year 2)	R		3			F '12 Sp '13	L 144 L 116
ME 27000 Basic Mechanics I (F - Year 2)	R		3			F '12 Sp '13	L 120 L 118
ME 29000 Global Engineering Professional Seminar (F- Year 2)	R		1			F '12 Sp '13	L 273 L 193
PHYS 24100 Electricity and Optics (F - Year 2)	R	3				F '12 Sp '13	L 264, R 43 L 244, R 45
Economics Elective (F - Year 2)	SE			3		F '12 Sp '13	Variable Variable
MA 26200 Linear Algebra & Ordinary Differential Eqns. (Sp - Year 2)	R	4				F '12 Sp '13	L 38, R 38 L 44, R 44
ME 26300 Intro to ME Design, Innov, and Entreneurship (Sp - Year 2)	R		3(√)			F '12 Sp '13	L 92, LB 26 L 127, LB 24
ME 27400 Basic Mechanics II (Sp - Year 2)	R		3			F '12 Sp '13	L 131 L 135
ECE 20100 Linear Circuit Analysis I (Sp - Year 2)	R		3			F '12 Sp '13	L 125 L 125
ECE 20700 Electronic Measurement Techniques (Sp - Year 2)	R		1			F '12 Sp '13	LB 31 LB 30
World Affairs and Cultures Elective (Sp - Year 2)	SE			3		F '12 Sp '13	Variable Variable

L=Lecture, R=Recitation, LB=Lab, S=Studio

Course (Department, Number, Title)	Course is Required, Elective or a Selected Elective by an R, an E or an SE.[2]	Curricular Area (Credit Hours): Math & Basic Sciences	Check if Contains Significant Design (√)	General Education	Other	Last Two Terms the Course was Offered: Quarter and Year	Average Section Enrollment for the Last Two Terms the Course was Offered[1]
Year 3							
MA 30300 Diff. Eqns. for Engineering and the Sciences (F - Year 3)	R	3				F '12 Sp '13	L 173 L 167
ME 30900 Fluid Dynamics (F - Year 3)	R		4			F '12 Sp '13	L 128, R 34, LB 3* L 106, R 35, LB 3*
ME 32300 Mechanics of Materials (F - Year 3)	R		3			F '12 Sp '13	L 120 L 94
ME 36500 Systems and Measurements (F - Year 3)	R		3			F '12 Sp '13	L 99, LB 20 L 78, LB 20
Generals Education Elective (F - Year 3)	SE			3		F '12 Sp '13	Variable Variable
ME 35200 Machine Design I (Sp - Year 3)	R		4(√)			F '12 Sp '13	L 72, LB 15 L 103, LB 16
ME 37500 System Modeling and Analysis (Sp - Year 3)	R		3			F '12 Sp '13	L 76 L 79
MSE 23000 Structure and Properties of Materials (Sp - Year 3)	R		3			F '12 Sp '13	L 138, R 37 L 190, R 48
Technical Elective (Sp - Year 3)	SE				3	F '12 Sp '13	Variable Variable
General Education Elective (Sp - Year 3)	SE			3		F '12 Sp '13	Variable Variable

L=Lecture, R=Recitation, LB=Lab, S=Studio

* ME 30900 utilizes an Open Lab concept that schedules lab groups individually (typically 3 students per group) rather than in typical sections.

Course (Department, Number, Title)		Course is Required, Elective or a Selected Elective by an R, an E or an SE.[2]	Curricular Area (Credit Hours): Math & Basic Sciences	Curricular Area (Credit Hours): Check if Contains Significant Design (√)	Curricular Area (Credit Hours): General Education	Curricular Area (Credit Hours): Other	Last Two Terms the Course was Offered: Quarter and Year	Average Section Enrollment for the Last Two Terms the Course was Offered[1]
Year 4								
ME 31500 Heat and Mass Transfer	**(F - Year 4)**	R		3			F '12 Sp '13	L 75, LB 15 L 51, LB 16
Restricted Elective Course (ME 30000, ME 45200, ME 47500)	**(F - Year 4)**	SE		3			F '12 Sp '13	Var, L 74, LB 13** Var. L 88, LB 15**
Technical Elective Course	**(F - Year 4)**	SE				3	F '12 Sp '13	Variable Variable
General Education Elective	**(F - Year 4)**	SE			3		F '12 Sp '13	Variable Variable
Free Elective Course	**(F - Year 4)**	E				3	F '12 Sp '13	Variable Variable
ME 46300 Engineering Design	**(Sp - Year 4)**	R		3(√)			F '12 Sp '13	L 27, LB 27 L 291, LB 29
Restricted Elective Course (ME 30000, ME 45200, ME 47500)	**(Sp - Year 4)**	SE		3			F '12 Sp '13	Var, L 74, LB 13** Var. L 88, LB 15**
Technical Elective Course	**(Sp - Year 4)**	SE				3	F '12 Sp '13	Variable Variable
Technical Elective Course	**(Sp - Year 4)**	SE				3	F '12 Sp '13	Variable Variable
General Education Course	**(Sp - Year 4)**	SE			3		F '12 Sp '13	Variable Variable
TOTALS-ABET BASIC-LEVEL REQUIREMENTS			33	53	24	17		
OVERALL TOTAL CREDIT HOURS FOR THE DEGREE		128						
PERCENT OF TOTAL			25.8%	41.4%	18.8%			
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours		32 Hrs	48 Hrs				
	Minimum Percentage		25%	37.5 %				

L=Lecture, R=Recitation, LB=Lab, S=Studio
** ME 47500 Only

5A.3 Curriculum Structure and Outcomes

Table 5.2 is a matrix of the Student Outcomes mapped to the individual courses required for the BSME degree. Table 5.3 is the ME Program Map which shows the prerequisite structure for the ME Program. The program is designed to provide a sequence of laboratory, design, group project, and computational experiences through the program vertically and across the three disciplinary stems (mechanical sciences, fluid/thermal sciences, and systems, measurements and control). This provides multiple experiences which, along with the cornerstone and capstone design experiences, directly ensure the attainment of each and every one of the Student Outcomes. The prerequisite structure is such that students apply their recent learning in the mechanical engineering core sciences to laboratory and practical design experiences in several key places throughout the curriculum.

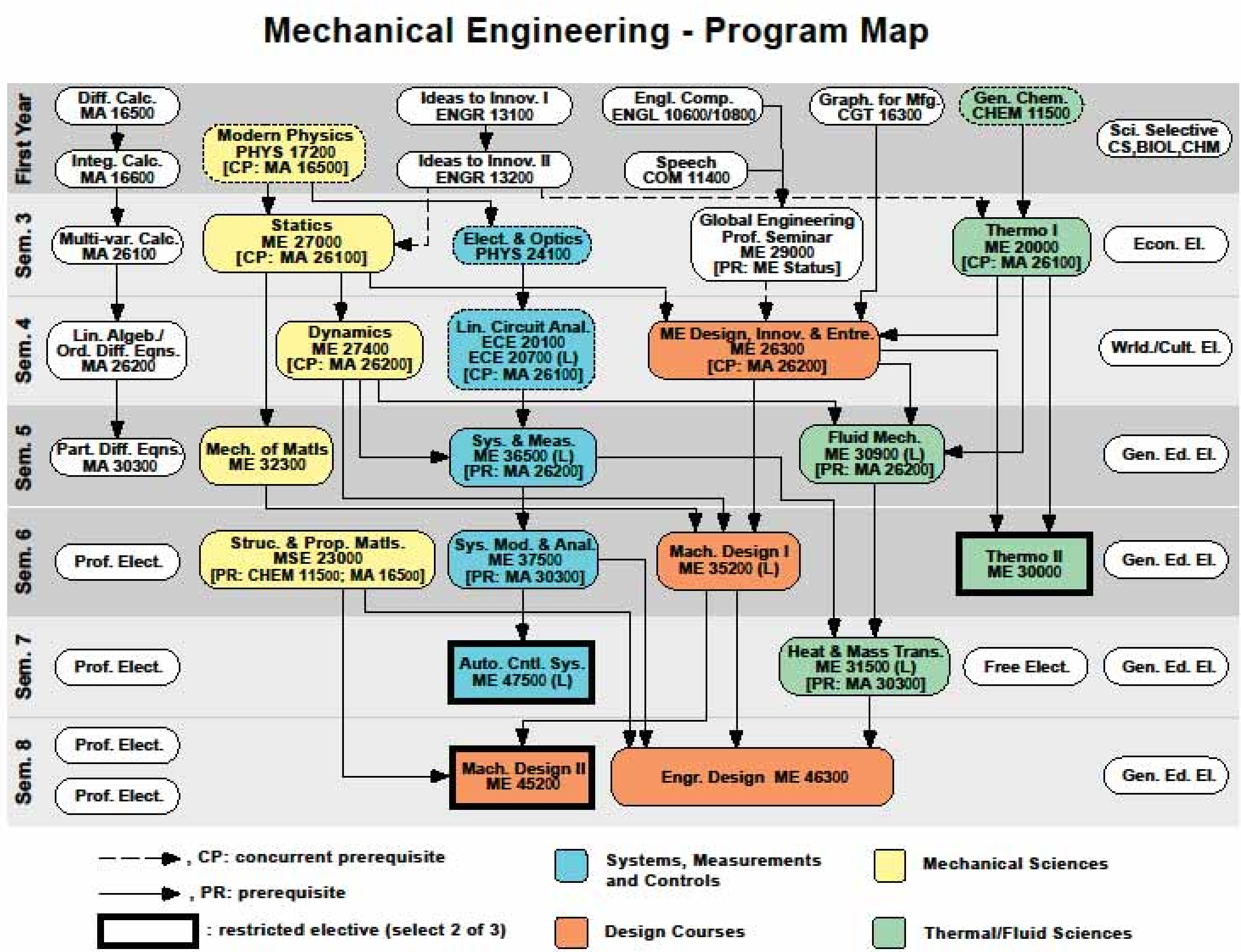
Table 5.2 Matrix of ME Program outcomes vs. the Required Courses in the ME Program.

Matrix of ME Program Outcomes vs. Required Courses

ME Program Outcomes	Sem. 1					Sem. 2					Sem. 3						Sem. 4						Sem. 5					Sem. 6						Sem. 7					Sem. 8				
Rev 4/3/13	MA 165 Analy. Geom. & Calculus I	CHEM 115 General Chemistry	ENGR 131 Ideas to Innovation I	CGT 163 Graphical Comm. and Spatial Analy.	ENGL 106/108 First Year Composition	MA 166 Analy. Geom. & Calculus II	ENGR 132 Ideas to Innovation II	PHYS 172 Modern Mechanics	Science Select. (CHM 116, CS 159, or BIOL 110)	COM 114 Fundamentals of Speech Comm.	ME 200 Thermodynamics I	ME 270 Basic Mechanics I (Statics)	ME 290 Global Engrng Professional Sem.	MA 261 Multivariate Calculus	PHYS 241 Electricity & Optics	Economics Elective	ME 263 Intro. to ME Design, Innov. & Entre.	ME 274 Basic Mechanics II (Dynamics)	ECE 201 Linear Circuit Analysis	ECE 207 Electronic Measurement Techniques	MA 262 Lin. Algeb. and Ordinary Diff. Eqns.	World & Cultural Affairs Elective	ME 309 Fluid Mechanics	ME 323 Mechanics of Materials	ME 365 Systems & Measurements	MA 303 Part. Diff. Eqns for Engrs & Scient.	General Education Elective (GE - 1)	ME 300 Thermodynamics II (RE - 1)*	ME 352 Machine Design I	ME 375 System Modeling & Analysis	MSE 230 Structure & Properties of Materials	Professional Elective (PE - 1)	General Education Elective (GE - 2)	ME 315 Heat & Mass Transfer	ME 475 Automatic Control Systems (RE - 2)*	Professional Elective (PE - 2)	Free Elective	General Education Elective (GE -3)	ME 452 Machine Design II (RE - 3) *	ME 463 Engineering Design	Professional Elective (PE - 3)	Professional Elective (PE - 4)	General Education Elective (GE - 4)
Credit Hours	4	4	3	2	3	4	2	4	3	3	3	3	1	4	3	3	3	3	3	1	4	3	4	3	3	3	3	3	4	3	3	3	3	4	3	3	3	3	3	3	3	3	3
Average Workload (hours/week)	12	12	12	6	6	12	12	12	12	6	13	13	3	13	13	6	18	13	13	5	13	6	18	13	18	13	6	18	18	13	13	13	6	18	18	13	6	6	18	18	13	13	6
A. Engineering Fundamentals																																											
A1. Engineering Fundamentals (a)	P	P	P			P	P	P	P		P	P		P	P		P	P	P	P	P		P	P	P	P		P	P	P	P	V		P	P	V	V		P	P	V	V	
A2. Analytical Skills (e)	P	P	P	P		P	P	P	P		P	P		P	P		P	P	P	P	P		P	P	P	P		P	P	P	P	V		P	P	V	V		P	P	V	V	
A3. Experimental Skills (b)		P		P				P	V											P			P		P							V		P	P	V	V			P	V	V	
A4. Modern Engineering Tools (k)								P									P			P			P		P				P	P		V		P	P	V	V		P	V	V	V	
A5. Design Skills (c)			P	P			P										P						S						P			V		P	P	V	V		P	P	V	V	
A6. Impact of Engineering Solutions (h)			P				P									P	P					V					V		S			V	V	S		V	V		S	P	V	V	V
B. Professional Skills																																											
B1. Communications (g)		S	P	P	P		P	P	V	P	S	S	P				P	S		P			P	S	P			S	P	S		V		P	P	V	V		P	P	V	V	
B2. Teamwork (d)			P				P	P	V								P			P			P		P				P			V		P	P	V	V		S	P	V	V	
B3. Professional and Ethical Responsibility (f)													P				P							P			V			S		V	V			V	V	V		P	V	V	V
B4. Contemporary Issues (j)													P			P						P					V					V	V			V	V	V			V	V	V
B5. Life-Long Learning (i)													P				P										P					P	P			P	P	P		P	P	P	P
C. Emerging Skills																																											
C1. Leadership (l)			P				P						P				P						S		S				S			V		S	S	V	V		S	P	V	V	
C2. Global Skills (m)													P				P					P					V					V	V			V	V	V			V	V	V
C3. Innovative (n)			P				P										P															V				V	V			P	V	V	
C4. Entrepreneurship (o)			P				P										P															V				V	V			P	V	V	

P = Primary Outcome **S = Secondary Outcome** **V = Variable Outcome (depending on elect. chosen)**

Table 5.3: ME Program Map



5A.4 Curricular Areas

Mathematics and Basic Sciences - Mathematics is covered by five courses in calculus and analytic geometry, multivariate calculus, linear algebra and ordinary differential equations and partial differential equations totaling 19 credit hours. In addition students are given exposure to statistics within some core mechanical engineering courses. This provides a sound foundation in mathematics which our students use throughout their curriculum. Physics is covered by two courses in modern mechanics and electricity and magnetism, totaling 7 credit hours. This material is solidly reinforced in much of the mechanical engineering core. The minimum chemistry requirement is one course totaling 4 credit hours. The total minimum number of semester credit hours is 33. Together this provides our students with the necessary background in mathematics and the basic sciences to engage in all of their core engineering curriculum, as well as the exposure necessary to understand the basic science behind other engineering and non-engineering disciplines and applications.

Engineering Topics - The non-ME engineering portion of the curriculum consists of one course in materials science (3 cr hrs), and two courses in circuits and electronics (4 cr hrs), one of which is a one-credit laboratory experience. All of these courses have direct applications to the ME core curriculum as the prerequisite structure indicates. The ME portion of the engineering curriculum consists of three courses in standard engineering mechanics (9 cr hrs), two courses in design and manufacturing (7 cr hrs), two courses in systems, measurements and controls (6 cr hrs), three courses in the fluid and thermal sciences (11 cr hrs), and the senior capstone design experience (3 cr hrs). In addition to these core requirements, each student is required to select two restricted electives out of three options (6 cr hrs). The three options include one course deeper in each of the main three stems of the curriculum (mechanical sciences, thermal-fluid sciences, and systems measurements and controls). The total minimum number of semester credit hours in engineering topics is 57. Together this provides the necessary background in the well accepted key disciplinary areas of mechanical engineering with a strong focus on analysis, modeling, computations, and design.

General Education - Our students are required to take COM 114 Fundamentals of Speech Communication and ENGL 106/108 English Composition (6 crs.). In addition to these core courses, 18 crs. of General Education courses are required, 3 crs. of which have to be an Economics course and 3 crs. have an emphasis in World Affairs and Cultures. The remaining 12 crs. can be taken in any number of different areas of humanities and social sciences. Also, other courses have been approved in select topic areas which have been deemed consistent with the spirit of the General Education Program (e.g., a number of leadership courses have been added to our General Educations list). This makes for a total of 24 crs. of general education courses.

5A.5 Major Design Experience

All students in the School of Mechanical Engineering have two major design experiences in ME 26300 Introduction to Mechanical Engineering Design, Innovation, and Entrepreneurship and ME 46300 Engineering Design.

ME 26300: ME 26300 is our cornerstone design experience and as such lays the foundation of design theory. The semester is divided into three distinct phases. Phase I is the Problem Definition phase. In this phase, students are given a general topical area (e.g., exercise equipment) and asked to study this market. They identify benchmark products, review key patents, survey target customers and study the market itself. This information is analyzed using a House of Quality to determine the engineering design requirements needed to their product to compete in the market.

In phase II the students focus on concept generation and evaluation. Students use techniques such as functional decomposition and brainstorming to generate numerous ideas for products. They use decision matrices to determine their best ideas and they develop analytical models to analyze and improve upon their designs. At the end of this phase students have both a primary and a backup concept.

Phase III is the detailed design phase. Students decide which parts to purchase and which parts to make. They prepare a complete Bill of Materials. They estimate volumes of sales and prepare a financial model to evaluate key economic parameters (Return on Investment, Payback, Net, Present Value, etc.) to assess the economic viability of their project. Finally, they conduct an assembly analysis to help reduce the part count, and simplify the assembly process. In the end they have a detailed design of their final product along with an economic plan of how to proceed to market.

At the end of each phase, students are required to write an extensive project report that documents their design process and prepare a summary presentation of their work. Students are also required to keep a daily design notebook documenting their activities, accomplishments and milestones.

In summary, ME 26300 serves an important role in helping students understand a typical design process and gain experience with common tools engineers use to make decisions throughout the design process.

ME 46300: ME 46300 Engineering Design differs from ME 26300 in four critical ways. First, the projects are significantly more complicated as the students have at their disposal much more content knowledge which they are expected to draw upon. Second, students take the design much further down the design process, in this case typically fabricating full-scale prototypes of their designs. This manufacturing experience really highlights for students the difficulty of the manufacturing phase of the design process. Third, students get to select from a number of different project topics or develop their own project proposal. In other words, in contrast to ME 26300 where students are all working in a similar domain (e.g., exercise equipment), ME 46300 students all have vastly different project topics they are working on. Fourth, a number of projects involve students from other disciplines. For example, we have had a number of biomedical device projects involving ME and BME students. Similarly, we have also recently partnered with the School of Management to take advantage of their business and marketing skills in some of our projects.

Students typically have four options for projects. First, they can propose their own project. Such proposals have to be submitted early in the previous semester and have to be vetted with Dr. John Starkey, the Director of Senior Design. The value of this option is that it allows students with specific interests to propose a project in an area they are passionate about. Students in our Innovation and Entrepreneurship Certificate Program who use ME 46300 as their capstone experience are required to prepare a project proposal for a new product idea. Recently, Purdue approved a plan that gives students full ownership of their intellectual property for such student-sponsored projects. This decision helps foster an entrepreneurial spirit among our students. They can feel comfortable in bringing their best ideas to the table without worry that others will own their ideas.

Second, students can participate in a faculty-sponsored project. Many faculty have creative project ideas for devices they need designed and fabricated. Very sophisticated projects such as a spinal testing machine have been developed via this mechanism. Faculty often provide much needed additional funds for the development of such devices.

Third, students can participate in an industry-sponsored project. Each semester we have a number of companies that sponsor a variety of projects. The company provides funding for the project as well as technical expertise to help get students up to speed on their project and serve as a resource for future questions.

Fourth, some students participating in significant design competitions (e.g., Mini Baja, SAE Formula, ASME Design competitions, etc.) can utilize these projects for their ME 46300 capstone experience. These projects tend to be even more demanding, often requiring a two-semester commitment. When this occurs, the first semester can be taken as a Professional Elective and the second semester as their ME 46300 Senior Capstone Design experience.

As with ME 26300, students follow a design process. However in this case, students are allowed to draw on their ME 26300 experience to develop their own design process. Typically there is somewhat less emphasis on the problem definition phase of the project to make more room for the fabrication phase of the process.

At the end of the semester, all student groups participate in the Malott Innovation Competition. Since there are so many projects (typically 40-50 projects in the spring semester), each faculty instructor determines the top 2-3 projects in their section. This pares the competition down to around 15 projects. A panel of faculty and a separate panel of external judges independently rate each of the projects utilizing a poster show format. The top projects as determined by the faculty and external judges are compared and consensus is sought concerning the top 5-6 projects. Typically, these two independent assessments are well aligned. The top contenders prepare oral presentations of their projects for the combined panel of faculty and external judges before final winners are announced. The highlight of the competition is the final showcase of all of the projects which include a public poster show where ME student peers, faculty and staff, family and friends, and the press are invited to review all of the projects, culminating in the announcement of the final winners. As such this event provides a valuable venue for the ME 463 students to showcase their work, experience closure to their Purdue career in the presence of their student peers, faculty and staff, family and friends, the press. It is truly the highlight and culmination of their Purdue experience.

In both ME 26300 and ME 46300, students typically are in sections of 20-24 students with 5-6 teams of 4 students each. In ME 26300, each lab section has a lab coordinator and a graduate TA. In ME 46300, each section has a faculty coordinator.

ME 31500 and ME 35200: In addition to these two major design experiences (ME 26300 and ME 46300), all students also have significant design experiences in both the thermal sciences in ME 31500 Heat and Mass Transfer and in the mechanical sciences in ME 35200 Machine Design I. ME 31500, students conduct a half-semester project on a selected topic. Sample projects include design and analysis of window defoggers, heat exchangers, pizza bags, dimmer switches, and dynamic braking just to name a few. Likewise, students gain valuable design experience in the mechanical sciences in ME 35200. These projects typically involve the design and synthesis of various mechanisms for a variety of applications (such as a hydraulic bucket for an off-road vehicle).

ENGR 13100 and ENGR 13200: Beyond these design experiences, all students also receive introductory design practice in ENGR 13100 and ENGR 13200. Students are introduced to simplified design processes and apply these processes to their projects. These experiences serve an important role in that they help introduce students to the idea of open-ended type design problems.

5A.6 Cooperative Education

While roughly 90% of our students take advantage of the optional co-op (20%) and internship (70%) programs at Purdue University, none of these experiences are currently used to satisfied curricular requirements.

5A.7 Course Materials for Review

A course syllabus and multiple examples of varying quality of the graded student work from the course will be available for review for every course in the required curriculum. Graded student work includes homework, quizzes, exams, laboratories, and project reports, depending on which of these were used for the course. The material will be organized primarily by course number. We will also duplicate the materials for each course used in our direct assessments of student outcomes and organize this subset of courses by student outcome.

5B. Course Syllabi

Appendix A includes a syllabus for each course used to satisfy the mathematics, science, and discipline-specific requirements required by Criterion 5.

CRITERION 6. FACULTY

6A. Faculty Qualifications

As of Fall 2013, the School of Mechanical Engineering had 64 regular tenure-track faculty members, of whom five had joint appointments with other Schools at Purdue, two are serving as School/Department Heads, one as an Associate Dean of Engineering, one was serving full-time as Chief Global Affairs Officer of Purdue, and one is serving full-time as Vice President for Research. Two additional faculty members have half-time appointments as Director of the Honors Programs and Director of the Office of Professional Practice, both for the College of Engineering. Faculty distribution among the ranks includes 43 full Professors, 8 Associate Professors, and 13 Assistant Professors. The full-time equivalent (FTE) faculty strength associated with School responsibilities is about 59 as of fall 2013.

In terms of undergraduate instructional expertise the faculty are divided into six academic area committees led by a chairperson of the area (see Figure 6.1). There is an adequate distribution of faculty in each of these curricular areas to meet the instructional needs of the School. Furthermore, we encourage interested faculty to teach outside their academic area to help facilitate integration and cross-fertilization of instructional ideas across the curriculum.

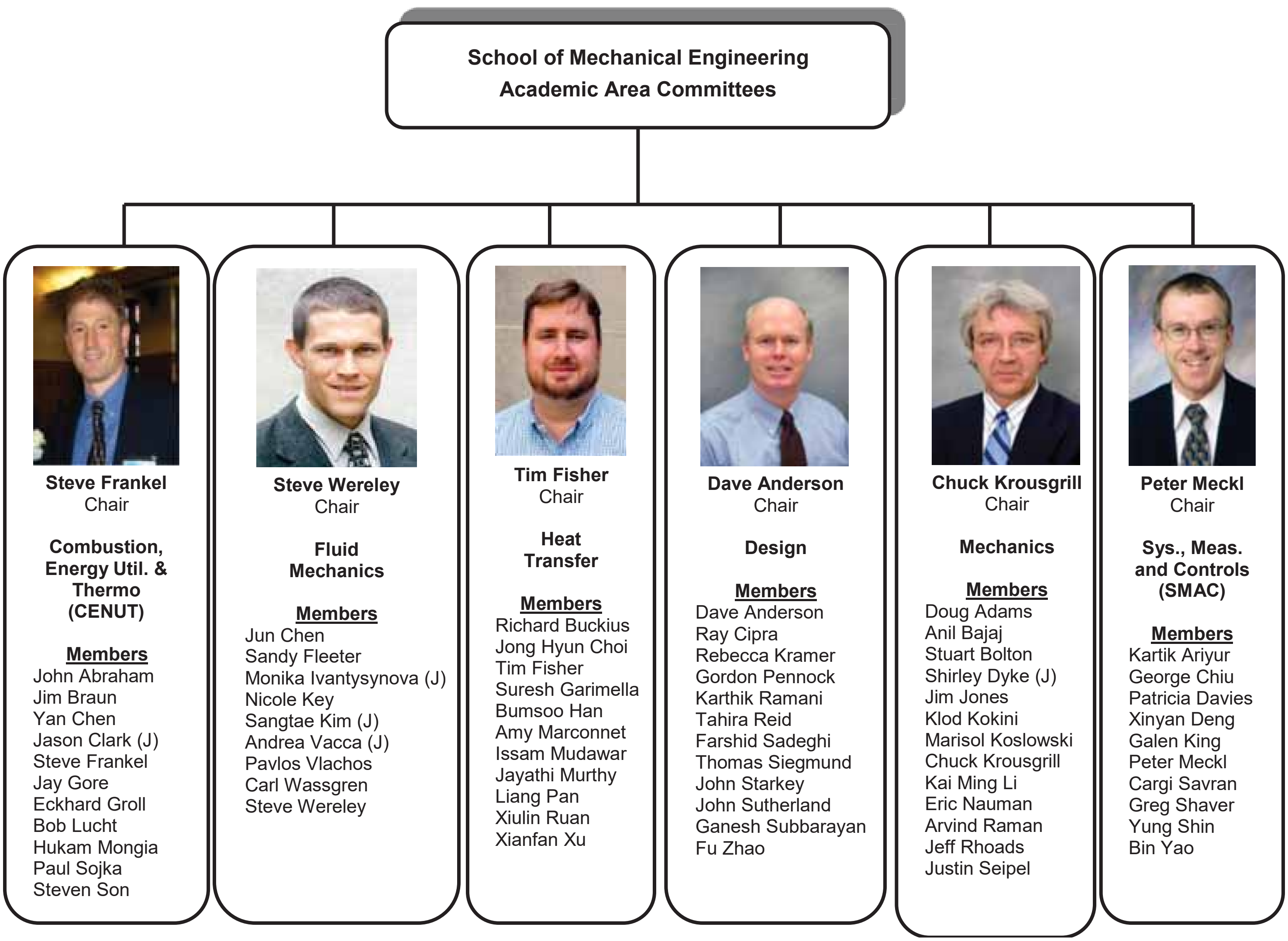


Figure 6.1 Academic Area Committees (J – Indicates Joint Appointment).

Professional development for faculty is a continuous process. As shown in Table 6.1, the typical faculty member is high-to-medium on professional society involvement (primarily ASME), high-to-medium on research activities (approximately 20% industry, and 80% state and federal), and medium-to-low in consulting and summer work in industry. In addition, the faculty collectively has conducted roughly 6.7 million dollars of industry-based research activity. As shown on the faculty vitae (see Appendix B), most faculty members are actively publishing and presenting their findings in top journals and conferences across the world. Hence, there is strong evidence that faculty are active in cutting-edge research and professional development.

In addition to being active in research, all members of the faculty are committed to teaching in the undergraduate and/or graduate program. When a new faculty member arrives, they self-select the academic area committee which best fits their background. The Chair of the area committee serves as a mentor for general questions about ME. In addition, each new faculty member selects a faculty mentor who helps guide their professional development as well as their academic progress and ultimately the promotion and tenure case. In early teaching assignments, we generally assign new faculty members to a multi-division undergraduate course. The supervisor of the course organizes much of the course materials (syllabus, exams, quizzes, etc.); hence, this takes some of the extra burden off new faculty so that they can more gradually transition to Purdue. New faculty are also invited to participate in a biweekly mentor-teacher program that Prof. Jones organizes. This program helps guide new faculty who are teaching for the first time. The Center for Instructional Excellence also organizes a series of College Teaching Workshops every semester on fundamental and advanced instructional methods that the faculty are encouraged to utilize.

ME faculty have also been active in handbooks as well as textbook development. Recent examples of this activity include:

"Part 17: Damage prognosis in metallic and composite structures," Encyclopedia of Aerospace Engineering, **Adams, D.E**., Jata, K., John Wiley & Sons, 2010.

"Dynamics based health monitoring and control in wind turbine rotors," Kusnick, J., Dana, S., Yutzy, J., **Adams, D.E**., Emerging Topics of Aerodynamics in Wind Energy, Ed: Ryo, WIT Press, accepted.

"Chapter x: Commonly used sensors and their associated algorithms," Yoder, N. and **Adams, D. E.**, Sensor Technologies for Civil Infrastructure, Woodhead Publishing, Eds. Jerome Lynch and Hoon Sohn, submitted for review.

"Health Monitoring of Structural Materials and Components: Methods with Applications" **Douglas E. Adams**, John Wiley & Sons, Chichester, UK. ISBN: 978-0-470-03313-5, 512 pages.

"Heating, Ventilation, and Air Conditioning in Buildings, John W. Mitchell, and **James E. Braun**, ISBN 978-0-470-62457-9, 2012, 600 pages.

"Thermal Energy at the Nanoscale", **T.S. Fisher**, book in preparation and under contract, part of book series: *Lectures in Nanoscience and Technology: Electronics from the Bottom Up*, Eds. M.S. Lundstrom and S. Datta, World Scientific Publishers, Singapore.

“Microchannel Heat Sinks for Electronics Cooling”, **S. V. Garimella** and T. Harirchian, Vol. 1 in the *Encyclopedia of Thermal Packaging*, World Scientific, Singapore, 2013 (248 pp., ISBN 978-981-4313-80-3).

“Predicting Outdoor Sound,” Attenborough, K., **Li, K.M.**, Horoshenkov, K., Taylor & Francis, 2006. ISBN- 9780419235101, 456 pages.

“Theory of Machines and Mechanisms,” Uicker, John J., Jr, **Pennock, Gordon R.**, and Shigley, Joseph E., Oxford University Press Inc., 2010. ISBN 9780195371239.

”Sound and Vibrations of Positive Displacement Compressors,” **Soedel, W**., CRC Press, Boca Raton, 2007. ISBN 0-8493-7049-3, 342 pages.

“Particle Image Velocimetry: A Practical Guide,” Raffel, M., Willert, C., **Wereley, S.**, Kompenhans, J., Springer, New York, 2007. (ISBN: 978-3-540-72307-3), 350 pages.

“Fundamentals and Applications of Microfluidics,” N.T. Nguyen and **S.T. Wereley** Artech House, Boston, 2nd edition, 2006. ISBN 978-1-58053-972-2, 497 pages.

One measure of the high quality of the faculty is the number of faculty named as a Fellow in various professional organizations, some of them even receive multiple recognitions in recent years (multiple award winners are noted in parentheses). Since 2006, seventeen faculty (Abraham, Bolton, Braun (2), Chiu, Gore (3), Garimella, Groll (2), Kokini, Lucht, Raman, Sadeghi, Shin, Siegmund, Subbarayan, Sutherlans, Xu (2), Yao) have been awarded fellow status (3 were recognized by two different professional societies and 1 by three societies). Since 2006, thirteen of our faculty members (Adams, Choi, Deng, Groll, Han, Nauman (2), Raman, Rhoads, Ruan, Panchal (2), Wereley, Vlachos, Yao) have been recognized with an early-stage career awards (e.g. NSF CAREER, Young Investigator Awards, etc.) from government agencies or Purdue in support of their scholarship.

In addition to these strong indicators of peer recognition and numerous other awards for research excellence, departmental faculty members have won numerous awards for excellence in teaching and education at the national level, as well as within Purdue and its College of Engineering. At the national level, Professor Adams was awarded the 2009 Demichelle Award for educational contributions in modal analysis. Professor Qingyan (Yan) Chen has been selected by the ASHRAE Chapter Technology Transfer committee as an ASHRAE Distinguished Lecturer. Prof. Groll was awarded the 2011 ASHRAE Distinguished Lecturer Award as well as the 2010 E.K. Campbell Award (also from ASHRAE) for outstanding service and achievement in teaching and research in subjects related to industry and the profession. Professor Krousgrill was recognized with the 2011 Archie Higdon Distinguished Educator Award by the Mechanics Division of ASEE. Professor Rhoads was awarded the Ferdinand P. Beer and E. Russell Johnston Jr. Outstanding New Mechanics Educator award by the Mechanics Division of ASEE. Professor Shaver was awarded the 2013 Ralph R. Teetor Educational Award of SAE. Finally, Professor Sutherland was recognized with the 2009 SME Education Award. Beyond these recognitions, several faculty have also been cited for service awards for various professional societies.

At Purdue, the ME faculty have also been recognized with many University, College and School teaching and educational awards. Professor Groll was inducted into the Book of Great Teachers (University) in 2008, perhaps the highest teaching honor at Purdue. Professor Krousgrill have been awarded the Solberg Best Teacher Award (ME) in 2007 and 2012, the Potter Best Teacher Award (CoE) in 2012, the Special Boilermaker Award (University) in 2010, and the Helping Students Learn Award (University) in 2009. Professors Bolton (2008) and Garimella (2009) have been awarded the Distance Teaching Award (College). Prof. Rhoads was awarded the Solberg Best Teacher Award (2009) and Prof. Starkey was awarded the same in 2006 and 2010. Professor Abraham was awarded the 2008 Minority Engineering Award (College) for his commitment to academic excellence. Professor Kokini was awarded the 2007 Violet Haas Award (University) for contributions to women, and currently the only male recipient. Professors Adams (2006), Groll (2007), Siegmund (2008), Garimella (2009), Subbarayan (2011), and Ramani (2012) have been awarded the Ruth and Joel Spira Award for outstanding contribution in ME (School) for inspiring students and fostering excellence in commercial or defense product realization. Beyond these awards the faculty have receive numerous other University and CoE awards based on Advising/Mentoring (Bajaj, Fisher, Garimella, Groll, Jones), Research (Bajaj, Lucht, Nauman, Raman, Ramani), Team (Gore, Nauman, Koslowski, Raman) and Engagement/Service (Chiu). Finally, the faculty have also received numerous Best Paper/Best Poster awards at a variety of professionals conferences, either individually or with their students.

6B. Faculty Workload

The faculty workload summary is given in Table 6.2. To prepare the faculty teaching assignments, Dr. Jones sends out a teaching plan framework to each Area Committee to formulate an Area Teaching plan including what courses each area wants to offer and the teaching preferences of the faculty in that area. Dr. Jones then puts a draft teaching plan together and works with the faculty to fill in any gaps, while also working with Dr. Bajaj on any adjustments that may need to be included due to sabbaticals, other leaves of absence, decline in research funding, etc. Ideally, we are striving to have each faculty with a base teaching load of one course per semester. A faculty’s remaining time would be determined by their personalized professional plan. Most faculty would use this added time to pursue research opportunities or activities relevant to the school having impact (such as large research program development, textbook writing, pedagogy development, etc.), though some will serve in other administrative capacities or seek additional teaching responsibilities. While most faculty are sufficiently active in research to teach only two courses per year, a small number of faculty choose to regularly teach 3-4 courses per year.

Over the past seven years our ME Program has grown roughly by 50% (from around 800 students in the Undergraduate Program to over 1200 students). While ME has added faculty in that time, the net gain has lagged behind student growth. We continue to seek new faculty to address this growth in the ME Program (currently there are 4 active faculty searches in progress). However, one concern is the inequity in teaching loads throughout the College of Engineering. In some cases, other Schools in the College have much lower than the current ME teaching load. These differences in faculty teaching loads across the College are being addresses but very slowly.

6C. Faculty Size

As indicated above, as of Fall 2013, about 59 FTE faculty were involved with the ME undergraduate and graduate programs, roughly divided evenly between the six areas. This represents a significant growth in the faculty since our last ABET visit when we had about 51 FTE faculty in the School. However, over this same time period we have seen a 50% growth in enrollment in the undergraduate program. This dramatic growth is due to many factors including the continued weak economy and the decline in jobs in select industrial sectors (e.g., aerospace/defense, civil, nuclear, etc.) coupled with the added flexibility a ME degree provides graduates to help them navigate in times with heightened levels of uncertainty.

Lecture classes in undergraduate courses are primarily taught by faculty members, supplemented by select lecturers who have doctoral degrees as well as Lambert Teaching Fellows (described below). However, with approximately 1243 students currently in our Undergraduate Program and essentially 59 FTE faculty, there is a 21-to-1 student-to-faculty ratio. This is a notable increase over the 16.7-to-1 student-to-faculty ratio that existed seven years ago. To address this concern, we are on the path to to hire sufficient faculty to reduce our student-to-faculty ratio to around the 2007 level.

While the Purdue ME Program has a large student enrollment, faculty actively interact with students in a variety of venues both within and outside the classroom. Our goal is to foster a sense of community within ME. In class, many faculty go to considerable effort to get to know all of their students by name, even in the large-enrollment classes with up to 120 students. Faculty have developed successful techniques like taking pictures of the students to aid in learning names. This greatly fosters more personal interactions with students both within and outside the classroom.

Faculty also serve as advisors for the professional and honorary societies in the School. These advisors spend considerable time attending chapter meetings, advising student leaders, and traveling with students to regional and national conferences (e.g., ASME and PTS). At the end of each semester, ASME and PTS sponsor a formal fall and spring banquet to recognize faculty and student award winners, organize a fall and spring picnics for all ME students, faculty and staff, and facilitate the ME Forum to discuss curriculum and facility issues. All of these events are reasonably well attended with typically 20-60 participants, including a healthy percentage of concerned faculty and staff. Two other popular faculty/student events include the "Lunch with a Professor" series in which an invited faculty member shares experiences with students about their career and life, and Happy Hour at Jakes, a local student hangout. Also, Pi Tau Sigma, sponsors fall and spring semester golf outing that typically draws 40-50 students and several faculty and staff. Finally, the School has an annual Fall ME Awards Convocation to recognize recent scholarship and fellowship recipients. In 2012, we honored over 400 scholarship and 10 fellowship winners and had approximately 500 people in attendance, including numerous students, parents, faculty, and donors.

Senior PhD students interested in academic careers are strongly encouraged to consider the Lambert Fellowship Program, which has been designed to educate such Ph.D. students in practical pedagogical issues and prepare them for faculty positions. The Lambert Fellowship Program is a two-semester commitment involving a semester of observation/apprenticeship followed by a formal lecture opportunity. These Lambert Fellows are hand-picked for their good communication skills and teaching potential. During the observation/apprenticeship semester, the Lambert Fellow attends the lectures of the faculty mentor, observes the class he/she will be assigned to teach in a subsequent semester, and also helps with preparation of homework problems, mid-term exams and their solutions, etc. During the course of the semester, the Lambert Fellow is also asked to teach 2-3 lectures with significant feedback from the faculty mentor. In the second instructional semester, the student is assigned his/her own section of a multi-section core course. Each Lambert Fellow has a supervising mentor guiding them throughout this teaching experience. They are expected to sit through their mentor's class in preparation for their own class later in the afternoon. This gives them an opportunity to see how an experienced instructor presents the material, as well as address the types of questions students are posing. This greatly aids in their preparation for teaching their own section.

All course instructors are required to maintain regular office hours during the semester, and some instructors supplement these office hours with review sessions conducted in evenings prior to mid-term and final exams. Also, most lower-level core courses offer extensive tutorial room hours, often exceeding 40 hours per week.

Academic advising is conducted by Prof. Jim Jones with the assistance of two full-time professional advisors. Given the extensive rules that need to be followed, we have chosen to primarily use professionals who advise full-time to minimize advising errors. If students seek career advice that we are unable to answer, they are directed to the appropriate faculty member(s) who work in the student's area of interest. This centralized advising approach minimizes the burden on the faculty, reduces advising errors and yet takes advantage of the breath of the faculty expertise.

Service, either rendered internally to a University committee or externally to the professional community, is expected of each faculty member. Faculty members in the program participate in College and University committees involved in self-governance. Each School is represented in the following committees of the College of Engineering: the Engineering Leadership Team (ELT) consisting of School heads and College administrative leadership, the First-Year Engineering Curriculum Committee, the Undergraduate Chairs Committee, the Engineering Curriculum Committee, and the Faculty Affairs Committee. In addition, selected faculty members participate in other committees of the College and the University. In recent years, departmental faculty members have served in the following college committees: Promotion and Tenure, Honors, Dean's Junior Faculty Advisory Committee, Dean's Faculty Advisory Committee, University Senate, and the Faculty Affairs Committee.

Faculty members interact with industrial and professional practitioners in a number of ways. Industrial sponsorship of research in the department has always been strong, averaging up to 20% of all annual sponsored research expenditures for the last few years. Industrial sponsorship of capstone design projects in the course sequence, ME 463, is yet another avenue for our faculty and students to interact with industrial representatives.

6D. Professional Development

All faculty members are expected to stay current in the fields where they are teaching. All of them read the technical literature and most review the current state of the art by reviewing the most current text books in their area. In addition, the school encourages each faculty member to attend at least one conference per year and the vast majority of faculty members do this. The School is willing to finance all or part of the costs to attend conferences such as ASEE and educational workshops. In particular, junior faculty are encouraged to attend multi-day workshops dedicated to refining teaching skills, at department expense, and almost all of our junior faculty members have availed of this opportunity. In recent years, a number of our faculty members have been sent to conferences focused on curriculum design. Most faculty members also attend conferences devoted to their field of research. Almost all of the faculty members are active in publishing books and/or technical papers in their areas of expertise, and such activity is documented in their annual reports which form the subject of annual performance reviews. And finally, each School in the College sponsors a seminar series. These meet most weeks, and the faculty are urged to attend. Almost all faculty members attend several such seminars each year, and some attend seminars each week.

6E. Authority and Responsibility of Faculty

Each course has a designated course supervisor who is responsible for maintenance and updating of the course content, textbook selection, and syllabus, including the course outcomes. Each of the six area committees in the School is represented on the ME Curriculum Committee, which is centrally involved with evaluation, assessment, and continuous program improvement. The representation from the area committees covers all facets of the Mechanical Engineering undergraduate program.

Students are also encouraged to complete on-line Course and Instructor Evaluation forms, a process managed by the Center of Instructional Excellence (CIE) at Purdue. Data from completed Course and Instructor Evaluations are compiled on a semester basis by the CIE, and made available on-line to the individual faculty members as well as to the School Heads (and related administration). These are a primary means for faculty to receive feedback on teaching technique as well as on course content, at the end of each semester.

Results from all these assessment tools for the preceding semester, as well as other assessment instruments such as the senior exit survey are reviewed at the beginning or middle of each semester by the ME Curriculum Committee (MECC). Cases where topic coverage and performance problems need to be addressed, as well as instances of omissions of use of these assessment tools by faculty, are noted. If personnel related actions are warranted, the Head or Associate Head take action. If curricular issues are involved, the concerns are passed on to the ME Curriculum Committee for discussion and appropriate action.

The Curriculum Committee examines this assessment data in combination with other assessments such as the alumni and employer surveys. If the MECC feels the needed changes can be implemented by administrative action, such action is taken by the Head or Associate Head. Actions warranting faculty discussion typically occur at either bi-semester faculty meetings or at a special faculty luncheon. Recommendations arrived at, based on further discussions with course supervisors and the relevant area committees, are then discussed by the department faculty (if needed), and are reported annually to the ME Advisory Council as well. Implementation of the assessment activities is also documented annually in reports filed with the College's Undergraduate Chairs Committee, the latter also serving as a forum to exchange assessment experiences and coordinate assessment activities at a college-wide level. The Undergraduate Chairs Committee is chaired by the Associate Dean for Undergraduate Education, who reports to the Dean of the College.

Table 6.1: Faculty Qualifications
Mechanical Engineering Program

Faculty Name	Highest Degree Earned- Field and Year	Rank [1]	Type of Academic Appointment[2] T, TT, NTT	FT or PT[4]	Years of Experience: Govt./Ind. Practice	Years of Experience: Teaching	Years of Experience: This Institution	Professional Registration/ Certification	Level of Activity H, M, or L: Professional Organizations	Level of Activity H, M, or L: Professional Development	Level of Activity H, M, or L: Consulting/summer work in industry
Abraham, John	PhD, Mechanical Engineering, 1986	P	T, TT	FT	5	21	17		H	H	L
Adams, Douglas	PhD, Mechanical Engineering, 2000	P	T, TT	FT	0	15	15		H	H	M
Anderson, David	PhD, Mechanical Engineering, 1974	P	T, TT	FT	1	39	39	EIT-IN	M	M	L
Atkinson, Dianne (CL)	PhD, Educational Psychology, 1993	CL	NTT	FT	0	20	20		H	H	L
Ariyur, Kartik.	PhD, Mechanical Engineering, 2002	Asst	T, TT	FT	0	5	5		H	H	L
Bajaj, Anil K.	PhD, Mechanics, 1981	P	T, TT	FT	0	33	33		H	H	L
Bolton, J. Stuart	PhD, Mechanical Engineering, 1984	P	T, TT	FT	1	30	30		H	H	L
Braun, James	PhD, Mechanical Engineering, 1988	P	T, TT	FT	8.5	23	23	PE-WI	H	H	M
Buckius, Richard	PhD, Mechanical Engineering, 1975	P	T, TT	FT	5	38	4		M	M	L
Chen, Jun	PhD, Mechanical Engineering, 2005	Asst	TT	FT	2	5	5		H	H	L
Chen, Quingyan	PhD, Mechanical Engineering, 1988	P	T, TT	FT	4	20	12		H	H	L
Chiu, George (On Leave)	PhD, Mechanical Engineering, 1994	P	T, TT	FT	2	18	18		H	H	L
Cipra, Raymond	PhD, Mechanical Engineering, 1978	P	T, TT	FT	2	36	36	PE-WI	H	H	L
Davies, Patricia	PhD, Mechanical Engineering, 1985	P	T, TT	FT	1	27	25		H	H	L
Deng, Xinyan	PhD, Mechanical Engineering, 2004	Asst	TT	FT	0	8	3		H	H	L
Dyke, Shirley	PhD, Mechanical Engineering, 1996	P	T, TT	FT	0	21	21		H	H	L
Fisher, Tim	PhD, Mechanical Engineering, 1998	P	T, TT	FT	7	16	12		M	H	H

1. Code: P = Professor Assoc = Associate Professor Asst = Assistant Professor L = Continuing Lecturer A = Adjunct O = Other
2. Code: TT = Tenure Track T = Tenured NTT = Non Tenure Track
3. The level of activity, high, medium or low, should reflect an average over the year prior to the visit plus the two previous years.
4. At the institution.

Table 6-1: Faculty Qualifications (Continued)

Mechanical Engineering Program

Faculty Name	Highest Degree Earned- Field and Year	Rank [1]	Type of Academic Appointment[2] T, TT, NTT	FT or PT[4]	Years of Experience			Professional Registration/ Certification	Level of Activity H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/summer work in industry
Fleeter, Sanford	PhD, Mechanical Engineering, 1970	P	T, TT	FT	10	37	34		H	H	L
Frankel, Steven	PhD, Mechanical Engineering, 1993	P	T, TT	FT	0	20	20		H	H	L
Garimella, Suresh	PhD, Mechanical Engineering, 1989	P	T, TT	FT	0	24	15		H	H	H
Gore, Jay	PhD, Mechanical Engineering, 1986	P	T, TT	FT	4	27	23		H	H	H
Groll, Eckhard	PhD, Mechanical Engineering, 1994	P	T, TT	FT	2.5	20	20		H	H	M
Han, Bumsoo	PhD, Mechanical Engineering, 2001	Assoc	T, TT	FT	0	9	4		H	H	L
Ivantysynova, Monika	PhD, Mechanical Engineering, 1983	P	T, TT	FT	13	18	10		H	H	M
Jones, James D.	PhD, Mechanical Engineering, 1987	Assoc	T, TT	FT	17	13	13	EIT-TN	M	M	L
Key, Nicole	PhD, Mechanical Engineering, 2007	Asst	TT	FT	0	6	6		H	H	L
Kim, Sangtae (On Leave)	PhD, Mechanical Engineering, 1983	P	T, TT	FT	9	22	8		H	H	H
King, Galen B.	PhD, Mechanical Engineering, 1983	P	T, TT	FT	0	30	30		H	H	H
Kokini, Klod	PhD, Mechanical Engineering, 1982	P	T, TT	FT	0	31	29		H	H	L
Koslowski, Marisol	PhD, Mechanical Engineering, 2003	Assoc	T, TT	FT	3	8	8		H	H	L
Kramer, Rebecca	PhD, Mechanical Engineering, 2012	Asst	TT	FT	0	1	1		H	H	L
Krousgrill, Charles	PhD, Mechanical Engineering, 1981	P	T, TT	FT	0	33	33		H	H	L
Li, Kai Ming	PhD, Civil Engineering, 1987	P	T, TT	FT	4	23	8		H	H	L
Lucht, Robert	PhD, Mechanical Engineering, 1981	P	T, TT	FT	11	22	12		H	H	L

1. Code: P = Professor Assoc = Associate Professor Asst = Assistant Professor L = Continuing Lecturer A = Adjunct O = Other
2. Code: TT = Tenure Track T = Tenured NTT = Non Tenure Track
3. The level of activity, high, medium or low, should reflect an average over the year prior to the visit plus the two previous years.
4. At the institution

Table 6-1: Faculty Qualifications (Continued)

Mechanical Engineering Program

Faculty Name	Highest Degree Earned- Field and Year	Rank [1]	Type of Academic Appointment[2] T, TT, NTT	FT or PT[4]	Years of Experience			Professional Registration/ Certification	Level of Activity H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/summer work in industry
Marconnet, Amy	PhD, Mechanical Engineering, 2012	Asst.	TT	FT	0	1	1		H	H	L
Meckl, Peter	PhD, Mechanical Engineering, 1988	P	T, TT	FT	0	26	26	EIT-IL	H	H	L
Mongia, Hukam	PhD, Mechanical Engineering, 1971	P	TT	PT	44	4	4		M	M	M
Mudawar, Issam	PhD, Mechanical Engineering, 1984	P	T, TT	FT	0	30	30		H	H	L
Murphy, Morgan (CL)	PhD, Mechanical Engineering, 1993	CL	NTT	FT	30	14	14		M	M	H
Nauman, Eric	PhD, Mechanical Engineering, 2000	Assoc	T, TT	FT	2	13	10		H	H	L
Nolfi, John (CL)	BS, Mechanical Engineering, 1973	CL	NTT	FT	27	13	13	EIT-IN	L	M	M
Pan, Liang	PhD, Mechanical Engineering, 2010	Asst	TT	FT	0	1	1		H	H	L
Panchal, Jitesh	PhD, Mechanical Engineering, 2005	Asst	TT	FT	0	7	1		H	H	L
Pennock, Gordon	PhD, Mechanical Engineering, 1983	P	T, TT	FT	5	42	31	PE-UK	H	H	L
Raman, Arvind	PhD, Mechanical Engineering, 1999	P	T, TT	FT	0	13	13		H	H	L
Ramani, Karthik	PhD, Mechanical Engineering, 1991	P	T,TT	FT	0	23	23		H	H	M
Reid, Tahira	PhD, Mechanical Engineering, 2010	Asst	TT	FT	0	1.5	1.5		H	H	L
Rhoads, Jeff	PhD, Mechanical Engineering, 2007	Assoc	T, TT	FT	0	6	6		H	H	L
Ruan, Xiulin	PhD, Mechanical Engineering, 2007	Asst.	TT	FT	0	6	6		H	H	L
Sadeghi, Farshid	PhD, Mechanical Engineering, 1986	P	T, TT	FT	2	28	28		H	H	L
Savran, Cagri	PhD, Mechanical Engineering, 2004	Assoc	T, TT	FT	0	10	10	EIT-IN	H	H	L

1. Code: P = Professor Assoc = Associate Professor Asst = Assistant Professor L = Continuing Lecturer A = Adjunct O = Other
2. Code: TT = Tenure Track T = Tenured NTT = Non Tenure Track
3. The level of activity, high, medium or low, should reflect an average over the year prior to the visit plus the two previous years.
4. At the institution

Table 6-1: Faculty Qualifications (Continued)
Mechanical Engineering Program

Faculty Name	Highest Degree Earned- Field and Year	Rank [1]	Type of Academic Appointment[2] T, TT, NTT	FT or PT[4]	Years of Experience			Professional Registration/ Certification	Level of Activity H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/summer work in industry
Seipel, Justin	PhD, Mechanical Engineering, 2006	Asst	TT	FT	0	4	4		H	H	L
Shaver, Greg	PhD, Mechanical Engineering, 2005	Assoc	T, TT	FT	1	6	6		H	H	L
Shin, Yung	PhD, Mechanical Engineering, 1984	P	T, TT	FT	7	26	24		H	H	L
Siegmund, Thomas	PhD, Mechanical Engineering, 1994	P	T, TT	FT	2	15	15		H	H	L
Sojka, Paul	PhD, Mechanical Engineering, 1983	P	T, TT	FT	1	31	31		H	H	M
Son, Steve	PhD, Mechanical Engineering, 1993	P.	T, TT	FT	13	9	7		H	H	L
Starkey, John	PhD, Mechanical Engineering, 1983	Assoc	T, TT	FT	0	30	30		M	M	M
Subbarayan, Ganesh	PhD, Mechanical Engineering, 1991	P	T, TT	FT	3	19	10		H	M	M
Sutherland, John	PhD, Mechanical Engineering, 1980	P	T,TT	FT	2	23	4	BCEEM	H	H	L
Vacca, Andrea	PhD, Mechanical Engineering, 2005	Asst	TT	FT	0	10	2		H	H	M
Vlachos, Pavlos	PhD, Engineering Mechanics, 2000	P	T, TT	FT	3(PT)	10	0		H	H	L
Wassgren, Carl	PhD, Mechanical Engineering, 1997	P	T, TT	FT	1	17	15		H	H	L
Wereley, Steve	PhD, Mechanical Engineering, 1997	P	T, TT	FT	0	15	15		H	H	L
Xu, Xianfan	PhD, Mechanical Engineering, 1994	P	T, TT	FT	0	20	20		H	H	L
Yao, Bin	PhD, Mechanical Engineering, 1996	P	T, TT	FT	0	17	17		H	H	L
Zhao, Fu	PhD, Mechanical Engineering, 2005	Asst	TT	FT	0	7	7		H	H	L

1. Code: P = Professor   Assoc = Associate Professor   Asst = Assistant Professor   L = Continuing Lecturer   A = Adjunct   O = Other
2. Code: TT = Tenure Track   T = Tenured   NTT = Non Tenure Track
3. The level of activity, high, medium or low, should reflect an average over the year prior to the visit plus the two previous years.
4. At the institution

Table 6-2: Faculty Workload Summary
Mechanical Engineering Program

Faculty Member (name)	PT or FT[1]	Classes Taught (Course No./Credit Hrs.) Term and Year[2]	Program Activity Distribution[3]			% of Time Devoted to the Program[5]
			Teaching	Research or Scholarship	Other[4]	
Abraham, John	FT	[F12-Sabbatical], [Sp13-Sabbatical]	0	60	40	100
Adams, Douglas	FT	[F12 - ME 563 (3)], [Sp13 - ME 274 (3)]	30	60	10	100
Anderson, David	FT	Assoc Head, [F12 – ME 597 (3)], [Sp13 – ME 578 (3)]	30	10	60	100
Atkinson, Dianne CL	FT	[F12 – ME 290 (1)], [Sp13 – ME 290 (1)]	100	0	0	100
Ariyur, Kartik.	FT	[F12 – ME 597 (3)], [Sp13 – ME 578 (3)]	30	60	10	100
Bajaj, Anil	FT	Head, School of Mechanical Engineering	0	0	100	100
Bolton, J. Stuart	FT	[F12 – ME 513 (3)], [Sp13 – ME 613 (3)]	30	60	10	100
Braun, James	FT	[F12 – Off], [Sp13 – ME 200 (3)]	15	75	10	100
Buckius, Richard	FT	Vice President of Research, Purdue University	0	0	100	0
Chen, Jun	FT	[F12 – ME 509 (3)], [Sp13 – ME 611 (3)]	30	60	10	100
Chen, Quingyan	FT	[F12 – On-Leave], [Sp13 – ME 200 (3)]	15	85	10	100
Chiu, George	FT	On-Leave at NSF	0	0	100	100
Cipra, Raymond	FT	[F12 – ME 557 (3)], [Sp13 – ME 352 (4), ME 572 (3)]	45	45	10	100
Davies, Patricia	FT	Herrick Labs Director, [F12 – ME 579 (3)]	15	25	60	100
Deng, Xinyan	FT	[F12 – ME 375 (3)], [Sp13 – ME 375 (3)]	30	60	10	100
Dyke, Shirley	FT	[F12 –CE], [Sp13 – Off]	30	60	10	75
Fisher, Tim	FT	[F12 – ME 315 (4)], [Sp13 – ME 597 (3)]	30	60	10	100
Fleeter, Sanford	FT	[F12 – ME 514 (3)], [Sp13 – ME 438 (3)]	30	60	10	100
Frankel, Steven	FT	[F12 – ME 200 (3)], [Sp13 – ME 614 (3)]	30	60	10	100
Garimella, Suresh	FT	Chief Global Affairs Officer, Purdue University	0	20	80	100
Gore, Jayavant	FT	[F12 – ME 200 (3)], [Sp13 – ME 525 (3)]	30	60	10	100
Groll, Eckhard	FT	Co-op Director, [F12 – ME 500 (3)]	0	50	50	100
Ivantysynova, Monika	FT	[F12 – ME 515 (3)], [Sp13 – ABE]	30	60	10	50
Jones, Jim	FT	Assoc Head [F12 – ME 270 (3)], [Sp13 – ABET Prep]	30	60	10	100
Key, Nicole	FT	[F12 – ME 433 (3)], [Sp13 – ME 510 (3)]	30	60	10	100
Kim, Sangtae	FT	Exe Director, Morgridge Inst for Res. (on-Leave)	0	0	100	100
King, Galen	FT	[F12 – ME 365 (3), ME 587 (3)], [Sp13 – ME 463 (3), ME 475 (3)]	60	30	10	100
Kokini, Klod	FT	Associate Dean, CoE, [Sp 13 – ME 263L (3)]	15	0	85	25
Koslowski, Marisol	FT	[F12 – ME 581 (3)], [Sp13 – ME 612 (3)]	30	60	10	100
Kramer, Rebecca	FT	[F12 – N/A], [Sp13 – 2 ME 263L (3)]	30	60	10	100

1. FT = Full Time Faculty or PT = Part Time Faculty, at the institution
2. For the academic year for which the self-study is being prepared.
3. Program activity distribution should be in percent of effort in the program and should total 100%.
4. Indicate sabbatical leave, etc., under "Other."
5. Out of the total time employed at the institution.

Faculty Member (name)	P T or F T[1]	Classes Taught (Course No./Credit Hrs.) Term and Year[2]	Program Activity Distribution[3]			% of Time Devoted to the Program[5]
			Teaching	Research and Scholarship	Other4	
Krousgrill, Charles	FT	Co-op Dir, [F12 – ME 274 (3), ME 323 (3)], [Sp13 – ME 375 (3), ME 562 (3)]	60	15	25	100
Li, Kai Ming	FT	[F12 – 2 ME 270 (3)], [Sp13 – ME 413 (3)]	30	60	10	100
Lucht, Robert	FT	[F12 – ME 687 (3)], [Sp13 – Off]	15	75	10	100
Marconnet, Amy	FT	Starts Fall 2013	30	60	10	100
Meckl, Peter	FT	Asst Head, [F12 – ME 586 (3)], [Sp13 – ME 365 (3)]	30	20	50	100
Mongia, Hukam	FT	[F12 – Off], [Sp13 – ME 463 (3)]	30	60	10	50
Mudawar, Issam	FT	[F12 – ME 315L (4)], [Sp13 – ME 315L (4)]	30	60	10	100
Murphy, Morgan CL	FT	[F12 – ME 263 (3), ME 270 (3)], [Sp13 – ME 263 (3), 2 ME 263L (3)]	100	0	0	100
Nauman, Eric	FT	[F12 – ME 270 (3)], [Sp13 – ME 270 (3), ME 577 (3)]	30	60	10	100
Nolfi, John CL	FT	[F12 – ME 455 (3), ME 463 (3)], [Sp13 – 3 ME 463 (3)]	90	0	10	100
Pan, Liang	FT	[F12 – ME 315 (4)], [Sp13 – ME 505 (3)]	30	60	10	100
Panchel, Jitesh	FT	[F12 – ME 452 (3)], [Sp13 – ME 352 (4)]	30	60	10	100
Pennock, Gordon	FT	[F12 – 2 ME 352 (43)], [Sp13 – ME 352 (4), ME 452 (3)]	60	30	10	100
Raman, Arvind	FT	[F12 – ME 597 (3)], [Sp13 – ME 323 (3)]	30	60	10	100
Ramani, Karthik	FT	[F12 – ME 553 (3)], [Sp13 – ME 444 (3)]	30	60	10	100
Reed, Tahira	FT	[F12 – ME 463 (3)], [Sp13 – ME 263 (3)]	30	60	10	100
Rhoads, Jeff	FT	[F12 – ME 580 (3)], [Sp13 – ME 274 (3)]	30	60	10	100
Ruan, Xiulin	FT	[F12 – ME 200 (3)], [Sp13 – ME 614 (3)]	30	60	10	100
Sadeghi, Farshid	FT	[F12 – Off], [Sp13 – ME 556 (3)]	15	75	10	100
Savran, Cagri	FT	[F12 – ME 365 (3)], [Sp13 – Off]	15	75	10	100
Seipel, Justin	FT	[F12 – ME 597 (3)], [Sp13 – ME 274 (3)]	30	60	10	100
Shaver, Greg	FT	[F12 – ME 575 (3)], [Sp13 – ME 689 (3)]	30	60	10	100
Shin, Yung	FT	[F12 – ME 363 (3)], [Sp13 – ME 576 (3)]	30	60	10	100
Siegmund, Thomas	FT	[F12 – ME 323 (3)], [Sp13 – ME 559 (3)]	30	60	10	100
Sojka, Paul	FT	[F12 – ME 200 (3), ME 300 (3)], [Sp13 – ME 200 (3), ME 375 (3)]	60	30	10	100
Son, Steve	FT	[F12 – ME 697 (3)], [Sp13 – ME 440 (3)]	30	60	10	100
Starkey, John	FT	[F12 – ME 452 (3), ME 463 (3)], [Sp13 – ME 463 (3)]	50	0	50	100
Subbarayan, Ganesh	FT	[F12 – ME 497 (3)], [Sp13 – ME 681 (3)]	30	60	10	100
Sutherland, John	FT	Head, Department of Ecol & Envir Engrg	0	0	100	0
Vacca, Andrea	FT	Taught in ABE	30	60	10	25
Wassgren, Carl	FT	[F12 – ME 309 (4)], [Sp13 – ME 597 (3)]	30	60	10	100
Wereley, Steve	FT	[F12 – ME 309 (4)], [Sp13 – 2 ME 309 (4)]	60	30	10	100
Xu, Xianfan	FT	[F12 – ME 507 (3)], [Sp13 – ME 463 (3)]	30	60	10	100
Yao, Bin	FT	[F12 – ME 475 (3)], [Sp13 – Off]	15	75	10	100
Zhao, Fu	FT	[F12 – ME 597 (3)], [Sp13 – Taught in EEE]	30	60	10	100

CRITERION 7. FACILITIES

7A. Offices, Classrooms and Laboratories

Offices, classrooms and laboratories of the School of Mechanical Engineering are located in the Mechanical Engineering Building which now includes a new and state-of-the-art Gatewood Wing. The Gatewood Wing was opened in June 2011 and is named for Roger B. Gatewood, the primary benefactor for the $34.5 million state-of-the-art addition. The new wing is the first Purdue building constructed to the LEED certification standards. The Leadership in Energy and Environmental Design (LEED) standard is set by the U.S. Green Building Council and it awarded a Gold Certification to the new wing. The wing adds an additional 41,000 square feet of assignable space to the Mechanical Engineering Building, increasing the original building's space by 55%.

Offices: Typical offices are readily available in the ME Building including a Main Office (where the Head resides, ME 2007), an Undergraduate Office complex (where advising meetings are conducted, ME 2008), a Business Office (where project materials can be ordered, ME 2051), and a Graduate Office (for students interested in graduate study opportunities, ME 1003). In addition to these offices, the ME Building also houses a Technical Services facility (for assistance with computer and instrumentation issues, ME 2042) and a ME Student Machine Shop (for fabrication of projects, G039).

All faculty and administrators have primary office in the ME Building to meet with students. Likewise, TAs are also provided with office space to meet with students. Clerical staff is distributed throughout the building to provide easy access and support for faculty and TAs.

Classrooms: Collectively, the School primarily uses 10 classrooms ranging in capacity from 171 to 30. Each of these classrooms are equipped with an in-room computer with a projection system. The larger rooms typically have 2 or 3 projection screens while the smaller rooms have one. The larger classrooms typically have two document cameras available while smaller classrooms may have a single document camera or an overhead projector. All classrooms have a blackboard available at the front of the room. With the addition of the Gatewood Wing, a new 120 seat collaborative classroom is now our flagship instructional facility. It is unique in that it can be used in a traditional didactic lecture format or instantaneously adapted to a collaborative setting by students pivoting to form 30 groups of 4 students each. As such, it is an ideal instructional facility to implement collaborative learning techniques.

Tutorial Rooms and General Study Space: There are three dedicated Tutorial rooms (ME 2136, ME 2138, ME 2142, capacity 20 students each) for the explicit purpose of tutorial assistance. Many of the core courses hold tutorial room hours in these spaces, some in excess of 40 hours per week. This allows ample time for students to seek assistance with homework, quiz or exam problems throughout the week as needed at a time that is convenient for them.

In addition to these Tutorial rooms, three other large general purpose study spaces exist in the ME Building. These study spaces include the Railside Station (capacity 60) and The Commons area (capacity 56), both on the second floor of the Gatewood Wing, and the study space in the back of ME Undergraduate Labs (ME 1030) (capacity 50). In addition to these study spaces in the building, the Siegesmund Engineering Library, located on the main floor of the A.A. Potter Engineering Center (commonly referred to as the Potter Library), also has ample study space. The Potter Building is located just behind the ME Building and is a very short 100 feet from the ME Building.

In addition to the tutorial rooms and general study space, many students utilize the School computer labs for study space as well, especially when there is need of computer resources for the work they are completing. Details of the School's computing facilities are provided below.

Laboratory Facilities: Room ME 1030 houses all of the ME undergraduate laboratory facilities for our core courses. These include the Fluid Dynamics Lab (ME 30900), the Heat Transfer Lab (ME 31500), the Systems and Measurements Lab (ME 36500), and the Automatic Controls Lab (ME 47500). In addition, our sophomore design course (ME 26300) has a dedicated design space and our capstone design course (ME 46300) has a dedicated Product Engineering and Realization Laboratory (PEARL) facility for these design experiences. A brief summary of each of these lab facilities is provided below.

ME 30900 - Fluid Mechanics Laboratory (ME 1030D/ME1030F/ME1030H) (3555 sq. ft.)
The Fluid Mechanics Laboratory primarily serves the ME 30900 Fluid Mechanics course and features facilities and instrumentation designed to reinforce the students' conceptual understanding of the physics of fluid flow. The laboratory houses two low-speed wind tunnels equipped for wake visualization and drag force measurements. A water channel facility is also available for flow visualization and optical diagnostics. The water channel facility is fitted with equipment for conducting PIV studies. For compressible flow studies, a converging-diverging nozzle facility is used to introduce the students to supersonic flow and normal shocks. A water based fluid power test rig is the most recent additional and provides capability for pump characterization and valve characterization studies. Test apparatus are also installed to support a variety of experiments including pipe flow and pump performance. Instrumentation available in the laboratory includes manometers, flow meters, pressure transducers, pitot-static probes, and a hot-wire anemometry system.

ME 31500 - Heat Transfer Laboratory (ME 1030B) (956 sq. ft.)
The Heat Transfer Laboratory primarily serves the ME 31500 Heat and Mass Transfer course and is designed to reinforce the fundamentals of conduction, convection, radiation, multimode heat transfer and mass transfer. The laboratory equipment consists of ten computer workstations equipped with data acquisition equipment, two 'high channel count' data acquisition workstations, an infrared camera, radiant lamps, balance, blowers, various heaters and heat sinks, multimeters, and a thermocouple fabrication station. The lab utilized National Instruments hardware and LabVIEW software for general purpose thermocouple measurements and Agilent Hardware and Software for high channel count thermocouple measurement.

ME 36500 - Systems and Measurements Lab (ME 1030A) (1036 sq. ft.)
The Systems and Measurements Lab primarily serves the ME 36500 Systems and Measurements course. The lab has thirteen workbenches, each containing a personal computer with data

acquisition board, oscilloscope, digital multimeter, digital power supply, and digital function generator. Special equipment includes: a temperature-measuring setup, including RTD and thermocouple in a beaker of water; a force transducer, utilizing a cantilever beam with strain gages, proximity probe, and LVDT; an Analog to digital and digital to analog conversion trainer with capability to change sampling rates; a musical keyboard for generating different acoustic signals; a set of digital programmable filters for shaping waveforms; and an electromechanical shaker with fixture for measuring the physical properties of foam. Data collection is performed using National Instruments LabVIEW software.

ME 47500 - Automatic Controls Laboratory (ME 1030E) (1155 sq. ft.)
The Automatic Controls Lab primarily serves the ME 47500 Automatic Control Systems course. The lab has seven workstations each consisting of personal computers with data acquisition boards, oscilloscopes, and function generators. Special equipment includes: an electromechanical servo-system that rotates a platter using a dc motor with potentiometer feedback; an electromechanical servo system that rotates a platter with inverted pendulum using a DC motor with encoder and potentiometer feedback; a track based inverted pendulum apparatus using a powered cart with pendulum, a non-powered cart connected via spring and a teeter-totter mounting system for the track; and a “black box” that can be configured to represent a variety of physical systems. The controls for the apparatus are provided by National Instruments Compact RIO real time controllers and National Instruments LabVIEW software.

In addition to these instructional labs, the ME Building also houses dedicated spaces for our cornerstone (ME 26300) and capstone (ME 46300) design courses.

ME 26300 – ME Design, Innovation, and Entrepreneurship Lab (ME 2063)
The ME sophomore design lab is in a dedicated space for this design activity. The only specialized equipment utilized in this space is a portable laptop station. There are two carts of laptops with each cart containing a wifi access point for 32 laptops. These computers are heavily utilized by students conducting their design projects.

ME 46300 - Engineering Design (Product Engineering and Realization Laboratory) (PEARL)
The Product Engineering and Realization Laboratory (PEARL) is a 6000 sq. ft. complex of several facilities located on the ground floor of the Gatewood Wing adjacent to the Atrium. These facilities all support the senior design experience and include an innovation instructional facility, a rapid prototyping facility, three fabrication and assembly facilities, and seven breakout rooms for team consultations.

The Innovation Instructional Facility (ME 1185) provides 800 sq.ft. space for the weekly meetings of the ME 46300 design sections. Typically these sections have approximately 24 students each. The instructional facility has a flexible table and chair arrangement that can be easily adapted to group work or modified for preliminary, critical or final design reviews. The room is equipped with a dedicated computer and large projection system for presentations.

The 600 sq. ft. Rapid Prototype Laboratory (ME 1191) is equipped with two laser stereo Lithography rapid prototyping machines (Model SLA 250/30), a ProJet 5000 3-D Printer, a 3-D

Curing Oven, a Pro-Jet Finisher XL, a LABCONCO Protector Laboratory Hood and a sink and cabinet space. It also houses several display cases to showcase a variety of prototype projects.

Three 1200 sq. ft. Fabrication and Assembly rooms (ME 1178, 1202, and 1203) are each equipped with storage space and lockers, work benches, ample overhead power, an industrial sink, an Emergency Shower and Eye Wash Station, a first aid kit and an assortment of hand tools. These spaces are intended for fabrication and assembly of student projects.

Seven Breakout rooms (ME 1186, 1188, 1192, 1194, 1196, 1198, 1200) of roughly 132-216 sq. ft. size each are available for student teams to meet individually with their teammates. Three of these rooms are also equipped with a 60 in monitor on the wall for projection of project documents for discussion.

7B. Computing Resources

School Computing Facilities: The ME Building houses three general purpose computer labs and one mixed use instructional facility. The general purpose labs include ME 2028 with 24 workstations, ME 2038 with 25 workstations, and ME 3021 with 40 workstations. All of the workstations in ME 2028, 2038 and 3021 are certified platforms for Ansys, Pro Engineer and several additional software packages. ME 1030 serves as a mixed use instructional facility housing the formal instructional labs as well as 30 CAD certified general purpose computing workstations. Computers installed in formal lab areas are available for general use during 'off hours' of courses. In total, we have 157 computers dedicated for ME students only. Several University computer labs also exist in nearby buildings, but are open to all students across the University. The computer facilities are secured using RS2 card access hardware and are available 120 hours per week.

In addition to the core computers, the department provides students with 20GB of network storage on the ECN networks and access to an additional 100GB (in rollout now) cloud storage through the central ITaP group.

The core network at Purdue University is 10Gbit redundant link fiber with 1gibabit network links to individual machines. Purdue University has several links to the Internet as a whole as well as links to internet2. The ME building has full wireless coverage in all areas at the 400mbit 'N' standard.

The school provides computer support through personnel working in the Mechanical Engineering Technical Services. Shop personnel integrate support from the college level 'Engineering Computer Network' (ECN) and campus level Information Technology at Purdue (ITaP) groups. The electronics shop staff include two Electrical Engineers, one Systems Analyst, one webmaster, one instructional labs technician and one research technician.

University Computing Facilities: A detailed description of the University Computing Facilities is provided in Appendix II of this report. A brief summary of the University ITaP (Information Technology at Purdue) Computing Facilities is provided below. The University supports a broad array of ITaP instructional computing facilities. Teaching and Learning Technologies supports and maintains over 60 instructional computing labs on campus, located all across the campus. The computing labs range in size from 14 computers to over 200 computers. The ITaP computers in these labs provide an extensive software suite and a secure work environment for our faculty, staff, and students. Instructors can request to have software installed on the lab computer network for course use, and can reserve instructional labs for teaching.

7C. Guidance

The instructional laboratories are taught by teaching assistants who are trained on the equipment and safety procedures that are used in the classroom. In general, the lab supervisor trains the laboratory teaching assistants (with the assistance of the head TA) on the use of the instructional equipment, and the teaching assistants instruct the students. During the training sessions, safety topics are addressed. The safety topics include eye protection, appropriate attire, burn potentials, location and how to use eye washing stations, MSDS information location, and emergency preparedness. The students are guided on safety through demonstration by the teaching assistant during the lab class period.

The use of the computer and computer programs are described in the labs where they are required. Many of the programs are available to the students because of site licensing arrangements through the university. These come with manuals, electronic help, or the students can download instructions from the web.

7D. Maintenance and Upgrading of Facilities

7D.1: Computer Laboratories

Computational equipment is regularly upgraded. Student computing facilities are supported by a differential technology fees paid by the students, which allows for continual updating of hardware and software. Laboratory computers are updated on a 3-year cycle, with 1/3 of the systems replaced every year. The computer fees support hardware and software needs, while the School and College funds support operational costs (personnel and supplies).

7D.2: Machine and Technical Services Shops

The School maintains a machine shop and technical services shop to support instruction and research work along with student project work, especially the capstone design course. For the Technical Services shop, the school employs two electrical engineers, a graphics designer, systems analyst and two technicians. This group forms a working team to support IT and electronics systems within the school. In the student machine shop, two full time machinists and a significant number of part-time student workers are employed to instruct and assist students with fabrication of design projects. A third machinist is dedicated to supporting the lithography facilities and supervising the capstone design course build areas.

The electronics shop provides a wide array of equipment for students and researchers to check out for specific design projects. Equipment includes: an IR camera; hot wire anemometers; light meters; humidity meters; pH meters; Digital multimeters; function generators; oscilloscopes; logic analyzers; frequency counters; spectrum analyzers; power supplies; instrumentation amplifiers; instrumentation bridges and filters; thermocouple fabrication supplies; microcontrollers; soldering equipment; and various electronic parts.

The student machine shop provides a significant number of machines for student use. There are two vertical band saws, one horizontal band saw; seven vertical manual mills with digital readout; 4 manual lathes with digital readout; one large manual lathe; one CNC lathe; two CNC mills; a vacuum forming machine; a 100watt CO_2 laser cutter/engraver; sandblasting cabinet; metal bending brakes; metal shears; several arbor presses; a two hundred ton hydraulic press; and large assortment of hand tools and handheld power tools.

7D.3: Updating Instructional Equipment

Funding for updating instructional equipment is primarily provided by student differential and technology fees. Each engineering student pays a $775 per semester Differential General Service fee and a $94.10 Technology fee. The allocations are usually made annually. The School has traditionally given undergraduate laboratory equipment top priority in the use of these funds. Table 7.1 shows the funds expended from this source in the past six years. As shown in Table 7.1, over $1.25 million has been spent over the last six years on further modernizing the laboratory equipment and acquiring more basic instrumentation, which benefit many required undergraduate laboratory classes.

Table 7.1 Annual Expenditures for Equipment Funds Allocated to Department

Year	Expenditures	Equipment Purchased
FY 07-08	**$70,000**	Updated instrumentation for lab stations in ME 36500 (10 stations). Updated computers in ME 58600 lab, ME 31500 lab, ME 36500 lab and ME 47500 lab. Updated Microcontroller software for ME 58600 lab.
FY 08-09	**$85,000**	Updated ME 26300 Laptops (quantity 10). Updated network infrastructure in instructional labs. Retrofit new CNC controller to existing CNC lathe. Updated 40 computers for ME3021
FY 09-10	**$ 245,000**	Rebuilt ME 30900 compressible flow apparatus. Added dedicated license server machine for departmental software licenses. Replaced MB10 CNC mill in student machine shop. Updated ME 47500 lab area microcontrollers to Compact Rio platform.

FY 10-11	**$305,000**	Updated PIV lab to for multiple laser paths. Purchased 16 laptops for ME 26300. Updated PC hardware in ME 2038 with 17 new machines. Purchased third Stereo Lithography machine. Built 10 new Servo table systems with inverted pendulums for ME 47500 lab area. Added 24 core Linux computational server for instructional use. Purchased IR camera for ME 31500 Lab. Replaced large format printer for printing student design documents and posters.
FY 11-12	**$323,000**	Expanded ME 36500 Lab area to 13 stations. Expanded ME 31500 lab area to 10 stations. Completed extensive rehab on all equipment used in ME 31500 and ME 36500 Lab areas. Purchased a Vacuum-forming machine for Student Machine Shop. Purchased 100 watt CO_2 Laser cutter/engraver for Student Machine Shop. Replaced MB15 CNC mill in Student Machine Shop. Replaced Microcontrollers used in ME 58600 course with custom trainer devices. Purchased a second set of laptops with cart for ME 26300. Updated PC hardware in ME 2028 with 24 new machines
FY 12-13	**$240,000+**	Updated ME 3021 CAD lab with 40 new machines, repurposed existing hardware to update ME 1030 lab and expanded ME 1030 and ME 2038 computer labs. Additional $200,000 allocation is on hold pending results of additional funding proposals.

7E. Library Services

The Purdue University Libraries offer a wide range of physical and virtual collections and services to the university community. There are 13 libraries in the Purdue Libraries system, including the Siegesmund Engineering Library, located on the main floor of the A.A. Potter Engineering Center, an Aviation Technology Library in the Terminal Building, and a central Undergraduate Library that provides substantial productivity space for students.

The Engineering Library contains over 26,000 square feet of space and houses approximately 400,000 physical volumes. The library is a patent and trademark resource center, and contains approximately one million microforms, largely technical reports. In addition to physical collections, the Libraries subscribe to many electronic resources, including over 4300 engineering journals, magazines, and newsletters. Over 100 indexes to the scientific and technical literature are available, including all the major indexes for engineering disciplines. Full-text databases, such as IEEE Xplore, and the ACM, ASCE, ASME, SAE, and AIAA digital libraries are also available, as is access to a wide variety of full-text standards through IHS. The Libraries also provide access to comprehensive e-book collections from the major science and technology publishers, Wiley, Elsevier, and Springer, among others, and collections of technology publications such as the Safari computer books collection.

The Engineering Library is open 82 hours per week during the fall and spring semesters. During the interim, the library is open 45 hours a week, and during the main summer sessions, 77 hours per week. During Finals Week and the week prior, the library is open 24/7. The Library has seats for approximately 400 students, including the Informed Learning Studio active learning classroom space that seats 66 students and reservable conference rooms that range in seating capacity from 6 to 30 students. A mix of individual and group study spaces accommodate a variety of student study habits and assignment tasks. The Hicks Undergraduate Library provides additional study space, accommodating about 1,300 students.

The Engineering Library provides assistance to library users at a combined Information Desk, staffed by professional reference assistants. In addition to face-to-face reference assistance in the library, virtual reference service is provided, including chat reference 11 hours/day during the fall and spring semesters, and email reference. Librarians provide individual consultations on an appointment basis. Librarians also provide office hours in the departments of the more physically remote Schools of Engineering. The Libraries provide a robust instructional program in engineering and technology, providing over 100 in-person instructional sessions reaching 2,300 students. In addition, an integrated information literacy curriculum in the first-year Engineering program develops basic information literacy skills in all incoming Engineering students. An online expert system provides automated assistance locating technical information. Specialized subject guides, including over 20 developed to support specific courses, provide targeted pathfinders for locating high-quality information.

7F. Overall Comments on Facilities

The School of Mechanical Engineering has professional staff to manage and maintain laboratory equipment. The staff checks instructional laboratory equipment for safety concerns before the students run an experiment or use the machine, including looking for frayed wires and other possible shock hazards, checking and maintaining attachments of moving parts, and any other potential issues that may arise from students using equipment in the labs. The teaching assistants are also made aware that they should report any potentially dangerous procedures to the instructional laboratory staff. General safety procedures are provided on posters in the labs to increase the students' awareness of safety.

Rick Duval (Building Operations Manager), Mike Sherwood (Manager of the PEARL Labs), and Mike Logan (Manager of Technical Services) all serve as emergency contacts for all activities in Mechanical Engineering Building. These staff advise the faculty, students, and other staff members about safety practices in the building. They also work with the campus fire department and the Emergency Preparedness and Planning Office and the Radiological Environmental Management (REM) to inspect and report findings for our facilities. If approached by faculty or students for assistance in their areas, these staff will advise them of options to meet their needs or have them contact the appropriate University office for further assistance. During daily activities, these staff also report any unsafe activities to the applicable faculty or staff members, and report to the administrators of the School.

CRITERION 8. INSTITUTIONAL SUPPORT

8A. Leadership

The School is led by an experienced administrative leadership team. Anil K. Bajaj, Alpha P. Jamison Professor of Mechanical Engineering, serves as the Head of the School and has done so for 2 years. In addition to leading the School, some of his time has been devoted to developing a new strategic plan that emphasizes continuous careful review of the undergraduate curriculum and developing changes that are consistent with modern trends in engineering education. David C. Anderson has served as the Associate Head for Graduate Education for more than 2 years. With the help of the Graduate Committee he oversees the graduate program and serves as chair of the Graduate Committee. James D. Jones has served as Associate Head for Undergraduate Education for 15 years. He oversees the undergraduate program and serves as the chair of the ME Curriculum Committee. He also supervises the registration process for undergraduate students, prepares the teaching assignments for faculty and is the primary individual responsible for organizing our ABET self-study report. Peter Meckl has been appointed recently (starting January 2013) as the Assistant Head for personnel and facilities management. Charles M. Krousgrill serves as the Coordinator for the Professional Practice (Co-Op) Programs and the International Programs. He has served in these roles for two years. Scott Benfield and Travis Stoutenborough serve as Senior Director and Director, respectively, for Development activities for the School. Their primary focus is to develop, solicit, and steward the School's development efforts. While Scott joined the School in 2013, Travis joined in 2012. Finally, Cheryl Bluett serves as the School's Business Manager and has done so for last 6 months. She, along with the Head, is responsible for developing, monitoring and balancing our annual budget. In addition to these members, Jackie Baumgardt serves as the Head's administrative assistant, managing his calendar and projects.

The School of Mechanical Engineering is also served by an Industrial Advisory Committee. The current chair of the MEAC (Mechanical Engineering Advisory Committee) is Bill White who served in various leadership roles in E.I. du Pont Inc. with the last assignment being President of du Pont Canada. Since 2009, he is a Partner in CBW Associates, a business and leadership consulting firm.

8B. Program Budget and Financial Support

8.B.1 Program Budget Process

The general fund (010 fund) budget request for the School of Mechanical Engineering is established by the School Head (Anil K. Bajaj) and submitted to the Dean of Engineering (Dean Leah Jamieson) for approval at the beginning of the fourth quarter of the fiscal year in accordance with guidelines from the President and the Provost. Final approval of the budget is by the Board of Trustees. Total percent increases in the broad categories of the budget, such as the increase available for faculty salaries and for supplies and expenses (S&E), are pre-established by the campus administration. Considerable flexibility is available to the School Head in reallocation of financial resources not tied to salaries as needed during the fiscal year.
The majority of the annual general fund budget, 99%, is allocated to salaries and wages for faculty, staff, teaching assistants, and student labor. The remaining 1% is allocated for supplies,

travel, and capital equipment. Annual expenditures for teaching assistants and supplies (S&E) are currently considerably higher than that supported by the annual budget. The additional resources needed are provided through implementation of the 'resource enhancement policy' of the School whereby faculty charge a portion of their academic year salaries to research, and through gifts needed to sustain the quality of the program.

The faculty and staff salary increases are established by a formal review process. All staff, except faculty and teaching assistants are reviewed by their supervisors and written evaluations are submitted in the spring to the Assistant Head for Personnel and Facilities (Professor Peter Meckl). Based on the performance reviews, the Assistant Head establishes the salary increases for the staff, in consultation with the Head. The Associate Head for Graduate Education (Professor David Anderson) and the Graduate Committee of the School establish teaching assistant (TA) stipends based on market conditions, available funds, and performance as determined by student and faculty evaluations.

At the beginning of the calendar year, the various offices of the School compile data on faculty activities. Faculty members submit to the Head a summary of their accomplishments in the areas of learning (teaching), discovery (research), and engagement (service). Faculty members are requested to annually meet with the Head to review their accomplishments. The accomplishments in learning, research, and engagement are evaluated by the Head. The Head establishes the proposed salary raise for each faculty member based on accomplishments, market conditions, and funds available for faculty salary increases. All raises are merit-based and no increases are mandatory. The Dean and the Executive Vice President for Academic Affairs review all salary increase recommendations.

In addition to the general fund allocation, the University levies Differential Fee for students in the College of Engineering. Significant portion of the revenues generated under this are provided to the College which then shares with the various schools based on Undergraduate and Graduate Weekly Class Hours, partially reflecting the teaching loads of the faculty in various schools. Differential Fee funds can be used for covering salaries of staff, teaching assistants, and graders directly benefitting the undergraduate student education, and on-going upkeep as well as development of instructional laboratories. The Provost also periodically provides opportunity to apply for funds that support instructional laboratory enhancements consistent with University strategic goals. Through these processes, the School has received $430K/yr over the last many years. Other significant costs incurred by the School include the School's share of faculty start up packages. These have amounted to about $750K annually and are higher at times when more faculty members are hired. College support for the hiring of new faculty is significant, with the college providing startup costs associated with equipment and the School being required to provide the remaining costs (nearly half the overall cost). It remains a challenge for the School to come up with its share of the startup costs, however, since the School relies upon soft funds with significant uncertainty to cover recurring costs as well including graduate teaching assistants support and supplies and services, as indicated above.

Gift and endowment funds are not part of the annual budget process. Those funds provide important flexibility in responding to opportunities and needs such as faculty development, cost sharing on proposals, and faculty research start-up expenses, in addition to ongoing expenses associated with the educational program that are not covered by general funds, as discussed above.

The Mechanical Engineering program has seen a long period of significant growth in its undergraduate and graduate programs and in its sponsored research expenditures. Specifically as shown in Figure 8.1, undergraduate enrollment in the program increased from 847 in Fall 2006 to 1232 in Fall 2012, graduate enrollment in the department increased from 363 in Fall 2006 to 523 in Fall 2012. Similarly as shown in Figure 8.2, undergraduate and graduate degrees have also increased. BSME degrees granted increased from 275 in AY 2005-06 to 290 in AY 2011–12, MS degrees granted increased from 57 in AY 2005–06 to 98 in AY 2011–12, and PhD degrees granted increased from 38 in 2005–06 to 43 in AY 2011–12. Finally, the number of faculty and research expenditures has also grown as shown in Figure 8.3. The number of FTE faculty (tenured or tenure-track) associated with ME had increased from 52 FTE in AY 2005-06 to about 58 FTE at the end of AY 2011–12. The sponsored research expenditures in the School have increased from $15.6M in AY 2005-06 to $28.5M in AY 2011-12.

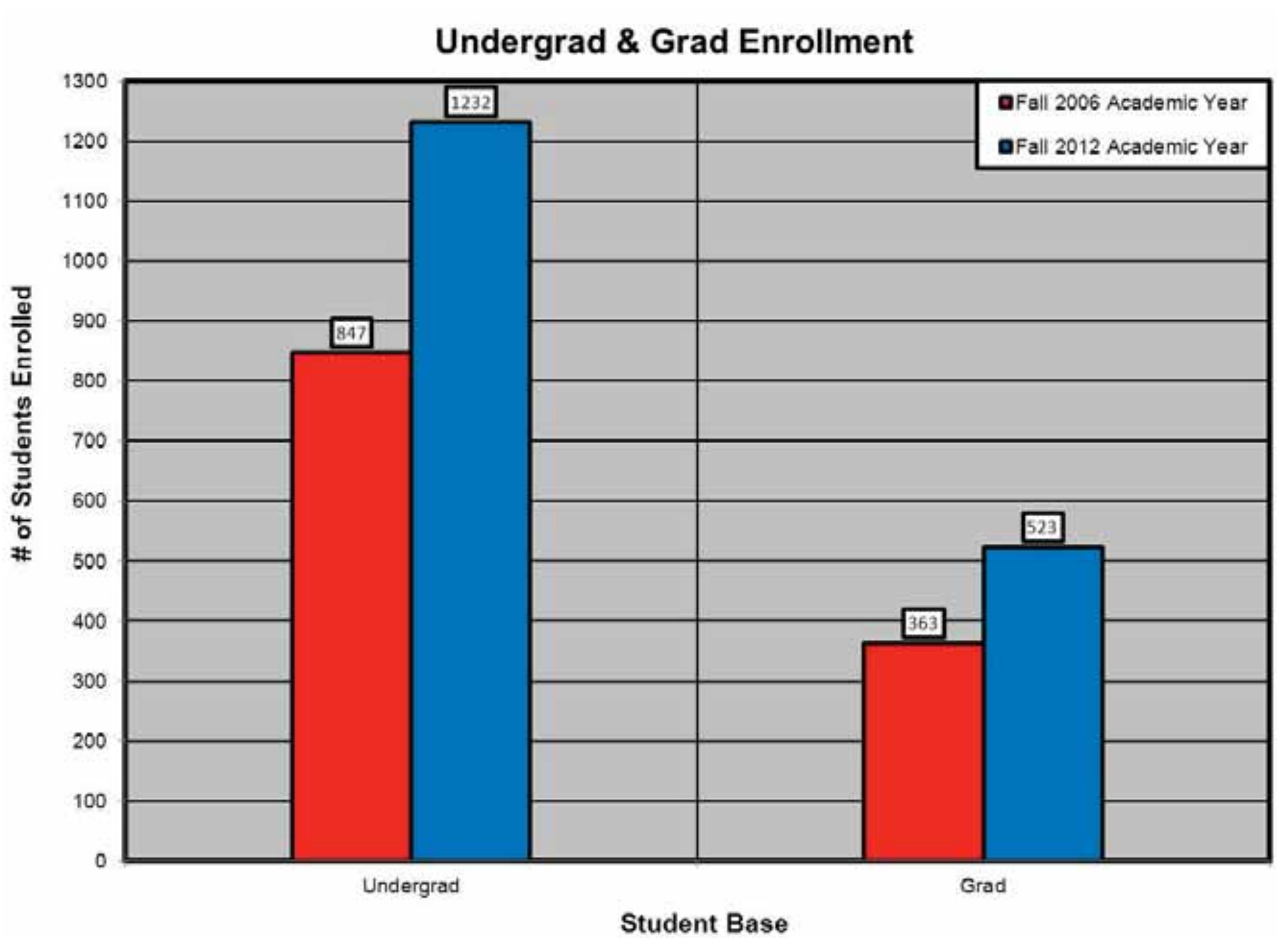


Figure 8.1 Growth in Undergraduate and Graduate Student Enrollment between Fall 2006 and Fall 2012.

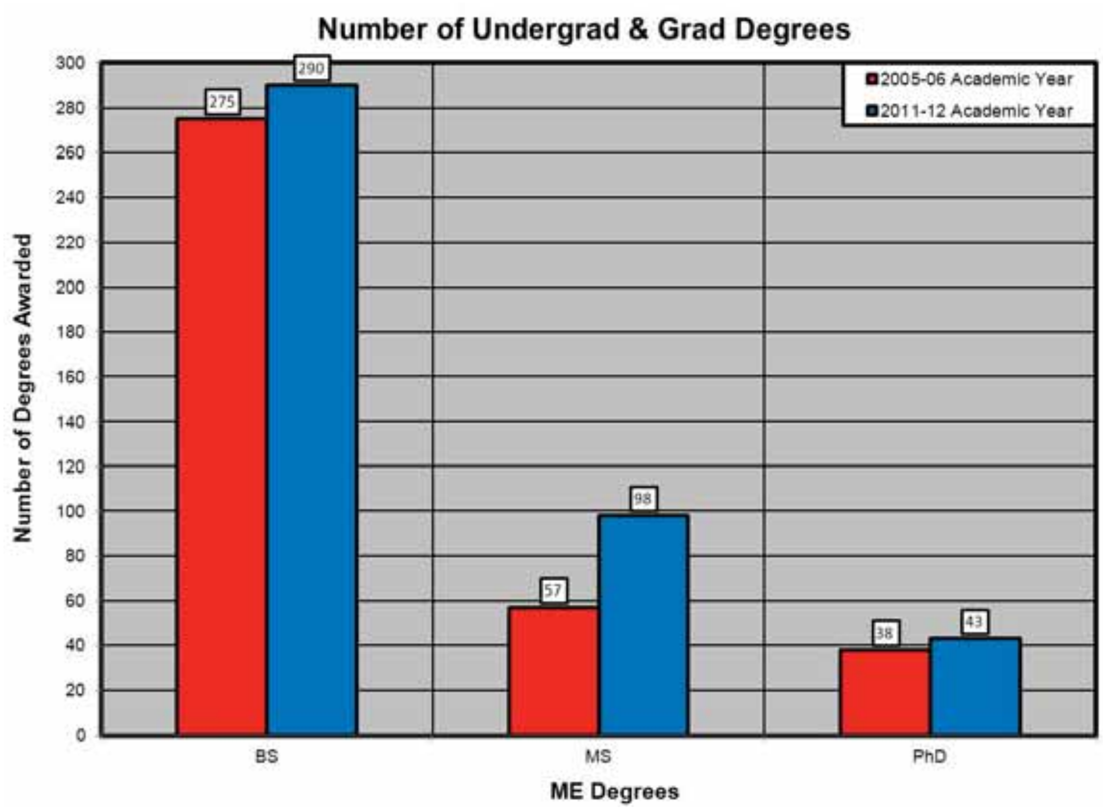


Figure 8.2 Growth in Undergraduate and Graduate Student Degrees Awarded between Fall 2006 and Fall 2012.

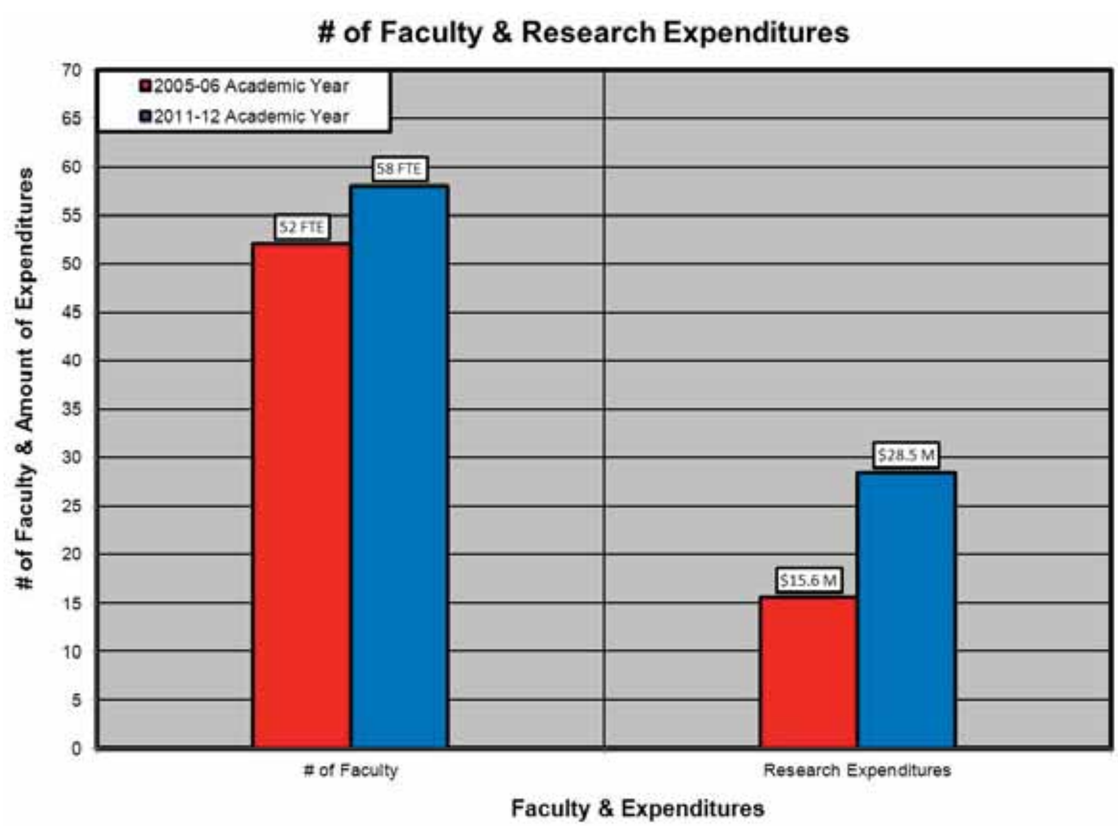


Figure 8.3 Growth in Tenure-Track Faculty Positions and Research Expenditures between Fall 2006 and Fall 2012.

The significant increase in the undergraduate (as well as graduate) student body over the last 3-4 years in School of ME has necessitated the use of large lecture sections for sophomore and junior level courses. In addition, the School has been using 3-4 non-tenure track Visiting Assistant Professors as well as 3-4 Lambert Teaching Fellows (see description below in section 8.B.2) to meet the teaching needs. This shortage of T&TT faculty has been recently recognized by the University and an aggressive growth plan has been put in place for the College of Engineering. Under this plan, the CoE is expected to grow by 107 additional faculty members over the 2012-2017. Resources have been promised to not only cover all the faculty lines, staff and graduate teaching staff positions needed to support the faculty growth have been programmed as well. As part of this plan, Mechanical Engineering has been authorized to hire at least 4 new tenure-track faculty members in 2012-13 academic year. It is expected that the number of BSME degrees granted annually will continue to grow slowly as ME is a very popular major and the freshman enrollment in CoE is expected to grow though at a much slower pace than in the recent past.

8B.2 Instructional Support

Hiring teaching assistants (TA) and graders is the responsibility of each School. In the School of Mechanical Engineering, the Associate Head for Graduate Education selects TAs based on applications submitted by graduate students, matching their credentials with the teaching assistant needs in various courses being offered in the School in a given semester. The number of sections in a particular course is determined by the Associate Head for Undergraduate Education who is responsible for making teaching assignments for the faculty. The salaries for TAs are part of the general fund allocation to the School, and the University provides a tuition waiver for all TAs with appointments at 0.25 FTE or higher level. All new TAs are required to participate in a 2-hour orientation workshop and each international student with a TA appointment is required to additionally attend a ‘Teaching in American Classroom’ workshop. The TAs not coming from English-speaking countries are required to pass a test offered by Purdue’s Oral English Proficiency Program. The University’s Center of Instructional Excellence (CIE) conducts TA training workshops at the beginning of each semester. Almost all required courses in Mechanical Engineering use TAs as well as graders. Graders are mostly undergraduate students and they are recruited for grading home works of the students.

As indicated above, 3-4 Lambert Teaching Fellows are also being used every semester as Instructors in the School. The Lambert Teaching Fellows Program was instituted when the School received a generous endowment with the stated purpose of developing future faculty from our doctoral graduate students by training them under ‘master teachers’. In keeping with the wishes of the endowment, a two-semester highly competitive program has been developed whereby senior PhD students interested in pursuing academic careers are selected as fellows. In the first semester of the fellowship, a fellow is required to serve as an apprentice under a senior faculty member teaching a multi-section sophomore or junior required class in ME. The fellow is expected to participate in developing course syllabus, homework assignments, sample homework and midterm exams, and attend 3-4 specified Teaching Workshops offered by the Center for Instructional Excellence. The fellow is also expected to prepare 2-3 lectures and teach the class as a substitute and feedback is provide by the ‘master teacher’. In the second semester of the fellowship, the fellow serves as an instructor for the same multi-section course.

8B.3 Support for Infrastructure, Facilities, and Equipment

Major new initiatives, such as the Gatewood Wing of the School of Mechanical Engineering, required funds from the State of Indiana and private sources. Resources needed to maintain and upgrade facilities and equipment have been provided by the University, though as the state support has reduced, Purdue has increasingly turned to industry and alumni/alumnae to help fund buildings and major equipment. The ongoing School investment for acquiring, operating, and maintaining facilities and equipment supporting our educational objectives is approximately $500k/year over the 6 years since the last accreditation (in 2007). The operations required for maintaining good facilities and services to the students include 2.0 FTE staff for the Student Machine Shop, and approximately 4.0 FTE of the 6.0 FTE in the ME Technical Services (Electronics Shop). The School also has developed endowments for educational infrastructure as well as equipment that total about $2.25M and provide nominally 5.0% per year ($105K in 2011-12). These resources are adequate for supporting facilities and laboratories. Upgrading of computer hardware and software in the computing laboratories is supported by the Engineering Differential Fee. Computer hardware is typically upgraded on a three to four-year cycle at this expenditure level.

8B.4 Adequacy of Resources

The resources provided are more than adequate to support the program and attain the student outcomes.

8C. Staffing

The university at large provides centralized support for a number of crucial functions that ensure the needs for continual improvement of the curriculum are met. These include computing support, space planning and facilities management, and support for advancement (communications, development, and alumni relations).

For the undergraduate program, the School has an experienced and talented support staff to provide all of the support services needed to meet the needs of the ME Program. The Head has a full-time administrative assistant to help manage his calendar and projects. The Undergraduate Office houses the Director for Industrial Experience, two full-time academic advisors, and an administrative assistant to assist the Associate Head and the Director of the Professional Practice Program with the registration, intern/co-op counseling, international program counseling and career counseling duties. A clerical staff of 5.5 FTE provides clerical support for faculty and additional 2.0 FTE clerical staff is devoted to supporting the two Directors of Development. The Undergraduate Laboratories are supervised by ME Technical Services (Electronics Shop) which has 2.0 FTE staff (along with several part-time student workers) to supervise, support, troubleshoot, and upgrade (as needed) all of the undergraduate laboratories and School computing facilities. Two FTE staff are responsible for overseeing and maintaining safety in the ME Student Shop and supervising a number of part-time student workers. In addition to these staff, we also have one part-time and one full-time continuing lecturer. These staff members with their broad industrial work experience primarily assist us with our sophomore and senior design courses. One staff member serves as Director of Global Studies and Cultural Experience, teaches course in Global Professional Experiences, and coordinates many semester-long study-abroad programs available to undergraduate students in Mechanical Engineering.

The ME Business Office under the supervision of a business manager handles all financial matters. The School also has a full-time Communications Specialist who works within the Development Office. The responsibilities of the specialist include coordinating development of 'Impact Magazine' and preparing e-newsletter for the School to maintain connection with approximately 17,000 living alumni. The two Directors of Development for ME work with the Head to develop and nurture relations with alumni/alumnae as well as corporate organizations, to identify opportunities for engagement, and to raise funds for the School. The Development Directors and the staff also work closely with the Head and the faculty to identify alumni/alumnae who should be considered for awards such as 'Outstanding Mechanical Engineer', Distinguished Engineering Alumni, and Honorary Doctor of Engineering.

8D. Faculty Hiring and Retention

8D.1 Faculty Hiring Process

In summer, the College of Engineering seeks proposals from each of the Schools and Divisions for faculty needs. The Head of the School of ME seeks input from each of the academic areas in the School for their needs based on teaching responsibilities as well as strategic research directions. After discussions with the ME Leadership Team, the Head incorporates these into a prioritized proposal based on core and Strategic Growth areas of the School to the College administration, and the Dean makes a determination of the faculty lines allocation to each of the units. The total number of faculty lines is based on the allocations from the Provost. With the faculty positions allocated to the School, the School Head appoints a search committee chair. The chair and the Head jointly choose the faculty to serve on the committee. Efforts are made to balance the committee as far as position level, diversity, gender, and academic areas. The Head and the search committee develop a job description and advertisement that must be approved by the Head, the Dean's office, as well as Purdue's Office of Institutional Equity. Advertisements are placed in appropriate publications such as *ASME Magazine*, *ASME Online*, *AcademicKeys, Chronicle of Higher Education* and *ASEE PRISM.* In addition, the advertisement is shared with Heads of ~ 125 Mechanical Engineering Departments, ASME's list-serve is used, and the ME faculty is asked to network and recommend names.

Applicants must apply through a web site maintained by Ms. Marion Ragland in the Dean's Office. Applicants provide CV, a teaching statement, a research statement, and names of at least four references. The advertisement lists Ms. Ragland's contact information in case candidates have questions about the web site procedures. The advertisement also lists the contact information for the Head of the School for questions about the position.

Members of the search committee have access to this web site and review all applications, giving grades of A, A^-, B^+, B, etc. as well as providing comments on suitability for serious consideration. Applicants with interesting backgrounds and good overall credentials are discussed in more detail in the search committee. Before inviting applicants for an on-campus interview, the search committee seeks letters of reference. Some search committees have done preliminary phone interviews with applicants before deciding whom to invite to Purdue for interviews. When this is done, all applicants of interest to the committee – even those at Purdue – are required to do a phone interview.

The search committee gives a list of selected applicants to the Head who obtains approval from College of Engineering's Strategic Oversight Committee to invite them for an interview. Typical interviews last two days, starting with a dinner on Sunday with some of the search committee members, followed by a full-day of interviewing including presentation of a technical seminar to faculty and others. Following the seminar, the candidates have a one-hour meeting with the search committee, which may be as a lunch-meeting. The candidates meet the Head, Associate Head for Undergraduate Studies as well as the Associate Head for Graduate Studies and an Associate Dean of the College of Engineering. There is a second dinner that evening. Interviews continue the next day and typically end after lunch. The goal in the interview process is to have most relevant faculty members have opportunity to talk individually with the candidate, and at least two of the areas in the School meet with the candidate in a group setting. In addition, candidates are given a tour of some of the research laboratories (Ray Herrick Labs, Maurice J. Zucrow Labs, Birck Nanotechnology Center), have lunch with a group of graduate students and meet faculty members outside of ME as appropriate.

After the interview, rating forms are obtained from everyone who met the candidate and attended the seminar. The feedback for each of the candidates is discussed in the search committee which then sends the Head a list in alphabetical order of all acceptable candidates. The Head uses this large amount of information and consultation with the Dean's office to make a decision. All negotiations with the candidate regarding start-up package including salary, joining date, and rank of appointment are done by the Head.

8D.2 Faculty Retention Strategies

First, Purdue is quite competitive in salary and benefits compared to peers, the cost of living is lower than many comparable universities, and the start-up packages are generous. Second, Mechanical Engineering at Purdue in West Lafayette is one of the premier mechanical engineering programs in the world with a strong legacy, and thus it attracts excellent undergraduate as well as graduate students. Third, the School has excellent research as well as instructional facilities. Fourth, the faculty is well-known for their interdisciplinary research and ability to collaborate with faculty from other programs as well as disciplines even outside of engineering. Most other engineering programs at Purdue are also top-ten programs, and interdisciplinary research collaboration is highly valued at Purdue. Fifth, Purdue realizes that if the spouse or significant other is unhappy, professors are more likely to leave; thus, Purdue has a credible spousal hire program. Sixth, most people with children consider West Lafayette and surrounding Tippecanoe County as a very desirable location to raise a family. Although none of these items are necessary or sufficient, they add up to a very desirable general package.

The university through Purdue Research Foundation provides opportunities for travel and research grants that, although competitive, are not nearly as competitive as national grant programs. The university also has special programs to reward and retain highly qualified faculty. Mid-career faculty, who show exceptional promise and accomplishments, and are associate or full professors within five years of promotion, can be recognized through the University Faculty Scholar program. Full professors with exceptional contributions with impact on university's mission have the prospect for being recognized with named or distinguished professorships. The School has made significant progress over the last ten years in developing many endowed named professorships through the generous support of our alumni.

8E. Support of Faculty Professional Development

There are so many opportunities for faculty professional development that few professors have time to take advantage of all their opportunities. The Center of Instructional Excellence (CIE) runs a series of workshops and seminars on teaching improvement that are available throughout the year to Purdue faculty as well as other members of instructional staff. Discovery Park hosts several seminar series in a wide variety of topics including education. Every School and Department in the university has a seminar series that are advertised and are open to the public. The University provides workshops on grant writing and administration of grants. Most professors are pleased to have other faculty audit their courses. The University also has a formal program for faculty to study in a second discipline. The Teaching Academy runs a Purdue-wide program of mentoring in teaching. Purdue is also a member of Committee on Institutional Cooperation**,** an academic consortium of Big Ten universities and the University of Chicago. The CIC's Academic Leadership Program (CIC-ALP) is designed to develop the leadership and managerial skills of faculty who have demonstrated exceptional ability and administrative promise. It is specifically oriented to the challenges of academic administration of major research universities and to the preparation of faculty members to meet those challenges.

The College of Engineering also provides separate opportunities for professional development. In March 2012, CoE invited Prof. Rich Felder to present a teaching workshop for new faculty and a mentoring workshop for experienced faculty. Every School within the College of Engineering has a mentoring program. Engineering also provides funds for curriculum development through proposal competitions run through the office of the Associate Dean for Undergraduate Affairs.

The School of Mechanical Engineering has a graduate seminar series in fall semester and the faculty has the opportunity to propose speakers. Nearly 10-12 outside speakers, mostly experts in technical areas, are invited with 2-3 speakers being internal from Purdue including the School. These seminars are generally supported by gift funds from the generous alumni of the School and from other supporters. Faculty has the opportunity to host and talk individually with the speakers. There are a few special (distinguished) seminars sponsored by the School including the Hawkins Lecture, the Oldenberger Lecture, and the Adams Distinguished Lecture.

New faculty receives a start-up package that helps initiate research activities in Purdue. The start-up package has specific allocation of funds for equipment and instrumentation, high-performance computing, support for two graduate students, summer salary for a few months for initial two years, and discretionary funds for travel to conferences, sponsors etc. If needed, details of the monetary value of start-up supplies can be obtained during the visit from the School Head though the value varies significantly based on nature of research of the faculty member.

Funds for travel are obtained from various sources. The most common source is research grants. New faculty can use start-up funds. Travel funds for international travel are also available through a grant competition run by the Purdue Research Foundation. University Faculty Scholars, Named Professors, and Distinguished Professors have access to funds set aside by the university. The School Head can also be approached for travel support on a case by case basis.

Sabbaticals and leave-of-absence opportunities are available to tenured faculty. After six years of service, faculty can request a sabbatical of one semester at full pay or two semesters at one-half pay. Sabbaticals are a privilege, not a right. Professors need to develop a plan for the sabbatical and show that the sabbatical will be beneficial to them as well as to the School. The Schools of Engineering believe in the strong benefits derived through grant of sabbaticals in the form of rejuvenation and retooling of the faculty, and development of collaborative research efforts. However, due to teaching and other needs of the School, more than a few professors cannot avail of sabbatical privilege concurrently and a careful plan needs to be followed keeping in mind the faculty as well as School's needs. In the last few years, the School has granted a total of 2-3 sabbatical as well as research leaves every academic year.

PROGRAM CRITERIA

A. Curriculum

The ABET program criteria for mechanical engineering programs require that graduates have demonstrated the following skills and abilities:

a) an ability to apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations),
b) an ability to model, analyze, design, and realize physical systems, components, or processes,
c) an ability to work professionally in thermal systems areas including the design and realization of such systems,
d) an ability to work professionally in mechanical systems areas including the design and realization of such systems.

Our program addresses each of these skills and abilities as detailed below.

Ability to Apply Engineering, Basic Science, and Mathematics

Mechanical engineering students are required to take a five-course sequence in calculus and analytical geometry constituting 19 semester credits, from the Department of Mathematics. This sequence culminates in MA 30300, which is a course on partial differential equations. This math sequence includes multivariate calculus, ordinary differential equations as well as partial differential equations, among other mathematics topics. Our students must apply mathematical and engineering concepts in virtually every mechanical engineering course that they take. This is apparent in the student work that will be made available to the reviewer. Similarly, every graduate has to complete two physics courses (Modern Mechanics and Electricity and Optics), the first of which has a lab, as well as a General Chemistry course with a lab. As with the mathematics, many of the concepts from these basic science courses are applied in their engineering courses.

Ability to Model, Analyze, Design, and Realize Physical Systems, Components, or Processes

All students in the School of Mechanical Engineering have two semester-long design experiences in ME 26300 Introduction to Mechanical Engineering Design, Innovation, and Entrepreneurship and ME 46300 Engineering Design.

ME 26300: ME 26300 Introduction of Mechanical Engineering Desing, Innovation, and Entrepreneurship is our cornerstone design experience and as such lays the foundation of design theory. The semester is divided into three distinct phases. Phase I is the Problem Definition phase. In this phase, students are given a general topical area (e.g., exercise equipment) and asked to study this market. Phase II is the concept generation and evaluation phase. Students use techniques such as functional decomposition and brainstorming to generate numerous ideas for products. They use decision matrices to determine their best ideas and they develop analytical models to analyze and improve upon their designs to converge on a primary concept. Phase III is the detailed design phase. Students decide which parts to purchase and which parts to make. They prepare a complete Bill of Materials. They estimate volumes of sales and prepare a financial model to evaluate key economic parameters and they conduct an assembly analysis to help reduce the part count, and simplify the assembly process. In summary, ME 26300 serves an important role in helping students understand a typical design process and gain experience with modeling, analyzing, designing and realizing physical systems.

ME 46300: ME 46300 Engineering Design differs from ME 26300 in four critical ways. First, the projects are significantly more complicated due to having much more content knowledge to draw on. Second, students take the design much further down the design process, in this case typically fabricating full-scale prototypes of their designs. This manufacturing experience really highlights for students the difficulty of the manufacturing phase of the design process. Third, students get to select from a number of different project topics or develop their own project proposal. In other words, in contrast to ME 26300 where students are all working in a similar domain (e.g., exercise equipment), ME 46300 students all have vastly different project topics they are working on. Fourth, a number of projects involve students from other disciplines. For example, we have had a number of biomedical device projects involving ME and BME students. Similarly, we have also recently partnered with the School of Management to take advantage of their business and marketing skills in some of our projects. As such, ME 46300 provides a complimentary design experience to ME 26300 that is less focused the problem definition phase of design and more focused on the realization aspects of product development.

Malott Innovation Competition: At the end of ME 46300, all student groups participate in the Malott Innovation Competition. Since there are so many projects (typically 40-50 projects in the spring semester), each faculty instructor determines the top 2-3 projects in their section. This pares the competition down to around 15 projects. A panel of faculty and a separate panel of external judges independently rate each of the projects utilizing a poster show format. The top projects as determined by the faculty and external judges are compared and consensus is sought concerning the top 5-6 projects. Typically, these two independent assessments are well aligned. The top contenders prepare oral presentations of their projects for the combined panel of faculty and external judges before final winners are announced. The highlight of the competition is the final showcase of all of the projects which include a public poster show where ME student peers, faculty and staff, family and friends, and the press are invited to review all of the projects, culminating in the announcement of the final winners. As such this event provides a valuable venue for the ME 46300 students to showcase their work, experience closure to their Purdue career in the presence of their student peers, faculty and staff, family and friends, the press. It is truly the highlight and culmination of their Purdue experience.

In summary, the Malott Innovation Competition serves as a catalyst to motivate the competitiveness in students to maximize their capstone design experience. Students take pride in their creative design ideas and also look forward to showcasing their designs not only at the Malott Innovation Showcase event, but also at our graduation reception for their parents, families and friends.

Ability to Work Professionally in Thermal Systems

The mechanical engineering curriculum includes one course in thermodynamics (ME 20000), one in fluid mechanics (ME 30900), and one in heat transfer (ME 31500). In addition, a second course in Thermodynamics (ME 30000 Thermodynamics II) is taken by about 60% of the students as one of their two restricted electives. There are laboratory experiments involving issues in thermal systems in the laboratories associated with ME 30900 Fluid Mechanics and ME 31500 Heat and Mass Transfer.

The students currently demonstrate their ability to design thermal systems in design projects in ME 31500. In this course, half-semester projects are done in teams, and the projects involve a significant open-ended problem associated with the design or redesign of thermal and fluid systems/components. These projects are graded and count as a portion of the class grade. In addition to the half-semester projects in ME 31500, about half of the students projects in the senior design classes, ME 46300 (Engineering Design), have some thermal/fluids aspects. While this is not a requirement for the course and the projects actually proposed by the instructors depend on the background of the instructors, it is common to have at least one team member responsible for issues in thermal systems, depending on the project.

Ability to Work Professionally in Mechanical Systems

The mechanical engineering curriculum includes one course in statics (ME 27000 Basic Mechanics I), one course in dynamics (ME 27400 Basic Mechanics II), one course in mechanics of materials (ME 32300 Mechanics of Materials), one course in mechanism design (ME 35200 Machine Design I) and one course in material science engineering (MSE 230 Structure and Properties of Materials). In addition, students have the option to take a course in machine design (ME 45200 Machine Design II) as one of their restricted electives. Typically, about 80% of students take ME 45200. Students also are introduced to basic manufacturing techniques (our ME student Shop) in ME 26300 Introduction to Innovation, Design, and Entrepreneurship. Students interested in a broader background in manufacturing methods can also choose from several technical elective courses on manufacturing (ME 36300, IE 37000, IE 47000, etc.). Finally, the students are required to take one course in systems and measurements (ME 36500), one course in system dynamics (ME 37500), and one in controls (ME 47500). This curriculum gives the students a comprehensive background in mechanical systems.

There are laboratories associated with ME 35200. All of these involve significant issues in mechanical systems. The laboratory in ME 35200 deals entirely with experiments in the area of mechanism design, synthesis, and analysis.

Students also demonstrate their ability to design mechanical systems in design projects in the cornerstone design course ME 26300 (Introduction to Innovation, Design, and Entrepreneurship) and our capstone design course ME 46300 (Engineering Design). In ME 26300 virtually all of the projects involve the design of a mechanical system (since the majority of their engineering background at this stage of their academic career is mostly on the mechanical side). In ME 46300, over half of the projects have significant mechanical design elements. At the end of the projects, the students are required to write a comprehensive report and to present their designs orally. Top projects in each section of the course are nominated to compete in an Innovation competition. All projects are graded and count as a significant portion of the class grade. In addition, homework assignments in the machine design courses regularly involve design aspects. Some open-ended design exercises are also included in ME 47500 Automatic Control Systems, involving control system design for mechanical systems.

In summary, the curriculum provides students with numerous opportunities to demonstrate their abilities to design components, systems and/or processes in both the thermal and mechanical systems areas.

B. Faculty

In addition to the program curricular requirements, the faculty responsible for the upper-level professional program must maintain currency in their specialty area.

All faculty members in the School of Mechanical Engineering are active in scholarship in teaching, research, or both. Virtually all attend at least one professional conference or meeting every year (most attend several), and most are well read in the technical literature in their area of expertise. Most also regularly publish in journals and/or proceedings, and several have published textbooks. Their interaction with others at the forefront of their technical specialty areas ensures that they are maintaining currency in their specialty areas. Details of these faculty activities and accomplishments are discussed under Criterion 6 - Faculty of this self-study report and are captured in Appendix B – Faculty Vitae.

APPENDIX A: COURSE PROFILES

Appendix A contains course profiles of all First-Year Engineering courses, all required core courses (including both ME and non-ME courses) and all ME elective courses open to undergraduate students. Each course profile contains a one-page course map (a graphical representation of the course content including the course outcomes), and a one-page matrix of other requested information including the course number and title, the credits and contact hours, the instructor/course coordinator's name, the textbook information, the course catalog description, and the specific course outcomes (cross-referenced to the ME student outcomes).

This appendix is logically divided into three sections:

A. **First-Year Engineering Courses**:

B. **ME Core Courses**:

C. **ME Elective Courses**:

A. First-Year Engineering Courses

CGT 16300

GRAPHICAL COMMUNICATION & SPATIAL ANALYSIS

Course Outcomes [Related ME Program Outcomes in Brackets]

1. Demonstrate the knowledge, technical skills and personal discipline required to be successful utilizing sketching abilities for creative problem solving in an engineering environment. [A2, A5, B3]
2. Discover miscellaneous 3D solid & surface modeling CAD database issues such as file formats and translations and database management strategies. [A2, A3]
3. Demonstrate the knowledge, technical skills and personal discipline required to be successful utilizing visualization abilities for creative problem solving in an engineering environment. [A2, A5]
4. Systematically identify, evaluate and solve problems using points, lines, surfaces, and solid geometric forms in the solution of engineering problems. [A2, A3]
5. Develop an understanding and be able to use common geometric construction techniques when creating 2D and 3D geometric forms for the solution of engineering problems. [A2, A3]
6. Acknowledge the history, research and implications of the engineering design process, as well as the importance of engineering graphics for its successful implementation. [A5, B3]
7. Develop skill and proficiency in the ability to present clearly identified solutions using graphical communication conventions and standards in an engineering environment. [A2, B3]

Basic Theory

1. 3D Modeling: surface & solid parametric constraint-based master model concepts; top-down & bottom-up assemblies, drawing, digital mock-up
2. Orthographic Projections and Multi-view sketching: coordinate systems; 3D views & displays; auxiliary views; isometric pictorial sketches.
3. Engineering Geometry and Construction:
4. The Design Process and Analysis: 3D graphical databases.
5. Graphical design standards; dimensioning, tolerancing, & GTD: working drawings reading & development, threads & fasteners:

CAD (CATIA V5, Siemens NX, Inventor, Creo (Pro/E) Exercises

1. CAD interfaces
2. Development of solid & surface geometry; extrusions, revolutions, sweeps
3. Coordinate systems:, construction planes, & RH rule
4. Transformations, 3D viewing & display
5. Top-down & bottom-up assemblies
6. CAD file interoperability
7. Digital mock-up
8. CAD interferences and clearances.
9. View extraction and drawing standards

Freehand Sketching Exercises

1. Orthographic projection multiview sketching including auxiliary and section view sketches.

2 Pictorial sketching

3. Design intent sketching
4. Dimensioning
5. Tolerancing
6. GT&D
7. Threads and fasteners
8. Working drawings
9. Other standards such as ISO, SME, ANSI

1. **COURSE NUMBER AND NAME:** CGT 16300 Graphical Communication and Spatial Analysis

2. CREDITS AND CONTACT HOURS: 2 credits

a. Lecture – 1 day per week at 50 minutes for 16 weeks
b. Laboratory – 1 day per week at 100 minutes for 16 weeks
c. Laboratory Prep. – 1 day per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

C.L. Miller

4. TEXTBOOK:

C.L. Miller, *Applied Geometry for Engineering Design*, 2013. (eBook)

5. SPECIFIC COURSE INFORMATION:

a. Course Description: An introductory course in computer graphics for mechanical and aeronautical related professions. Experiences focus on visualization, sketching, graphic standards and problem-solving strategies for engineering design. The course will emphasize the proper use of parametric solid modeling for design intent. Typically offered in fall, spring and summer. (Maymester/distance only)

b. Prerequisites:
None

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes: [Related ME Program Outcomes in Brackets]

1. Demonstrate the knowledge, technical skills and personal discipline required to be successful utilizing *sketching abilities* for creative problem solving in an engineering environment. [A2, A5, B3]
2. Discover miscellaneous *solid modeling CAD database issues* such as file formats and translations and database management strategies. [A2, A3]
3. Demonstrate the knowledge, technical skills and personal discipline required to be successful utilizing *visualization abilities* for creative problem solving in an engineering environment. [A2, A5]
4. Systematically identify, evaluate and solve problems using points, lines, surfaces, and solid geometric forms in the solution of engineering problems. [A2, A3]
5. Develop an understanding and be able to use common *geometric construction techniques* when creating 2D and 3D geometric forms for the solution of engineering problems. [A2, A3]
6. Acknowledge the history, research and implications of the engineering design process, as well as the importance of engineering graphics for its successful implementation. [A5, B3]
7. Develop skill and proficiency in the ability to present clearly identified solutions using *graphical communication conventions* and *standards* in an engineering environment. [A2, B3]

b. Related ME Program Outcomes: [Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: C. L. Miller

REVISION UPDATE: February 2013

CHM 11500
GENERAL CHEMISTRY

Course Outcomes

1. Develop a broad understanding of *energy*, *fuels* and the *chemical basis of biochemical processes*. [A1, A2, A3]
2. Develop an basic knowledge of *nuclear chemistry and kinetics* and *energetics of nuclear decay*. [A1, A2]
3. Learn the fundaments of *atomic structure*, *bonding*, *Lewis structures*, and the *VSEPR model* for predicting molecular structures. [A1, A2]
4. Build on this molecular background and discuss *hydrocarbons*, *organic functional groups*, and *polymers*, then use *bond energies* to discuss the *molecular sources of energy in exothermic reactions*. A1, A2]
5. Develop an introductory knowledge of *inter-molecular forces* and of *biochemical molecules* to enable discussion of *solution properties*, the *chemical basis for biochemical reactions*, *how typical drugs function*, and *shape recognition*. [A1, A2, A3]
6. Learn the basic structures of *simple inorganic solids* and use these to describe *metals*, *semiconductors*, *insulators*, *solar cells*, and *solar energy*. [A1, A2, A3]

General Chemistry Concepts (H.S. Review) (1wk)

1. Atoms/molecules/formulas/chemical transformations/gas laws

Nuclear Chemistry (2 wks)

1. Power Plants/energy
2. Fusion/radioactive waste (kinetics)
3. Radio imaging (Medical)
4. Energetics of nuclear decay

Polymers

1. Reaction types for polymers: distillations, cracking
2. Proteins/carbohydrates/nucleic acids
3. Natural polymers
4. The chemical basis for biochemical reactions

Inter-Molecular Forces/Biochemical Molecules

1. The chemical basis for biochemical reactions
2. How typical drugs work
3. Shape recognition

Chemistry on the Atomic Scale (2 wks)

1. *Atomic structure*
   Structure of the atom; particles/waves; light & other forms of electromagn. Radiation; atomic spectra; Bohr model of the atom; wave-particle duality; quantum nos.; shells/ subshells of orbitals, and electron configurations.
2. *Periodic Trends*
   Valency, radii, ionization energies, molecular formula trends as a prelude to bonding..
3. *The Covalent Bond*
   Valence electrons & covalent bonds; electronegativity & polarity; dipole moments; Lewis structures; resonance hybrids; formal charge; predicting the shapes of molecules (VSEPR theory); hybrid atomic orbitals.

Laboratory Experiments

1. Analyzing a solid using the conservation of mass
2. Sodium Carbonate/Amt of HCL in Hydrochloric Acid
3. From Element to salt.
4. Concentration & Spectroscopy
5. Hess's Lab & Enthalpy changes
6. Where's the Ion?
7. Molecular Geomery
8. Preparation of Luminol
9. Organic Reactions: Aspirin/Nylon/Cross-linked PVA
10. Preparing/standardizing a NaOH Soln.
11. The Acid in your beverage
12. Models of the solid state.

Simple Inorganic Solids

1. Metals
2. Semiconductors
3. Insulators
4. Solar cells
5. Solar energy

1. COURSE NUMBER AND NAME: CHM 11500 General Chemistry

2. CREDITS AND CONTACT HOURS: 4 credits

- **a.** Lecture – 2 days per week at 50 minutes for 16 weeks
- **b.** Recitation – 1 day per week at 50 minutes for 16 weeks
- **c.** Laboratory – 1 day per week at 150 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

W. Robinson

4. TEXTBOOK:

M.S. Silberberg, *Chemistry: The Molecular Nature of Matter and Change*, 4h ed., McGraw-Hill, 2006.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Stoichiometry; atomic structure; periodic properties; ionic and covalent bonding; molecular geometry; gases, liquids, and solids; crystal structure; thermochemistry; descriptive chemistry of metals and non-metals. Required of students majoring in science and students in engineering who are not in CHM 12300. Typically offered in fall, spring and summer.

b. Prerequisites:

MA 15900 – Pre-Calculus
MA 16100 – Plane Analytic Geometry & Calculus I or
MA 22300 – Introductory Analysis I

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Develop a broad understanding of *energy*, *fuels* and the *chemical basis of biochemical processes*. [A1, A2, A3]
2. Develop a basic knowledge of *nuclear chemistry and kinetics* and *energetics of nuclear decay*. [A1, A2]
3. Learn the fundaments of *atomic structure*, *bonding*, *Lewis structures*, and the *VSEPR model* for predicting molecular structures. [A1, A2]
4. Build on this molecular background and discuss *hydrocarbons*, *organic functional groups*, and *polymers*, then use *bond energies* to discuss the *molecular sources of energy in exothermic reactions*. [A1, A2]
5. Develop an introductory knowledge of *inter-molecular forces* and of *biochemical molecules* to enable discussion of *solution properties*, the *chemical basis for biochemical reactions*, *how typical drugs function*, and *shape recognition*. [A1, A2, A3]
6. Learn the basic structures of *simple inorganic solids* and use these to describe *metals*, *semiconductors*, *insulators*, *solar cells*, and *solar energy*. [A1, A2, A3]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page

PREPARED BY: M. H. Towns

REVISION UPDATE: June 21, 2013

CHM 11600
GENERAL CHEMISTRY

Course Outcomes

1. Recognize the implications of *incomplete reactions.* [A1, A2]
2. Introduce the four major topics of *equilibrium*, *kinetics*, *electrochemistry* and *thermodynamics.* [A1]
3. Build a link between *equilibrium* and *kinetics* and between *electrochemistry* and *thermodynamics*. [A1, A2]
4. Learn how *electrochemistry* and *thermodynamics* can be used to measure *equilibrium constants*. [A1, A2]
5. Learn how to *collect* and *analyze observations* and *experimental data* obtained in the laboratory. [A3]
6. Reinforce *written communication skills* through laboratory reports. [B1]

Equilibrium

1. EQUILIBRIA
   Expression for equilibrium constant; reaction quotients and equilibrium constants; using equilibrium constants in calculations; equilibria expressed in partial pressures for gases; disturbing equilibrium: LeChatelier's principle; applying principles of equilibrium to optimize reactions.
2. ACID-BASE EQUILIBRIA
   Arrhenius and Bronsted acids/bases; Kw, pH & pOH; acid-dissociation equilibrium const. (Ka); strong acids; weak acids; relative strengths of acids; periodic trends in acidity; assumptions made in weak-acid calculations; bases (Kb); Lewis acids and bases; chemical reactivity; buffers, buffer capacity & titration curves; polyprotic acids & bases;

Electrochemistry

1. OXIDATION/REDUCTION REACTIONS
   Assigning oxidation nos.; balancing oxidation-reduction eqns.; redox reactions in acidic or basic soln.; molecular redox reactions; oxidizing/reducing agents.
2. VOLTAIC CELLS
   Work from spontaneous oxidation-reduction reactions; voltaic cells; std-state cell & half-cell potentials; the Nernst eqn.; Nernst eqn. to measure equilibrium const.
3. ELECTROLYTIC CELLS
   Electrolytic cells; Faraday's laws; batteries; galvanic corrosion & cathodic protection.

Kinetics

1. RATE LAWS AND RATE CONSTANTS
   Instantaneous rate of reaction & rate law for a reaction; determining order of reaction from experimental data; integrated rate laws.
2. ORDER AND MOLECULARITY
   Collision theory model of chemical reaction; Arrhenius equation; reactions that are 1^{st}-order in two reactants; mechanisms of chem. reactions.
3. ACTIVATION ENERGY
   Catalysts & rate of chem. reactions; activation energy of a reaction.

Thermodynamics

1. 1st LAW OF THERMODYNAMICS
   Enthalpy vs. internal energy; spontaneous chemical reactions.
2. 2^{nd} & 3^{rd} LAWS OF THERMODYNAMICS
   Entropy as a measure of disorder; standard-state entropies of reaction; state functions.
3. FREE ENERGY
   Gibbs free energy; effect of temp. on the free energy of a reaction; relationship between free energy & equilibrium const.; temp. dependence of equilibrium consts.; relationship between free energy & cell potentials.

Laboratory Experiments

1. Electrolytes and Nonelectrolytes
2. A Chemical Oscillation reaction
3. Rate Law and Activation energy
4. LeChatelier's Principle
5. Equilibrium Constant/Concentrations
6. Acid-Base Equilibria
7. Enthalpy: Hess's Law
8. Thermodynamics and Equilibrium
9. Oxidizing and reducing agents
10. A metal ion sensor

1. COURSE NUMBER AND NAME: CHM 11600 General Chemistry

2. CREDITS AND CONTACT HOURS: 4 credits

- **a.** Lecture – 2 days per week at 50 minutes for 16 weeks
- **b.** Recitation – 1 day per week at 50 minutes for 16 weeks
- **c.** Laboratory – 1 day per week at 150 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:
W. Robinson

4. TEXTBOOK:
Chemistry & Chemical Reactivity, 7th Edition, Kotz, Treichel & Townsend, Thomson/Brooks-Cole Publishing, 2009.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: A continuation of CHM 11500. Quantitative equilibria; acid-base equilibria; introductory thermodynamics; oxidation-reduction and electrochemistry; chemical kinetics; qualitative analysis; further descriptive chemistry of metals and nonmetals. Typically offered in fall, spring, and summer.

b. Prerequisites:
CHM 11500 – General Chemistry I

c. Status:
Required

6.SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Recognize the implications of *incomplete reaction.s* [A1, A2]
2. Introduce the four major topics of *equilibrium*, *kinetics*, *electrochemistry* and *thermodynamics.* [A1]
3. Build a link between *equilibrium* and *kinetics*, and between *electrochemistry* and *thermodynamics.* [A1, A2]
4. Learn how *electrochemistry* and *thermodynamics* can be used to measure *equilibrium constants*. [A1, A2]
5. Learn how to *collect* and *analyze observations* and *experimental data* obtained in the laboratory. [A3]
6. Reinforce *written communication skills* through laboratory reports. [B1]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: G. Bodner

REVISION UPDATE: June 21, 2013

COM 11400
PRINCIPLES OF HUMAN COMMUNICATION
(30 Students/Section Max.)

Course Outcomes [Related ME Program Outcomes in brackets]

1. Introduce students to the fundamentals of *human communication* [B1].
2. Develop basic *interpersonal communication* skills [B1].
3. Develop basic *teamwork skills* and learn how to prepare *group presentations* [B1, B2, C1]
4. Learn how to prepare and deliver effective *informational speeches* [B1]
5. Learn how to prepare and deliver effective *persuasive speeches* [B1]

Human Communication

1. Background and Definitions
2. Areas of Communication Study
3. Language
4. Implications for Communication
5. Ethical Communication

Interpersonal Communication

1. Definitions
2. Interpersonal Skills
3. Conversational Skills
4. Comforting
5. Conflict Resolution

Practice

1. Interpersonal Exercises

Teamwork Skills and Group Presentations

1. Characteristics
2. Roles and Leadership
3. Problem Solving Procedures

Practice

1. Small Group Exercises
2. Group Presentation (4-7 students/group, 30-35 min. speech)
3. Written Report on their "Group Presentation Experience" (Individual, 5 pages)

Informational Speeches

1. Analyzing the Situation:
2. Audience, Speaker, and Message
3. Brainstorming Topic Ideas
4. Narrowing the Topic: The Thesis
5. Statement
6. Selecting/Arranging Major Points
7. Introductions, Transitions,
8. Conclusions
9. Language/Tone of Speaker
10. Organizing the Speech
11. Rehearsing the Speech
12. Purpose & Approaches &
13. Principles of Informational
14. Speaking

Practice

1. Informative Speech I (Individual,
2. 4-6 min. speech)
3. Informative Speech II (Individual,
4. 5-7 min. speech)

Persuasive Speeches

1. Influencing Decisions
2. Composing a Persuasive Speech
3. Persuasion and Reasoning

Practice

1. Persuasive Speech (Individual, 6-8 min. speech)

Revision Date: 2/26/2013

1. COURSE NUMBER AND NAME: COM 11400 Fundamentals of Speech Communication

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

Jane Natt, Clinical Assistant Professor, COM 114 Course Director

4. TEXTBOOK:

M. Morgan & J. Natt, *Effective presentations*, 8th ed., McGraw-Hill, 2010.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: A study of communication theories as applied to speech; practical communicative experiences ranging from interpersonal communication and small group process through problem identification and solution in discussion to informative and persuasive speaking in standard speaker-audience situations. Typically offered fall, spring, and summer.

b. Prerequisites:
None

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Introduce students to the fundamentals of *human communication* [B1].
2. Develop basic *interpersonal communication* skills [B1].
3. Develop basic *teamwork skills* and learn how to prepare *group presentations* [B1, B2, C1]
4. Learn how to prepare and deliver effective *informational speeches* [B1]
5. Learn how to prepare and deliver effective *persuasive speeches* [B1]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: Zachery Koppelmann, ME WEP Coordinator

REVISION UPDATE: February 26, 2013

CS 15900
PROGRAMMING APPLICATIONS FOR ENGINEERS

Course Outcomes

1. Demonstrate competency in the *fundamental principles*, *concepts* and *methods of programming* (C and MATLAB), with emphasis on developing solutions in the domains of physical sciences, mathematics, and engineering. [A1, A2]
2. Demonstrate the ability to function as part of a *technical team* to generate the solution to a programming problem. [B2]
3. Explore common *programming concepts* in various computing environments and implement those concepts *across more than one language*. [A1, A23]
4. Analyze *alternative algorithm designs* to implement a solution designed to make *efficient* use of limited resources of the computer. [A5, A6]

UNIX, Text Editors, and Compilers (½ week)

Directory navigation and file management in the UNIX operating system
Using the vi text editor
The process of compiling and developing an executable file

User/Programmer Defined Functions (2 weeks)

Rationale for function use
Top-down design and task factoring.
Function declarations and definitions.
Calling functions, parameter passing.
Returning values from a function
Passing parameters by value and address
Scope
Using structure charts to design a software solution

Repetition (2 weeks)

Pretest and post-test, selection- and counter-controlled repetition
Pretest repetition constructs while and for
Post-test repetition construct do-while
Repetition applications and common logical errors
Recursive functions and solution development

Introduction to Computers (½ week)

Primary components of a computer
The central processing unit
Hierarchical memory
The role of the processor and memory and why each is a limited resource

Flowcharts (1 week)

Using flowcharts to design a visual representation of an algorithm
Solving problems using sequence, selection, and repetition

External File I/O (1 week)

Redirection of input and output
Read data from and writing output to an external file
Searching for the end of a file

Processing Larger Data Sets (3 weeks)

Declaring and defining arrays
Characteristics of arrays in C
Arrays and inter-function communication
Manipulation of data stored in an array
Sorting algorithms: bubble, selection, and insertion
Searching algorithms: linear and binary
Analysis of algorithms that utilize arrays
Character arrays and string.h functions

Introduction to the C Language and Structure of a C Program (2 weeks)

Sections of a C program
Single and multi-line commenting
Identifiers, data types, variables, and constants
Standard input/output functions and formatting
Identifying errors
Expressions, operators, operands, precedence
Prefix and post-fix expressions
Single- and mixed-type expressions

Selection (1 week)

Logical data, relational and logical operators
Evaluating logical expressions
Writing complements to logical expressions
Two-way selection constructs including if/else and conditional expressions
Multi-way selection constructs including if/else if/else and switch

Pointers and Pointer Applications (1 week)

Pointers variable declaration and assignment
Pointers, arrays, and pointer arithmetic
Dynamic memory allocation
Returning pointer values from a function
Substring pattern matching

1. COURSE NUMBER AND NAME: CS 15900 Programming Applications for Engineers

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 50 minutes for 16 weeks

b. Laboratory – 1 day per week at 110 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

W. Crum

4. TEXTBOOK:

Forouzan and Gilberg, *Computer Science, A Structured Programming Approach Using C*, 3rd ed.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Fundamental principles, concepts and methods of programming (C and MATLAB), with emphasis on applications in the physical sciences and engineering. Basic problem solving and programming techniques; use of programming logic in solving engineering problems. Students are expected to complete assignments in a collaborative learning environment. Typically offered in fall, spring and summer.

b. Prerequisites:
ENGR 13200 – Transforming Ideas to Innovation II (may be taken concurrently)

c. Status: Science Selective (FYE)

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Demonstrate competency in the *fundamental principles*, *concepts* and *methods of programming* (C and MATLAB), with emphasis on developing solutions in the domains of physical sciences, mathematics, and engineering. [A1, A2]
2. Demonstrate the ability to function as part of a *technical team* to generate the solution to a programming problem. [B2]
3. Explore common *programming concepts* in various computing environments and implement those concepts *across more than one language*. [A1, A2]
4. Analyze *alternative algorithm designs* to implement a solution designed to make *efficient* use of limited resources of the computer. [A5, A6]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship;

7. LIST OF TOPICS: See following page.

PREPARED BY: W. Crum

REVISION UPDATE: February 2013

ENGL 10600
FIRST-YEAR COMPOSITION
(20 Students/Section Max)

Course Outcomes [Related ME Program Outcomes in brackets]

Introductory Composition at Purdue (ICaP) fulfills five major goals:

1. Developing students' rhetorical knowledge [B1, B4, B5]
2. Developing students' critical thinking, reading, and writing [A2, B1, B4, B5]
3. Developing students' writing processes [B1]
4. Developing students' knowledge of conventions [B1, B5, C2]
5. Developing students' use of technology in composition [B1, B5]

Rhetorical Knowledge

1. To help students understand the inherent rhetorical situation of writing including purpose, audience, and context.
2. To prepare students for writing in later university courses across the curriculum by helping them learn to articulate, develop, and support a point through both primary and secondary research.
3. To help students understand that they can and should use writing for multiple academic, civic, professional, and personal purposes.

Critical Thinking, Reading, and Writing

1. To provide students with opportunities to write as a means of discovery and learning about themselves; as an integral part of inquiry about the material, social, and cultural contexts they share with others; and as a means of exploring, understanding, and evaluating ideas in academic disciplines.
2. To help students develop their abilities to create, interpret, and evaluate a variety of types of texts integrating verbal and visual components.

Writing Process

1. To help students develop effective and efficient processes for writing by providing practice with planning, drafting, revising, and editing their writing in multiple genres using a variety of media.

Technology in Composition

1. To provide students with experience using multiple composing technologies to produce a variety of genres of texts.

Knowledge of Conventions

1. To introduce students to the conventions of form, style, and citation and documentation of sources that are appropriate to their purposes for composing in a variety of media for a variety of rhetorical contexts.
2. To demonstrate that coherent structure, effective style, and grammatical and mechanical correctness contribute to a writer's credibility and authority.

Revision Date: 2/27/2013

1. COURSE NUMBER AND NAME: ENGL 10600 First Year Composition

2. CREDITS AND CONTACT HOURS: 4 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

b. Conference – weekly at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

Samantha Blackmon, Professor, Director of Introductory Composition

4. APPROVED TEXTBOOKS:

a. Bergmann, Linda. *Academic Research and Writing: Inquiry and Argument in College*. Longman.

b. Blakesley, David and Jeffrey Hoogeveen. *Writing: A Manual for a Digital Age*. Wadsworth.

c. Bullock, Richard. *Norton Field Guide to Writing*. Norton.

d. Johnson-Sheehan, Richard and Charles Paine. *Writing Today*. Longman.

e. Wysocki, Anne and Dennish Lynch. *Compose Design Advocate*. Longman.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Typically offered fall, spring, and summer.

b. Prerequisites:

None

c. Status:

Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Developing students' rhetorical knowledge [B1, B4, B5]
2. Developing students' critical thinking, reading, and writing [A2, B1, B4, B5]
3. Developing students' writing processes [B1]
4. Developing students' knowledge of conventions [B1, B5, C2]
5. Developing students' use of technology in composition [B1, B5]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: Zachery Koppelmann, ME WEP Coordinator

REVISION UPDATE: February 27, 2013

ENGR 13100
TRANSFORMING IDEAS TO INNOVATION I

Course Outcomes [Related ME Program Outcomes in Brackets]

1. Examine and analyze career information from various resources to make informed decisions about which engineering discipline to pursue. [A1]
2. Explain the critical role of cross-cultural and multidisciplinary teamwork in nurturing diverse perspectives and the creation of innovative engineering solutions that meets the needs of the diverse users. [B2, C3]
3. Reflect on your teamwork and leadership abilities, recognizing how your behavior impacts the whole team, and making team process adjustments whenever necessary. [B2]
4. Explain critical and diverse uses of modeling in engineering to understand problems, represent solutions, compare alternatives, make predictions, etc. [A2]
5. Use multiple models, estimation, and logic to triangulate and evaluate information coming from various data sources. [A1, A3]
6. Collect, analyze, and represent data to make informative explanations and persuasive arguments. [A3]
7. Implement iterative processes, rich information gathering, and multiple modes of modeling when solving complex design problems. [A2]
8. Use systematic methods to develop design solutions and compare design alternatives. [A4]
9. Consider the interconnectedness among social, economic, and environmental factors (in the context of sustainability or systems) when solving engineering problems. [A6]

Excel & MATLAB Modeling

1. Software Interface Familiarity
2. Basic Math/Trig. Functions
3. MATLAB Vectors and Matrices
4. Data Structures, Data Creation, and Manipulation
5. Files and Templates
6. Reading Files (CSV, TXT, DAT)
7. Basic & Formatted Graphics/Plotting
8. Descriptive Statistics
9. Histograms

Modeling: Model Eliciting Activities (MEA)

1. Developing mathematical models for real-world problems
2. Using models to solve engineering problems
3. Reviewing Peers's Work

Professional Habits: Teaming

1. Teaming
2. Diversity
3. Contributing to Multi-Disciplinary Teams by Understanding Other Engineering Disciplines

Intro to Prof. Schools

1. AAE/ABE/BME
2. ChE/CE/CEM
3. IDE/IE/MDE
4. ME/MSE/NE

Design

1. Problem Framing/ Information Literacy
2. Understanding the Broader Context
3. Ideation and Idea Fluency
4. Representing Ideas Through Deep Drawings and Models
5. Balancing Benefits and Trade-Offs
6. Evaluating Designs Through Valid Tests and Experiments
7. Design as an Iterative Process
8. Design as a Reflective Process

1. **COURSE NUMBER AND NAME:** ENGR 13100 Transforming Ideas to Innovation I

2. CREDITS AND CONTACT HOURS: 2 credits

a. Studio – 2 day per week at 110 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

M. Cardella & M. Ohland

4. TEXTBOOK:

Ideas to Innovation, 3rd Edition, **H. Moore/Purdue**; Pearson Education, ISBN: 1-256-75227-4

5. SPECIFIC COURSE INFORMATION:

a. Course Description: A partnership between Schools and Programs within the College of Engineering, introduces students to the engineering profession using multidisciplinary, societally relevant content. Developing engineering approaches to systems, generating and exploring creative ideas, and use of quantitative methods to support design decisions. Explicit model-development activities (Engineering eliciting activities, EEAs) engage students in innovative thinking across the engineering disciplines at Purdue. Experiencing the process of design and analysis in engineering including how to work effectively in teams. Developing skills in project management, modern engineering tools (e.g., Excel and MATLAB).

b. Prerequisites:
None

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes: [Related ME Program Outcomes in Brackets]

1. Examine and analyze career information from various resources to make informed decisions about which engineering discipline to pursue. [A1]
2. Explain the critical role of cross-cultural and multidisciplinary teamwork in nurturing diverse perspectives and the creation of innovative engineering solutions that meets the needs of diverse users. [B2, C3]
3. Reflect on your teamwork and leadership abilities, recognizing how your behavior impacts the whole team, and making team process adjustments whenever necessary. [B2]
4. Explain critical and diverse uses of modeling in engineering to understand problems, represent solutions, compare alternatives, make predictions, etc. [A2]
5. Use multiple models, estimation, and logic to triangulate and evaluate information coming from various data sources. [A1, A3]
6. Collect, analyze, and represent data to make informative explanations and persuasive arguments. [A3]
7. Implement iterative processes, rich information gathering, and multiple models of modeling when solving complex design problems. [A2]
8. Use systematic methods to develop design solutions and compare design alternatives. [A4]
9. Consider the interconnectedness among social, economic, and environmental factors (in the context of sustainability or systems) when solving engineering problems. [A6]

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: Monica Cardella

REVISION UPDATE: May 30, 2013

ENGR 13200

TRANSFORMING IDEAS TO INNOVATION II

Course Outcomes [Related ME Program Outcomes in Brackets]

1. Develop a logical problem-solving process that includes sequential structures, conditional structures, and repetition structures for fundamental engineering problems. [A1, A2]
2. Translate a written problem statement into a mathematical model. [A2]
3. Solve fundamental engineering problems using computer tools. [A4]
4. Employ design and problem processes in modeling, problem-solving, and design work. [A5]
5. Work effectively and ethically as a member of a technical team. [B2, B3]
6. Develop a work ethic appropriate to the engineering profession. [B3]
7. Evaluate and provide feedback to improve solutions to engineering problems. [A5]
8. Reflect on personal and team performance to achieve continuous improvement. [B2]
9. Demonstrate an ability to engage in continuing professional development. [B1, B2]

MATLAB Programming Skills

1. Vector and Array Manipulations
2. Relational/Logical Operations
3. Decision/Repetition Structures
4. User-Defined Functions
5. Graphical-User Interfaces (GUIs)

Problem-Solving

1. Evidence-Based Decisions
2. Flowcharting and Logical Decision-Making
3. Flowchart to programming algorithm conversion

Mathematical Modeling

1. Problem Formulation
2. Iterative Model Creation/Development/Evaluation
3. Model Argumentation/Justification
4. Model Communication

Data Analysis

1. Data Representations
2. Descriptive Statistics
3. Linear Regression
4. Function Forms & Discovery

Engineering Design (GUI Design)

1. Problem Formulation
2. Information Gathering
3. Idea Generation
4. Iterative Prototype Creation/Development/Evaluation
5. Prototype Review with Client

1. **COURSE NUMBER AND NAME:** ENGR 13200 Transforming Ideas to Innovation II

2. CREDITS AND CONTACT HOURS: 2 credits

a. Studio – 2 day per week at 110 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

H. Diefes-Dux

4. TEXTBOOK:

On-Line Modules

5. SPECIFIC COURSE INFORMATION:

a. Course Description: A partnership between Schools and Programs within the College of Engineering continues building on the foundation developed in ENGR 13100. Students take a more in depth and holistic approach to integrating multiple disciplines perspectives while constructing innovative engineering solutions to open-ended problems. Extending skills in project management engineering fundamentals, oral and graphical communication, logical thinking, team work, and modern engineering tools (e.g., Excel, and MATLAB).

b. Prerequisites:

ENGR 13100 – Transforming Ideas to Innovation I (grade of "C" or better)

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes: [Related ME Program Outcomes in Brackets]

1. Develop a logical problem-solving process that includes sequential structures, conditional structures, and repetition structures for fundamental engineering problems. [A1, A2]
2. Translate a written problem statement into a mathematical model. [A2]
3. Solve fundamental engineering problems using computer tools. [A4]
4. Employ design and problem processes in modeling, problem-solving, and design work. [A5]
5. Work effectively and ethically as a member of a technical team. [B2]
6. Develop a work ethic appropriate to the engineering profession. [B3]
7. Evaluate and provide feedback to improve solutions to engineering problems. [A5]
8. Reflect on personal and team performance to achieve continuous improvement. [B2]
9. Demonstrate an ability to engage in continuing professional development. [B1, B2]

b. Related ME Program Outcomes: [Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: H. Diefes-Dux

REVISION UPDATE: June 07, 2013

MA 16500*
ANALYTIC GEOMETRY AND CALCULUS I

Course Outcomes [Related ME Program Outcomes in brackets]

1. Students obtain the skills necessary to deal with models in engineering and science involving *differential calculus of one variable*. [A1, A2]
2. Students gain a familiarity with the *elementary special functions* (e.g. exponential, log, and trigonometric functions) which arise in engineering and science. [A1, A2]
3. Students learn the basic calculus concepts concerning *growth* and *decay* which are pursued in later courses. [A1, A2]
4. Students learn the notion of *Riemann sums* in order to understand the development of many models in engineering and science which arise this way. [A1, A2]

Review

1. Functions and Graphs
2. Trigonometric Function
3. Exponential Functions
4. Logarithmic Functions

→

Differentiation

1. Limits and Continuity
2. Definition of Derivative
3. Rules of Differentiation
4. Derivatives of Trigonometric, Exponential and Logarithmic Functions
5. Related Rates and Approximations

→

Applications of the Derivative

1. Maxima and Minima
2. Mean Value Theorem
3. Exponential Growth and Decay
4. Curve Sketching, Concavity and Asymptotes
5. L'Hopital's Rule

→

Integration

1. Definition of Definite Integral
2. Fundamental Theorem of Calculus
3. Indefinite Integrals
4. Integration by Substitution
5. Definition of Logarithm

→

Other Functions

1. Inverse Functions
2. Exponential Functions
3. Inverse Trigonometric Functions
4. Conic Sections

*** Equivalent Courses: MA 16100 (includes a second hour of recitation)**

1. COURSE NUMBER AND NAME: MA 16500 Analytic Geometry and Calculus I

2. CREDITS AND CONTACT HOURS: 4 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

b. Recitation – 1 day per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

A. Yip, Chair, Calculus Committee

4. TEXTBOOK:

J. Stewart, *Calculus, Early Transcendentals*, Purdue Custom 7th ed. Brooks/Cole Publishing Company, 2012.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Introduction to differential and integral calculus of one variable, with applications. Conic sections. Designed for students who have had at least a one-semester calculus course in high school, with a grade of "A" or "B", but not qualified to enter MA 16200 or MA 16600, or the advanced placement courses MA 17300 or MA 27100, or the honors calculus course MA 18100. Typically offered in fall and spring.

b. Prerequisites: Demonstrated competency in college algebra, trigonometry at the level of MA 15800.

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Students obtain the skills necessary to deal with models in engineering and science involving *differential calculus of one variable*. [A1, A2]
2. Students gain a familiarity with the *elementary special functions* (e.g. exponential, log, and trigonometric functions) which arise in engineering and science. [A1, A2]
3. Students learn the basic calculus concepts concerning *growth* and *decay* which are pursued in later courses. [A1, A2]
4. Students learn the notion of *Riemann sums* in order to understand the development of many models in engineering and science which arise this way. [A1, A2]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: A. Sa Barreto

REVISION UPDATE: February 25, 2013

MA 16600*
ANALYTIC GEOMETRY AND CALCULUS II

Course Outcomes [Related ME Program Outcomes in brackets]

1. Learn the basic notions used in *vector algebra* which are needed in their early courses in engineering and science, and which are also needed later in the development of vector calculus. [A1, A2]
2. Learn techniques of integration which are needed to compute basic integrals in engineering and science. [A1, A2]
3. Apply *integration* to compute *geometric* and *physical* quantities of importance in science and engineering. [A1, A2]
4. Learn the basic ideas in *sequences* and *series* which will be needed in later studies of Fourier analysis and signal processing. [A1, A2]

Vectors

1. Cartesian Coordinates
2. Vectors in Space
3. Dot Product
4. Cross Product

Techniques of Integration

1. Integration by Parts
2. Trigonometric Integration
3. Trigonometric Substitutions
4. Partial Fractions
5. Improper Integrals

Applications of the Integral

1. Volumes by Disks and Shells
2. Length of a Curve
3. Area of a Surface
4. Work
5. Moments and Center of Gravity

Sequences and Series

1. Convergence
2. Integral, Comparison, Ratio and Root Tests
3. Alternating Series and Absolute Convergence
4. Power Series and Taylor Series

Curves in the Plane

1. Parametrized Curves
2. Polar Coordinates

*** Equivalent Courses: MA 16200 (includes a 2nd hr. recitation)**
MA 17300 (Accelerated option – requiring testing out of MA 16500)
MA 18100 (Honors option – requiring testing out of MA 16500)

1. COURSE NUMBER AND NAME: MA 16600 Analytic Geometry and Calculus II

2. CREDITS AND CONTACT HOURS: 4 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

b. Recitation – 1 day per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

A. Yip, Chair, Calculus Committee

4. TEXTBOOK:

J. Stewart, *Calculus, Early Transcendentals*, Purdue Custom 7th ed. Brooks/Cole Publishing Company, 2012.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Continuation of MA 16500. Vectors in two and three dimensions. Techniques in integration, infinite series, polar coordinates, surfaces in three dimensions. Not open to students with credit in MA 16200. Typically offered in fall, spring and summer.

b. Prerequisites:
MA 16500 Analytic Geometry and Calculus I

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Learn the basic notions used in *vector algebra* which are needed in their early courses in engineering and science, and which are also needed later in the development of vector calculus. (A1, A2]
2. Learn techniques of integration which are needed to compute basic integrals in engineering and science. [A1, A2]
3. Apply *integration* to compute *geometric* and *physical* quantities of importance in science and engineering. [A1, A2]
4. Learn the basic ideas in *sequences* and *series* which will be needed in later studies of Fourier analysis and signal processing. [A1, A2]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: A. Sa Barreto

REVISION UPDATE: February 25, 2013

PHYS 17200
MODERN MECHANICS

Course Outcomes [Related ME Program Outcomes in Brackets]

1. Learn how to understand and *describe a wide range of physical phenomena using only a few fundamental principles of physics*. [A1, A2, A3]
2. Learn a *unified approach* that relates microscopic behavior to macroscopic behavior, such as the combination of *traditional mechanics*, a *modern view of quantized atomic levels* and *statistics* leading to basic thermodynamics from mechanics. [A1,A2, A3]
3. Learn how to apply this unified approach to a broad array of applications including *asteroids*, *black holes*, *nuclear fission and fusion*, *quantization in atoms and molecules*, and *heat capacity*. [A1, A2, A3, A4]
4. Learn to *model* natural phenomena, enabling quantitative studies such as *computer simulations* describing specific physical behaviors using a programming language called *VPython*, with little or no prior programming experience. [A1, A2, A3]
5. Gain experience in team building practice while conducting experiments in the labs and solving problems in recitations in small groups. [A3, B2]

Momentum

1. Interactions and Motion
2. The Momentum Principle: Impulse and Momentum Change
3. The Momentum Principle: Non-constant Forces
4. Contact forces and the Momentum Principle

→

Energy

1. The Energy Principle
2. Energy in Macroscopic Systems
3. Energy Quantization
4. Multiparticle Systems
5. Collisions

→

Angular Momentum

1. Angular Momentum of Macroscopic Systems

→

Thermodynamics

1. Entropy: Limits on the Possible
2. Gasses and Engines

Recitation Applications

1. Relativity
2. Asteroid Mass
3. Dark Matter, Black Holes
4. Fission
5. Fusion
6. Driven Harmonic Oscillator
7. Molecules
8. Binary Stars
9. Fusion Revisited
10. Bohr Model of Hydrogen
11. Probabilities
12. Measure of Heat Capacity of Water

Laboratory Experiments

1. Vectors & VPython
2. Motion & Modeling
3. Gravity & Moon Voyage
4. The Spring Ball Model of Matter
5. Modeling Spring oscillations
6. Momentum & Energy of a Bouncing Ball
7. Energy on a Moon Voyage
8. Energy, Power and Internal Energy
9. Real and Point Particle Systems: Spectra
10. Collisions: Rutherford Scattering
11. Angular Momentum, Torques, & Moment of Inertia
12. Entropy & Temperature
13. Heat Capacity

1. COURSE NUMBER AND NAME: PHYS 17200 Modern Mechanics

2. CREDITS AND CONTACT HOURS: 3 credits

- **a.** Lecture – 2 days per week at 50 minutes for 16 weeks
- **b.** Recitation – 1 day per week at 50 minutes for 16 weeks
- **c.** Laboratory – 1 day per week at 100 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

A. Hirsch

4. TEXTBOOK:

R. Chabay and B. Sherwood, *Matter & Interactions – Volume 1 – Modern Mechanics*, 3rd Ed., Wiley.

Lab Manual: *Physics 172 Laboratory Manual, 10th Ed.*

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Introductory calculus-based physics course using fundamental interactions between atoms to describe Newtonian mechanics, conservation laws, energy quantization, entropy, the kinetic theory of gases, and related topics in mechanics and thermodynamics. Emphasis is on using only a few fundamental principles to describe physical phenomena extending from nuclei to galaxies. 3-D graphical simulations and numerical problem solving by computer are employed by the student from the very beginning. Typically offered in fall, spring and summer.

b. Prerequisites:
MA 16100 – Plane Analytic Geometry and Calculus II

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Learn how to understand and *describe a wide range of physical phenomena using only a few fundamental principles of physics*. [A1,A2, A3]
2. Learn a *unified approach* that relates microscopic behavior to macroscopic behavior, such as the combination of *traditional mechanics*, a *modern view of quantized atomic levels* and *statistics* leading to basic thermodynamics from mechanics. [A1,A2, A3]
3. Learn how to apply this unified approach to a broad array of applications including *asteroids*, *black holes*, *nuclear fission and fusion*, *quantization in atoms and molecules*, and *heat capacity*. [A1, A2, A3, A4]
4. Learn to *model* natural phenomena, enabling quantitative studies such as *computer simulations* describing specific physical behaviors using a programming language called *VPython*, with little or no prior programming experience. [A1,A2, A3]
5. Gain experience in team building practice while conducting experiments and solving problems in small groups. [A3, B2]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: S. Durbin **REVISED BY:** H. Nakanishi with instructors of the course **REVISION DATE:** February 22, 2013

B. ME Core Courses

ECE 20100
LINEAR CIRCUIT ANALYSIS I

Course Outcomes [Related ME Program Outcomes in Brackets]

1. An ability to analyze *linear resistive circuits* (A1, A2, A4)
2. An ability to *analyze 1st order linear circuits* with sources and/or passive elements (A1, A2, A4)
3. An ability to *analyze 2nd order linear circuits* with sources and/or passive elements (A1, A2, A4)

DC Analysis

1. Resistive Calculations
   - Ohm's Law
   - Nodal Mesh
   - Mesh Analysis
2. Source-Free Response Calculations
   - RL and RC Circuits
   - RLC circuits
3. Complete Response with Batteries and/or Step Response
   - RL and RC circuits
   - RLC circuits

→

Phasor Analysis

1. Impedance and Admittance Calculations
2. Nodal and Mesh Analysis
3. Sinusoidal Steady-State Calculations
   - RL and RC circuits
   - RLC circuits

→

Network Theorems

1. KVL & KCL (Resistive and Phasors)
2. Voltage and Current Division (Resistive and Phasors)
3. Superposition and Linearity (Resistive and Phasors)
4. Source Transformations (Resistive and with L's and C's)
5. Thevenin's and Norton Equivalent Circuits (resistive and in terms of phasors)

→

Power

1. DC & AC Instantaneous
2. Maximum Power Circuits
   - resistive circuits
   - RLC circuits using phasors
3. Average Power
4. Effective Power
5. Complex Power
6. Polyphase Circuits

→

Op Amp Circuits

1. Resistive Only
2. RC Op Amp Circuits excited by Step Inputs
3. Phasor Analysis of RC and RLC Op Amp Circuits

Revision Date: 6/21/2013

1. COURSE NUMBER: ECE 20100 Linear Circuit Analysis I

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

D. Elliott

4. TEXTBOOK: *Linear Circuit Analysis:* Time Domain, Phasor, and Laplace Transform Approaches, 3rd Edition, R. DeCarlo and P. M. Lin, Kendall Hunt, ISBN No. 9780757564994, 2009.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Volt-ampere characteristics for circuit elements; independent and dependent sources; Kirchhoff's laws and circuit equations. Source transformation; Thevenin's and Norton's theorems; superposition. Step response of 1st order (RC, RL) and 2nd order (RLC) circuits. Phasor anlaysis, impedance calculations and computation of sinusoidal steady state responses. Instantaneous and average power, complex power, power factor correction, and maximum power transfer. Instantaneous and average power.

b. Prerequisites:

ENGR 13100 – Transforming Ideas to Innovation I
MA 26100 – Multivariate Calculus

c. Status:

Required

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes: [Related ME Program Outcomes in Brackets]

1. An ability to analyze *linear resistive circuits* (A1, A2, A4)
2. An ability to *analyze 1st order linear circuits* with sources and/or passive elements (A1, A2, A4)
3. An ability to *analyze 2nd order linear circuits* with sources and/or passive elements (A1, A2, A4)

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: D. Elliott

REVISION DATE: June 21, 2013

ECE 20700
ELECTRONIC MEASUREMENT TECHNIQUES

Course Outcomes

1. An ability to competently *operate basic laboratory equipment* (A4)
2. An ability to make *voltage, current, impedance, transient, and frequency response measurements* (A4).
3. An ability *to layout, wire and troubleshoot electronic circuits*. (A2,A4)
4. An ability to *design operational amplifier circuits* from a set of specifications. (A1, A2, A3, A4, A5)
5. An ability to *keep a laboratory notebook* and *prepare a formal laboratory report*. (B1)

Laboratory Equipment
(3 wks)

1. Oscilloscopes
2. Ohmmeters
3. Voltmeters

Circuit Elements
(6 wks)

1. Follower Circuit
2. Summing Amplifier
3. Integrator
4. Simple op-amp circuits
5. Op-amp equations

Circuit Analysis
(6 wks)

1. Step response and time constant measurement
2. AC bridge circuit
3. Frequency response measurements
4. Filter design

1. COURSE NUMBER AND NAME: ECE 20700 Electronic Measurement Techniques

2. CREDITS AND CONTACT HOURS: 1 credit

a. Laboratory – 1 day per week at 150 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

B.F. Robinson

4. TEXTBOOK:

Class Notes

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Experimental exercises in use of laboratory instruments. Voltage, current, impedance, frequency and waveform measurements. Frequency and transient response. Elements of circuit modeling and design.

b. Prerequisites:
ECE 20100 – Linear Circuit Analysis I
(may be taken concurrently)

c. Status:
Required

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes: [Related ME Program Outcomes in Brackets]

1. An ability to competently *operate basic laboratory equipment* (A4)
2. An ability to make *voltage, current, impedance, transient, and frequency response measurements* (A4).
3. An ability *to layout, wire and troubleshoot electronic circuits*. (A2,A4)
4. An ability to *design operational amplifier circuits* from a set of specifications. (A1, A2, A3, A4, A5)
5. An ability to *keep a laboratory notebook* and *prepare a formal laboratory report*. (B1)

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: B.F. Robinson

REVISION DATE: June 21, 2013

MA 26100*
MULTIVARIATE CALCULUS

Course Outcomes [Related ME Outcomes in Brackets]

1. Students develop the concepts of vector calculus which are needed in the studies of many areas of engineering and science such as dynamics and electromagnetic field theory. These include properties of the gradient of a scalar field, line and surface integration, and Green's Theorem. [A1, A2]
2. Students learn how to apply calculus techniques in elementary problems of optimization in several variables. [A1, A2]

3-D Analytic Geometry

1. Angle Between Two Vectors
2. Scalar Plot
3. Cross Product
4. Planes, Lines, Surfaces
5. Curves in 3-D Space

→

Partial Differentiation

1. Functions of Several Variables
2. Partial Derivatives
3. Differential of a Function of Several Variables
4. Partial Derivatives of a Higher Order
5. Chain Rule
6. Extreme Value Problems
7. Directional Derivatives
8. Gradient
9. Implicit Functions and LaGrange Multipliers

→

Multiple Integrals

1. Double Integrals
2. Iterated Integrals
   - rectangular coordinates
   - polar coordinates
3. Surface Integrals
4. Triple Integrals
   - rectangular coordinates
   - cylindrical coordinates
   - spherical coordinates

→

Integration of Vector Fields

1. Vector Fields
2. Line and Surface Integrals
3. Independence of Path and Potential Functions
4. Green's Theorem
5. Divergence Theorem

*** Equivalent to: MA 17400 (Accelerated option)**
MA 18200 (Honors option – requires MA 18100)

1. COURSE NUMBER AND NAME: MA 26100 Multivariate Calculus

2. CREDITS AND CONTACT HOURS: 4 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks
b. Recitation – 1 day per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

A. Yip, Chair, Calculus Committee

4. TEXTBOOK:

J. Stewart, *Calculus, Early* **3.** *Transcendentals*, Purdue Custom 7th ed. Brooks/Cole Publishing Company, 2012.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Planes, lines, and curves in three dimensions. Differential calculus of several variables; multiple integrals. Introduction to vector calculus. Not open to students with credit in MA 17400 or MA 27100. Typically offered in fall, spring, and summer.

b. Prerequisites:
MA 16200 Plane Analytic Geometry and Calculus II, or
MA 16600 Analytic Geometry and Calculus II

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Students develop the concepts of vector calculus which are needed in the studies of many areas of engineering and science such as dynamics and electromagnetic field theory. These include properties of the gradient of a scalar field, line and surface integration, and Green's Theorem. [A1, A2]
2. Students learn how to apply calculus techniques in elementary problems of optimization in several variables. [A1, A2]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: A. Sa Barreto **REVISION UPDATE:** February 25, 2013

MA 26200
LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS

Course Outcomes [Related ME Program Outcomes in brackets]

1. Students learn the standard methods for solving differential equations as they arise in engineering and science. [A1, A2]
2. Students learn the linear algebra concepts which are needed to solve linear algebraic systems and linear systems of differential equations. [A1, A2]
3. Students obtain the computational skills in matrix theory which are needed in computational linear algebra. [A1, A2]

Differential Equations

1. First-Order Diff. Equations with and without Initial Conditions
   - separable variables
   - exact
   - linear
2. Applications of First-Order Diff. Equations
   - mixture problems
   - growth and decay problems
   - falling bodies
   - electrical circuits
   - orthogonal trajectories
3. Second Order and Higher Diff. Equations with Constant Coefficients
   - undetermined coefficients
   - variation of parameters
   - initial value problems
4. Applications of Second-Order Diff. Equations
   - Newton's 2^{nd} law
   - electrical circuits
   - etc.

Linear Algebra

1. Vector Spaces
   - subspace
   - basis
   - spanning set
   - linear combination
   - linear independence
2. Matrix Operations
   - addition
   - multiplication
   - inverse
   - determinants
3. Row Reduction of Matrices
   - row-echelon normal form
   - rank
4. Systems of Linear Equations
   - solve using matrix methods
   - augmented matrices
   - Cramer's rule
   - solution space
5. Complex Numbers, Polar Representation, Roots of Complex Numbers
6. Eigenvalues and Eigenvectors

Systems of Differential Equations

1. Matrix Formulation
2. Solutions for Linear Equations
   - constant coefficient using eigenvalues and eigenvectors
3. Variation of Parameters

1. COURSE NUMBER AND TITLE: MA 26200 Linear Algebra and Differential Equations

2. CREDITS AND CONTACT HOURS: 4 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

b. Recitation – 1 day per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

A. Yip, Chair, Calculus Committee

4. TEXTBOOK:

S. Goode, S. Annin *Differential Equations and Linear Algebra*, 3rd ed., Prentice Hall, 2008.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Planes, lines, and curves in three dimensions. Differential calculus of several variables; multiple integrals. Introduction to vector calculus. Not open to students with credit in MA 17400 or MA 27100.

b. Prerequisites:
MA 26100 Multivariate Calculus

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Students learn the standard methods for solving differential equations as they arise in engineering and science. [A1, A2]
2. Students learn the linear algebra concepts which are needed to solve linear algebraic systems and linear systems of differential equations. [A1, A2]
3. Students obtain the computational skills in matrix theory which are needed in computational linear algebra. [A1, A2]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page

PREPARED BY: A. Sa Barreto

REVISION UPDATE: February 25, 2013

MA 30300
DIFFERENTIAL EQUATIONS AND PARTIAL DIFFERENTIAL EQUATIONS FOR ENGINEERING AND THE SCIENCES

Course Outcomes [Related ME Program Outcomes in brackets]

1. Students are introduced to more advanced techniques for solving differential equations and systems. These include series solutions and applications to Bessel's equation. [A1, A2]
2. Students use Laplace transform methods to solve differential equations. [A1, A2]
3. Students are introduced to Fourier series and learn how to apply the theory to solving partial differential equations. [A1, A2]
4. Students learn how to use standard numerical methods to solve differential equations. [A1, A2]

Methods

1. Power Series
2. Numerical Methods
3. Laplace Transforms
4. Fourier Series

→

Ordinary Differential Equations

1. Solving by Power Series (ordinary and regular singular points, Bessel functions)
2. Solving by Laplace Transforms
3. Solving Numerically
4. Solving Linear Systems

→

Partial Differential Equations

1. Separation of Variables
2. Heat Equation
3. Wave Equation
4. Laplace Equation

1. COURSE NUMBER AND NAME: MA 30300 Differential Equations and Partial Differential Equations for Engineering and the Sciences

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

b. Recitation – 1 day per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

P. Stefanov, Chair, Advanced Services Committee

4. TEXTBOOK:

Boyce and DiPrima, *Elementary Differential Equations and Boundary Value Problems*, 10^{th} ed., Wiley, 2012

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description This is a methods course for juniors in any branch of engineering and science, designed to follow MA 26200. Basic techniques for solving systems of linear ordinary differential equations. Series solutions for second order equations, including Bessel functions, Laplace transform, Fourier series, numerical methods, separation of variables for partial differential equations and Sturm-Louisville theory. Not open to students with credit in MA 30400. Typically offered in fall, spring and summer.

b. Prerequisites:

MA 26200 Linear Algebra and Differential Equations, or
MA 27200 Differential Equations and Linear Algebra, or
MA26500 Linear Algebra and MA26600 Ordinary Differential Equations.

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Students are introduced to more advanced techniques for solving differential equations and systems. These include series solutions and applications to Bessel's equation. [A1, A2]
2. Students use Laplace transform methods to solve differential equations. A1, A2]
3. Students are introduced to Fourier series and learn how to apply the theory to solving partial differential equations. [A1, A2]
4. Students learn how to use standard numerical methods to solve differential equations. [A1, A2]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

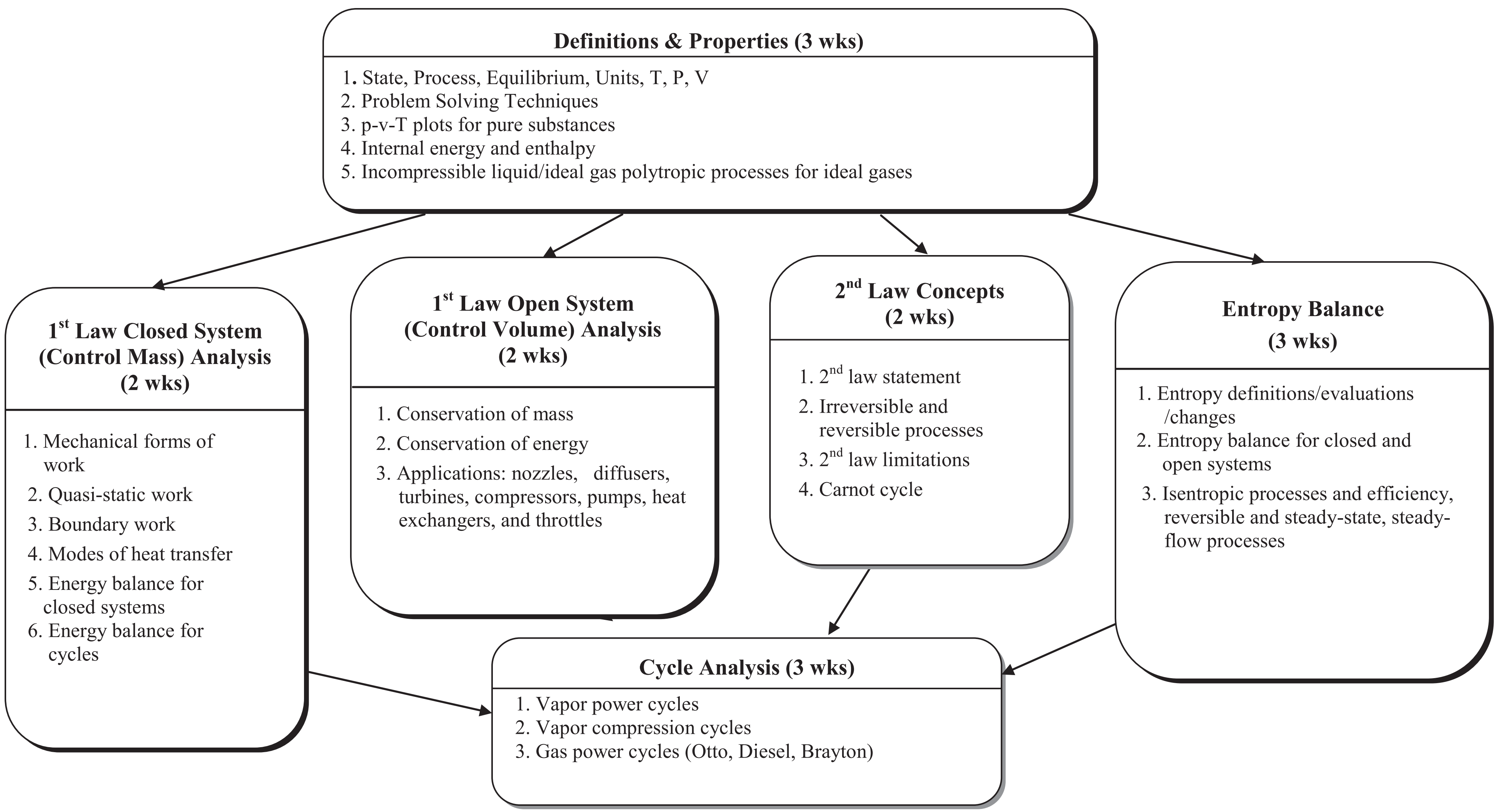
PREPARED BY: A. Sa Barreto

REVISION UPDATE: February 25, 2013

ME 20000
THERMODYNAMICS I

Course Outcomes [Related ME Program Outcomes in brackets]

1. Provide a thorough understanding of the *basic concepts* of thermodynamics, (i.e., 1st and 2nd law). [A1, A2]
2. Apply the basic concepts of thermodynamics to the solution of *practical problems*. [A1, A2]
3. Develop a systematic approach to *problem-solving* skills. [A2, B1]



1. COURSE NUMBER AND NAME: ME 20000 Thermodynamics I

2. CREDITS AND CONTACT HOURS:

a. Lecture - 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

E.A. Groll

4. TEXTBOOK:

M. J. Moran, H.N. Shapiro, D. D. Boettner, and M. B. Bailey, *Fundamentals of Engineering Thermodynamics*, 7th ed, John Wiley and Sons, Inc., 2011.

Other Supplemental Material: None

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: First and second laws, entropy, reversible and irreversible processes, properties of pure substance. Application to engineering problems. Typically offered in fall, spring and summer.

b. Prerequisites

CHM 11500 – General Chemistry

Concurrent Prerequisites

MA 26100 Multivariate Calculus

ENGR 13200 Ideas to Innovation II

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in brackets]

1. Provide a thorough understanding of the *basic concepts of thermodynamics* (i.e., 1st and 2nd law). [A1, A2]
2. Apply the basic concepts of thermodynamics to the solution of *practical problems in a social context*. [A1, A2]
3. Develop a systematic approach to *problem-solving skills*. [A2, B1]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: E.A. Groll

REVISION DATE: June 1, 2013

ME 26300
INTRODUCTION TO MECHANICAL ENGINEERING DESIGN, INNOVATION, AND ENTREPRENEURSHIP

Course Outcomes [Related ME Program Outcomes in brackets]

1. Instill the philosophy that real engineering design problems are open-ended and multifaceted. [A5, A6]
2. Teach a systemic design methodology. [A5, A6, C2]
3. Provide guidance in applying engineering principles to open-ended problems. [A1, A2, A5, A6]
4. Develop the ability to mathematically model and analyze engineering systems. [A2, A4]
5. Sharpen skills in leadership, teamwork, communication, project planning, innovation, design and entrepreneurship. [A5, B1, B2, B3, B5, C1, C2, C3, C4]
6. Instill a philosophy of professional and ethical behavior. [B3]
7. Provide a foundation for the rest of the mechanical engineering curriculum and future careers. [B5]

Phase I: Problem Definition (4.5 wks)

1. Problem Statement
2. Customer Survey
3. Competitive Product Study (Benchmarking)
4. Market Analysis
5. Patent/Periodical Search
6. Quality Function Deployment (HOQ)
7. Problem Definition
8. Design Review

→

Phase II: Concept Generation and Evaluation (4.5 wks)

1. Functional Decomposition
2. Brainstorming
3. Preliminary Concept Evaluations:Feasibility Judgment, Technology Readiness Assessment, Decision Matrix
4. Concept Selection
5. Engineering Modeling of Concepts
6. Comparison with Benchmarks
7. Design Review

→

Phase III: Product Design (6 wks)

1. Selection Design
2. Bill of Materials
3. Assembly/Parts CAD Modeling
4. Manufacturing Processes
5. Performance Analyses
6. Assembly Analysis
7. Economic Analysis
8. Final Design Presentation

→

Example Projects

1. Personal Transportation Systems
2. Assistive Devices in Multi-Level Apartments
3. Personal Exercise Machines
4. Personal Power Generation
5. Roof Rack Loading Devices
6. Hitch/Receiver Mounting Accessories

1. COURSE NUMBER AND NAME: ME 26300 Introduction to Mechanical Engineering Design, Innovation and Entrepreneurship

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture - 2 days per week at 50 minutes for 15 weeks

b. Lab – 2 days per week at 110 and 50 minutes for 15 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

D. C. Anderson

4. TEXTBOOK:

The Mechanical Design Process, D. G. Ullman, Fourth Edition, McGraw-Hill, 2010.

Other Supplemental Material: Purchased notes packet

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: The product design process. Development of product design specifications using customer inputs, benchmarking, product/ market research and patent review. Concept generation and evaluation using brainstorming, functional decomposition, modeling and decision matrices. Detailed product design including assembly, economic analysis, CAD, and bill of materials. Oral and written design reviews. Key skills developed include leadership, teamwork, communication, project planning, innovation, design, and entrepreneurship. Typically offered Fall Spring.

b. Prerequisites – ME 20000 Thermo. I, ME 27000 Basic Mech. I or CE27100; COM 11400 or COM C1100; ENGL 10600 or ENGL 10800; ENGR 12600 or ENGR 10600 or ENGR 12600 or ENGR 10600 or ENGR 12100; CGT 16300

Concurrent Prerequisites – MA 26200 – Linear Algebra and Differential Equations, ME 29000 – Global Engineering Professional Seminar

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in brackets]

1. Instill the *philosophy* that real engineering design problems are open-ended and multifaceted. [A5, A6]
2. Teach a *systematic design methodology*. [A5, A6, C2]
3. Providence *guidance* in applying engineering principles to open-ended problems. [A1, A2, A5, A6]
4. Develop the ability to *mathematically model* and *analyze* engineering systems. [A2, A4]
5. Foster key skills in *leadership*, *teamwork*, *communication*, *project planning*, *innovation*, *design* and *entrepreneurship*. [A6, B1, B2, B3, B5, C1, C2, C3, C4]
6. Instill a philosophy of *professional* and *ethical behavior*. [B3]
7. Provide a *foundation* for the rest of the mechanical engineering curriculum and future careers. [B5]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: D. C. Anderson

REVISION DATE: June 20, 2012

ME 27000
BASIC MECHANICS I

Course Outcomes [Related ME Program Outcomes in brackets]

1. Develop an understanding of *static equilibrium* and *stresses in statically determinate structures* and how to apply them to engineering systems. [A1, A2]
2. Learn a systematic approach to *problem solving*. [A2]
3. Foster effective mathematical and graphical *communication skills*. [B1]

Statics of Rigid Bodies (9 wks)

Fundamentals (2 wks)

1. Newton's Laws
2. Vector algebra; vector components
3. Position, unit and force vectors
4. Dot product
5. Cross product
6. Moment of a force about a point
7. Moment of a force about a line

Static Equilibrium (5 wks)

1. Equilibrium of a particle
2. Support reactions and free body diagrams
3. Static indeterminacy and partial constraints
4. 2-D and 3-D static equilibrium
5. Trusses
   - method of joints
   - method of sections
6. Frames and machines
7. Dry friction
   - Coulomb's Laws
   - Systems with friction
   - Sliding or tipping
   - Wedges

Equivalent Systems (2 wks)

1. Determination of the resultant of concurrent forces
2. Equivalent force/couple systems
3. Centroid and center of mass
   - by composite parts
   - by integration
4. Surface loadings
   - line loads
   - pressure distributions
5. Fluid statics
   - rectangular surfaces

Stresses in Statically-Determinate Structures (6 wks)

Introduction of Stress and Strain in Materials (1 wk)

1. Basic definitions of stress and strain
2. Mechanical properties of materials
3. Shear stress and strain

Stress Analysis (5 wks)

1. Stress due to axial loading
2. Shear stress due to torsion
3. Shear force and moment diagrams
4. Second area moments for beams
5. Flexural and shear stresses in beams
6. Stress analysis of beams

1. COURSE NUMBER AND NAME: ME 27000 Basic Mechanics I

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

J.D. Jones

4. TEXTBOOK: Printed Course Notes

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Fundamental concepts of mechanics: vector operations, forces and couples, free body diagrams, equilibrium of a particle and of rigid bodies. Friction. Distributed forces. Centers of gravity and centroids. First and second moments of areas, lines and volumes. Stress analysis of statically-determinate structures. Applications from structural and machine elements such as bars, trusses and friction devices. Typically offered in fall, spring, and summer.

b. Prerequisites:

PHYS 17200 – Modern Mechanics
MA 16600 – Analytical Geometry & Calculus II or equivalent

Concurrent Prerequisites:

MA 26100 – Multivariate Calculus
ENGR 13200 – Transform Ideas to Innovation II

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Develop an understanding of *static equilibrium* and *stresses in statically determinate structures* and how to apply them to engineering systems. [A1, A2]
2. Learn a systematic approach to *problem solving*. [A2]
3. Foster effective mathematical and graphical *communication skills*. [B1]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: J.D. Jones

REVISION DATE: January 2013

ME 27400
BASIC MECHANICS II

Course Outcomes [Related ME Program Outcomes in brackets]

1. Develop an understanding of *Newton's Laws of Motion* and how to apply them to engineering systems. [A1, A2]
2. Develop an understanding of *conservation principles* (work-energy, linear impulse-momentum and angular impulse-momentum). [A1, A2]
3. Introduce methods to model and evaluate the response of *2nd order linear mechanical systems*. [A1, A2]
4. Develop a systematic approach to *problem solving*. [A2]

Particle Dynamics (5 wks) → **Rigid Bodies In Planar Motion (6 wks)** → **3 – D Motion (2 wks)**

Particle Dynamics (5 wks)

Kinematics (2 wks)

1. Cartesian Coordinates
2. Path Variables
3. Cylindrical Coordinates
4. Relative Motion
5. Cable-Pulley Systems

Kinetics (3 wks)

1. Newton's Laws
   - Rectilinear Motion
   - Curvilinear Motion
2. Work and Energy
3. Linear Impulse Momentum
4. Central Inpact
   - Coefficient of Restitution
   - Linear Momentum
5. Angular Impulse-Momentum

Rigid Bodies In Planar Motion (6 wks)

Kinematics (2.3 wks)

1. Velocity Relations
2. Instant Centers
3. Acceleration Relations

Kinetics (3.7 wks)

1. Newton-Euler Equations
2. Work & Energy
3. Impulse-Momentum

3 – D Motion (2 wks)

Kinematics (Moving Reference Frame) (2 wks)

1. Angular Velocity
2. Angular Acceleration
3. Velocity Relations
4. Acceleration Relations

Special Topic: Vibrations (2 wks)

1. Drawing Free Body Diagrams
2. Deriving Equations of Motion
3. Free Response
4. Forced Response
   - homogeneous + particular
   - harmonic input

1. COURSE NUMBER AND NAME : ME 27400 Basic Mechanics II

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

C.M. Krousgrill

4. TEXTBOOK: Class Notes

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Review and extension of particle motion to include energy and momentum principles. Planar kinetics of rigid bodies. Kinetics for planar motion of rigid bodies including equations of motion and principles of energy and momentum. Introduction to three-dimensional kinematics of rigid bodies. Introduction to linear vibrations with emphasis on single-degree-of-freedom systems. Typically offered in fall, spring and summer.

b. Prerequisites:
ME 27000 – Basic Mechanics I or equivalent and
ENGR 13200 – Transform Ideas to Innovation II

Concurrent Pre-requisites:
MA 26200 – Linear Algebra and Differential Equations or
MA 26600 – Ordinary Differential Equations

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Develop an understanding of *Newton's Laws of Motion* and how to apply them to engineering systems. [A1, A2]
2. Develop an understanding of *conservation principles* (work-energy, impulse-momentum and angular impulse-momentum). [A1, A2]
3. Introduce methods to model and evaluate the response of 2nd *order linear mechanical systems*. [A1, A2]
4. Develop a systematic approach to *problem solving*. [A2]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals; B3. Prof/Ethical Responsibility;
A2. Analytical Skills; B4. Contemporary Issues;
A3. Experimental Skills; B5. Life-Long Learning;
A4. Modern Engr Tools; C1. Leadership,
A5. Design Skills; C2. Global Engineering Skills;
A6. Impact of Engr Solns; C3. Innovation;
B1. Communication Skills; C4. Entrepreneurship
B2. Teamwork Skills

7. LIST OF TOPICS: See following page.

PREPARED BY: C.M. Krousgrill

REVISION DATE: January 2013

ME 29000
Global Engineering
Professional Seminar

Course Outcomes [Related ME Program Outcomes in Brackets]

1. Provide a solid foundation in *global engineering skills*. [B1, B2, B4, C1, C2]
2. Introduce the *global engineering community* and encourage active involvement with *professional associations* such as ASME and SAE to develop teamwork and leadership skills. [B1, B2, B5, C1, C2]
3. Explore the *ME Curriculum* and identify resources available for planning academic a program including global literacies (language and area studies) and for obtaining diverse *industrial experience appropriate for developing global competencies*. [B1, B2, B4, C1, C2]
4. Support the development of a strong *ethical framework for global professional workplace* as a responsible member of the global engineering community. [B2, C1, C2]

Global Communication Skills

1. Professional presentation of engineering interests and credentials;
2. Competency with digital media for diverse and distant audiences.
3. Knowledge of cultural differences.
4. Strategies for collaborating across cultural boundaries.

Global Professional Engineering Opportunities

1. Industry speakers representing a range of ME global career paths.
2. Curricular resources for language area studies; options for diploma endorsement, "Global Engineering Studies Minor."
3. Professional association representatives (e.g., ASME, SAE).

Global Professional and Ethical Issues

1. Code of Ethics of Engineers.
2. Ethical reasoning frameworks.
3. Ethical practices: case studies.
4. Guidelines for Professional Conduct.
5. Ethical approaches to cultural differences.

Capable Global Professionals

Skilled global communicators committed to professional and ethical leadership in the global engineering community. [B1, B2, B3, B4, C1, C2]

1. COURSE NUMBER & COURSE TITLE : ME 29000 Global Engineering Professional Seminar

2. CREDITS AND CONTACT HOURS: 1 credit

a. Lecture – 1 day per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

D.L. Atkinson

J.D. Jones

4. TEXTBOOK:

The Post-American World, 2nd ed., Zakaria

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Forum on contemporary issues in the global profession of mechanical engineering. Professionalism and ethics. Interactions with engineering faculty and with professionals outside the University. Quizzes on assigned readings in the areas of globalization, cultural difference and collaborating across cultural boundaries. Individually developed professional profiles describe technical interests and convey awareness of ethical responsibilities in global context. Typically offered in fall and spring.

b. Prerequisites:
COM 11400
ENGL 10100, 10200, 10300, 10600, or 10800,
Mechanical Engineering Majors Only

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Provide a solid foundation in *global engineering skills*. [B1, B2, B4, C1, C2]
2. Introduce the in *global engineering community* and encourage active involvement with *professional associations* such as ASME and SAE to develop teamwork and leadership skills. [B1, B2, B5, C1, C2]
3. Explore the *ME Curriculum* and identify resources available for planning academic a program including global literacies (language and area studies) and for obtaining diverse *industrial experience appropriate for developing global competencies*. [B1, B2, B4, C1, C2]
4. Support the development of a strong *ethical framework for global professional workplace*, including an appreciation for cultural differences, as a responsible member of the global engineering community. [B2, C1, C2].

b. Related ME Program Outcomes
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: D.L. Atkinson

DATE: March 1, 2013

ME 30000
THERMODYNAMICS II

Course Outcomes [Related ME Program Outcomes in Brackets]

1. Provide a thorough understanding of the *applications* of classical thermodynamics to practical problems. Applications include refrigeration and air conditioning, reciprocating engines, gas turbine engines, and power plants. [A2, A3]
2. Introduce the *new concepts* of transient energy analysis, availability analysis and generalized property relations. [A2, A3]
3. Provide an introductory treatment of thermodynamics for an *expanded range of fluids* including gas mixtures, real gases, and reacting flows. [A2, A3]
4. Provide limited *design experiences* for systems requiring significant consideration of thermodynamics. [A3]

Review (1 wk)

1. Properties
2. First and Second Law

First and Second Law Analyses (2 wks)

1. Transient Analysis
2. Irreversibility
3. Availability Analysis

Mixture Properties (2.7 wks)

1. Ideal Gas Mixtures
2. Mixture Properties
3. Gas–Vapor Mixtures
4. Air Conditioning Processes
5. Thermodynamic Relations

Combustion Analyses (3.3wks)

1. Stoichiometry of Reactions
2. Actual Combustion
3. Energy Analysis
4. Adiabatic Flame Temperature
5. Equilibrium Criteria
6. Chemical Potential
7. Equilibrium Constant
8. Equilibrium Composition
9. Equilibrium Calculations

Typical Applied Problems (5 – 6 per semester)

1. Psychrometric Applications (e.g., Buildings, Swimming Pools, etc.)
2. Design and Efficiencies of
   - Cogeneration Plants
   - Combined Power Plants
   - Industrial or Residential Furnaces
3. Emission Analysis of Industrial or Residential Furnaces

Gas Power Cycles (3 wks)

1. Air Standard Cycles
2. Otto, Diesel, Dual Cycles
3. Brayton Cycle
4. Regeneration
5. Multi-Staging
6. Intercooling
7. Reheating
8. Aircraft Gas Turbines

Vapor Power Cycles (1.7 wks)

1. Rankine Cycle
2. Reheat Cycle
3. Regeneration
4. Co-generation
5. Combined Cycles

Vapor Compression Cycles (1.3 wks)

1. Vapor Compression Cooling
2. Heat Pumps
3. Multi-Staging
4. Alternative Refrigeration Cycles

1. COURSE NUMBER AND NAME: ME 30000 Thermodynamics II

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

E.A. Groll

4. TEXTBOOK:

M.J. Moran and H.M. Shapiro, Fundamentals of Engineering Thermodynamics, 6th ed, Wiley, 2007.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Properties of gas mixtures, air-vapor mixtures, applications. Thermodynamics of combustion processes, equilibrium. Energy conversion, power, and refrigeration systems. Typically offered in fall and spring.

b. Prerequisites:

ME 20000 – Thermodynamics I
ME 26300 Introduction to Mechanical Engineering Design, Innovation and Entrepreneurship

c. Status: Restricted Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Provide a thorough understanding of applications of classical thermodynamics to practical problems. Applications include refrigeration and air conditioning, reciprocating engines, gas turbine engines, and power plants. [A2, A3]
2. Introduce the new concepts of transient energy analysis, availability analysis and generalized property relations. [A2, A3]
3. Provide an introductory treatment of thermodynamics for an *expanded range of fluids* including gas mixtures, real gases, and reacting flows. [A2, A3]
4. Provide limited design experiences for systems requiring significant consideration of thermodynamics. [A3]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: E.A. Groll

REVISION DATE: July 02, 2012

ME 30900
FLUID MECHANICS

Course Outcomes [Related ME Program Outcomes in brackets]

1. Develop the ability to identify and classify the various *types of flows* one may encounter. [A1, A2]
2. Develop (from first principles) the *control volume formulation* of the basic laws with emphasis on conservation of mass and Newton's 2^{nd} law. [A1, A2, A3]
3. Apply the control volume formulation of the basic laws to *model physical systems*. [A2, A3, A4, A5]
4. Conduct *simple experiments* and analyze data [A3, A4, B1]
5. Enhance systematic *problem solving skills* and sharpen *written communication skills* through short technical laboratory reports. [A4, B2, B3]

Fundamental Concepts (2.0 wks)

1. System, control volume (CV), basic laws for system
2. Pressure, density, manometry
3. Fluid statics, buoyancy
4. Flow visualization, Eulerian & Lagrangian descriptions
5. Stress, Newtonian fluid, viscosity

Dimensional Analysis and Similitude (1.0 wks)

1. Determining Dimensionless Groups
   - Buckingham Pi Theorem
   - Non-dimensionalizing basic differential equations
2. Flow Similarity and Model Studies

Basic Equations (3.3wks)

1. Relation of system derivatives to Control Volume formulation
2. Integral form for Control Volume (CV)
   - conservation of mass
   - momentum equation (inertial, differential and linearly accelerating CVs
   - angular momentum, first law of thermodynamics
3. Differential Analysis of Fluid Motion
   - conservation of mas
   - acceleration of fluid element
   - Navier-Stokes equations

Compressible Flow (3.0 wks)

1. Review thermodynamics of an ideal gas
2. Speed of sound, Mach cone
3. Stagnation and sonic conditions
4. Isentropic flow: converging, converging-diverging nozzle
5. Stationary normal shocks
6. Flow in converging-diverging nozzles

Incompressible Flow (5.7 wks)

1. Inviscid
   - Euler's equations in streamline system
   - Bernoulli equation
2. Viscous Flow
   - Internal
     - fully developed laminar flow
     - flow in pipes and ducts
     - fluid machinery, system performance
   - Flow Measurement
   - External
     - boundary layer
     - flow about immersed bodies
     - lift and drag

Representative Laboratory Experiments

1. Flow pattern study
2. Reynold's experiment
3. Draining of a tank
4. Momentum study: Force on an elbow
5. Momentum study: Force of a jet on a flat plate
6. Wind tunnel air speed measurements
7. Radial flow between parallel disks
8. Velocity profile in pipe flow
9. Pipe friction
10. Boundary layer study
11. Pressure drag on a cylinder
12. Drag coefficient of a disk
13. Pump calibration
14. Compressible flow

1. COURSE NUMBER AND NAME: ME 30900 Fluid Mechanics

2. CREDITS AND CONTACT HOURS: 4 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

b. Laboratory Prep – 1 day per week at 50 minutes for 16 weeks

c. Laboratory – 1 day per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

C. Wassgren & S. Wereley

4. TEXTBOOK:

Pritchard, P.J., *Fox and McDonald's Introduction to Fluid Mechanics*, 8th ed., Wiley & Sons.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Continuum, velocity field, fluid statics, manometers, basic conservation laws for systems and control volumes, dimensional analysis. Euler and Bernoulli equations, viscous flows, boundary layers, flow in channels and around submerged bodies, one-dimensional gas dynamics, turbomachinery. Typically offered in fall and spring.

b. Prerequisites:

ME 20000 – Thermodynamics I
ME 26300 – Introduction to Mechanical Engineering Design, Innovation, and Entrepreneurship
ME 27400 – Basic Mechanics II
MA 26200 – Linear Algebra and Differential Equations

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Develop the ability to identify and classify the various types of flows one may encounter. [A1, A2]
2. Develop (from first principles) the control volume formulation of the basic laws with emphasis on conservation of mass and Newton's 2^{nd} law. [A1, A2, A3]
3. Apply the control formulation of the basic laws to model physical systems. [A2, A3, A4, A5]
4. Conduct simple experiments and analyze data. [A3, A4, B1]
5. Enhance systematic problem solving skills and sharpen written communication skills through short technical laboratory reports. [A4, B2, B3]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: J. Chen

REVISION DATE: Jan 18, 2013

ME 31500
HEAT AND MASS TRANSFER

Course Outcomes [Related ME Program Outcomes in brackets]

1. Develop the ability to identify the relevant *transport processes* (heat, momentum and energy) when confronted with a particular problem. [A2, A3]
2. Develop the ability to *model* and *analyze* heat and mass transfer processes. [A2, A3, A5, B2, B4, B5]
3. Augment the ability to *design* and *conduct experiments* to solve open-ended engineering problems. [A4, A7, C1, C3, C6]
4. Reinforce technical *written and oral communication skills* through a formal project report. [B2, B3]

Thermodynamics & Fluid Mechanics Fundamentals (1.5 wks)

Conservation Laws (mass, momentum, energy), Boundary Layer Concept, Velocity Distribution, Laminar and Turbulent Flows, Friction Factor, Pressure Difference, Head Loss, etc.

Heat & Mass Transfer Fundamentals (1.5 wks)

Rate Equations (Fourier's Law, Newton's Law of Cooling, Stefan-Boltzmann Law, Planck's Law, Fick's Law)

Conduction Heat Transfer (4 wks)

1. Introduction, Rate Equations
2. Rate Equations Combined with Conservation Equations*
3. Introduction to Conduction, Generalized Transient Conduction Relationships*
4. 1D Steady State Conduction, Thermal Resistance
5. Radial Conduction
6. Thermal Generation
7. Extended Surfaces*
8. 2D Steady State Conduction
9. Finite Difference Method (steady state)
10. Transient Conduction-Lumped Capacitance
11. Analytical Results (wall, cylinder, sphere, semi-infinite case)
12. Finite Difference Method (transient)

Convection Heat & Mass Transfer (4 wks)

1. The Convection Transfer Problem (local & average coefficients)
2. Convection Equations
3. Dimensionless Forms, Dimensionless Parameters, Similarity
4. Heat-Mass Analogy*
5. External Flow (flat plate*, cylinder, etc.)
6. Internal Flow
7. Free Convection
8. Two-Phase Heat Transfer (boiling & condensation)
9. Heat Exchangers (LMTD and NTU methods)

Radiation Heat Transfer (4 wks)

1. Thermal Radiation, Spatial & Spectral Effects
2. Energy Balances Incorporating Emission, Absorption & Transmission
3. Blackbody Emission
4. Real Surface Emission
5. Isothermal Enclosure, Kirchhoff's Law
6. Gray and Non-Gray Surfaces plus Environmental Radiation
7. View Factor
8. Blackbody Radiation Exchange
9. Diffuse-Gray Surface Radiation Exchange
10. Multimode Processes Involving Radiation

Semester Project (8 wk duration) – Typical Projects

- Windshield Defogger
- Heat Exchanger
- Heat Sink
- Pizza Bag
- Jet Impingment
- Dimmer Switch (Overheating)
- Silicon Wafer
- Thermal Conductivity
- Dynamic Braking

1. COURSE NUMBER AND NAME: ME 31500 Heat and Mass Transfer

2. CREDITS AND CONTACT HOURS: 4 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

b. Laboratory – 1 day per week at 100 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

T. Fisher

4. TEXTBOOK:

T. Bergman, A.S. Lavine, F.P. Incropera, D.P. DeWitt, *Fundamentals of Heat and Mass Transfer*, 7th ed, Wiley, 2011.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Fundamentals of heat transfer by conduction, convection, and radiation; mass transfer by convection. Relevance to engineering applications. Typically offered in fall and spring.

b. Prerequisites:
ME 30900 – Fluid Mechanics
ME 36500 – Systems and Measurements

Co-Requisites:
MA 30300 Differential Eqns and Partial Differential Eqns for Engineering and the Sciences

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Develop the ability to identify the relevant *transport processes* (heat, momentum and energy) when confronted with a particular problem. [A2, A3]
2. Develop the ability to *model* and *analyze* heat and mass transfer processes. [A2, A3, A5, B2, B4, B5]
3. Augment the ability to *design* and *conduct experiments* to solve open-ended engineering problems. [A4, A7, C1, C3, C6]
4. Reinforce technical *written* and *oral communication* skills through a formal project report. [B2, B3]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: T. Fisher

REVISION DATE: June 10, 2012

ME 32300
MECHANICS OF MATERIALS

Course Outcomes [Related ME Program Outcomes in brackets]

1. Introduce concepts of *stress*, *strain, failure* and *strain energy*. [A1, A2]
2. Learn how to analyze structures under *axial* and *torsional* loading. [A1, A2]
3. Learn how to analyze stresses and deflections of beam structures experiencing a combination of internal *transverse shear* and *bending moment*. [A1, A2]
4. Learn how to analyze structures experiencing *combined loads* and *characterize multiaxial stress states*. [A1, A2]
5. Learn how to analyze *buckling*. [A1, A2]
6. Reinforce a systematic approach to *problem solving*. [A1, A2]
7. Foster effective mathematical and graphical *communication skills*. [B1]
8. Cultivate *ethical engineering decisions*. [B3]

Fundamentals (2 wks)

1. Normal Stress and Strain
2. Mechanical Properties
3. Shear Stress and Strain
4. Design of Deformable Bodies

→

Axial Loading (2 wks)

1. Thermal Stress
2. Planar Trusses
3. Axial Deformation
4. Statically Undetermined Problems

→

Torsion (1 wk)

1. Torsional Loading
2. Torsional Deformation
3. Statically Undetermined Problems

→

Beam Loading (4 wks)

1. Equilibrium of Beams
2. Shear Force
3. Bending Moments
4. Flexural Stresses
5. Shear Stresses
6. Beam Deflection
7. Discontinuity Functions
8. Superposition
9. Statically Undetermined Probs.

→

Multiaxial Stress States (3 wks)

1. Transformation of Stresses
2. Principal Stresses and Max. Shear Stress
3. Mohr's Circle
4. Absolute Max. Shear Stress
5. Stress Transformation
6. Strain energy
7. Failure Criteria

→

Analysis of Structures (3 wks)

1. Pressure Vessels
2. Beams
3. Combined Loading
4. Buckling

1. COURSE NUMBER AND NAME: ME 32300 Mechanics of Materials

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

T. Siegmund

4. TEXTBOOK:

R.R. Craig Jr., *Mechanics of Materials*, 3rd ed, Wiley 2011

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Integrated approach to mechanics of materials. Topics include: stress and strain in structural elements; mechanical properties of materials; extension; torsion and bending of members; thermal stress; pressure vessels; static indeterminacy, stress transformation, Mohr's circle, strain energy, failure criteria, buckling. Typically offered in fall and spring.

b. Prerequisites:

ME 27000 – Basic Mechanics I or equivalent

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Introduce concepts of stress, strain, failure and strain energy. [A1, A2]
2. Learn how to analyze structures under axial and torsional loading conditions. [A1, A2]
3. Learn how to analyze stresses and deflections of beams experiencing a combination of internal transverse shear and bending moment. [A1, A2]
4. Learn how to analyze structures experiencing combined loads and characterize multiaxial stress rates. [A1, A2]
5. Learn how to analyze buckling. [A1, A2]
6. Reinforce a systematic approach to problem solving. [A1, A2]
7. Foster effective mathematical and graphical communication skills. [B1]
8. Cultivate ethical engineering decisions. [B3]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: T. Siegmund

REVISION DATE: January 2013

ME 35200
MACHINE DESIGN I

Course Outcomes [Related ME Program Outcomes in brackets]

1. Understand the fundamental *kinematics of machines*. [A2, A3]
2. Understand the fundamental *kinetics of machines*. [A2, A3]
3. Understand the fundamentals of *stress analysis* of machine components. [A2, A3]
4. Understand the fundamentals of *static failure theories* for machine components. [A2, A3]
5. Enhance *problem-solving* and *communication* skills via brief reports and formal design projects. [A2, A3, A5, A7, B1, B3]

Kinematics of Machines (6 wks)

1. Synthesis
2. Vector Loops
3. Position Analysis
4. Velocity Analysis
5. Acceleration Analysis
6. Point Path, Path Curvature
7. Rolling Contact
8. Instant Centers of Velocity
9. Cam Design

Typical Projects on Kinematics

- Synthesis of a reclining chair mechanism
- Analysis of a geared five-bar mechanism
- Design a cam-follower system

Kinetics of Machines (6 wks)

1. Dynamic Force Analysis
2. Static Force Analysis
3. Graphical Methods
4. Effects of Friction
5. Buckling
6. Shaking Forces
7. Dynamically Equivalent System
8. Engine Balancing
9. Equation of Motion

Typical Projects on Kinetics

- Six-bar spring-damper mechanism
- Balancing a multicylinder engine
- Forces in a plough linkage

Stress and Static Failure (3 wks)

1. Stress Analysis
2. Strength of Materials
3. Static Failure Theories for:
   (a) Ductile Materials
   (b) Brittle Materials

Typical Projects on Static Failure Theories

- Design a beam for a hoist
- Design a windshield wiper arm
- Design a member for a truss

1. COURSE NUMBER AND NAME: ME 35200 Machine Design I

2. CREDITS AND CONTACT HOURS: 4 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

b. Laboratory – 1 day per week at 110 minutes & 1 day at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

G.R. Pennock

4. TEXTBOOK:

Uicker, Pennock, Shigley, *Theory of Machines and Mechanisms*, 4th ed, Oxford University Press, 2011.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Introduction to the principles of design and analysis of machines and machine components. Design for functionality, motion, force, strength, and reliability. The laboratory experience provides open-ended projects to reinforce the design process. Typically offered in fall, spring, and summer.

b. Prerequisites:

ME 26300 – Introduction to Mechanical Engineering Design, Innovation, and Entrepreneurship
ME 27400 – Basic Mechanics II
ME 32300 – Mechanics of Materials

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Understand the fundamental kinematics of machines. [A2, A3]
2. Understand the fundamental kinetics of machines. [A2, A3]
3. Understand the fundamentals of stress analysis of machine components. [A2, A3]
4. Enhance problem-solving and communication skills through creative design projects. [A2, A3, A5, A7, B1, B3]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: G.R. Pennock

REVISION DATE: July 16, 2012

ME 36500
SYSTEMS AND MEASUREMENTS

Course Outcomes [Related ME Program Outcomes in brackets]

1. Provide a fundamental knowledge of the *theory of measurement sciences*. [A1, A2, A3]
2. Gain knowledge of the *practice and art of measurements* through laboratory experiments. [A1, A2, A3]
3. Sharpen skills in *problem formulation and integration* of a broad range of technical capabilities through certain deliberately ill-defined experimental procedures. [A1, A2, A3]
4. Sharpen *technical communication skills* through short technical reports. [B1, B2]
5. Develop *team skills* with measurement design project. [B1, B2]

Static Instrument Characteristics (2 wks)

1. Calibration
2. Digital-to-Analog Conversion
3. Sampling and Aliasing

Statistics (3 wks)

1. Probability Density Functions
2. Sample Statistics & Confidence Intervals
3. Linear Regression
4. Propagation of Error
5. Hypothesis Testing (Chi-Squared Test)

Dynamic Instrument Characteristics (3 wks)

1. Transient and Steady-state Response
2. Frequency Response
3. Bode Plots
4. System Identification

Signal Conditioning & Analysis (5 wks)

<u>Signal Analysis:</u>
1. Fourier Series
2. Spectrum Analysis
3. Signals through Systems

<u>Signal Conditioning</u>:
1. Filters
2. Loading (Impedance Matching)
3. Op Amps
4. Variable Impedance Devices (strain gages) & Bridge Circuits
5. Modulation and Demodulation

Noise (2 wks)

1. Noise Spectra and Signal to Noise Ratio
2. Noise Sources
3. Noise Reduction

2 Week Mini-Project

Laboratory Experiments

1. Basic Operation of Oscilloscopes, Function Generators, Timer-Counters, and Digital Multimeter
2. Digital Data Acquisition Hardware (A/D & D/A Converters, Op Amps, Quantization, Filters)
3. Introduction to LabVIEW software.
4. Statistics (Prob. Density Functs, Sample Stats, Confidence Intervals)
5. Temperature Measurements (Thermocouples, Calibration, Transient & Steady-State Response, Linear Regression, Propagation of Errors).
6. Frequency Response (Time and Frequency Domain Response, System Identification, Bode Plots)
7. Signal Conditioning and Loading (Filters, Op Amps, Impedance)
8. Freq. Analysis (Sampling, Aliasing Spectrum Analysis, Fourier Analysis)
9. Force Measurements (LVTDs, Proximeters, Strain Gages, Calibration, Spectrum Analysis, Modulation & Demodulation, Signal-to-Noise Ratio)

1. COURSE NUMBER AND NAME: ME 36500 Systems and Measurements

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 50 minutes for 16 weeks

b. Laboratory – 1 day per week for 150 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

G. B. King

4. TEXTBOOK: Course Notes

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: The fundamentals of dynamic system modeling are reviewed with special reference to measurement systems. Analytical and experimental techniques of general importance in systems engineering are presented, including sensor utilization in feedback control. Engineering measurement fundamentals, including digital and frequency domain techniques, noise, and error analysis are covered. Typically offered in fall and spring.

b. Prerequisites:

ME 27400 – Basic Mechanics II

MA 26200 – Linear Algebra and Differential Equations

EE 20100 – Linear Circuit Analysis

EE 20700 – Electric Measurement Techniques

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Provide a fundamental knowledge of the *theory of measurement* sciences. [A1, A2, A3]
2. Gain knowledge of the practice and art of measurements through laboratory experiments. [A1, A2, A3]
3. Sharpen skills in problem formulation and integration of a broad range of technical capabilities through certain deliberately ill-defined experimental procedures. [A1, A2, A3]
4. Sharpen technical communication skills through short technical reports. [B1, B2]
5. Develop team skills with measurement design project. [B1, B2]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fund.;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: G.B. King

REVISION DATE: February 5, 2013

ME 37500
SYSTEM MODELING AND ANALYSIS

Course Outcomes [Related ME Program Outcomes in brackets]

1. Introduce a systematic and unified system level modeling of *lumped dynamic systems* in *different domains* using first principles. [A1, A2]
2. Provide necessary *mathematical tools* for analyzing and predicting the performance of an engineered system based on its dynamic response. [A1, A2]
3. Provide an introductory treatment of *designing feedback controllers* to achieve closed-loop stability and specified system performance. [A1, A2]

Dynamic Modeling (4 wks)

1. Introduction to General Modeling Procedure
2. Standard Forms of Models
   - State Variable Model
   - Input/Output Model
3. Mechanical Systems
   - Translational
   - Rotational
4. Electrical Systems
5. Electro-Mechanical Systems
6. Hydraulic (Fluid) Systems
7. Thermal (Heat Transfer) Systems

→

System Analysis (6 wks)

1. Dynamic Response
   - Steady State
   - Transient
2. Laplace Transform
   - Solution to ODE
3. Transfer Function
4. Pole Position & System Response
5. Stability Concept
6. Frequency Response
   - Bode Diagram
7. Block Diagram

→

Feedback Control Design (5 wks)

1. Structures & Feedback Control
2. Performance Specifications
   - Steady State
   - Transient
   - Relation to Pole Position
3. Design Procedure
4. Root Locus
5. PID Control

1. COURSE NUMBER AND NAME: ME 37500 System Modeling and Analysis

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

G. B. King

4. TEXTBOOK:

W. J. Palm III, *System Dynamics*, 2nd ed, McGraw-Hill, 2010.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: This course provides an introduction to modeling electrical, mechanical, fluid, and thermal systems containing elements such as sensors and actuators used in feedback control systems. Modeling techniques based on physical laws and principles are used to generate subsystem and system transfer functions. Closed-loop system analysis will include the use of proportional, integral, and derivative elements to control system response. Typically offered in fall and spring.

b. Prerequisites:

ME 36500 – Systems and Measurements
MA 30300 – Differential Eqns & Partial Differential Eqns for Engineering & the Sciences

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Introduce a systematic and unified system level modeling of *lumped dynamic systems* in *different domains* using first principles. [A1, A2]
2. Provide necessary *mathematical tools* for analyzing and predicting the performance of an engineered system based on its dynamic response. [A1, A2]
3. Provide an introductory treatment of *designing feedback controllers* to achieve closed-loop stability and specified system performance. [A1, A2]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engr Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page

PREPARED BY: G. B. King

REVISION DATE: February 5, 2013

ME 45200
MACHINE DESIGN II

Course Outcomes [Related ME Program Outcomes in brackets]

1. Understand *fatigue failure mechanisms*. [A1, A2]
2. Analyze *fatigue stresses* in machine components. [A1, A2, A6]
3. Gain fundamental knowledge of *indeterminate problems* with and without *preload*. [A1, A2]
4. Apply Statics, Dynamics, and Strength of Materials to basic *machine component design*. [A1, A2, A5, A6]
5. Improve design communications in formal design projects. [B1]

Fatigue Failure Theories (5 wks)

1. S-N Diagrams
2. Endurance Limit
3. High Cycle Fatigue
4. Stress Concentration
5. Fully Reversed Loading
6. Non-Zero Mean Stress
7. Combined Loading
8. Application to Shafts

Bearings (2 wks)

1. Rolling Element Bearings
   - Types
   - Load/Life
   - Effects of axial loads
   - Cumulative Damage
2. Journal Bearings
   - Types/Materials
   - Petroff's Model
   - Reynolds Equations
   - Short/Long Brng. Solutions

Spur Gears (2 wks)

1. Geometry
2. Loads
3. Stresses
   - surface
   - bending
4. Strength
5. Safety factors
   - surface
   - bending

Helical Springs (2 wks)

1. Materials
2. Geometry
3. Stresses
4. Spring Rate
5. Static Failure
6. Fatigue Failure
7. Buckling
8. Surge

Indeterminate Problems - Bolted Joints (2 wks)

1. Geometry
2. Standards
3. Preload
4. Joint Constant
5. Static Failure
6. Fatigue Failure
7. Initial Torque
8. Gaskets

Fatigue Failure (Typical Projects)

- Bicycle crank arm
- Wind turbine blade
- Engine crankshaft
- Tractor spindle

Design of Machine Components (Typical Projects)

- Design of a 2-speed transmission
- Valve spring and head bolt design for an engine

Indeterminate Problems - Brakes/Clutches Typical Projects (2 wks)

1. Self-Energizing concept
2. Self-Locking concept
3. Materials
4. Short Shoe Brake
5. Long Shoe Brake
6. Disk Clutch/Brake

1. COURSE NUMBER AND NAME: ME 45200 Machine Design II

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

J.M. Starkey

4. TEXTBOOK:

R.G. Budynas and J. Keith Nisbett, *Shigley's Mechanical Engineering Design*, 9th ed, McGraw-Hill, 2011.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Design and analysis of mechanical systems for fluctuating loading. Fatigue analysis. Application of design fundamentals to mechanical components and integration of components to form systems. Typically offered in fall and spring.

b. Prerequisites:
ME 35200 – Machine Design I
MSE 23000 – Structure and Properties of Materials

c. Status: Restricted Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Understand *fatigue failure mechanisms*. [A1, A2]
2. Analyze *fatigue stresses* in machine components. [A1, A2, A6]
3. Gain fundamental knowledge of *indeterminate problems* with and without *preload*. [A1, A2]
4. Apply Statics, Dynamics, and Strength of Materials to basic *machine component design*. [A1, A2, A5, A6]
5. Improve design communications in formal design projects. [B1]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: J.M. Starkey

REVISION DATE: January 16, 2013

ME 46300
ENGINEERING DESIGN

Course Outcomes [Related ME Program Outcomes shown in brackets]

1. Learn by *experience* that engineering design problems are open-ended and multifaceted. [A4, A5, A6]
2. Learn the effects of design choices by *prototype fabrication and testing*. [A3, A5, A6]
3. Experience *collaboration* and *team ownership* in the design process. [A5, A6, B1, B2]
4. Broaden skills in *leadership*, *teamwork*, *communication*, *project planning, innovation, design,* and *entrepreneurship.* [B1, B2, B3, C1, C3, C4]
5. Experience the *application of core course materials* to practical design problems. [A1, A2, A5]
6. Practice *professional* and *ethical behavior* in an engineering context [B3]
7. Provide a practical *foundation for continued learning*. [B5]

Problem Definition (2 wk)

1. Problem Statement
2. Competitive Product Study (Benchmarking)
3. Patent/Periodical Search
4. Problem Definition

Concept Generation and Evaluation (3 wks)

1. Concept Generation
2. Engineering Modeling of Concepts using Core Course Material
3. Preliminary Design Review

Product Design and Marketing (5 wks)

1. Selection Design
2. Bill of Materials
3. Assembly/Parts Drawings
4. Performance Analysis
5. Economic Analysis
6. Critical Design Review

Prototyping, Fabrication, and Testing (5wks)

1. Material and parts acquisition
2. Fabrication
3. Assembly
4. Testing
5. Final Design Review

Recent Design Projects

1. Mini Baja and Formula Vehicles
2. Utility Vehicle Hitch Designs
3. Eco-Car
4. General Aviation Ladder
5. Solar Powered UAV
6. Car Self-Cooling System
7. Portable Refrigeration Unit for Vaccines
8. Portable Renewable-Energy Charging Device
9. Ping-Pong Ball Serving Machine

1. COURSE NUMBER AND NAME: ME 46300 Engineering Design

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

J.M. Starkey

4. TEXTBOOK: None

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Application of the design process to the design, fabrication, and testing of various engineering components and systems. Mathematical modeling in design is emphasized. Design problems from all areas of mechanical engineering are considered. Typically offered in fall, spring and summer.

b. Prerequisites:

ME 31500 – Heat and Mass Transfer
ME 35200 – Machine Design I
ME 37500 – System Modeling and Analysis
MSE 23000 – Structure and Properties of Materials

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Learn by *experience* that engineering design problems are open-ended and multifaceted. [A4, A5, A6]
2. Learn the effects of design choices by *prototype fabrication and testing*. [A3, A5, A6]
3. Experience *collaboration* and *team ownership* in the design process. [A5, A6, B1, B2]
4. Broaden skills in *leadership*, *teamwork*, *communication*, *project planning, innovation, design,* and *entrepreneurship.* [B1, B2, B3, C1, C3, C4]
5. Experience the *application of core course materials* to practical design problems. [A1, A2, A5]
6. Practice *professional* and *ethical behavior* in an engineering context [B3]
7. Provide a practical *foundation for continued learning*. [B5]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: J.M. Starkey

REVISION DATE: January 16, 2013

ME 47500
AUTOMATIC CONTROL SYSTEMS

Course Outcomes [Related ME Program Outcomes in brackets]

1. Provide a thorough understanding of *characterization of dynamic systems* for analyzing, predicting, and specifying the performance of an engineered system. [A1, A2, A3]
2. Provide a thorough treatment of designing *classical feedback controllers* in *time-domain* using Root-Locus method. [A1, A2, A3]
3. Provide a thorough treatment of designing *classical feedback controllers* in *frequency-domain*. [A1, A2, A3, A5]
4. Provide an introductory treatment of *digital control* and the associated implementation issues. [A1, A2, A3, A5]
5. Provide analog and digital feedback controller *design experiences* through laboratory experiments. [A1, A2, A3, A4]
6. Sharpen *technical communication skills* through laboratory and project reports. [B1]

System Characterization (3 wks)

1. Review and Expand
   - Transfer Functions & Characteristic Equations
   - Transient Response (Higher-order systems)
   - Block Diagram Reduction
2. Stability and Routh-Hurwitz Stability Criterion
3. Steady-State Errors
4. Sensitivity

Digital Control (4 wks)

1. Introduction to digital systems
2. Effect of sampling
3. Ideal sampler and zero order hold
4. Z-transforms
5. Digital realization of continuous system controller

Root Locus Based Controller Design (3 wks)

1. Root Locus
2. Compensation via Root Locus
   - Lead/Lag
   - PID

Frequency Method Based Controller Design (5 wks)

1. Nyquist Stability Criterion
2. Nyquist Diagram Sketching
3. Nyquist Diagram-Gain Margin and Phase Margin
4. Nyquist Diagram to Bode Plots
5. Closed Loop Transient/Closed Loop Frequency/Open Loop Frequency Response Relationships
6. Time Delays
7. Design via Frequency Methods

Laboratory Experiments

1. Introduction to FPGA Hardware, Control Design and Simulation
2. Pulse Width Modulation and Encoders
3. Time Domain Response of Higher Order Systems
4. System Identification
5. Root Locus Analysis
6. PID Control
7. Root Locus Compensator Design
8. Frequency Domain Compensator Design
9. Sampling Time and Digital Control
10. Special Project - Student designed controller to meet a set of given conditions for an unknown system.

1. COURSE NUMBER AND NAME: ME 47500 Automatic Control Systems

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 50 minutes for 16 weeks

b. Laboratory – 1 day per week at 110 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

G. B. King

4. TEXTBOOK:

G.F. Franklin, J.D. Powell and A. Emani-Naeini, Feedback Control of Dynamic Systems, 6th ed, Prentice Hall, 2009

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Capability developed in previous courses to model systems and sensors is utilized to design feedback controllers to meet specified system performance objectives. While emphasis is on continuous controllers, an introduction to digital control systems analysis is provided. Laboratory experiments utilizing hardware applications with continuous and digital controllers verify and expand on lecture material. Typically offered in fall and spring.

b. Prerequisites:
ME 37500 – System Modeling & Analysis

c. Status: Restricted Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Provide a thorough understanding of *characterization of dynamic systems* for analyzing, predicting and specifying the performance of an engineered system. [A1, A2, A3]
2. Provide a thorough treatment of designing *classical feedback controllers* in *time-domain* using Root-Locus method. [A1, A2, A3]
3. Provide a thorough treatment of designing *classical feedback controllers* in *frequency-domain*. [A1, A2, A3, A5]
4. Provide an introductory treatment of *digital control* and the associated implementation issues. [A1, A2, A3, A5]
5. Provide analog and digital feedback controller *design experiences* through laboratory experiments. [A1, A2, A3, A4]
6. Sharpen *technical communication skills* through laboratory and project reports. [B1]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engr Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page

PREPARED BY: G. B. King

REVISION UPDATE: February 5, 2013

MSE 23000
STRUCTURE AND PROPERTIES OF MATERIALS

Course Outcomes [Related ME Program Outcomes in Brackets]

1. Develop familiarity with the *different levels of structure (atomic, crystal, microscopic)* in engineering materials and deviations from "perfect" structure (structural defects). [A1, A2]
2. Understand the effects of *microstructure* on the mechanical properties of materials. [A1, A2]
3. Understand the basis for *microstructure development* in materials. [A1, A2]
4. Understand *how materials are processed*. [A1, A2]

Multiscale Structure of Matter

1. Atomic bond strength and macroscopic properties
2. Crystal structures, crystallography, Miller indices, X-ray diffraction
3. Atomic structures of metals, ceramics, and polymers
4. Microstructure and structural defects: vacancies, dislocations, and grain boundaries

→

Effect of Microstructure on Macroscopic Properties

1. Dimensional changes due to elastic and plastic deformation
2. Dislocations and their role in yielding and ductility
3. Strengthening by microstructure control
4. Griffith criterion for fracture strength of brittle materials
5. Comparisons of yield and fracture strengths for various materials
6. Composite structures

→

Microstructure Development

1. Mass diffusion mechanisms
2. Phase diagrams for binary metal and ceramic systems
   - lever law
   - invariant transformation
   - Fe-C system
3. Phase Transformations
   - grain growth, recrystallization, recovery
   - time-temperature transformation diagrams
   - precipitation hardening
4. Correlation of processing, microstructure, and mechanical properties

→

Materials Processing

1. Comparisons among processing methods for crystalline (metals and ceramics), semicrystalline (polymers) and amorphous (glasses and polymers) materials.
2. Glass processing
3. Polymer processing

Revision Date: 6/24/2013

1. COURSE NUMBER AND NAME: MSE 23000 Structure and Properties of Materials

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 50 minutes for 16 weeks
b. Recitation – 1 day per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:
Matt Krane & Elliot Slamovich

4. TEXTBOOK:

Callister, William D., *Materials Science and Engineering: An Introduction,* 8th Edition, ISBN# 978-0-047-0419977, Wiley, 2010

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: The relationship between the structure of materials and the resulting mechanical, thermal, electrical, and optical properties. Atomic structure, bonding, atomic arrangement; crystal symmetry, crystal structure, crystal symmetry, defects and the use of X-ray diffusion. Phase equilibria and microstructural development. Applications to design. Typically offered in the fall and spring.

b. Prerequisites:
CHM 11500 – General Chemistry
MA 16100 – Plane Analytic Geometry and Calculus I

c. Status:
Required

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes: [Related ME Program Outcomes in Brackets]

1. Develop familiarity with the *different levels of structure (atomic, crystal, microscopic)* in engineering materials and deviations from "perfect" structure (structural defects). [A1, A2]
2. Understand the effects of *microstructure* on the mechanical properties of materials. [A1, A2]
3. Understand the basis for *microstructure development* in materials. [A1, A2]
4. Understand *how materials are processed*. [A1, A2]

B. Related ME Program Outcomes:

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: Matt Krane &Elliot Slamovich

REVISION UPDATE: June 24, 2013

PHYS 24100
ELECTRICITY AND OPTICS

Course Outcomes [Related ME Program Outcomes in brackets]

1. Learn that a relatively small number of fundamental physics concepts form the basis of a wide variety of complex physical phenomena. [A1, A2, A3]
2. Learn that conceptual understanding can invariably be raised to the level of analytic and quantitative understanding by use of suitable mathematics. [A1, A2, A3]
3. Learn that the quantitative formulations so achieved can be used for problem solving and predicting outcomes of experiments. [A1, A2, A3]
4. Learn to apply this process to problem solving involving various natural phenomena, such as those encountered in electrostatics, dc and ac currents and circuits, magnetostatics, magnetic induction, electromagnetic waves, light and optics including both geometric and physical optics, as well as to an elementary understanding of the modern ideas of quantum physics. [A1, A2, A3]
5. Learn to relate the basic understanding and problem solving skills to concrete and practical examples. [A1, A2, A3]
6. Develop an elementary understanding of Maxwell's Equations. [A1, A2, A3]

Electricity (6wks)

1. The Electric Field I: Discrete Charge Distributions
2. The Electric Field II: Continuous Charge Distributions
3. Gauss' Law
4. Electric Potential
5. Electrostatic Energy and Capacitance
6. Electric Current and Direct-Current Circuits

→

Magnetism (5wks)

1. The Magnetic Field
2. Sources of the Magnetic Field
3. Magnetic Induction and Inductance
4. Alternating-Current Circuits

→

Optics (3 wks)

1. Maxwell's Equations and Electromagnetic waves
2. Properties of Light
2. Optical Images, Mirrors, Thin Lenses
3. Optical Instruments
4. Interference and Diffraction

1. COURSE NUMBER AND NAME: PHYS 24100 Electricity and Optics

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 50 minutes for 16 weeks

b. Recitation – 1 day per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

L. Pyrak-Nolte

4. TEXTBOOK:

R. Tipler and G. Mosca, *Physics for Scientists and Engineers*, 6th ed., Freeman & Co.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Electrostatics, current electricity, electromagnetism, magnetic properties of matter. Electromagnetic waves, geometrical and physical optics. Typically offered in the fall, spring and summer.

b. Prerequisites:
PHYS 17200 – Modern Mechanics

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes: [Related ME Program Outcomes in Brackets]

1. Learn that a relatively small number of fundamental physics concepts form the basis of a wide variety of complex physical phenomena. [A1, A2, A3]
2. Learn that conceptual understanding can invariably be raised to the level of analytic and quantitative understanding by use of suitable mathematics. [A1, A2, A3]
3. Learn that the quantitative formulations so achieved can be used for problem solving and predicting outcomes of experiments. [A1, A2, A3]
4. Learn to apply this process to problem solving involving various natural phenomena, such as those encountered in electrostatics, dc and ac currents and circuits, magnetostatics, magnetic induction, electromagnetic waves, light and optics including both geometric and physical optics, as well as to an elementary understanding of the modern ideas of quantum physics. [A1, A2, A3]
5. Learn to relate the basic understanding and problem solving skills to concrete and practical examples. [A1, A2, A3]
6. Develop an elementary understanding of Maxwell's Equations. [A1, A2, A3]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: N. Giordano **REVISED BY**: H. Nakanishi with instructors of the course **REVISION DATE:** February 22, 2013

C. ME Professional Electives

ME 36300
PRINCIPLES AND PRACTICES OF MANUFACTURING PROCESSES

Course Outcomes [Related ME Program Outcomes in brackets]

1. Provide a fundamental knowledge of the *principles and theories of manufacturing processes*. [A2, A3]
2. Gain knowledge of the *practice of measurements and manufacturing processes* through laboratory experiments. [A2, A3]
3. Sharpen skills in *problem formulation and integration* of a broad range of technical capabilities through certain open-ended experimental designs. [A2, A3, A4, A5, A7]
4. Sharpen *technical communication skills* through short technical lab reports. [B3]

Metrology, Quality Control, and Materials (3 wks)

1. Quality Measures
2. Measurement principles and Techniques
3. Quality Control
4. Properties of Materials

→

Machining Processes (4 wks)

1. Mechanics of Machining Processes
2. Cutting Tools
3. Tool Life and Machinability
4. Production Machining Processes

→

Processing of Non-metallic Materials (4 wks)

1. Processing and Design of Composite Materials
2. Processing of Plastics
3. Processing of Ceramics
4. Microfabrication

→

Other Manufacturing Processes (4 wks)

1. Non-traditional Machining Processes
2. Forming Processes
3. Surface Treatment
4. Finishing Processes

Laboratory Experiments

1. Basic Measurement Principles and Practice (Dimension, Tolerance, Surface Roughness, and Geometry)
2. Basic Operation of Machine Tools (Lathe and Milling Machine)
3. Measurement of Cutting Force and Tool Wear Using LabView and Instrumentation
4. Data Analysis Using Statistics (Histogram, Regression Analysis)
5. CNC programming and CNC machining
6. Microfabrication
7. Rapid PrototyING

1. COURSE NUMBER AND NAME: ME 36300 Principles and Practices of Manufacturing Processes

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

b. Laboratory – 1 day per week at 100 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

Y.C. Shin

4. TEXTBOOK:

Kalpakjtan, Schmid, *Manufacturing Engineering and Technology*, 6th ed, Prentice Hall 2009

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Metrology. Principles of metal removal and metal forming. Composite processing and joining. Manufacturing automation. Typically offered in the fall.

b. Prerequisites:
ME 263 – Introduction to Mechanical Engineering Design, Innovation, and Entrepreneurship

Co-Requisites:
ME 323 – Mechanics of Materials

c. Status: Required

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:
[Related ME Program Outcomes in brackets]

1. Provide a fundamental knowledge of the *principles and theories of manufacturing processes*. [A2, A3]
2. Gain knowledge of the practice of *measurements and manufacturing processes* through laboratory experiments. [A2, A3]
3. Sharpen skills in *problem formulation and integration* of a broad range of technical capabilities through certain open-ended experimental designs. [A2, A3, A4, A5, A7]
4. Sharpen *technical communication skills* through short technical lab reports. [B3]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: Y.C. Shin

REVISION DATE: June 10, 2013

ME 41300
NOISE CONTROL

Course Outcomes [Related ME Program Outcomes in brackets]

1. Provide a basic understanding of *fundamental concepts* in Engineering Noise Control. [A2, A3]
2. Apply these concepts to the solution of *practical problems*. [A2, A3, A5, A7]
3. Provide means to identify and correct potentially *hazardous sound levels* in the workplace. [[A1, B1, C3]
4. Teach sound and vibration *measurement techniques*. [A2, A3]
5. Develop *problem solving*, *reporting*, *communications*, and *team working skills*. [A3, A7, B2, B3]

Fundamentals of Acoustics

1. Simple harmonic motion
2. Wave equation
3. Energy variables
4. Solution of 1-d wave equation: fluctuating pressure and density; particle velocity
5. Sound pressure, sound intensity and sound power levels
6. Decibels
7. Concept of spherical waves
8. Resonance
9. Duct acoustics - standing waves vs. traveling wave

Analysis and design of mufflers/silencers

1. Sound transmission through an expansion chamber in a long pipe
2. Acoustic performance of mufflers/silencers: insertion loss, transmission loss and noise reduction
3. Design of mufflers/silencers: length and area ratio.

Control of noise at workplace

1. Control of machinery noise
2. Control of flow noise
3. Basic principles of vibration isolation
4. Sound transmission through panels: resonant frequency and co-incidence frequency
5. Sound insulation by enclosures

Techniques of sound measurements

1. Introduction to digital Fourier analysis
2. Octave band analysis
3. Noise metrics: Leq, LDN, L10, L90, SEL, Lmax, Lmin
4. Sound level meters, microphones, accelerometers, tape recorders
5. Standing wave apparatus: acoustical characterization of sound absorption materials

Evaluation of noise impacts

1. Commonly used noise scales and indices
2. Metrics for assessment of environmental noise
3. Metrics for assessment of industrial noise
4. Case study: Boston Central Artery/ Tunnel project

Human Response to noise

1. Anatomy and operation of human ears
2. Threshold of hearing; equal loudness contours – MAP and MAF
3. Noise induced hearing loss
4. Speech Interference and sound quality
5. Perceived noise level (PNL) and EPNL

Regulations

1. Noise regulating agencies
2. OSHA noise regulations
3. Other regulations for control of environmental noise

1. COURSE NUMBER AND NAME: ME 41300 Noise Control

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

K.M. Li

4. TEXTBOOK:

Leo Beranek, *Noise & Vibration Control*, INCE

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Fundamentals: acoustic waves, reflection, scattering, absorption, tones, noise. Psychoacoustics: voice, ear, theories of hearing, loudness, deafness. Environmental acoustics: sound in buildings, acoustic tiles, sound insulation, sound absorption. Measurement: microphones, accelerometers, sound level meters, data acquisition and reduction, frequency analysis, and Fourier analysis. Noise control: use of absorbing and damping materials, vibration isolation and enclosures. Machinery noise: gear, bearing, fan, compressor, heating and ventilation system noise, automobile and aircraft noise. Community reaction. Legal aspects. Design-oriented semester projects. Typically offered in the spring.

b. Prerequisites:

Differential Equations and Basic Physics

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes

[Related ME Program Outcomes in brackets]

1. Provide a basic understanding of *fundamentals concepts* in engineering noise control. [A2, A3]
2. Apply these concepts to the solution of *practical problems*. [A2, A3, A4, A5, A7]
3. Provide means to identify and correct potentially *hazardous sound levels* in the workplace. [A1, B1, C3]
4. Teach sound and vibration *measurement techniques* and *computer programming skills*. [A2, A3, A4]
5. Develop *problem solving*, *reporting*, *communications* and *teamwork skills*. [A3, A7, B2, B3]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: K. M. Li

REVISION DATE: February 13, 20012

ME 41800
ENGINEERING OF ENVIRONMENTAL SYSTEMS AND EQUIPMENT

Course Outcomes [Related ME Program Outcomes in brackets]

1. Integration of *fundamentals* (thermodynamics, heat transfer, fluid mechanics, numerical methods) to solve practical problems. [A2, A3, A5, A7]
2. Provide fundamental understanding necessary to *design* and *analyze systems* and *equipment* used in conditioning buildings. [A2, A3, A5, A7]

Fundamentals (4 wks)

1. Numerical Methods & Systems' Analysis
2. Thermodynamics (1st Law Performance Limits, Psychrometrics)
3. Heat & Mass Transfer (applied to building energy analysis and dry and "wet" heat exchangers)
4. Fluid Mechanics (pipe and duct flow)
5. Economics (life-cycle cost analysis)
6. Overview of HVAC Systems

→

Building Energy Analysis (3 wks)

1. Occupant Comfort and Indoor Air Quality
2. Energy Flows in Buildings
3. Design Heating and Cooling Reqs
4. Annual Heating and Cooling Energy Usage

→

Equipment Analysis (8 wks)

1. Air Handling Equipment
2. Heat Exchangers (Dry and Wet)
3. Vapor Compression Equipment
4. Pumping Systems
5. Cooling Towers
6. Thermal Storage
7. Absorption Cooling Equipment

Sample Design Projects

1. Optimal Design of Cooling Coils
2. Solar Powered Ventilator for an Automobile
3. Design of an HVAC System for a Library
4. Optimal Design of a Room Air Conditioner

Revision Date: June 26, 2012

1. COURSE NUMBER AND NAME: ME 41800 Engineering of Environmental Systems and Equipment

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

J.E. Braun

4. TEXTBOOK:

Mitchell, J.W and Braun, J.E., *Principles of HVAC in Buildings*, Wiley Inter-Science, 2012

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: This course is designed to give students the fundamental understanding necessary to design and analyze systems and equipment used in conditioning buildings. Topics include: review of fundamentals in thermodynamics, heat transfer, fluid mechanics, economics, non- linear equation solving, optimization; analysis of building heating and cooling requirements for design and annual energy use; design and selection of equipment, including ducts, fans, cooling coils, chillers, air conditioners, piping, pumps, cooling towers, thermal storage. Typically offered in spring.

b. Prerequisites:
ME 30000 – Thermodynamics II
ME 31500 – Heat and Mass Transfer

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Integration of *fundamentals* (thermodynamics, heat transfer, fluid mechanics, numerical methods) to solve practical problems. [A2, A3, A5, A7]
2. Provide fundamental understanding necessary to design and analyze systems and equipment used in conditioning buildings. [A2, A3, A5, A7]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: Jim Braun

REVISION DATE: June 26, 2012

ME 43000
POWER ENGINEERING

Course Outcomes [Related ME Program Outcomes in brackets]

1. Provide a basic understanding of the *operation*, *construction* and performance of *fossil fuel power plant equipment*. [A2, A3]
2. Provide a basic knowledge of the *generation* and *distribution* of *electric power*. [A2, A3]

Steam Generation (3 wks)

1. Fuels
2. Combustion
3. Energy balances
4. Steam generator designs

→

Rankine Cycle Analysis (3 wks)

1. First Law analysis
2. Second Law analysis
3. Regeneration
4. Reheat
5. Heater designs
6. Condenser designs

→

Power Plant Auxiliaries (4 wks)

1. Steam turbines
2. Draft
3. Fans
4. Pumps
5. Cooling towers

→

Energy Management (3 wks)

1. Station performance criteria
2. Load scheduling
3. Rate structures
4. Rate analysis

→

Field Trips (2 wks)

1. North Power Plant
2. South Power Plant
3. Utility Tunnels

1. COURSE NUMBER AND NAME: ME 43000 Power Engineering

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

Heather L. Cooper, MET Department

4. TEXTBOOK:

Powerplant Technology, M. M. El-Wakil, McGraw-Hill, 2002, ISBN 9780072871029

5. SPECIFIC COURSE INFORMATION:

a. Course Description: Rankine cycle analysis, fossil-fuel steam generators, energy balances, fans, pumps, cooling towers, steam turbines, availability (second law) analysis of power systems, energy management systems, and rate analysis. Typically offered in the fall.

b. Prerequisites:

ME 20000 – Thermodynamics I

c. Status:

Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Integration of *fundamentals* (thermodynamics, heat transfer, fluid mechanics, numerical methods) to solve practical problems. [A2, A3, A5, A7]]
2. Provide fundamental understanding necessary to design and analyze systems and equipment used in conditioning buildings. [A2, A3, A5, A7]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page

PREPARED BY: Heather Cooper, MET

REVISION DATE: June 12, 2013

ME 43300
PRINCIPLES OF TURBOMACHINERY

Course Outcomes [Related ME Program Outcomes in brackets]

1. Understand principles of operation of *pumps*, *fans*, *compressors*, and *turbines*. [A2, A3]
2. Develop the ability to *size* and *select turbomachinery* for a specific application. [A2, A3]
3. Develop the ability to analyze the *performance of turbomachinery*. [A2, A3]
4. Master the concepts of *classic mean-line* and *quasi-3D design methods*. [A2, A3]

Fundamental Concepts (3 wks)

1. Review of thermodynamics
2. Review of fluid mechanics
3. Introduction to 1-D compressible flow
4. Basics of energy transfer in a turbomachine

→

Dimensional Analysis (1 wk)

1. Corrected mass flow and corrected speed
2. Energy transfer coefficient and flow coefficient
3. Specific speed and specific diameter
4. Similitude

↓

Performance Analysis (4 wks)

1. Performance criterion
2. Performance maps
3. Pump Sizing and cavitation
4. Off design performance

→

Design Method (8 wks)

1. Simple stage analysis
2. Streamline analysis
3. Radial equilibrium
4. Axial blade element design
5. Radial impeller design
6. Design of diffusers

Revision Date: June 12, 2013

1. COURSE NUMBER AND NAME : ME 43300 Principles of Turbomachinery

2. CREDITS & CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

Nicole Key

4. TEXTBOOK:

Introduction to Turbomachinery, **Japikse, David & Baines, Nicholas**, Concepts NRES, January 1997, ISBN# 978-0933283107.

5. SPECIFIC COURSE INFORMATION:

a. Course Description: Unified treatment of principles underlying fluid mechanic design of hydraulic pumps, turbines and gas compressors, and turbines. Similarity and scaling laws. Cavitation. Analysis of radial and axial flow machines. Blade element performance. Radial equilibrium theory. Centrifugal pump design. Axial compressor design. Typically offered in the fall.

b. Prerequisites:

ME 20000 – Thermodynamics I
ME 30900 – Fluid Mechanics or
AAE 33000 – Fluid Mechanics and AAE 33301 – Fluid Mechanics

c. Status:

Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in brackets]:

1. Understand principles of operation of *pumps, fans, compressors*, and *turbines*. [A2, A3]
2. Develop the ability to *size* and *select turbomachinery* for a specific application. [A2, A3]
3. Develop the ability to analyze the *performance of turbomachinery*. [A2, A3]
4. Master the concepts of *classic mean-line* and *quazi-3D design methods*. [A2, A3]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page

PREPARED BY: Nicole Key

REVISION DATE: June 12, 2013

ME 43800
GAS TURBINE ENGINES

Course Outcomes [Related ME Program Outcomes in brackets]

1. Basic performance characteristics of *shaft power gas turbine engines*. [A2, A3]
2. Basic performance characteristics of *gas turbines for aircraft propulsion*. [A2, A3]
3. *Cycle analysis*. [A2, A3]
4. *Component performance analysis*. [A2, A3]
5. *Design* and *off-design operation*. [A2, A3]

Fundamental Concepts (3 wks)

1. Basic Equations
2. Stagnation Properties
3. Continuity relationships
4. Compressible flow

Shaft Power Cycles (5 wks)

1. Simple Cycle
2. Cycle Variations
3. Cycle Definition and Analysis
4. Component Performance
5. Power Balance
6. Design Point Performance

Aircraft Propulsion Cycles (4 wks)

1. Turbojet Cycle
2. Thrust
3. Engine Performance Parameters
4. Turbojet Performance
5. Turbofan Cycle and Performance
6. Design and Off-Design Performance

Aerodynamics of Compressors and Turbines (3 wks)

1. Energy Transfer
2. Velocity Diagrams
3. Radial equilibrium
4. Degree of Reaction
5. Axial and Radial Compressors
6. Axial Turbines
7. Wind Turbines

1. COURSE NUMBER AND NAME: ME 43800 Gas Turbine Engines

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

S. Fleeter

4. TEXTBOOK:

H. Cohen, G.F.C. Rogers and H.I.H. Saravanamutto, Gas Turbine Theory, 5th ed, John Wiley & Sons

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Basic operating principles and analysis of performance characteristics of gas turbine engines for aircraft and vehicular propulsion and stationary power. Turbojet, turbofan, turboshaft cycle analysis. Analysis of flow through compressors, turbines, combustors, inlets, nozzles, and regenerators. Component machine and off-design performance. Inspection trip to industrial plan required. Typically offered in spring.

b. Prerequisites:

ME 30000 – Thermodynamics
ME 30900 – Fluid Mechanics

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Basic performance characteristics of *shaft power gas turbine engines*. [A2, A3]
2. Basic performance characteristics of *gas turbines for aircraft propulsion*. [A2, A3]
3. *Cycle analysis*. [A2, A3]
4. Component *performance analysis*. [A2, A3]
5. Design and *off-design operation*. [A2, A3]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: S. Fleeter

REVISION DATE: July 1, 2012

ME 44000
Automotive Prime Movers: Green Engines and Clean Fuels

Course Outcomes [Related ME Program Outcomes in brackets]

1. Relate processes in automotive prime movers to *engineering fundamentals* [A1, A2, A3, A4]
2. Study *low-carbon emitting*, and LEV, ULEV, SULEV, PZEV, and ZEV prime mover designs [A2, A3, A4, A5, A6, A7]
3. Study *prime mover designs* that are *alternatives* to conventional combustion engines [A2, A3, A4, A5, A6, A7]
4. Study *cleaner alternatives* to conventional fossil fuels. [A1,A2, A3,A4]
5. Carry out *analysis of prime mover designs* and *fuel alternatives* to identify cost and energy tradeoffs [A2, A3, A5, A6, A7]

Motivation/ Performance Parameters (1 wk)

1. Classification of prime movers, vehicles
2. Performance parameters of prime movers

→

I.C. Engines (4 wks)

1. Clean diesels
2. DISI engines
3. HCCI engines
4. Alternate designs
5. Aftertreatment

→

Hybrid and Fuel Cell Engines (5 wks)

1. Hybrid engine components and their performance.
2. Hybrid system design and integration with vehicles.
3. Fundamental of PEM fuel cells
4. Performance parameters of fuel cells.
5. Integration with vehicles

→

Clean Fuels (3 wks)

1. Fuel chemistry and heating values
2. Fossil fuels, including natural gas
3. Hydrogen
4. Biofuels: sources, production, utilization

→

Cost and Energy Balance (2 wks)

1. Well-to-wheel analysis methodologies
2. Well-to-wheel analysis of alternate engine designs, including fuels
3. Estimates of life-cycle emissions
4. Cost analysis of alternate engine designs

Laboratory Experiments

1. Engine tear-down and re-assembly (2 weeks)
2. Spark-ignition engine performance with gasoline and gasoline/ethanol blends (2 weeks)
3. Compression-ignition engine performance with diesel and biodiesel (2 weeks)
4. Hybrid engine component performance and comparison with I.C.e engine (2 weeks)
5. Fuel cell performance (1 week)
6. Hybrid engine system arrangements (1 week)
7. Impact of driving cycle on hybrid engine performance (1 week)

Revision Date:
January 2012

1. **COURSE NUMBER AND NAME: ME 440**00 Automotive Prime Movers: Green Engines and Clean Fuels

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 meetings per week at 50 minutes for 16 weeks

b. Laboratory – 1 meeting per week at 110 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

J. Abraham

4. TEXTBOOK:

Class Notes

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Internal combustion engines (ICE), hybrid engines (HE), fuel-cell engines (FCE), and alternative/renewable fuels. ICEs topics - engines with advanced combustion systems such as clean diesels, direct-injection spark-ignition engines (DISI), and low-temperature combustion (LTC) compression-ignition. HE topics - different components of hybrid engines and the powertrain design. FCE topics - fundamentals of fuel cells and automotive applications. Clean fuel topics - biofuels, hydrogen, and natural gas, as well as, other cleaner fossil fuels for automotive applications. Well-to-wheel energy and cost analysis of prime mover designs/fuels. Includes lab. Typically offered in spring.

b. Prerequisites:
ME 30000 Thermodynamics

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Relate processes in automotive engines to the *engineering fundamentals*. [A1,A2, A3, A4]
2. Study *low-carbon emitting* and LEV,ULEV,SULEV,PZEV, & ZEV engine designs [A2, A3,A4,A5,A6,A7]
3. Study *prime mover designs* that are *alternatives* to conventional combustion engines [A2, A3,A4,A5,A6,A7]
4. Study *cleaner alternatives* to conventional fossil fuels. [A1,A2, A3,A4]
5. Carry out *analysis of prime mover designs* and *fuel alternatives* to identify cost and energy tradeoffs [A2, A3,A5,A6,A7]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: J. Abraham

REVISION DATE: January 2012

ME 44400
COMPUTER-AIDED DESIGN AND PROTOTYPING

Course Outcomes [Related ME Program Outcomes in Brackets]

1. Provide hands-on experiences with state-of-the-art *computer-aided design* (CAD) software. [A3]
2. Learn to use *CAD programs* for productive mechanical engineering design. [A3, A5, A7]
3. Become familiar with *computer-based prototyping* and *applications*. [A3, A5, A7]
4. Reinforce the ability to work in a *product design team*, sharing ideas and models. [B2, B3]
5. Learn to use computer-aided engineering programs for advanced stress analysis. [A3, A7]
6. Provide *practical experiences* to meet expectations of industry in design and manufacturing. [A5, A7]
7. Integrate *computer-based* product design with earlier experiences in design and manufacturing. [A3, A7]

Advanced CAD Modeling (6 wks)

1. Learn advanced CAD concepts
2. Parametric design
3. Feature based design
4. Part design
5. Assembly design
6. Mechanism simulation

Team-Based CAD Design Project

1. Design, simulate, manufacture and purchase, and build mechanical "action toy" product
2. Teams formulate their own design
3. CAD used to create full CAD model including purchased and new parts.
4. Selected parts built using rapid-prototyping.
5. Prototype built and demonstrated.

Design & Manufacturing Project (4 wks)

1. Action toy project for practical experience using CAD to design, simulate, manufacture and build a working prototype.
2. Simulate motion using CAD.
3. Evaluate manufacturability using CAD and rapid-prototyping planning software.

Example Projects

1. Airplanes with moving wings, landing gear.
2. Cars, trucks, etc. with remote controls.
3. Ancient clocks, military gadgets.
4. Merry-go-rounds, puzzles, games.

Introduction to Finite-Element Analysis (FEA) (5 wks)

1. Learn FEA theory – nodes, elements, boundary conditions, reaction forces.
2. Study 1-D element and 2-D solid element theory.
3. Hands-on learning using a commercial FEA program to solve truss and plane stress problems.
4. Learn how to develop appropriate FEA models with various types of boundary conditions, loading cases.
5. Use results data (displacements, stresses, and reaction forces) to solve various kinds of engineering problems.
6. 3-D modeling using both a CAD and a CAE program together.

1. COURSE NUMBER AND NAME: ME 44400 Computer-Aided Design and Prototyping

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture - 1 day per week at 50 minutes for 15 weeks

b. Lab – 2 days per week at 110 minutes each for 15 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

D. C. Anderson and K. Ramani

4. TEXTBOOK: None

Other Supplemental Material: None

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Introduction to advanced computer-aided design (CAD) and computer-aided engineering (CAE) for product design, modeling, and prototyping. Individual use and team-based environment to design and prototype a functional toy product. Project includes use of the advanced design tools to produce a working prototype that is manufacturable. Application to manufacturing and analysis. Typically offered Fall Spring.

b. Prerequisites

Senior standing or consent of instructor

c. Status: Elective.

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Provide hands-on experiences with state-of-the-art *computer-aided* design (CAD) software. [A3]
2. Learn to use *CAD programs* effectively for productive design. [A3, A5, A7]
3. Become familiar with *computer-based prototyping* and *applications*. [A3, A5, A7]
4. Reinforce the ability to work in a *product design team*, sharing ideas and models. [B2, B3]
5. Learn to use computer-aided engineering programs for advanced stress analysis. [A3, A7]
6. Provide *practical experiences* to meet expectations of industry in design and manufacturing. [A5, A7]
7. Integrate *computer-based* product design with earlier experiences in design and manufacturing. [A3, A7]

b. Related ME Program Outcomes

[Related ABET Outcomes listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: D. C. Anderson

REVISION DATE: July 23, 2012

ME 45500
VEHICLE DESIGN AND FABRICATION

Course Outcomes [Related ME Program Outcomes in brackets]

1. Apply the *design process* to the design of a vehicle (Mini-Baja or Formula SAE). [B1, B2, B3, C1, C3, C4]
2. Apply *engineering fundamentals* to evaluate the design of a vehicle. [A1, A2, A5]
3. Apply *team-work skills* to management of the Mini-Baja or Formula SAE teams. [A5, A6, B1, B2]
4. Learn the effect of design choices by *building and testing* students' designs. [A3, A5, A6]

Design Process (3 wks)

1. Problem Definition
2. Conceptual Design
3. Detail Design
4. Prototype Fabrication
5. Testing
6. Redesign

Team Management (2 wks)

1. Budgeting/Sponsorship
2. Group Dynamics
3. Recruiting new team members
4. Training new team members
5. Mentoring future leaders
6. Motivating/leading teams
7. Logistics

Engineering Fundamentals Applications (5 wks)

1. Stress analysis (Frame/suspension)
2. Kinematics/Kinetics (Suspension)
3. Machine Elements (Power train)
4. Electro-mechanical (Fuel-Spark Management)
5. Design for X (safety, maintenance, aesthetics)

Fabrication Techniques (5 wks)

1. Machine Tools (Lathe, Mill)
2. CNC Machines
3. Welding
4. Heat-Treatment

Revision Date: June 12, 2013

1. COURSE NUMBER AND NAME: ME 45500 Vehicle Design and Fabrication

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

J. Starkey

4. TEXTBOOK: N/A

5. SPECIFIC COURSE INFORMATION:

a. Course Description: An open-ended project course in which the goal is to design and build competitive prototype vehicles. The integration of design concept formulation, engineering analysis and testing, and prototype fabrication within the broad context of the engineering enterprise. The broad range of product development activities is covered in the course in a hands-on setting. Design constraints imposed by manufacturing limitations, funding constraints and market competition are included in the process. Typically offered in both the fall and spring.

b. Prerequisites:
Permission of Instructor

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Apply the *design process* to the design of a vehicle (Mini-Baja or Formula SAE). [B1, B2, B3, C1, C3, C4]
2. Apply *engineering fundamentals* to evaluate the design of a vehicle. [A1, A2, A4, A5]
3. Apply *teamwork skills* to management of the Mini-Baja or Formula SAE teams. [A5, A6, B1, B2]
4. Learn the effect of design choices by *building and testing* students' designs. [A3, A5, A6]

b. Related ME Program Outcomes
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: J. Starkey

REVISION DATE: June 12, 2013

ME 47300
ENGINEERING DESIGN USING MODERN MATERIALS

Course Outcomes [Related ME Program Outcomes in brackets]

1. To teach micro and macro properties of *metals*, *ceramics*, *polymers* and *composites*. [A1, B1]
2. To teach *design methodology* with these materials. [A1, B1]
3. To introduce *interdisciplinary aspects* of design with modern materials. [A1, B1]
4. To work in interdisciplinary teams. [B2]

Design Methods (4 wks)

1. Basic mechanics of materials
2. Failure criteria
3. Fracture mechanics and fatigue
4. Structural analysis

→

Metals and Ceramics (4 wks)

1. Properties of metals
2. Design with metals
3. Properties of ceramics
4. Design with ceramics

→

Polymers (4 wks)

1. Structures and properties of materials
2. Bonding and structure in polymers
3. Chemistry and microstructure
4. Mechanical properties
5. Manufacturing processes
6. Design with polymers

→

Composites (3 wks)

1. Fibers, matrices and composites

Revision Date: June 12, 2013

1. COURSE NUMBER AND NAME: ME 47300 Engineering Design Using Modern Materials

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

K. Kokini (ME) and J.M. Caruthers (ChE)

4. TEXTBOOK:

None

5. SPECIFIC COURSE INFORMATION:

a. Course Description: Interdisciplinary approach to design with modern materials such as metals, ceramics, polymers, and composites. Topics include: fundamentals of basic mechanics of materials, failure theories, and fracture mechanics applied to different materials; basic material properties and design with metals and ceramics; microstructure, chemistry, and bonding in polymers; materials properties and design with polymers; introduction to composite materials. Typically offered in the spring.

b. Prerequisites:
Senior Standing

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. To teach properties of *metals, ceramics, polymers* and *composites*. [A1, B1]
2. To teach *design methodology* with these materials. [A1, B1]
3. To introduce *interdisciplinary* aspects of design with modern materials. [A1, B1]
4. To work in *interdisciplinary* teams. [B2]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: K. Kokini (ME) and J.M. Caruthers (ChE)

REVISION UPDATE: June 12, 2013

ME 49200
TECHNOLOGY AND VALUES

Course Outcomes [Related ME Program Outcomes in Brackets]

1. Develop awareness of *technology's impact* on *people* and society. [A6]
2. Learn to critically assess *complex interdisciplinary issues*. [B4]
3. Develop a tolerant mind, *open to changes in values* and *institutions*. [C2]
4. Develop *moral autonomy* and a *moral vision*. [B3]
5. Develop skills necessary for *ethical assessment* of potential technological solutions. [B3]

Engineering Ethics (4 wks)

1. Ethics theories
2. Ethical dilemmas
3. Whistle-blowing
4. Case studies
5. Ethical design

→

Energy and Environment (3 wks)

1. Resources
2. Pollution
3. Population
4. Poverty
5. Economic Development
6. Appropriate Technology

→

Economics and Politics (3 wks)

1. Corporations
2. Economic Growth
3. Research and Development
4. Risk assessment
5. Legal issues
6. Democratic Decision-Making
7. Role of the Media

→

Culture and Community (3 wks)

1. Technological Optimism
2. Technological Pessimism
3. Cultural Paradigms
4. Technological Fixes
5. Political Fixes
6. Technological Determinism
7. Role of the Engineer
8. Futuristics

→

Philosophy and Religion (2 wks)

1. Personal Responsibility
2. Human Values
3. Warfare
4. God and Spirituality
5. Stewardship

Revision Date: 8/06/2012

1. **COURSE NUMBER AND NAME:** ME 49200 Technology and Values

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 1 day per week at 150 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

P. Meckl

4. TEXTBOOK:

W.M. Martin and R. Schinzinger, *Ethics in Engineering*, McGraw-Hill, 4th ed., 2005. R.M. Kidder, *How Good People Make Tough Choices*, Rev. ed., Harper Paperbacks, 2009. S.C. Florman, *The Existential Pleasures of Engineering*, St. Martin Press, 1996. Pacey, *Meaning in Technology*, MIT Press, 2001. R. Pirsig, *Zen & the Art of Motorcycle Maintenance*, Harper, 2005.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: The impact of science and technology on personal and societal value systems. The special responsibility of engineers. Practical methods for using human values to guide future technological developments. Societal problems considered: warfare, energy, over-population, resource depletion, and environmental degradation. Inter-disciplinary approaches stressed. Typically offered in spring (alternate years).

b. Prerequisites:
Senior Standing

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:
[Related ME Program Outcomes in Brackets]

1. Develop awareness of t*echnology's impact on people and society*. [A6]
2. Learn to critically *assess complex interdisciplinary issues*. [B4]
3. Develop a tolerant mind, *open to changes in values and institutions*. [C2]
4. Develop *moral autonomy* and a *moral vision*. [B3]
5. Develop skills necessary for *ethical assessment* of potential technological solutions. [B3]

b. Related ME Program Outcomes:
[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: P. Meckl

REVISION DATE: August 6, 2012

ME 50000
ADVANCED THERMODYNAMICS

Course Outcomes

1. Build an appreciation for the fundamentals and practical applications of classical thermodynamics.
2. Significantly enhance the understanding of thermodynamic principles and their relevance to the *problems of humankind*.
3. Provide the student with experience in applying thermodynamic principles to *predict physical phenomena* and to *solve engineering problems*.

Fundamental Thermodynamic Concepts (18 50-minute lectures)

1. 1st Law of Thermodynamics
2. 2nd Law of Thermodynamics
3. Transient Analysis
4. Exergy destruction
5. Exergy Analysis of Components and Cycles

→

Thermodynamic Properties and Phase Relations (15 50-minute lectures)

1. Equations of State
2. Thermodynamic Relationships
3. Liquid-Vapor Phase Change
4. Chemical Potential
5. Partial Properties
6. Fugacity
7. Phase Rule and Phase Equilibrium

→

Thermochemistry and Equilibrium (12 50-minute lectures)

1. Reaction Exergy
2. Fuel Cell Processes
3. Affinity
4. Ideal and Real Gas Equilibrium
5. Chemical Exergy

Example Engineering Problems

1. Analysis of Internal Combustion Engines
2. Analysis of Gas Turbines
3. Analysis of Vapor Compression Cycles with Refrigerant Mixtures
4. Fuel Cells
5. End Use of Resource Analyses

Revision Date: 6/29/12

1. COURSE NUMBER AND NAME: ME 50000 Advanced Thermodynamics

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

E.A. Groll

4. TEXTBOOK:

No Textbook; use of standard undergraduate textbooks as reference materials, such as Wark, Richards, *Thermodynamics*, 6th Ed., McGraw-Hill, 1999.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: The empirical, physical basis of the laws of thermodynamics. Availability/exergy concepts and applications. Properties and relations between properties in homogeneous and heterogeneous systems. The criteria of equilibrium. Application to a variety of systems and problems, including phase and reaction equilibrium. Typically offered in the fall (alternative years).

b. Prerequisites:
ME 30000 – Thermodynamics II

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Build an appreciation for the *fundamentals* and *practical applications* of *classical thermodynamics*.
2. Enhance the understanding of thermodynamic principles and their relevance to the *problems of humankind*.
3. Provide the student with experience in applying thermodynamic principles to *predict physical phenomena* and to *solve engineering problems*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: E.A. Groll

REVISION UPDATE: June 29, 2012

ME 50100
STATISTICAL THERMODYNAMICS

Course Outcomes

1. Provide a fundamental *microscopic understanding of thermodynamics*, temperature, radiation and transport phenomena.
2. Apply concepts and calculate thermodynamic and transport properties of *ideal gases*.
3. Evaluate properties in *reacting* and *non-reacting flow fields* from laser spectroscopic measurements.

Statistics of Independent Particles (4 wks)

1. Probability analysis
2. Most probable distribution
3. Maxwell-Boltzmann statistics
4. Thermal equilibrium
5. Partition function

→

Molecular Structures (3 wks)

1. Quantum mechanics
2. Schrödinger equation
3. Translational energy
4. Rotational energy
5. Vibrational energy
6. Electronic energy
7. Infrared spectroscopy
8. UV-visible spectroscopy

→

Ideal Gas Properties (4 wks)

1. Diatomic gases
2. Polyatomic gases
3. Equilibrium constant
4. Concentration measurements
5. Temperature measurements
6. Work and heat

→

Kinetic Theory (2 wks)

1. Maxwell-Boltzmann distribution
2. Collision theory
3. Transport properties
4. Chemical kinetics

→

Additional Applications (2 wks)

1. The Solid State
2. Blackbody radiation
3. Ensemble theory
4. Real gases

Revision Date: 7/31/2012

1. COURSE NUMBER AND NAME: ME 50100 Statistical Thermodynamics

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

R. Lucht

4. TEXTBOOK:

N. M. Laurendeau, *Statistical Thermodynamics: Fundamentals and Applications*, Cambridge University Press, 2005

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: The molecular interpretation of thermodynamic equilibrium. Development of the partition function. Solution of the Schrodinger equation for single cases. The Maxwell-Boltzmann formulations of statistical mechanics and application to ideal gases, radiation, laser diagnostics, sprays and solids. The Gibbs formulations of statistical mechanics and application to real gases. Kinetic theory and application to transport properties and chemical kinetics. Typically offered in the fall (alternative years).

b. Prerequisites:
ME 30000 – Thermodynamics II

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Provide a *fundamental microscopic understanding* of thermodynamics, temperature, radiation and transport phenomena.
2. Apply *concepts* and *calculate* thermodynamic and transport properties of ideal gases.
3. Evaluate *properties* in reacting and non-reacting flow fields from absorption and fluorescence measurements.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: R. Lucht

REVISION DATE: July 31, 2012

ME 50300
MICRO- AND NANO-SCALE ENERGY TRANSFER PROCESSES

Course Outcomes

Students in this course will:
1. Gain an understanding of the fundamental elements of solid-state physics.
2. Develop skills to derive continuum physical properties from sub-continuum principles.
3. Apply statistical and physical principles to describe energy transport in modern small-scale materials and devices.

1. Lattice Structure, Phonons, and Electrons (2 wks)

1.1: Introduction and Atomic Bonding
1.2: Mathematical Desc. of the Lattice
1.3: Lattice Vibrations and Phonons
1.4: Free Electrons
1.5: Example: 1D Atomic Chain with a Diatomic Basis

2. Carrier Statistics (2 wks)

2.1: Statistical Ensembles
2.2: Phonon Density of States
2.3: Electron Density of States
2.4: Example: Derivation of Planck's Law
2.5: Blackbody Emission Intensity

3. Basic Thermal Properties (2 wks)

3.1 Introduction to Specific Heat
3.2 Acoustic Phonon Specific Heat
3.3 Optical Phonon Specific Heat
3.4 Electron Specific Heat
3.5 Thermal Conductivity from Kinetic Theory

4. Landauer Transport Formalism (2 wks)

4.1 Basic Theory
4.2 Heat Flow Rate
4.3 Thermal Conductance
4.4 Spectral Conductance
4.5 Example: The Quantum of Thermal Conductance

5. Carrier Scattering and Transmission (3 wks)

5.1 Scattering Analysis Formalism
5.2 Thermal Conductivity Revisited
5.3 Boundary Scattering
5.4 Phonon Scattering Fundamentals
5.5 Interfacial Transmission
5.6 Thermionic Electron Emission

6. Modern Applications (4 wks)

1. Graphene: Unique Phonon Branches
2. Graphene: Scattering
3. Electro-thermal modeling of semiconductor devices
4. Thermionics and thermoelectrics
5. Near-field Radiation

Revision Date:
2/11/2013

Sample Projects

1. Thermal Effects on Operation and Reliability in Power Vertical DMOSFETs
2. Thermal Characterization of Field Emission from Diamond Thin Films
3. Microscale Engine Development: The Effect of Large Surface Area to Volume Ratio on Chemical Kinetics

1. COURSE NUMBER AND NAME: ME 50300 Micro- and Nano-Scale Energy Transfer Processes

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – Online recorded lectures via nanoHUB-U

b. Recitation – Weekly in-person led by the instructor

3. COURSE COORDINATOR OR INSTRUCTOR:

T. S. Fisher

4. TEXTBOOK:

Thermal Energy at the Nanoscale, by T.S. Fisher, World Scientific Publishing (in press, 2013 expected).

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: This course provides a detailed treatment of the transport of energy in natural and fabricated nanostructures. The physical nature of energy transport by four carriers—electrons, phonons, fluid particles, and photons—will be explored from first principles, as well as interactions among these carriers. Bulk material properties, such as thermal and electrical conductivity and thermal emissivity, will be derived from statistical particle transport theories, and the effects of spatial confinement on these properties will be explored. Following the treatment of fundamental physical principles, the course will focus on engineering applications, including heat generation and transport in semiconductor devices, quantum wells, wires, and dots, and alternative energy conversion. The applications are interdisciplinary in nature and will not presume prior expertise. Typically offered in the fall.

b. Prerequisites:
Masters Standing or Advanced Undergraduates

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

Students in this course will:

(1) Gain an understanding of the fundamental elements of solid-state physics and quantum mechanics.

(2) Develop skills to derive continuum physical properties from sub-continuum principles.

(3) Apply statistical and physical principles to describe energy transport in modern small-scale materials and devices

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: T.S. Fisher

REVISION DATE: February 11, 2013

ME 50500
INTERMEDIATE HEAT TRANSFER

Course Outcomes

1. To enhance the understanding of *heat* and *mass transfer processes* and their relevance to *industrial problems*.
2. To strengthen *analytical skills* and the ability to cope with *complex problems*.
3. To provide experience in treating *multimode heat transfer effects* and in solving *realistic engineering problems*.

Heat Transfer Fundamentals (1.5 wks)

1. Rate equations
2. Control volumes and energy balances
3. Heat transfer modes
4. Multimode analysis

Conduction Heat Transfer (3.5 wks)

1. Steady-state and transient conduction
2. Thermal resistances and capacitance
3. Separation of variables (including Bessel's functions)
4. Laplace transforms
5. Extended surfaces
6. Semi-infinite media, applications
7. Finite-difference methods
8. Applications

Convection Heat and Mass Transfer (4.5 wks)

1. Principles of convection
2. Governing equations
3. Boundary layers
4. Integral solutions
5. Forced convection in ducts
6. Turbulent boundary layers
7. Simple turbulence models
8. Free convection

Thermal Systems Analysis & Phase Change Heat Transfer (2.5 wks)

1. Thermal systems analysis
2. Stefan and Neumann problems
3. Boiling heat transfer
4. Two-phase flow
5. Condensation heat transfer

Radiation Heat Transfer (3 wks)

1. Radiative properties and energy balances
2. Diffuse-gray and spectrally selective enclosure analysis
3. Multimode effects
4. Participating media; modified radiosity equations
5. Mean-beam length and Hottel charts

Design Projects

1. Several 2-week design projects involving open-ended problems, needing computational analysis, using commercial codes and solvers
2. A semester-long project involving extensive study of a topic, computations and experiments

Revision Date: 6/10/2012

1. COURSE NUMBER AND NAME: ME 50500 Intermediate Heat Transfer

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

T. Fisher

4. TEXTBOOK:

T. Bergman, A.S. Lavine, F.P. Incropera, D.P. DeWitt, *Fundamentals of Heat and Mass Transfer*, 7th ed, Wiley, 2011

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Heat and mass transfer by diffusion in one-dimensional, two-dimensional, transient, periodic, and phase change systems. Convective heat transfer for external and internal flows. Similarity and integral solution methods. Heat, mass, and momentum analogies. Turbulence. Buoyancy driven flows. Convection with phase change. Radiation exchange between surfaces and radiation transfer in absorbing-emitting media. Multimode heat transfer problems. Typically offered in fall.

b. Prerequisites:
ME 31500 Heat and Mass Transfer

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Enhance the understanding of *heat* and *mass transfer processes* and their relevance to *industrial problems*.
2. Strengthen *analytical skills* and the ability to cope with complex problems.
3. Provide experience in treating *multimode heat* and *mass transfer effects* and in solving realistic engineering problems.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: T. Fisher

REVISION DATE: 10 June 2012

ME 50600
TWO-PHASE FLOW AND HEAT TRANSFER

Course Outcomes

1. Introduce fundamental transport phenomena associated with *phase change processes*.
2. Develop analytical tools for design and performance assessment of *two-phase devices*.

Introduction (1 wk)

1. Complexity of modeling multi-phase systems
2. Two-phase flow regimes
3. Dimensionless two-phase flow parameters

Two-Phase Fluid Dynamics (6 wks)

1. Homogeneous equilibrium model
2. Slip flow model
3. Drift-flux model
4. Annular flow model
5. Compressibility, choking and flashing
6. Interfacial instabilities

Condensation Heat Transfer (1 wk)

1. Laminar film condensation on a vertical wall
2. Laminar film condensation on 2D and 3D surfaces
3. Turbulent film condensation on a vertical wall
4. Heat exchanger calculation

Boiling Heat Transfer (6 wks)

1. Pool boiling curve
2. Nucleation criteria
3. Bubble growth models
4. Pool boiling heat transfer
5. Flow boiling heat transfer
6. Critical heat flux
7. Film boiling

Applications (2 wks)

1. Thermal management of computes, avionics and space systems
2. Design and/or performance assessment of a commercial thermal device

3. **Quenching of metallic alloys**

Live Classroom Demonstrations

1. Two-phase adiabatic flow regimes
2. Instabilities in vertical parallel heated tubes
3. Pool boiling on a wire
4. Surface microtexture

Revision Date: 6/26/2012

1. COURSE NUMBER AND NAME: ME 50600 Two-Phase Flow and Heat Transfer

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

I. Mudawar

4. TEXTBOOK:

Prepared class notes

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Basic two-phase flow equations, homogeneous model, drift-flux model, flow regimes, pressure drop in two-phase flow. Nucleation and bubble dynamics, pool boiling, subcooled boiling, forced convection boiling, critical heat flux in pool boiling, critical heat flux in forced convection boiling, minimum heat flux, film boiling, post-dryout heat transfer. Flow instabilities, choking in two-phase flow, film and dropwise condensation. Applications to heat exchanges. Special boiling and two-phase problems. Typically offered in spring.

b. Prerequisites:
ME 31500 – Heat and Mass Transfer

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Introduce fundamental transport phenomena associated with *phase change processes*.
2. Develop analytical tools for design and performance assessment of *two-phase devices.*

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: I. Mudawar

REVISION DATE: June 26, 2012

ME 50700
LASER PROCESSING

Course Outcomes

1. Provide background in *laser science* and *laser technology* used for laser materials processing.
2. Develop an understanding of the *physics of laser devices, laser beam propagation*, and fundamentals of *laser-matter interaction*.
3. Develop skills to quantify *thermal* and *thermomechanical phenomena* involved in laser processing.

Laser Fundamentals (3 wks)

1. Spontaneous emission, absorption, stimulated emission and Einstein coefficient
2. Laser gain equation and laser power
3. Laser efficiency

Laser Systems (2 wks)

1. Solid state lasers, Ruby, and rare-earth (glass, YAG, YLF, etc.) lasers
2. Gas lasers, HeNE, Arion, CO_2, Nitrogen, and excimer lasers
3. Liquid lasers, dye laser

Laser Beam Optics (3 wks)

1. Review of geometry optics
2. EM wave theory
3. Gaussian beam optics, propagation of laser beam in optical systems

Laser-matting Interaction (4 wks)

1. Physics of absorption of laser beam by a solid
2. Laser-induced heating, melting and evaporation
3. Laser-induced stress and strain development

Special Topics (3 wks)

1. Laser welding
2. Laser machining
3. Laser hardening
4. Laser micro and nano manufacturing
5. Ultrafast laser processing

Laboratory and Video Demonstrations

1. Laser fundamentals
2. Laser beam optics
3. Laser machining and laser-assisted machining

Examples of Projects (One project per semester)

1. Shaping of ultrafast laser pulses
2. Laser-based rapid prototyping
3. Laser-induced stress wave generation and propagation
4. Laser induced surface plasmon
5. Laser interaction with biological materials

Revision Date: 7/17/2012

1. COURSE NUMBER AND NAME: ME 50700 Laser Processing

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

X. Xu

4. TEXTBOOK: None

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Introduces background in laser science and laser technology, and fundamentals involved in laser processing and manufacturing. The following topics are discussed: laser fundamentals, industrial laser systems and processes, and the laser-induced thermal, thermo-mechanical and thermo-acoustic effects. The course also discusses emerging areas of laser applications, such as micro and nanoscale laser processing, ultrafast laser processing, and the related energy transport analyses. Laboratory and video demonstration sessions are used to enhance the overall understanding of the course materials. Typically offered in the fall (alternative years).

b. Prerequisites:

ME 31500 – Heat and Mass Transfer

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Knowledge in *laser science* and *laser technology*.
2. Develop an understanding of the *physics of laser devices*, *laser beam propagation*, and fundamentals of *laser –matter interaction.*
3. Develop skills to quantify thermal and *thermomechanical phenomena* involved in laser processing.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7 LIST OF TOPICS: See following page.

PREPARED BY: X. Xu

REVISION DATE: July 17, 2012

ME 50800
HEAT TRANSFER IN BIOLOGICAL SYSTEMS

Course Outcomes

1. Provide a thorough understanding of the *fundamentals* of *bio-heat* and *mass transfer*.
2. Introduce *clinical* and *industrial applications* of bio-heat and mass transfer.

Introduction to biological & physiological system (1 wk)

1. Biomaterials
2. Cellular structure and functions
3. Extracellular matrix
4. Water transport
5. Solute transport

→

Transport principles (1 wk)

1 Mass conservation
2. Momentum conservation
3. Energy conservation
4. Chemical species conservation

→

Characteristics of burn injury (4 wks)

1. Pennes equation
2. Arrhenius burn injury model
3. Blood perfusion
4. Hyperthermia
5. Thermography

→

Drug transport around tumor (4 wks)

1. Blood-borne transport
2. Transvascular transport
3. Interstitial transport
4. Cellular uptake
5. Nanotherapuetics

→

Biopreservation (4 wks)

1. Cellular Physics
2. Mass transport at the cell membrane
3. Cryopreservation
4. Tissue engineering
5. Microfluidics

Revision Date: 2/11/2013

1. COURSE NUMBER AND NAME: ME 50800 Heat Transfer in Biological Systems

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes in first two weeks & one week after the completion of each team project.

b. In-Class Discussion – 3 weeks of 3 days per week at 50 minutes

3. COURSE COORDINATOR OR INSTRUCTOR:

Bumsoo Han

4. TEXTBOOK: None

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Introduction to applications of heat transfer in living systems to students who have general interests in biomedical engineering. Fundamental concepts of biology and engineering involved in these applications are introduced. Regulation of blood flow under external thermal stimuli and its effect on heat transfer will be discussed. Clinical applications of heat transfer, including cancer therapy and gene therapy. Typically offered in spring semester (alternating years)

b. Prerequisites:
First Semester Senior Standing

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Provide a thorough understanding of the *fundamentals* of *bio-heat* and *mass transfer*.
2. Introduce *clinical and industrial applications* of bio-hat Transfer.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: Bumsoo Han

REVISION DATE: February 11, 2013

ME 50900
INTERMEDIATE FLUID MECHANICS

Course Outcomes

1. Unify and strengthen the student's background in *fluid mechanics*.
2. Develop an understanding of the *Lagrangian* and *Eulerian forms* of the *conservation equations*.
3. Master *classic solution techniques* for basic fluid mechanics problems.

Fundamental Concepts (1 wk)

1. Concept of a continuum
2. Eulerian description of a flow field
3. Lagrangian description of a flow
4. The Reynolds' Transport Theorem

Governing Equations: Integral Form (3 wks)

1. Conservation of mass
2. Linear momentum Equation
3. Angular momentum Equation
4. Conservation of energy

Governing Equations: Differential Form (4 wks)

1. Conservation of mass
2. Conservation of energy
3. Review of the stress tensor
4. Linear momentum equation
5. Newtonian Fluids: The Navier-Stokes equations

Solution Methods (7 wks)

1. Potential flow theory
2. Vorticity transport equations
3. Classic solutions to the N-S equations
4. Boundary layer theory
5. Turbulence and Reynolds' stresses
6. Prandtl's mixing length hypothesis

Revision Date: June 12, 2013

1. COURSE NUMBER AND NAME: ME 50900 Intermediate Fluid Mechanics

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

C. Wassgren

4. TEXTBOOK:

Incompressible Flow, Panton, Ronald L., Wiley 2005,
ISBN# 978-0-471-26122-3

5. SPECIFIC COURSE INFORMATION:

a. Course Description: Fluid properties. Basic laws for a control volume. Kinematics of fluid flow. Dynamics of frictionless incompressible flow and basic hydrodynamics. Equations of motion for viscous flow, viscous flow applications, boundary layer theory. Wall turbulence, lift and drag of immersed bodies. Typically offered in the fall.

b. Prerequisites:
ME 30900 – Fluid Mechanics
AAE 33400 – Aerodynamics

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Unify and strengthen the students' background in *fluid mechanics*.
2. Develop an understanding of the *Lagranian* and *Eulerian forms* of the *conservation equations*.
3. Master *classic solution techniques* for basic fluid mechanics problems.

b. Related ME Program Outcomes

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: C. Wassgren

REVISION DATE: June 12, 2013

ME 510
GAS DYNAMICS

Course Outcomes

1. Introduce the student to the fundamentals of *compressible fluid flow*.
2. Master solution methods for *one dimensional flow*.
3. Obtain a general understanding of the principles of *multi-dimensional flow*.

Fundamental Concepts (2 wks)

1. Concept of a continuum
2. Perfect fluids and equations of state
3. Acoustic speed and Mach number
4. Governing equations

One Dimensional Flow (5 wks)

1. Isentropic flow with area change
2. Flow with friction: the Fanno Line
3. Flow with heat transfer: the Rayleigh Line
4. Flow with mass addition
5. Generalized 1-D flow
6. Normal shock waves
7. Oblique shock waves
8. Expansion waves
9. Supersonic wind tunnels and diffusers

Multi-Dimensional Flow (4 wks)

1. Vorticity and circulation
2. Potential and stream functions
3. Kelvin's theorem
4. Crocco's theorem
5. Linearized flow equations
6. Thin airfoil theory

Advanced Topics (4 wks)

1. Method of characteristics
2. Supersonic nozzle design
3. Unsteady 1-D flow
4. Shock tubes

Revision Date: 2/12/2013

1. COURSE NUMBER AND TITLE: ME 51000 Gas Dynamics

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

C. Wassgren & N. Key

4. TEXTBOOK:

M.J. Zucrow and J.D. Hoffman, *Gas Dynamics*, Vol. 1, John Wiley, 1982. (This will likely change in 2014 because of difficulties encountered in acquiring out-of-print text.)

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Flow of compressible fluids. One-dimensional flows, including basic concepts, isentropic flow, normal and oblique shock waves. Rayleigh line, Fanno line, and simple waves. Multidimensional flows, including general concepts, small perturbation theory for linearized flows, and method of characteristics for nonlinear flows. Typically offered in spring (alternating years).

b. Prerequisites:
ME 30900 – Fluid Mechanics
AAE 33400 – Aerodynamics

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Introduce the student to the fundamentals of *compressible fluid flow*.
2. Master solution methods for *one dimensional flow*.
3. Obtain a general understanding of the principles of *multi-dimensional flow*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: N. Key

REVISION DATE: February 12, 2013

ME 51100
HEAT TRANSFER IN ELECTRONIC SYSTEMS

Course Outcomes

1. To introduce concepts in *thermal management* of electronics to senior undergraduate and graduate students and practicing engineers.
2. To provide an appreciation for the applications of *first principles* to electronics cooling and packaging problems in industry.
3. To provide students with *sound tools to approach existing packaging and cooling applications*, while also raising awareness of *novel techniques* at the cutting edge.

Introduction to Packaging & Heat Transfer Principles (4 wks)

1. Introduction to thermal management
2. Heat transfer modes
3. Thermal spreading and contact resistance
4. Natural convection and radiation
5. Forced convection
6. Boiling and condensation
7. Microscale heat transfer

Cooling Technologies (4 wks)

1. Fin analysis; heat sink design and optimization
2. Air and liquid jet impingement
3. Immersion cooling
4. Phase change energy storage
5. Multi-mode heat transfer problems
6. Case studies and applications

Systems Analysis (2.5 wks)

1. Thermal systems analysis
2. Cold plates and heat exchangers
3. Flow network modeling
4. Thermodynamic analysis of cooling systems; economic analysis
5. Compact models
6. Acoustics and mechanical design issues

Thermal Measurements (1.5 wks)

1. Temperature, pressure, flow, sound, strain and other measurements
2. Microscale measurement techniques
3. Uncertainty in experimental measurements

Emerging Technologies (3 wks)

1. Heat pipes and thermosyphons
2. Microchannel heat exchangers
3. Thermoelectric and thermoacoustic cooling
4. Piezoelectrics
5. Other
6. Thermal challenges and trends

1. COURSE NUMBER AND NAME: ME 51100 Heat Transfer in Electronic Systems

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 75 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

S.V. Garimella

4. TEXTBOOK:

No Text Required

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: This course covers both traditional and more innovative methods for heat extraction in electronic systems and the effectiveness and applicability of these methods over a wide range of scales. Special emphasis is given to industry-related applications with experts often attending and presenting material as part of class instruction. Typically offered in the spring (odd numbered years).

b. Prerequisites:
ME 31500 – Heat and Mass Transfer

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. To introduce concepts in thermal management of electronics to senior undergraduate and graduate students and practicing engineers.
2. To provide an appreciation for the applications of first principles to electronics cooling and packaging problems in industry.
3. To provide students with sound tools to approach existing packaging and cooling applications, while also raising awareness of novel techniques at the cutting edge.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: S. V. Garimella

REVISION DATE: June 20, 2013

ME 51300
ENGINEERING ACOUSTICS

Course Objectives

1. Introduce the fundamental concepts of acoustical analysis to engineers with an emphasis on the wave approach.
2. Study wave propagation, sound radiation, absorption and transmission.
3. Apply fundamental concepts to noise control practice.

Fundamentals of Vibrations

1. Simple oscillator – free and forced vibration
2. Resonance
3. Impedance

The Vibrating String

1. Development of wave equation
2. Solution of wave equation
3. Boundary conditions
4. Forced vibration
5. Normal modes of vibration

The Acoustic Wave Equation and Simple Solutions

1. Linearized wave equation
2. Speed of sound
3. One-dimensional solutions – plane and spherical waves
4. Impedance
5. Intensity

Sound Transmission and Reflection

1. Normal incidence transmission and reflection at fluid interface
2. Oblique incidence reflection and transmission
3. Transmission through a limp panel
4. Reflection from absorbing media

Radiation of Sound

1. Radiation from monopoles and dipoles
2. Line sources
3. Radiation from a piston
4. Directivity
5. Radiation impedance

Pipes, Cavities and Wave Guides

1. Boundary conditions
2. Forced oscillations and standing waves
3. Rectangular ducts
4. Circular ducts

Room Acoustics

1. Sound in enclosures
2. Growth of sound in a room
3. Concept of reverberation time
4. Sound absorption materials
5. Acoustic factors in architectural design

Revision Date: 2/13/13

1. COURSE NUMBER AND NAME: ME 51300 Engineering Acoustics

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

K.M. Li and J.S. Bolton

4. TEXTBOOK:

L.E. Kinsler, A.R. Frey, A.B. Coppens and J.V. Sanders, *Fundamentals of Acoustics*, 4th ed., , John Wiley & Sons, 1999.

5. SPECIFIC COURSE DESCRIPTION:

a. Catalog Description: The simple oscillator, lumped acoustical elements. Wave motion in strings. Introduction to linear acoustics through derivation of the wave equation and simple solutions. Plane and spherical waves. Acoustic intensity. Plane wave transmission through fluid layers and simple barriers. Sound absorption. Modeling of acoustical sources: monopoles, dipoles, quadrupoles. Mechanisms of sound generation and directionality. Sound propagation in one-dimensional systems: e.g., ducts and mufflers. Introduction to room acoustics. Typically offered in the fall.

b. Prerequisites:
First Semester Senior Standing

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Introduce the fundamental concepts of *acoustical analysis* to engineers with an emphasis on the *wave approach*.
2. Study *wave propagation, sound radiation, absorption* and *transmission*.
3. Apply fundamental concepts to *noise control* practice.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: K. M. Li and J. S. Bolton

REVISION DATE: February 12, 2013

Revision Date: 2/13/13

ME 51400
FUNDAMENTALS OF WIND ENERGY

Course Outcomes

1. To introduce students to the technology and economics of converting wind energy to electricity.
2. To inform students to the environmental concerns of wind energy.
3. Understand principles of wind turbine aerodynamics
4. Develop the ability to design optimum& arbitrary blading
5. Develop ability to evaluate a potential site in terms of wind energy
6. Understand wind turbine control & vibration issues

Introduction to Wind Turbines (2 wks)

1. Alternative Energy Need
2. Demand for Electricity
3. History of Wind Energy
4. Current Statuses

Wind Energy Fundamentals (3 wks)

1. Power in the Wind
2. Wind Turbine Classification
3. Wind Turbine Power & Torque
4. Turbine Actuator Disk Theory
5. Turbine Characteristics

Wind Regimes (3 wks)

1. Wind
2. Wind Measurements
3. Wind Data Analysis
4. Statistical Models for Wind Data Analysis
5. Energy Estimation of wind regimes

Wind Turbine Aerodynamics (3 wks)

1. Airfoil Aerodynamics
2. Axial Momentum Theorem
3. Blade Element Theory
4. Rotor Design
5. Rotor Performance

Wind Energy Systems (3 wks)

1. Wind Electric Generators
2. Turbine Control & Reliability
3. Wind Farms
4. Turbine Environmental Issues

Wind Energy Economics (1 wk)

1. Wind Energy Benefits
2. Wind Energy Cost
3. Economic Figures of Merit

1. COURSE NUMBER AND NAME: ME 51400 Fundamentals of Wind Energy

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

S. Fleeter

4. TEXTBOOK: None

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Introduction to wind turbines - history, demand and current status. Wind energy fundamentals - power, torque, aerodynamics and rotor design and performance. Wind regimes - measurements and analysis. Wind energy systems - electric generators, wind farms, offshore wind farms. Wind energy economics – benefits, cost and figures of merit. Wind energy environmental issues. Typically offered in the fall.

b. Prerequisites:
ME 20000 – Thermodynamics I
ME 30900 – Fluid Mechanics

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Introduce students to the *technology* and *economics* of converting wind energy to electricity
2. Inform students to the *environmental concerns* of wind energy.
3. Understand principles of *wind turbine aerodynamics*.
4. Develop the ability to design *optimum blading*.
5. Develop ability to *evaluate a potential site* in terms of wind energy.
6. Understand wind turbine *rotor vibration & control issues*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: S. Fleeter

REVISION DATE: June 26, 2012

ME 51700 (ChE 51700)
MICRO/NANOSCALE PHYSICAL PROCESSES

Course Outcomes

1. To study physical processes in *micro/nanoscale systems*.
2. To determine *when to expect those processes to behave differently* than at macroscopic length scales.
3. To learn *how* and *when to use these behavior differences* to accomplish tasks at microscopic length scales.
4. To learn how to use *analysis tools* (ANSYS, Matlab) to study these systems and predict their behavior.

Introduction (2 weeks)

1. What is MEMS?
2. Why MEMS? Scaling laws.
3. Fundamentals of microfabrication;
   i. wet bulk micromachining
   ii. surface micromachining
   iii. alternative methods

→

Mechanics and Dynamics (2.5 weeks)

1. Steady state deformation of cantilevers and membranes
2. Dynamical behavior of cantilevers and membranes
3. Introduction to ANSYS
4. Applications: ANSYS analysis of atomic force microscopy and pressure sensing

→

Electricity and Magnetism (3.5 weeks)

1. Maxwell's Equations
2. Applications: electrophoresis, electrostatic force transduction, and magnetic force transduction

→

Surface Phenomena (1.5 weeks)

1. Surface Tension/Adhesion
2. Surface forces: DLVO, hydration, hydrophobic
3. Applications: Electrosmosis, thermocapillarity, electrowetting

→

Fluidics (3 weeks)

1. Low Reynolds number hydrodynamics: flow through a rectangular pipe
2. Nonlinear Phenomena: acoustical streaming
3. Applications: Electrohydrodynamics/ magnetohydrodynamics

Heat and Mass Transfer (2.5 weeks)

1. Fourier's Law
2. Fick's Law
3. Convection
4. Applications: LIGA heat exchangers, magnetic separation

Revision Date: 6/17/2013

1. COURSE NUMBER AND NAME: ME 51700 (ChE 51700) Micro/Nanoscale Physical Processes

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

S. Wereley

4. TEXTBOOK:

Nguyen & Wereley, *Fundamentals and Applications of Microfluidics*, Artech House, 2006, ISBN# 978-1-58053-972-2

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: This class will prepare engineers and scientists to address problems they will encounter when studying physical phenomena in Micro-Electromechanical Systems (MEMS). The course will prove the student with the tools to analyze statics, dynamics, electricity and magnetism, surface phenomena, fluid dynamics heat transfer and mass transfer problems at the micron scale. Quantitative analysis is specific MEMS devices will be achieved through finite element analysis using the ANSYS programming package. Typically offered in the spring.

b. Prerequisites:
ME 31500 – Heat and Mass Transfer

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. To study physical processes in *microscale systems*.
2. To determine *when to expect those processes to behave differently* than at macroscopic length scales.
3. To learn *how* and *when to use these behavior differences* to accomplish tasks at microscopic length scales.
4. To learn how to use *analysis tools* (ANSYS, Matlab) to study these systems and predict their behavior.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: S. Wereley

REVISION DATE: June 17, 2013

ME 51800
ANALYSIS OF THERMAL SYSTEMS

Course Outcomes

1. To develop a comprehensive understanding of the fundamentals of *thermal systems' modeling* and *analysis*.
2. To develop a detailed understanding of *vapor compression systems*, *absorption systems*, and *other advanced heat pumping equipment*.

Vapor Compression Equipment (7 wks)

1. Thermodynamics
2. Refrigerants
3. Compressors
4. Heat Exchangers
5. Expansion Devices
6. System Modeling and Optimization
7. System Improvements

→

Absorption Equipment (4 wks)

1. Thermodynamics of Mixtures
2. Ammonia Water Systems
3. Water/LiBr Systems
4. Advanced Cycles
5. Absorption-Compression Systems

→

Advanced Heat Pumps (4 wks)

1. Dessicant Cooling
2. Air Cycles
3. Stirling Cycles
4. Ericsson Cycles
5. Thermoacoustic Cooling
6. Other Advanced Cycles

Sample Projects (One project per semester)

1. Optimal Design of a Room Air Conditioner
2. Analysis of Water as a Refrigerant for Vapor Compression Chillers
3. Energy Analysis of Vapor Compression Cycle Improvements
4. Energy Analysis of Alternative Chiller Capacity Control Methods

Revision Date: 06/29/12

1. COURSE NUMBER AND NAME: ME 51800 Analysis of Thermal Systems

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

E.A. Groll

4. TEXTBOOK:

No textbook required. Use of undergraduate Thermodynamic and HVAC&R textbooks as reference materials.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Modeling and optimization of thermal systems with a focus on heat pumping equipment, such as vapor compression, absorption, and some advanced heat pumping cycles. Students combine the use of thermodynamics, heat transfer, fluid mechanics, and numerical methods to develop and apply mathematical models for the analysis and optimization of specific equipment. Typically offered in the fall (alternative years).

b. Prerequisites:

ME 30000 – Thermodynamics II
ME 31500 – Heat and Mass Transfer

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Fundamentals of *thermal systems' modeling* and *analysis*.
2. Detailed understanding of *vapor compression systems*, *absorption systems*, and *other advanced heat pumping equipment*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship;

7. LIST OF TOPICS: See following page.

PREPARED BY: E.A. Groll

REVISION DATE: June 29, 2012

ME 52500
COMBUSTION

Course Outcomes

1. To introduce mass and energy balance in the presence of *chemical reactions*.
2. To apply mass and energy balances to *combustion processes*, such as fuel and mixture preparation, premixed and non-premixed flames, reactors, fires, and detonations.
3. To establish links between *combustion processes* and *combustion equipment* and *applications*.

Fundamentals (3 wks)

1. Thermodynamic properties of mixtures
2. Chemical and phase equilibrium
3. Basic chemical kinetics
4. System level mass, species, and energy conservation in the presence of chemical reactions

Reactors (3 wks)

1. Constant volume combustion
2. Constant pressure combustion
3. Well stirred and plug flow reactors
4. Ignition and extinction

Fundamentals (3 wks)

1. Heat, mass transfer, phase change
2. Differential equations for conservation of species, mass, and energy
3. Rudiments of turbulent reacting flows
4. Statistics of turbulent reactions

Flame Models (4 wks)

1. Non-premixed flames
2. Premixed flames
3. Turbulent jet flames
4. Deflagrations and detonations

Applications (2 wks)

1. Reciprocating engines
2. Gas turbine engines
3. Furnaces
4. Fire safety

Sample Projects

1. Spark ignition engine combustion analysis- e.g. Effects of EGR on emissions
2. Effects of ambient temperature on ignition, fuel vaporization, and other aspects
3. Effects of spray characteristics on combustion processes
4. Design of a combustor based on load and flame size

Revision Date: 6/17/2013

1. COURSE NUMBER AND NAME: ME 52500 Combustion

2. CREDITS AND CONTACT HOURSE: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

J. Abraham

4. TEXTBOOK:

Turns, S.R., *An Introduction to Combustion Concepts & Applications*, 3rd ed., McGraw Hill 2012, ISBN# 978-0-07-338019-3

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Physical and chemical aspects of basic combustion phenomena. Chemical energetics and equilibrium. Basic chemical kinetic, chain reactions and explosions. Chain and thermal ignition. Homogeneous combustion models. Detonations and deflagrations. Laminar flame speed and flame extinction. The Shvab-Zeldovich formulation of the multicomponent conservation equations. Diffusion flames and droplet combustion. Introduction to turbulent combustion. Typically offered in the spring.

b. Prerequisites:
First Semester Senior Standing

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Introduce mass and energy balance in the presence of *chemical reactions*.
2. To apply fundamental mass and energy balances to *combustion processes*, such as fuel and mixture preparation, premixed and non-premixed flames.
3. To establish links between *combustion processes* and *combustion equipment* and *applications*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engineering Tools;
A5. Design Skills;
A6. Impact of Solutions;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: J. Abraham

REVISION DATE: June 17, 2013

ME 52600
SPRAY APPLICATIONS AND THEORY

Course Outcomes

1. Analyze current *spray processes* via analysis and experiment.
2. Quantitatively decide which *hardware* to use for an application.
3. *Design new spray hardware* and/or *processes* on a natural basis.

Introduction (2 wks)

1. Basic spray processes
2. Factors controlling drop formation
3. Drop size and velocity distribution functions

→

Sheet and Ligament Breakup/Drop Formation (4 wks)

1. Instability analysis
2. Design models based on instability analysis
3. Drop static/dynamic force balances
4. Secondary atomization
5. Collisions/Coalescence

→

Drop Motion/Spray Surroundings Interaction (4 wks)

1. Force balances
2. Steady and transient trajectories
3. Entrainment of surrounding gas
4. Evaporation

→

Atomizer Performance (5 wks)

1. Correlation based models
2. Basic principles based models
3. Drop size measurements
4. Drop velocity measurements
5. Mass distribution
6. Internal flow models

Revision Date: 6/27/12

1. **COURSE NUMBER AND NAME:** ME 52600 Spray Applications and Theory

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

P.E. Sojka

4. TEXTBOOK: None

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Theory of spray formation and evolution, as well as treating a host of spray applications. Topics include drop size distributions, breakup of liquid sheets and ligaments, drop formation and breakup, drop motion and the inter-action between a spray and its surroundings, drop evaporation, nozzle performance, and experimental techniques relevant to these subjects. Applications include: 1) agriculture sprays, 2) consumer products, 3) gas turbine and rocket combustion, 4) heat transfer, 5) internal combustion engines, 6) paints and coatings, 7) pharmaceutical and medicinal sprays, and 8) spray drying. Typically offered in fall (alternative years).

b. Prerequisites:

ME 31500 Heat and Mass Transfer

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Analyze current *spray processes* via analysis and experiment.
2. Quantitatively decide which *hardware* to use for an application.
3. Design new *spray hardware* and/or *processes* on a rational basis.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship;

7. LIST OF TOPICS: See following page.

PREPARED BY: P.E. Sojka

REVISION DATE: June 27, 2012

ME 53300
TURBOMACHINERY II

Course Outcomes

1. Understand the fundamentally unsteady nature of *turbomachine energy transfer*.
2. Understand the fundamental processes involved in *forced response* and *flutter*.
3. Understand the fundamental processes involved in *discrete frequency noise.*
4. Understand the fundamental processes involved in *compressor surge* and *stall*.
5. Gain the ability to *analyze problems* in blade row interaction to *predict unsteady loading*, *noise*, and *flutter boundaries*.

Fundamental Concepts (4 wks)

1. Complex Numbers
2. Energy Transfer
3. Linearized Flow Equations
4. Reduced Frequency

Linear Theory Unsteady Aerodynamics (4 wks)

1. Fundamental equations
2. Rotational & irrotational splitting
3. Plane wave solutions
4. Discrete frequency noise generation

Forced Response and Flutter (5 wks)

1. Single degree-of-freedom systems
2. Stability and flutter
3. Aerodynamic damping
4. Blade row structural dynamics
5. Bladed disk vibrations
6. Wind Turbine Blade Vibration Issues

Discrete Frequency Noise Generation (2 wks)

1. Response Modes
2. Annular Duct Acoustics
3. Turbomachine & Wind Turbine Application
4. Active Noise Control

Compressor Stability (2 wks)

1. Rotating stall
2. Surge
3. Theory of initiation
4. Small perturbation stability theory
5. Surge line management

Revision Date: 6/26/2012

1. COURSE NUMBER AND NAME: ME 53300 Turbomachinery II

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

S. Fleeter

4. TEXTBOOK: None

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Aerodynamic analysis and design of axial flow and radial flow gas compressors and gas turbines. Blade element performance (deflection, profile and shock losses, etc.). Meridional flow analysis for general radial equilibrium. Secondary flow and end-wall boundary layer models. Centrifugal compressor modeling. Unsteady flow, rotating stall and surge. Typically offered in the spring.

b. Prerequisites:

ME 43300 – Principles of Thermodynamics or
AAE 53800/ME 53800 – Air Breathing Propulsion

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Understand the fundamentally unsteady nature of *turbomachine energy transfer*.
2. Understand the fundamental processes involved in *forced response* and *flutter*.
3. Understand the fundamental processes involved in *discrete frequency* noise.
4. Understand the fundamental processes involved in *compressor surge* and *stall*.
5. Gain the ability to analyze problems in blade row interaction - to *predict unsteady loading*, *flutter boundaries*, *resonant response*, *discrete frequency noise generation and control*, and *rotating stall/surge onset*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: S. Fleeter

REVISION DATE: June 26, 2012

ME 53800 /A&AE 53800
AIR BREATHING PROPULSION

Course Outcomes

1. Understand principles of operation of turbojet, turbofan, and turboprop engines.
2. Develop the ability to select a cycle and size an engine for mission requirements.
3. Develop the ability to perform fundamental component design and analysis.
4. Develop the ability to perform component matching.
5. Develop the ability to predict on and off design operating points for an engine.

Fundamental Concepts (2 wks)

1. Review of thermodynamics
2. Review of fluid mechanics
3. Review of compressible flow
4. Basics of energy transfer

Cycle Analysis (3 wks)

1. Ideal cycle analysis
2. Engine performance parameters
3. Component performance parameters
4. Real cycle analysis
5. Design point performance

Inlet and Nozzle (1 wk)

1. Inlet performance parameters
2. Subsonic inlets
3. Supersonic inlets
4. Thrust nozzle performance

Combustor (2 wks)

1. Diffusion combustor terminology
2. Main combustor aerodynamics
3. Combustor performance parameters
4. Radial profiles and profile factor
5. Emissions
1. Operability
7. Augmentors

Turbomachinery (4 wks)

1. Inlet design for transonic compressors
2. Mean line design
3. Full radial equilibrium
4. Blade element design
5. CFD for design systems
6. Real fluid effects

Operability and Durability (2 wks)

1. Spool balancing in two-shaft engines
2. Engine off design performance
3. Compressor operability issues
4. Turbine durability issues

Revision Date: 6/17/2013

1. COURSE NUMBER AND NAME: ME 53800 (A&AE 53800) Air Breathing Propulsion

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

C. Merkle

4. TEXTBOOK:

Cohen, Rogers, & Saravanamuttoo, *Gas Turbine Theory,* 5th Edition, Addison-Wesley, ISBN# 013015847-x

Heiser & Pratt, *Hypersonic Air Breathing Propulsion,* AIAA, ISBN# 1-56347-035-7

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Analysis of operating characteristics of turbojet, turbofan, turboshaft, afterburning, and ramjet propulsion systems. Analysis and design of inlet, diffuser, combustor, compressor, turbine, and nozzle. Component matching and off-design performance. Inlet distortion, nozzle-afterbody, and installation losses. Mission analysis. Typically offered in the fall.

b. Prerequisites:
ME 43800 – Gas Turbine Engines or
A&AE 37200 – Jet Propulsion Power Plants

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Understand principles of operation of *turbojet*, *turbofan* and *turboprop engines*.
2. Develop the ability to *select a cycle* and *size an engine* for mission requirements.
3. Develop the ability to perform fundamental *component design* and *analysis*.
4. Develop the ability to perform *component matching*.
5. Develop the ability to *predict on-* and *off-design operating points* for an engine.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: C. Merkle

REVISION DATE: June 17, 2013

ME 54000
INTERNAL COMBUSTION ENGINES

Course Outcomes

1. Study the fundamentals of turbulence, boundary layers, liquid atomization, sprays, combustion, and pollutant formation as applied to internal combustion engines.
2. Study the modeling of engine flows, sprays, combustion, and pollutant formation in internal combustion engines.

Engine Basics (2 wks)

1. Geometry
2. Performance parameters
3. Engine cycles
4. Phenomenological engine models

→

In-cylinder fluid motion (2 wks)

1. Valve flow, swirl, tumble, squish
2. Boundary layers
3. Fundamentals of turbulence production and decay in engines
4. Modeling of engine flows

→

Fuel Injection and Sprays (3.5 weeks)

1. Injectors and spray patterns in engines
2. Liquid jet breakup mechanisms
3. Drop and spray vaporization
4. Fuel/air mixing
5. Modeling of engine sprays

→

Combustion in engines (4.5 wks)

1. Modes of combustion in engines
2. Regimes of turbulent combustion
3. Chemical kinetics
4. SI engine combustion
5. Ignition/Autoignition/ knock
6. CI engine combustion
7. Modeling of combustion in engines

→

Pollutant in engines (3 wks)

1. Kinetics of pollutant formation
2. UHC, CO, NO, soot formation mechanisms in engines
3. Environmental impact
4. Exhaust aftertreatment
5. Modeling of pollutants in engines

Revision Date: 6/15/2012

1. COURSE NUMBER AND NAME: ME 54000 Internal Combustion Engines

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 75 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

J. Abraham

4. TEXTBOOK:

Heywood, J.B., Internal Combustion Engine Fundamentals, McGraw-Hill, New York, 1988.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Spark-ignition and compression-ignition engine processes. Study of the fundamentals of turbulence, boundary layers, liquid atomization, sprays, combustion, and pollutant formation as applied to engines. Engine aftertreatment. Modeling of engine flows, sprays, combustion, and pollutants. Typically offered in the spring (alternate years).

b. Prerequisites:

ME 30000 – Thermodynamics II
ME 31500 – Heat and Mass Transfer
ME 44000 – Internal Combustion Engines or consent of instructor

b. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Study the fundamentals of turbulence, boundary layers, liquid atomization, sprays, combustion, and pollutant formation as applied to internal combustion engines.
2. Study the modeling of engine flows, sprays, combustion, and pollutant formation in internal combustion engines.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: J. Abraham

REVISION DATE: June 15, 2012

ME 54900
EXPERIMENTAL VIBRATIONS

Course Outcomes

1. Introduce/review the theory of *linear mechanical vibrations*.
2. Learn how to model and analyze *single/multi-degree-of-freedom (SDOF/MDOF) systems* in *free* and *forced vibration*.
3. Learn how to *plan experiments*/tests and *interpret dynamic response data* using modern technology.
4. Introduce basic *experimental methods*, *vibration hardware* and *advanced analysis techniques* like modal analysis, impedance modeling, and experimental nonlinear vibration.

Fundamentals SDOF (review) – 2 wks

1. Assumptions and nomenclature
2. Degrees-of-freedom
3. Inertia, damping, stiffness
4. Laplace transforms
5. Transfer functions, frequency response, impulse response
6. Free/forced vibration
7. Time/freq./spatial concepts
8. Importance of SDOF systems (superpos.)
9. Matrix methods/ eigen-analysis

→

Fundamental MDOF (review) – 3 wks

1. Free vibration
   - Poles/eigenvalues
   - Eigen-/modal vectors
   - Coord. transformation
   - Coupling (static/dyn.)
   - Modal superposition
2. Forced vibration
   - TF/FRF matrices
   - Impedance analysis
   - Fourier series and superposition
   - Relationship to modal parameters
3. General damping
   - Proportional
   - Non-proportional
   - Effects on FRF and impulse response

→

Modal Analysis – 4 wks

1. Modal superposition
   - Single to multiple DOFs
2. Experimental methods
   - Sinusoidal I-O
   - Frequency response
   - Damped Complex Expn.
   - Mathematical I-O
3. Parameter estimation
   - Concepts (MPE process)
   - Model order
   - SDOF techniques
   - Low order techniques
   - High order techniques
   - Residue estimation
   - Modal data validation

→

Impedance Models – 3 wks

1. Impedance models
   - Input-output models
   - Dynamic stiffness
   - Dynamic compliance
   - Compatibility and continuity constraints
   - Components and assembly
2. Perturbed boundary conditions
   - Rigid body transformation
   - Vibration absorber ex.
   - Mass, damping, stiffness
   - Nonlinear connections

→

Intro. to Nonlinear Vibration – 3 wks

1. Qualitative methods
   - State space/geometric
   - Phase plane projection
   - Poincare maps
2. Basic phenomena
   - Fixed points/orbits
   - Nonlinear resonance
   - Modulation
   - Limit cycles
   - Bifurcation, etc.

Laboratory Experiments - Weekly

1. Structural dynamic imedance analysis and modeling
   - FRF estimation, MIMO testing, sub-structuring
2. Structural dynamic modal analysis and modeling
   - Model order, modal parameter estimation, impact testing
3. Introduction to experimental nonlinear dynamics and vibrations
   - Periodic response, Poincare maps, harmonic distortion

Experimental Considerations

1. Hardware
   - Transducers
   - Signal conditioners
   - Front-end
2. Signal processing
   - Time domain
   - Frequency domain
   - Fourier analysis
   - Excitation methods

Revision Date: June 26, 2012

1. **COURSE NUMBER AND NAME:** ME 54900 Experimental Vibrations

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 50 minutes for 16 weeks

b. Laboratory – 1 day per week at 150 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:
D. Adams

4. TEXTBOOK: Class Notes

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Theory and application of experimental structural dynamics. Experimental techniques in modal analysis, impedance modeling, and basic nonlinear vibrations. Time, frequency, and spatial characteristics of vibrating systems. Virtual and real-time demonstrations and experiments. Vehicle vibrations in ride, machinery diagnostics, and health monitoring of structural materials and components. Typically offered in the spring.

b. Prerequisites:
ME 37500 – System Modeling and Analysis

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Introduce/review the theory of *linear mechanical vibrations*.
2. Learn how to model and analyze *single/multi-degree-of-freedom* (SDOF/MDOF) *systems* in *free* and *forced vibration*.
3. Learn how to *plan experiments/tests* and *interpret dynamic response data* using modern technology.
4. Introduce basic *experimental methods*, *vibration hardware* and *advanced analysis techniques* like modal analysis, impedance modeling and experimental nonlinear dynamics.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: D. Adams

REVISION DATE: June 26, 2012

ME 55300
PRODUCT AND PROCESS DESIGN

Course Outcomes

1. Reinforce the *philosophy* that product and process development is resource intensive.
2. Integrate marketing and business strategy considerations into the design and manufacturing plan.
3. Broaden skills in *using modern CAD design tools and methods* for product prototyping, integration of business issues and information technology into the product design process.
4. Prototype the product, design and process plan and marketing strategy (mini-business plan).
5. Integrate development with use of information technology infrastructure.

Opportunity Identification (4 wks)

1. Customer and market identification
2. Product Planning
3. Product Specification
4. Marketing considerations

User Centered Design (6 wks)

1. Concept development
2. Principles of good design
3. Product interfaces
4. Product architecture
5. Tools: Design for X

Product Design and Prototyping (5 wks)

1. Product prototyping
2. Rapid tooling
3. Intellectual Property Issues
4. Supply chain integration
5. Information technology

Example Products (Each team develops their own concept to a project)

1. Ergonomic Auditory Device
2. Cargo Keeper
3. Ford's Vehicle Seat Tray
4. Ladder Leveling Device
5. The Smart Mat
6. Get Tanked
7. Cleaner Dog Paws
8. Nozzle2K

Revision Date: 6/17/2013

1. COURSE NUMBER AND NAME: ME 55300 Product and Process Design

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

K. Ramani

4. TEXTBOOK:

No textbook required

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Fundamental principles of product and process design to produce a marketable product, develop a preliminary business strategy, and construct an operation prototype. Overview of relevant principles related to product and process design. Market analysis, design parameters, manufacturing prototype plan, production process plan, and business strategy developed in teams. Broad overview of the entire product development process including patents, commercialization of new technologies and the highly interdisciplinary nature of product design through industry guest lectures. Impact of information technologies and the internet on product design, prototyping, marketing and customization. Product prototype is required. Design and product software – information technology service-type concepts. Typically offered in the spring.

b. Prerequisites:
First Semester Senior Standing or Higher

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Reinforce the *philosophy* that product and process development is resource intensive.
2. Integrate *marketing* and *business* strategy considerations into the design and manufacturing plan.
3. Broaden skills in *using modern CAD design tools and methods* for product prototyping, integration of business issues and information technology into the product design process.
4. Prototype the *product*, *design* and process *plan* and marketing *strategy* (mini-business plan).
5. Integrate *development* with use of information technology infrastructure.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: K. Ramani

REVISION DATE: June 17, 2013

ME 55400
INTELLECTUAL PROPERTY

Course Outcomes

1. Understand and practice the basics of *defining inventions*.
2. Learn basics of *patents*, *trade secrets*, *trademarks*, *copyrights*.
3. Understand *licensing* and *litigation* of intellectual property.

Invention Definitions (4 wks)

1. Breadth of definitions
2. Diversity of definitions
3. Genus/Species
4. Markush Group

Typical Examples

- two handled leaf rake
- eyeglasses/ear protector
- reciprocating pedal bike
- wire door stop
- folding boat

Intellectual Property (Typical Project) (4 wks)

- Design to avoid patent claim
- Improvement design encompassed by patent claim

Patents and Trade Secrets (3 wks)

1. Subject matter
2. Types of patents
   - Utility
   - Design
   - Plant
3. Term of patents
4. Standard of prior art
5. Obviousness
6. Licensing
7. Litigation

Trademarks and Copyrights (2 wks)

1. Types of trademarks
2. Quality Control issues
3. Copyright issues
4. Special computer program deposit requirements

Employment, Confidential Disclosure, and General IP issues (2 wks)

1. Covenants not to compete
2. Obligations to Assign to employer
3. Confidential Disclosures
4. New business scenarios

Licensing and Litigation (2 wks)

1. Exclusive/ nonexclusive
2. Valuation and royalty bases
3. Jurisdiction
4. Damages
5. Injunctive Relief

Revision Date: 6-17-2013

1. COURSE NUMBER AND NAME: ME 55400 Intellectual Property

2. CREDITS AND CONTACT HOURS: 1 credit

a. Lecture – 1 day per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

J.C. McNett and K. Ramani

4. TEXTBOOK:

No Text Required

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Survey of the law of patents, trade secrets, trademarks and copyrights with special emphasis on the process of defining inventions broadly and diversely. Obtaining, registering, licensing and litigation of intellectual property. Typically offered in the fall.

b. Prerequisites:
PHYS 17200 – Modern Mechanics

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Understand and practice the basics of *defining inventions*.
2. Learn basics of *patents*, *trade secrets*, *trademarks*, *copyrights*.
3. Understand *licensing* and *litigation* of intellectual property.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: K. Ramani

REVISION DATE: June 17, 2013

ME 55600
LUBRICATION. FRICTION. AND WEAR

Course Outcomes

1. Understand the *fundamental science*, *technology* and *application* of *interacting lubricated surfaces* in relative motion.
2. Learn how to use the *latest analysis techniques* to model lubrication problems in tribology.
3. Provide practical *hands-on experience* with *modern measurement techniques* used in tribology.

Fundamentals (2 wks)

1. History of lubrication, friction, and wear
2. Defns (conformal and non-conformal)
3. Regimes of lubrication
4. Lubricants (Newtonian and non-Newtonian)
5. Units, grades, pressure & temperature dependence
6. Mineral/synethic lubricants, greases, viscometry

→

Surface Effects (1 wk)

1. Surface Meas. Tech.
   - Contacting
   - Non-contacting
2. Surface Parameters of interest

→

Bearings (6 wks)

1. Types of Bearings (journal, thrust, rolling,).
2. Bearing matls
3. Fund.of lubrication (Reynolds eqn)
4. Hydrodynamic lubrication
5. Journal, Thrust & Hydrostatic Bearings

→

Non-Conformal Contacts (2.5 wks)

1. Line and point contacts
2. Hertz Stress Theory
3. Elastohydrodynamic lubrication
4. Film thickness equations

→

Friction and Wear (2 wk)

1. Internal stresses and fatigue
2. Friction definition, models and measurements techniques
3. Wear models and measurement techniques

Laboratory Projects (1.5 wks)

1. Optical surface profilometry
2. Optical interferometry
3. Pin-on-disk contact
4. Ball on flat apparatus contact
5. Numerical modeling

Revision Date: 6/18/2013

1. COURSE NUMBER AND NAME: ME 55600 Lubrication, Friction, and Wear

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

F. Sadeghi

4. TEXTBOOK:

B.J. Hamrock, S.R. Schmid, B.O. Jacobson, *Fundamentals of Fluid Film Lubrication*, 2nd ed., Marcel Dekker, Inc., 2004.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Science, technology, and application of lubricated interacting surfaces in relative motion. Advanced analysis techniques and hands-on exposure to modern experimental methods provide an enhanced understanding of fundamental principles of lubrication, friction, and wear. Basics of design and analysis of machine components operating in the presence of air and liquid lubricants. Rolling fatigue, friction and wear models, and measurement techniques. Typically offered in the spring (alternate years).

b. Prerequisites:
First Semester Senior Standing or Higher

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Understand the fundamental *science*, *technology* and *application* of *interacting lubricated surfaces* in relative motion.
2. Learn the use of *analysis techniques* to model lubrication problems in tribology.
3. Provide practical *hands-on experience* with *modern measurement techniques* used in tribology.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: F. Sadeghi

REVISION DATE: June 18, 2013

ME 55700
DESIGN FOR MANUFACTURABILITY

Course Outcomes

1. Augment the mechanical design process with a body of knowledge concerning the *manufacturing aspects as related to design*.
2. Provide a *design experience* in which the students can disassemble, suggest redesigns for, create new parts, and obtain feedback from industry concerning manufacturability.

Design Process Representation (4 wks)

1. Product development cycle
2. Design process
3. Quality function deployment

→

Manufacturing Considerations (3 wks)

1. Material and manufacturing selection
2. Statistical tolerancing

→

Assembly (2 wks)

1. Assembly process
2. Design for assembly

→

Economic Analysis (2 wks)

1. Quality
2. Cost breakdown (fixed and variable cost)
3. Value engineering

→

Robust Design for Manufacturing (4 wks)

1. Robust design
2. Taguchi methods
3. Reliability, life cycle engineering, failure modes and effects analysis (FMEA)

Laboratory Projects

1. CAD, machining, and measurement exercises. (3 weeks)
2. Quality function deployment exercise focused on household appliances. (2 weeks)
3. Statistical tolerancing exercise. (2 weeks)
4. Design for assembly exercise. (1 week)
5. Industry-sponsored project (Redesign of a product including concept explanation, DFA analysis, manufacturing/material selection, tolerance analysis, FMEA, and cost analysis). (6 weeks)
6. Taguchi exercise. (1 week)

Typical Industry Related Projects

1. Redesign of a Washing Machine (Whirlpool)
2. Redesign of an Automotive Fuel Sender (Ford)
3. Redesign of a Kitchen Mixer (KitchenAid)

Revision Date: 7/30/12

1. COURSE NUMBER AND NAME: ME 55700 Design for Manufacturability

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 50 minutes for 16 weeks

b. Laboratory – 1 day per week at 170 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

R.J. Cipra

4. TEXTBOOK:

G.E. Dieter, *Engineering Design: A Materials and Processing Approach*, 3rd ed, McGraw-Hill, 2000.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Introduction to manufacturing concerns such as efficient design, producibility, and quality, which must be considered early in the engineering design process. Topics include the product development cycle, manufacturing process selection, tolerancing, quality function deployment (QFD), design for assembly (DFA), quality control techniques, Taguchi's robust design methodology, life cycle engineering and reliability. Laboratory projects in the area of tolerancing, assembly and manufacturability are included along with a project from industry in which the students can disassemble, analyze, and redesign a product while obtaining feedback from industry concerning manufacturability. Typically offered in the fall.

b. Prerequisites:

First Semester Senior Standing or Higher

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Augment the mechanical design process with a body of knowledge concerning the *manufacturing aspects as related to design*.
2. Provide a *design experience* in which the students can disassemble, suggest redesigns for, create new parts, and obtain feedback from industry concerning manufacturability.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: R. J. Cipra

REVISION DATE: July 30, 2012

ME 55900
MICROMECHANICS OF MATERIALS

Course Outcomes

1. Introduce concepts of *heterogeneous materials*.
2. Learn *continuum mechanics* concepts for improved material description.
3. Learn about advanced *constitutive equations*.
4. Learn how *microstructure* is connected to *material properties*.
5. Learn how to apply *less commonly used materials*.
6. Apply these concepts to *analysis of engineering components*.
7. Foster an *interdisciplinary approach* among mechanics and materials science.

Fundamentals (4 wks)

1. Review of Continuum Mechanics Concepts
2. Basic Composite Mechanics
3. Homogenization
4. Localization
5. Stiffness, Thermal Expansion, Yield Strength, Fracture of Long Fiber Composites
6. Shear Lag Model Approach

Two Phase Materials (4 wks)

1. Mean Field Methods
2. Eigenstrain, Eigenstress
3. Eshelby Tensor
4. Dilute Model
5. Self Consistent Model
6. Mori-Tanaka Method
7. Microstructure-Property Relationships
8. Applications

Cellular Solids (3 wks)

1. Honeycomb Structures: Metals, Polymers, Ceramics
2. Stiffness, Nonlinear Behavior
3. Foams
4. Applications: Thermal Shock Resistance, Energy Absorption

Damage Mechanics (4 wks)

1. Solids and Microcracks
2. Damage Variable
3. Experimental Findings
4. Damage Equivalent Stress
5. Damage Evolution
6. Ductile Fracture
7. Application

Revision Date: 6/26/2012

1. COURSE NUMBER AND NAME: ME 55900 Micromechanics of Materials

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

T. Siegmund

4. TEXTBOOK:

None – hand-outs from recent literature provided.

5. SPECIFIC COURSE INFORMATION

a. Catalog Description: Prediction of the macroscopic behavior of materials from their microstructure and the design of new materials. Microstructure-property relationships between the macroscopic material behavior and microscopic structure. Application to traditional structural as well as to new engineering materials. Adapting emerging constitutive relations into structural analyses. Introduction of this new approach to materials, its application in predictive analysis tools, and its importance in simulation-based engineering. Typically offered in the spring.

b. Prerequisites:
First Semester Senior Standing or Higher

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Introduce concepts of *heterogeneous* materials.
2. Learn *continuum mechanics* concepts for improved material description.
3. Learn about advanced *constitutive equations*.
4. Learn how *microstructure* is connected to *material properties*.
5. Learn how to apply *less commonly used materials*.
6. Apply these concepts to *analysis of engineering components*.
7. Foster an *interdisciplinary approach* among mechanics and materials science.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: T. Siegmund

REVISION DATE: June 26, 2012

ME 56000
KINEMATICS

Course Outcomes

1. Study design of *planar mechanisms*.
2. *Graphical techniques* to kinematic synthesis.
3. Study *finite* and *infinitesimal rigid body motion*.
4. Use *curvature theory* in the synthesis of planar mechanisms.

Infinitisimal Motion (4 weeks)

1. Point Path
2. Geometry
3. Instant Centers
4. Velocity Analysis
5. Acceleration Analysis
6. Jerk Analysis

Curvature Theory (4 weeks)

1. Radius of Curvature
2. Center of Curvature
3. Inflection Circle
4. Bresse Circle
5. Stationary Curvature

Mechanism Design (2 weeks)

1. Planar Type Synthesis
2. Linkages
3. Cam-Follower System

Finite Motion (3 weeks)

1. Synthesis
2. Two Positions
3. Three Positions
4. Four Positions

Mechanism Design (2 weeks)

1. Continuous Motion
2. Assembly Configurations

Revision Date: 7/02/12

COURSE NUMBER AND NAME: ME 56000 Kinematics

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

G.R. Pennock

4. TEXTBOOK:

Uicker, Pennock and Shigley, *Theory of Machines and Mechanics*, 4th ed., Oxford University Press, 2011.

5. SPECIFIC COURSE INFORMATION

a. Catalog Description: Geometry of constrained plane motion with applications to linkage design. Type and number synthesis, size synthesis. Path curvature, inflection circle, cubic of stationary curvature. Finite displacements, three and four separated positions. Graphical, analytical, and computer techniques. Typically offered in the fall.

b. Prerequisites:
ME 35200 – Machine Design I

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Study design of *planar mechanisms*.
2. Study *finite* and *infinitesimal rigid body motion*.
3. *Graphical techniques* to kinematic synthesis.
4. Use *curvature theory* in the synthesis of mechanisms.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: G.R. Pennock

REVISION DATE: July 2, 2012

ME 56100
OPTIMAL DESIGN: THEORY WITH PRACTICE

Course Outcomes

1. Develop *optimization techniques* for Engineering Design.
2. Understand *computational implications* of optimization techniques.
3. *Apply optimization techniques* to contemporary design problems.
4. *Appreciate* basic aspects of linear, geometric, and integer programming.

Optimization Basics (1.5 wks)

1. Problem definition and classification
2. Matrix computation
3. Multivariate calculus

Unconstrained Methods (3 wks)

1. Necessary and sufficient conditions
2. Steepest descent, Newton and Quasi-Newton methods
3. Conjugate gradient algorithm
4. Globalization and line search

Constrained Methods (3 wks)

1. Kuhn-Tucker necessary conditions
2. Penalty and barrier methods
3. Projected gradient methods
4. Method of feasible directions

Sensitivity Analysis (2 wks)

1. Direct method
2. Adjoint method
3. Fast reanalysis techniques

Other Topics (5.5 wks)

1. Local, global and mixed approximations
2. Multicriteria optimization
3. Multilevel optimization
4. Linear programming

Case Studies and Contemporary Applications

- Students will complete four projects, each lasting three weeks covering the above four topics. The projects will use the same example and will increase in complexity of the solution approach to illustrate the trade-off between algorithmic complexity and solution efficiency. Issues related to accuracy, efficiency and robustness will be demonstrated using codes developed in the Matlab environment.

Revision Date: 6/18/2013

1. COURSE NUMBER AND NAME: ME 56100 Optimal Design: Theory with Practice

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 75 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

G. Subbarayan

4. TEXTBOOK:

No Text Required

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Optimization as an element of the engineering design process. Case studies that demonstrate the theory and application of nonlinear programming as a design tool. Comparative examination of unconstrained algorithms. Development and application of methods for the constrained case. Selected contemporary topics. Typically offered in the spring.

b. Prerequisites:

None

c. Status:

Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Develop *optimization techniques* for Engineering Design.
2. Understand *computational implications* of optimization techniques.
3. Apply *optimization techniques* to contemporary design problems.
4. Appreciate *basic aspects* of multicriteria optimization, multilevel optimization and linear programming.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: G. Subbarayan

REVISION DATE: June 18, 2013

ME 56200
Advanced Dynamics

Course Outcomes

1. Develop an understanding of the principles governing the motion of *mechanical systems modeled as rigid bodies*.
2. Develop an ability to analyze *rigid-body kinematics* in *stationary* as well as *moving frames of reference*.
3. Develop an ability to use *Newton-Euler Laws* of rigid body motion.
4. Develop an understanding of the fundamental concepts in *analytical dynamics*, and the ability to use them to formulate the equations of motion for rigid bodies and systems.

Review of Newtonian Mechanics (1.5 wks)

1. Kinematics of a particle
2. Reference frames and Newton's Laws
3. Various coordinate systems for motion description
4. D'Alembert's principle applied to a particle

→

Kinematics of a Particle (2 wks)

1. Concept of angular velocity of one frame relative to another
2. Rigid body motion about a fixed point
3. Time derivative of a unit vector
4. Velocity and acceleration of a point in a rigid body
5. Vector derivatives in rotating frames
6. Motion of a particle in a moving coordinate system

→

Dynamics of a System of Particles (2 wks)

1. Newton's Laws and direct integration of equation of motion
2. Equations of motion for a system of particles
3. Work and kinetic energy
4. Linear impulse and momentum
5. Angular impulse and momentum
6. Central impact and collisions

→

Analytical Mechanics (4 wks)

1. Constraints and their classification
2. Possible and virtual displacements
3. Generalized coordinates, forces, and degrees of freedom
4. Principle of virtual work and D'Alembert's principle
5. Conservative, gyroscopic and dissipative forces
6. Lagrange's equations for holonomic systems
7. Lagrange multipliers and nonholonomic systems

→

Dynamics of a Rigid Body (4 wks)

1. Degrees of freedom and moments of inertia
2. Angular momentum and kinetic energy of a rigid body
3. Transformation of coordinates and principal axes
4. Infinitesimal and finite rotations, angular velocity
5. Euler angles
6. Euler's equations of motion
7. Impulse-momentum and work-energy principles

Special Topics (1.5 wks)

1. Dynamics of a rigid body: a. Free motion of a rigid body; b. motion of a symmetric top; c. stability of steady motions
2. Analytical dynamics: a. generalized momenta and conservation; b. ignorable coordinates and routhian; c. Hamilton's principle and Hamiltonian form of equations of motion
3. Linear systems and stability: a. Linearized equations of motion for holonomic systems; b. classification of systems; c. systems dependent on parameters – divergence and flutter

Revision Date:
6/18/2013

1. COURSE NUMBER AND NAME: ME 56200 Advanced Dynamics

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

A. Bajaj

4. TEXTBOOK:

Greenwood, *Principals of Dynamics*, 2nd ed., Prentice Hall.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Dynamics of multi-degrees-of-freedom mechanical systems. Holonomic and nonholonomic constraints. Legrange's equations of motion. Hamilton's principle of holonomic systems. Kinematics and kinetics of rigid body motion. Classification of vibratory systems-gyroscopic, circulatory forces. Stability of linear systems-divergence and flutter. Applications to gyroscopes, satellite dynamics, etc. Typically offered in the spring.

b. Prerequisites:
ME 35200 – Machine Design I

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Develop an understanding of the principles governing the motion of *mechanical systems* modeled as rigid bodies.
2. Develop an ability to analyze *rigid-body kinematics* in stationary as well as moving frames of reference.
3. Develop an ability to use *Newton-Euler laws* of rigid body motion.
4. Develop an understanding of the fundamental concepts in *analytical dynamics*, and the ability to use them to formulate the *equations of motion for rigid bodies* and *systems*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: A. Bajaj

REVISION DATE: June 18, 2013

ME 56300
MECHANICAL VIBRATIONS

Course Outcomes

1. Develop an understanding of elements and concepts in *mechanical vibration*.
2. Develop ability to derive equations of motion for *discrete and continuous parameter vibrating systems*.
3. Introduce *methods of vibration analysis* including numerical and closed-form solutions.
4. Develop a familiarity with *common applications of vibration* in engineering including isolation and absorption.
5. Gain an appreciation for the key differences between *linear and nonlinear vibration*

Development of Equations of Motion (3 wks)

1. Newton-Euler Equations
2. Power Equation
3. Lagrange's Equations
4. Linearization of Equations of Motion

Free Vibration Response (5 wks)

1. Single-DOF Systems
2. Multi-DOF Systems
3. Continuous Systems
4. Rigid Body Modes
5. Beating Response
6. Damped Response

Forced Response (5 wks)

1. Harmonic Excitation
2. Periodic Excitation
3. Arbitrary Excitation
4. Modal Decomposition
5. Types of Damping
6. Applications

Approximate Methods and Nonlinearity (2 wks)

1. Finite Element Modeling
2. Nonlinear Stiffness and Damping
3. Limit Cycle Oscillations
4. Nonlinear Resonance

Revision Date: 6/26/2012

1. COURSE NUMBER AND NAME: ME 56300 Mechanical Vibrations

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

C. Krousgrill, D. Adams

4. TEXTBOOKS:

Thompson, *Theory of Vibration with Applications*, 5th ed, Prentice Hall

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Review of systems with one degree of freedom. Newton/Euler and Lagrange's equations of motion for multiple degrees of freedom systems. Continuous and lumped parameter vibration modeling. Introduction to matrix methods. Frequency response functions for harmonic response. Convolution integrals for response to arbitrary inputs. Natural frequencies and principal modes. Applications to critical speeds, measuring instruments, isolation, torsional systems. Introduction to linearization and nonlinear vibrating systems. Typically offered in the fall.

b. Prerequisites:
ME 32300 – Mechanics of Materials
ME 36500 – Systems and Measurements

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Develop an understanding of elements and concepts in *mechanical vibration*.
2. Develop ability to derive equations of motion for *discrete and continuous parameter vibrating systems*.
3. Introduce *methods of vibration analysis* including numerical and closed-form solutions.
4. Develop a familiarity with *common applications of vibration* in engineering including isolation and absorption.
5. Gain an appreciation for the key differences between *linear and nonlinear vibration*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: D. Adams

REVISION DATE: June 26, 2012

ME 56400
VIBRATION OF DISCRETIZED SYSTEMS

Course Outcomes

1. Develop an understanding of response of *higher order vibration systems*.
2. Introduce of *advanced topics* in vibration analysis.

Modeling of Vibrational Systems (3 wks)

1. Review of Lagrange's Equations
2. Hamilton's Principle
3. Assumed Modes Method
4. Galerkin's Method
5. Classification of Systems

Review of Conservative System Response (3 wks)

1. Natural Frequencies and Mode Shapes
2. Orthogonality
3. Modal Uncoupling
4. Proportional Damping
5. Applications

Nonconservative Systems (3 wks)

1. Modeling
2. Eigenvalue and Adjoint Eigenvalue Problems
3. Orthogonality and Modal Uncoupling
4. Stability Analysis
5. Applications

Rotating Systems (3 wks)

1. Modeling
2. Eigenvalue Problem for Gyroscopic Systems
3. Orthogonality and Modal Uncoupling Series
4. Critical Speeds and Stability
5. Applications

Special Topics (3 wks)

1. Finite Element Analysis
2. Random Vibrations
3. Introduction to Nonlinear Response

Revision Date: 6/18/2013

1. COURSE NUMBER AND NAME: ME 56400 Vibration of Discretized Systems

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

A. Raman

4. TEXTBOOK:

No Text Required

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Theory of small oscillations of discrete or discretized systems of high dimensionality. Formulation of equations of motion using Lagrange's equation and the influence coefficients. Finite element reductions of continuous systems. Natural frequencies and modes; numerical methods. Free vibrations and forced vibration characteristics; modal expansion; approximation techniques; damping. Assembly of large systems from subsystems concepts, impedance techniques. Typically offered in the spring.

b. Prerequisites:
ME 56300 – Mechanical Vibrations

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Develop an understanding of response of *higher order systems*.
2. Introduce *advanced topics in vibrations*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: A. Raman

REVISION DATE: June 18, 2013

ME 56500
VEHICLE DYNAMICS

Course Outcomes

1. To mature in application of modeling techniques to predict the *dynamic behavior of highway* vehicles.
2. To develop an understanding of the relationships between *vehicle design variables* and *vehicle dynamic behavior* (acceleration, braking, handling, and ride).

Performance (6 wks)

1. Tire Models
2. Aerodynamics
3. Drive-train Models
4. Vehicle Model
5. Braking Models
6. Acceleration Simulation

Handling (7 wks)

1. Indeterminacy of tire loads
2. Tire models and slip
3. Suspension models
4. Transient steering models and stability
5. Steady-State models, understeer/oversteer
6. Skid-pad testing

Ride (2 wks)

1. Comfort
2. Quarter-car models
3. Bounce-pitch models

Typical Simulation Projects

1. Manual Transmission vehicle full-throttle simulation of 1/4 mile
2. Lane-change steering simulation
3. Understeer coefficient variation with lateral acceleration

Revision Date: 6/18/2013

1. COURSE NUMBER: ME 56500 Vehicle Dynamics

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

J.M. Starkey

4. TEXTBOOK:

T. Gillespie, *Fundamentals of Vehicle Dynamics*, Society of Automotive Engineers, Inc., 1992.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Modeling of wheeled vehicles to predict performance, handling, and ride. Effects of vehicle center of mass, tire characteristics, traction and slip, engine characteristics, and gear ratios on performance. Suspension design. Steady state and transient handling models of four-wheeled vehicles and car-trailer systems to determine oversteer and understeer characteristics, critical speeds, and stability. Multi- degree-of-freedom ride models, including tire and suspension compliance. Computer simulations. Current research topics in vehicle vibration isolation. Typically offered in the spring.

b. Prerequisites:
ME 35200 – Machine Design I
ME 37500 – System Modeling and Analysis

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. To mature in *application* of modeling techniques to predict the dynamic behavior of highway vehicles.
2. To develop an *understanding* of the relationships between vehicle design variables and vehicle dynamic behavior (acceleration, braking, handling, and ride).

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: J.M. Starkey

REVISION DATE: June 18, 2013

ME 56600
MECHANICS OF MACHINERY

Course Outcomes

1. Develop ability to design and analyze *high speed mechanisms*.
2. Develop ability to design and analyze *mechanisms with deformable members*.
3. Understand effects of mechanism design on *transient and steady state response and stability*.

Analysis of High Speed Mechanisms (6.5 wks)

1. Kinematics of single-loop mechanisms
2. Harmonic motion linkages
3. Dynamics of single degree-of-freedom mechanisms
4. Balancing

→

Design of High Speed Mechanisms (3 wks)

1. Motion of lamina in plane
2. Planar synthesis
3. Harmonic motion linkages

→

Elastic Mechanisms (5.5 wks)

1. Modeling
2. Dynamic response (transient and steady state)
3. Parametric instability
4. Design considerations

Revision Date: 6/18/2013

1. COURSE NUMBER AND NAME: ME 56600 Mechanics of Machinery

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

J. Starkey

4. TEXTBOOK:

B. Paul, *Kinematics and Dynamics of Planar Machinery*, Prentice Hall, 1979.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Selected topics in machine analysis and design for high-speed applications. Rigid-body kinemtics and dynamics of mechanisms, and balancing of machinery. Cam-follower mechanisms. Mathematical modeling of mechanisms comprised of elastically deformable elements. Transient and steady-state vibration response and parametric instability inelastic mechanisms. Typically offered in the fall (alternate years).

b. Prerequisites:
ME 56300 – Mechanical Vibrations
First Semester Senior Standing or Higher

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Develop ability to design and analyze *high speed mechanisms*.
2. Develop ability to design and analyze *mechanisms with deformable members*.
3. Understand effects of mechanism design on *transient and steady response and stability*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: J. Starkey

REVISION DATE: June 18, 2013

ME 56700
DYNAMICAL PROBLEMS IN DESIGN

Course Outcomes

1. Review of fundamentals of *kinematics*, *dynamics*, *vibrations*.
2. Modeling *dynamic systems*.
3. Modeling *interaction* with *environment* and *determination of response*.
4. Investigation of *case studies*.

Review (2 wks)

1. Kinematics
2. Kinetics
3. Oscillatory motion

→

Modeling (5 wks)

1. Assumptions
2. Newtonian & Energy approaches
3. Analogies

→

Time Response (5 wks)

1. Phase Plane technique
2. General disturbances
3. Periodic disturbances

→

Case Studies (3 wks)

1. Balancing
2. Cam dynamics

Typical Semester Projects

1. Modeling a washing machine with an unbalanced load.
2. Modeling a playground swing and rider.
3. Modeling a golf swing.

Revision Date: 7/30/12

1. COURSE NUMBER AND NAME: ME 56700 Dynamical Problems in Design

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

R.J. Cipra

4. TEXTBOOK: Class Notes

5. SPECIFIC COURSE INFORMATION

a. Catalog Description: Design of devices required to have specified dynamic characteristics. Modeling of linear and nonlinear systems and determination of their performance under deterministic and random inputs. Analytical and approximate methods, including computer solutions. Individual project involves modeling, analysis, and system simulation of an actual physical system's motion. Typically offered in the fall (alternate years).

b. Prerequisites:
First Semester Senior Standing or Higher

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Review of fundamentals *of kinematics*, *dynamics*, and *vibrations*.
2. Modeling *dynamic systems.*
3. Modeling *interaction* with *environment* and *determination of response.*
4. Investigation of case *studies*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: R. J. Cipra

REVISION DATE: July 30, 2012

ME 56900
MECHANICAL BEHAVIOR OF MATERIALS

Course Outcomes

1. Understand fundamental *mechanical behavior* of *engineering materials*.
2. Understand fundamental response of engineering materials to *load* and *environmental conditions*.
3. Understand fundamental *models* that describe these responses.
4. Understand the *integration* of the *models* and the *material behavior* in design process.
5. Enhance *product/component design* for *durability*.

Review of Material Science & Strength of Materials (1 wk)

1. Structure
2. Heat treatment
3. Deformation mechanisms
4. Stress/strain
5. Principal stresses

Elastic/Plastic Behavior (2 wks)

1. Elastic response
2. Static failure
3. Plastic response
4. Residual stress

Fatigue (4 wks)

1. Stress based
2. Strain based
3. Stress concentration
4. Life prediction
5. Residual stress

Fracture (3 wks)

1. Brittle fracture
2. Brittle transition
3. Fracture mechanics
4. Stress intensity
5. Fracture toughness
6. Plane stress
7. Plane strain

Crack Propagation (3 wks)

1. Dynamic
2. Fatigue
3. Models
4. Life prediction

Environment (1 wk)

1. Corrosion
2. High temp

Failure Analysis (1 wk)

1. Case studies
2. Methods
3. Redesign

Student Projects

1. Case studies
   a. Stress analysis
   b. Environment
   c. Material structure
   d. Redesign

Revision Date: 6-19-2013

1. COURSE NUMBER: ME 56900 Mechanical Behavior of Materials

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

T. Siegmund

4. TEXTBOOK:

N.E. Dowling, *Mechanical Behavior of Materials*, 2nd ed., Prentice-Hall, 1998.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: A study of how loading conditions and environmental conditions can influence the behavior of materials in service. Elastic and plastic behavior, fracture, fatigue, low and high temperature behavior. Introduction to fracture mechanics. Emphasis is on methods of treating these conditions in design. Typically offered in the spring.

b. Prerequisites:
MSE 23000 – Structure and Properties of Materials

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Understand fundamental *mechanical behavior* of *engineering materials*.
2. Understand fundamental response of engineering materials to *load* and *environmental conditions*.
3. Understand fundamental *models* that describe these responses.
4. Understand the *integration* of the *models* and the *material behavior* in design process.
5. Enhance *product/component design* for *durability*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: T. Siegmund

REVISION DATE: June 19, 2013

ME 57000
MACHINE DESIGN

Course Outcomes

1. Understand complicated *3-D state of stress* for both *determinate* and *indeterminate problems*.
2. Learn *advance theory of elasticity*.
3. Gain fundamental knowledge of *bodies in contact*.
4. Learn solution methods for *torsion of prismatic section* and *bending of asymmetric cross section*.
5. Apply *energy method* to solve problems for *linear* and *nonlinear materials*.

Stress Analysis (3 wks)

1. Stress at a point, stress tensor, index notation
2. Stress-strain relationship
3. 3-D state of stress Cartesian and polar coordinates
4. Plane stress and plane strain conditions

→

Theory of Elasticity (5.5 wks)

1. 2-D & 3-D equil. equs. in Cartesian & polar coordinates
2. Compatibility equs.
3. Airy Stress functions for Cartesian and polar coord.
4. Straight and curved sections
5. Stress concentration
6. Example probs.

→

Contact Stress (2.5 wks)

1. Flamant solution
2. Hertz theory
3. Line contact
4. Circular contact
5. Point contact (1.5 weeks)

→

Bending & Torsion of Prismatic Sections (2 wks)

1. Bending of Asymmetric sect.
2. Stress in thin walled sections
3. Shear flow and shear center
4. Torsion of prismatic sections
5. Prandtl stress function
6. Membrane analogy

→

Energy Method (2 wks)

1. Castigliano's 1st and 2nd theorems.
2. Raleigh Ritz method
3. Crotti-Engesser theorem
4. Solutions for Non-linear materials

Revision Date: 6/19/2013

1. COURSE NUMBER AND NAME: ME 57000 Machine Design

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

F. Sadeghi

4. TEXTBOOK:

A.C. Ugural and S.K. Fenster, *Advanced Strength & Applied Elasticity*, 4th ed., McGraw-Hill.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Analysis of stresses and deflections due to complicated loading. Investigation of specific design problems through application of theory of elasticity, failure criteria, energy approach, and numerical methods. Individual design project. Typically offered in the fall.

b. Prerequisites:

ME 35200 – Machine Design I
ME 45200 – Machine Design II

c. Status:

Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Understand complicated *3-D state of stress* for both *determinate* and *indeterminate programs*.
2. Learn *advance theory of elasticity*.
3. Gain fundamental knowledge of *bodies in contact*.
4. Learn solution methods for *torsion of prismatic section* and *bending of asymmetric cross section*.
5. Apply *energy method* to solve problems for *linear* and *nonlinear materials*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: F. Sadeghi

REVISION DATE: June 19, 2013

ME 57100
RELIABILITY-BASED DESIGN

Course Outcomes

1. Review basics of *probability and random variables*.
2. Learn methods for *accessing reliability*.
3. *Predict the reliability* of existing designs.
4. *Design components* for specified reliability.

Probability and Random Variables (5 wks)

1. Probability rules
2. Expected value and variance
3. Functions of random variables
4. Expected value and variance of functions
5. Common probability distributions

→

Accessing Reliability (3 wks)

1. Cumulative failure and reliability
2. MTTF, MTTR and availability
3. Reliability block diagrams
4. Fault-Tree analysis
5. State-Space analysis

→

Predicting Reliability (2 wks)

1. Weakest link systems
2. Fail-safe systems
3. Monte Carlo simulation
4. First-order reliability methods

→

Design for Reliability (5 wks)

1. Uncertainty in load, geometry, material and stress
2. Load-Strength interference
3. Quality Function Deployment
4. Failure modes, effects, criticality analysis
5. Reliability in Mechanical systems
6. Reliability in Electronic svstems

Revision Date: 6/19/2013

1. COURSE NUMBER AND NAME: ME 57100 Reliability-Based Design

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 75 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

G. Subbarayan

4. TEXTBOOK:

Patrick D.T. O'Connor, *Practical Reliability Engineering*, 4th ed., Wiley.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Basic concepts of probability and random variables. Time-dependent reliability models. Strength-based reliability and interference theory. Weakest-link and fail-safe systems. Extremal distributions. Monte Carlo methods. Maintainability and availability. Fault tree analysis. Quality control and reliability. Typically offered in the spring.

b. Prerequisites:
ME 45200 – Machine Design II

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Review basics of *probability and random variables*.
2. Learn methods for *accessing reliability*.
3. *Predict the reliability* of existing designs.
4. *Design components* for specified reliability.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: G. Subbarayan

REVISION DATE: June 19, 2013

ME 57200
ANALYSIS AND DESIGN OF ROBOTIC MANIPULATORS

Course Outcomes

1. Analysis of *manipulator motion* and *forces*.
2. *Manipulator design* including actuator, drive, and sensor issues.
3. *Computer simulation* to predict motion and forces.

Configuration (2 wks)

1. Topology
2. Workspace

→

Motion (5 wks)

1. Position solution (Forward/Inverse)
2. Velocity & jacobian matrix
3. Acceleration
4. Trajectory planning
5. Singularities & dexterity

→

Dynamic Force (2 wks)

1. Analysis of rigid body forces & torques
2. Joint actuation requirements

→

Design Issues (5 wks)

1. Motor selection
2. Harmonic drives
3. Encoders & other sensors
4. Manipulator control requirements
5. Vision & tactile sensing

→

Simulation (1 wk)

1. Motion
2. Use of existing computer programs

Typical Projects

1. Forward position solution for a general manipulator
2. Path planning
3. Modeling and simulation of a manipulator

Revision Date: 7/30/12

1. COURSE NUMBER & NAME: ME 57200 Analysis and Design of Robotic Manipulators

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

R.J. Cipra

4. TEXTBOOK:

Class Notes

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Introduction to the analysis and design of robotic manipulators. Topics include kinematic configurations, forward and inverse position solution, velocity and acceleration, path planning, workspace analysis, force and torque solutions, rigid body dynamics, motors and actuators, robot design, sensors and controls, computer simulation, and graphical animation. Typically offered in the spring.

b. Prerequisites:
ME 35200 – Machine Design I

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Analysis of *manipulator motion* and *forces*.
2. *Manipulator design* including actuator, drive and sensor issues.
3. *Computer simulation* to predict motion and forces.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: R. J. Cipra

REVISION DATE: July 30, 2012

ME 57300 (CS 53500)
INTERACTIVE COMPUTER GRAPHICS

Course Outcomes

1. Develop an understanding of the fundamentals of *2D* and *3D computer graphics devices*, *techniques*, *algorithms* and *representations* useful in engineering applications.
2. Learn a *systematic approach* to developing computer graphics applications.
3. Foster effective skills in *applying computer graphics* to technical problems.

2D Graphics

Static Graphics Hardware (3 wks)

1. Hardcopy Plotting Devices
2. Dynamic Display Devices
3. Color

Static Graphics Software (3 wks)

1. Window to Viewport Mapping
2. Clipping
3. Interactive techniques
4. Data Structure for Interactive Graphics

3D Graphics

Fundamentals (3 wks)

1. 3D Rendering
2. Viewing Transformations
3. 3D Clipping
4. Computational Geometry

Realistic Rendering (3 wks)

1. Hidden Line and Surface Removal
2. Lighting Models
3. Ray Tracing

Geometric Modeling (3 wks)

1. Curves
2. Surfaces
3. Solid Modeling

Revision Date: 7/30/2012

1. COURSE NUMBER & NAME: ME 57300 (CS 53500) Interactive Computer Graphics

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

D.C. Anderson

4. TEXTBOOK: None

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: The principles of computer graphics and interactive graphical methods for problem solving. Emphasis placed on both development and use of graphical tools for various display devices. Several classes of graphics hardware considered in detail. Topics include hardcopy plotting, refresh displays, dynamic techniques, three dimensional transformations and hierarchical modeling, color, modeling of geometry, and hidden surface removal. Projects involve programming of interactive computer graphics applications. Typically offered in the fall.

b. Prerequisites:
None

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Develop an understanding of the fundamentals of *2D* and *3D computer graphics* devices, techniques, algorithms and representations useful in engineering applications.
2. Learn a *systematic approach* to developing computer graphics applications.
3. Foster *effective skills* in applying computer graphics to technical problems.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: D. C. Anderson

REVISION DATE: July 30, 2012

ME 57400 (CS 57400)
ADVANCED COMPUTER GRAPHICS APPLICATIONS

Course Outcomes

1. Develop an understanding of *advanced computer graphics concepts*.
2. Apply computer graphics concepts and systems to *design* and *develop a large-scale application* that uses computer graphics to solve a technical problem.

Concepts

3D Graphics Systems and Methods (6 wks)

1. OpenGL
2. Basic 3D Graphics
3. Texture Mapping
4. Blending
5. High Performance Graphics Methods
6. 3D Interaction Methods

Advanced Geometric Modeling (4 wks)

1. 3D Data Representations and Methods
2. Solid Modeling Methods and Systems

Applications (5 wks)

1. Project Topic Formulation
2. Project Design and Development
3. Technical Presentations on Project Topics
4. Project Presentations

Revision Date: 7/30/2012

1. COURSE NUMBER AND TITLE: ME 57400 (CS 57400) Advanced Computer Graphics Applications

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

D.C. Anderson

4. TEXTBOOK: None

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Direct application of interactive computer graphics to selected independent research projects. The projects are chosen, developed and implemented by the students in great detail, including documentation and presentation. Typically offered in the spring.

b. Prerequisites:

ME 57300 (CS 53500) – Interactive Computer Graphics

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Develop an understanding of *advanced computer graphics* concepts.
2. *Apply computer graphics concepts* and systems to design and develop a large-scale application that uses computer graphics to solve a technical problem.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: D.C. Anderson

REVISION DATE: July 30, 2012

ME 57500
THEORY AND DESIGN OF CONTROL SYSTEMS

Course Outcomes

1. Discuss *feedback control* system characteristics (stability & performance).
2. Provide tools to analyze *robustness* to plant uncertainty.
3. Describe methods for *frequency-domain loop shaping*.
4. Introduce *state-space representation*.
5. Cover state *feedback regulator design*.
6. Cover *state observer design*.
7. Develop *optimal control design methodology*.

Closed-Loop System Attributes (2 wks)

1. Feedback
2. Sensitivity and complementary sens.
3. Closed loop stability
4. Steady state perfor-mance
5. Norms
6. Robustness to plant uncertainty

→

Frequency Domain Loop Shaping (3 wks)

1. Constraints on achievable performance
2. Frequency domain controller design
3. Design examples
4. Nonminimum phase systems & time delay

→

State-Space Representation (2 wks)

1. Controllable and observable canonical forms
2. Eigenvalues and eigenvectors
3. Jordan canonical form
4. State transition matrix

→

State Feedback and Output Feedback (5 wks)

1. Controllability
2. State feedback regulator design
3. Observability
4. Observer design
5. Reduced observer design
6. Tracking control

→

Optimal Control (3 wks)

1. Calculus of variations
2. Pontryagin's principle
3. Linear quadratic regulator design
4. Optimal observer design

1. COURSE NUMBER AND NAME: ME 57500 Theory and Design of Control Systems

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

P.H. Meckl

4. TEXTBOOK:

Goodwin, Graebe, Salgado, *Control System Design*, Prentice Hall, 2001.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Course covers the analysis and design of control systems from both a classical and modern viewpoint, with emphasis on design of controllers. Classical control design is reviewed, including both root locus and Bode domain design methodologies. The state space representation is introduced, along with notions of stability, controllability and observability. State feedback controllers for pole placement and state observers are discussed with emphasis on their frequency domain implications. Typically offered in the fall.

b. Prerequisites:
ME 47500 – Automatic Control Systems

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Discuss *feedback contro*l system characteristics (stability and performance).
2. Provide tools to analyze *robustness* to plant uncertainty.
3. Describe methods for *frequency-domain* loop shaping.
4. Introduce *state-space representation*.
5. Cover state *feedback regulator design*.
6. Cover *state observer design*.
7. Develop *optimal control design methodology*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: P.H. Meckl

REVISION DATE: June 26, 2012

ME 57600
COMPUTER CONTROL OF MANUFACTURING PROCESSES

Course Outcomes

1. Provide a fundamental knowledge of the *theory of automation and discrete motion control*.
2. Gain knowledge of the *practice and art of controls* through laboratory experiments.
3. Sharpen skills in *problem formulation and integration* of a broad range of technical capabilities through certain open-ended design and programming problems.
4. Sharpen *technical communication skills* through short technical reports

Computer Numerical Control (4 wks)

1. Basics of CNC machines
2. CNC part programming
3. Logics and logic circuits
4. CNC architecture
5. CNC-PLC communication

→

Programmable Logic Control (3 wks)

1. PLC functions and applications
2. Boolean algebra
3. Logic circuit design
4. PLC programming
5. Logic control applications

→

Digital Control (4 wks)

1. Difference equation and Z-transform
2. Discrete control design by mapping
3. Frequency domain design
4. Direct design
5. Saturation and delay
6. Feedforward control

→

Command Generation for Motion Control (2 wks)

1. Linear interpolation
2. Cubic spline interpolation
3. Command generation with constraints
4. Command generation for multiple-axes

→

Actuators (2 wks)

1. DC motors
2. AC motors
3. Stepping motors
4. Motion control systems

Laboratory Experiments

1. Computer numerical controller (CNC) demonstration and introduction of the architecture.
2. CNC manual part programming
3. CNC automated programming (CAM-CNC)
4 Programmable logic controller (PLC) programming
5. CNC-PLC integration and communication
6. Discrete control of actuators (DC and AC motors)
7. Discrete control of a motion control system

Revision Date: 7/24/2012

1. COURSE NUMBER AND NAME: ME 57600 Computer Control of Manufacturing Processes

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 50 minutes for 16 weeks

b. Laboratory – 1 day per week at 180 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

Y.C. Shin

4. TEXTBOOK:

J. Bollinger and N. Duffie, *Computer Control of Machines and Processes*, Addison-Wesley, 1988.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Fundamental elements for manufacturing process control are presented with advanced control theories, modeling and analysis of actuators, controller architecture, interfacing and programming. Emphasis is on computer integrated manufacturing with computer numerical control of machine tools, automation via programmable logic controllers, motion control, process control examples, and manufacturing process monitoring. Hands-on experience is attained through laboratory experiments with state-of-the-art equipment. Typically offered in the spring.

b. Prerequisites:
ME 47500 – Automatic Control Systems or equivalent course

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Provide a fundamental knowledge of the *theory of automaton and discrete motion control*.
2. Gain knowledge of the *practice and art of controls* through laboratory experiments.
3. Sharpen skills in *problem formulation and integration* of a broad range of technical capabilities through certain open-ended design and programming problems.
4. Sharpen *technical communication skills* through short technical reports.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: Y.C. Shin

REVISION DATE: July 24, 2012

ME 57700
KINEMATICS AND DYNAMICS OF HUMAN MOTION

Course Outcomes

1. To provide an introduction into the study of the physics of human motion.
2. To relate studies of human motion to design of machine-human interfaces.
3. To provide an introduction to experimental methods in the study of human motion.

Introduction to Human Anatomy

1. Skeletal system
2. Muscular system
3. Antropomorphic data

→

Kinematics of Human Motion

1. Displacement analysis
2. Velocity analysis
3. Acceleration analysis
4. Higher order analysis

→

Kinetics of Human Motion

1. Newton-Euler formulation
2. Lagrangian formulation
3. Applications of mechanics to human motion
4. Case studies

Laboratory Experiments

1. Measurement of kinematics of finger motion during typing exercise.
2. Measurement and calculation of muscle loads during knee bend exercises.

Revision Date: 6/19/2013

1. COURSE NUMBER AND NAME: ME 57700 Kinematics and Dynamics of Human Motion

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

E. Nauman

4. TEXTBOOK: Books are recommended, but not required

James Watkins, *Structure and Function of the Musculoskeletal System,* Human Kinetics, ISBN# 0-7360-7890-8

Steven Vogel, *Prime Mover – A Natural History of Muscle,* W.W. Norton & Co., ISBN# 0-3933-2463-X

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Physiology and anatomy. Kinematic geometry of human motion. Differential kinematics of human movement. Joint geometry and joint kinematics. Anthropometry – processing data. Mechanics of the muscles, and motor control of human motion. Kinetics; Forces and Moments; and Newton-Euler equations. Equations of motion; the Power equation; and Lagrange equations. Typically offered in the spring.

b. Prerequisites:
ME 35200 – Machine Design I

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Provide an introduction into the study of the *physics of human motion*.
2. Relate studies of human motion to design of *machine-human interfaces*.
3. Provide an introduction to *experimental methods* in the study of human motion.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: E. Nauman

REVISION DATE: June 19, 2013

ME 57800
DIGITAL CONTROL

Course Outcomes

1. Familiarity with *sample theory*, *z-transform* and other analysis tools that are used to analyze and design digital control systems.
2. Familiarity with the *state-space* and *input/output representation*, modeling and analysis of digital control systems.
3. Familiarity with designing digital control system through emulating *continuous-time controllers*.
4. Familiarity with *modern control design methodologies* for both continuous-time and discrete-time systems that include but not limited to *state feedback*, *state estimation*, *LQ*, *Kalman filtering*, *LQG*, *internal model based design*, *Loop shaping*, and *servo control*.
5. Understand the issues with *implementing digital controllers*.

Mathematical Background (3 wks)

1. Sampling
   – sampling
   – aliasing
   – reconstruction
2. z-transform
3. Difference equations

Sampled Data Systems (3 wks)

1. Representations
   – Pulse transfer function
   – Frequency response
   – State space
2. Analysis
   – Nyquist stability
   – Lyapunov stability
   – Input/output stability
   – Stability robustness
   – Sensitivity
   – Controllability
   – Observability
   – Effect of sampling on system characteristics

Controller Design – Input/Output Approach (2.5 wks)

1. Emulation
   – Numerical integrations
   – Frequency warping
   – Response invariant
   – Pole-zero matching
2. Discrete Implementation of PID controllers
3. Direct design
   – Root locus
   – Frequency domain
4. Polynomial approach
   – Diophatine Equation
   – Pole placement
   – Model matching

Controller Design – State Space Approach (1 wk)

1. State feedback
2. State observer
3. Observer-based compensator
   – Separation principle

LQ Optimal Control (2 wks)

1. Principle of optimality
2. Infinite horizon and finite horizon solution
3. Solution to algebraic Riccati equation
4. Analysis
   – Return difference equality
   – Gain and phase margin of LQ systems
   – Symmetric root locus
5. Frequency shaped LQ

LQG Control (3 wks)

1. Review of probability and random variables
2. Discrete-time random process
3. Discrete-time Kalman filter
4. LQG control

Implementation Issues (0.5 wks)

1. Quantization effect
2. Fixed-point arithmetic
3. Computation delay

Revision Date: 6-19-2013

1. COURSE NUMBER: ME 57800 Digital Control

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 75 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

G.T. Chiu

4. TEXTBOOK:

No Text Required

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Introduction to and overview of the field of digital control. Prior knowledge of continuous control techniques is assumed. Topics include mathematical background from residue theory through integral transforms; samples data systems, including A/D, D/A, and hold properties, aliasing, and Z transforms. Digital control design via continuous, discrete and state space design techniques. Implementation considerations, including nonlinear effects. Mechanical engineering examples. Typically offered in the spring.

b. Prerequisites:
ME 57500 – Theory and Design of Control Systems or
Consent of Instructor

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Familiarity with *sample theory*, *z-transform* and other analysis tools that are used to analyze and design control systems.
2. Familiarity with the *state-space* and *input/output representation*, modeling and analysis of digital control systems.
3. Familiarity with designing digital control system through emulating *continuous-time controllers*.
4. Familiarity with *modern control design methodologies* for both continuous-time and discrete-time systems that include but not limited to *state feedback*, *state estimation*, *LQ*, *Kalaman filtering*, *LQG*, *internal model based design*, *Loop sharing*, and *servo control*.
5. Understand the issues with *implementing digital controllers*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: G.T. Chiu

REVISION DATE: June 19, 2013

ME 57900
FOURIER METHODS IN DIGITAL SIGNAL PROCESSING

Course Outcomes

1. To familiarize the students with the theory behind the functions found on most *frequency analysis systems or software tools* so that they can understand the effects of parameter settings on the analysis results.
2. To introduce the basics of *digital filtering* and *digital filter design* so that students understand the effects of manipulating discrete spectra, and are able to design simple digital filters.
3. To introduce the basics of *stationary signal analysis*, and show how it is used to derive input-output relationships for linear time-invariant systems excited by random processes.
4. To familiarize the students with methods of *estimating correlation functions*, *spectral densities*, *frequency response functions* and *coherence*, and the errors that arise from the estimation process.

Deterministic Continuous Signals and Systems (4 wks)

1. Fourier Series and transforms
2. Windowing of signals and resolution issues.
3. Convolution of signals
4. Continuous systems: impulse responses and frequency response functions.
5. Calculations of Fourier series coefficients and Fourier transforms.

Random Signal Analysis (3 wks)

1. Revision of basic statistics: PDFs, expectation.
2. Random Processes: stationary, ergodicity, ensemble and time averages.
3. Correlation functions.
4. Spectral density functions.
5. Random excitation of systems: input-output relationships.
6. Coherence

Estimation of Spectra and Frequency Response Functions (2 wks)

1. Estimation theory basics: bias and variance.
2. Estimation of correlation and spectral density functions.
3. Estimation of frequency response and coherence functions.

Deterministic Discrete Signals and Systems (3 wks)

1. Sampling and aliasing.
2. ADC and DAC operation.
3. z-transforms.
4. Transfer functions of discrete systems (ARMA models) and finite difference equations.
5. Frequency response of discrete systems.

Digital Filtering (3 wks)

1. Filter performance evaluation.
2. Finite impulse response (FIR) filter design
3. Infinite impulse response (IIR) filter design.
4. Discrete–time integrators, differentiators and Hilbert transformers.

Revision Date: 6/27/12

1. COURSE NUMBER AND NAME: ME 57900 Fourier Methods in Digital Signal Processing

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

P. Davies

4. TEXTBOOK: None

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Fundamentals of signal processing associated with commonly used Fourier analysis systems/software packages are presented. Emphasis is on the development of an understanding of the experimental methodologies & data acquisition requirements for robust spectral estimation, correlation analysis, & non-parametric system identification. Deterministic, as well as random, data analyses are presented. Students develop their own code to simulate signals & to implement signal processing algorithms. Typically offered in the fall.

b. Prerequisites:
ME 47500 – Automatic Control Systems

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. To familiarize the students with the theory behind functions found on most *frequency analysis systems or software toolboxes* so that they can understand the effects of parameter settings on the analysis results.
2. To introduce the basics of *digital filtering* and *digital filter* design so that students understand the effects of manipulating discrete spectra and are able to design simple digital filters.
3. To introduce the basics of *stationary signal analysis* and show how it is used to derive input-output relationships for linear time-invariant systems excited by random processes.
4. To familiarize the students with methods of *estimating correlation functions*, *spectral densities*, *frequency response functions* and *coherence* and the errors that arise from the estimation process.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: P. Davies

REVISION DATE: June 27, 2012

ME 58000
NONLINEAR ENGINEERING SYSTEMS

Course Outcomes

1. Develop an understanding of the principles governing the motion of *nonlinear mechanical and engineering systems*.
2. Develop an ability to analyze *nonlinear dynamical system models* in the form of ordinary and partial differential equations.
3. Develop an ability to understand the various *nonlinear phenomena* in free as well as excited systems.
4. Develop ability to model and solve *nonlinear dynamic problems* of engineering interest.

Review and Examples of Nonlinear Phenomena (3 wks)

1. Elementary Differential Equations
2. Vectors and Matrix Theory
3. Linear Dynamical Systems – Free and Forced Responses, Superposition Principal, Sub- and Super-harmonic Responses
4. Examples of Structural, Fluid-Mechanical, and Chemical Nonlinear Models and Responses

→

First-Order Nonlinear Systems (3 wks)

1. Exact Solutions and Phase Orbits, Trajectories
2. Autonomous Vector fields, Equilibrium Points, Invariant Sets
3. Stability and Linearization, Structural Stability, Normal Form
4. Systems Dependent on Parameters, Bifurcations
5. Linear Periodic Systems, Period Propagator and Stability
6. Examples

→

Second-Order Nonlinear Conservative/Dissipative Systems (3 wks)

1. Time Integration and Phase Plane of Solutions
2. Centers and Saddles
3. Potential Energy, Level Curves of Total Energy, Stability and Global Phase Plane
4. Conservative Parameter Dependent Systems, Bifurcations
5. Effects of Dissipation and Limit Cycles
6. Examples

→

First-Order Vector Systems and Linearization (3 wks)

1. Linearization – Time Varying and Autonomous Linear Systems Theory
2. Stability of Equilibrium Points and Periodic Solutions – Floquet Theory
3. Phase Plane for Linear Systems
4. Graphical Methods, Iso- and Nullclines, Limit Cycles, Lienard's Method
5. Bendixon and Poincare-Bendixon Theory
6. Exact Transformation Technique
7. Examples: Self Excited Systems, Clocks

→

Perturbation & Asymptotic Techniques (3 wks)

1. Regular and Singular Perturbations-Algebraic Equations
2. Straightforward Expansions, Secular Terms
3. Poincare-Lindstedt Technique, Convergent and Asymptotic Expansions
4. Method of Multiple Time Scales
5. Method of Averaging
6. Examples-Free Vibrations, Hard and Soft Springs

Forced Oscillations and Stability

1. Primary Resonance: a. Single Degree of Freedom System; b. Systems with Multiple Degrees of Freedom
2. Secondary Resonances: a. Sub-harmonic Responses; b. Super-harmonic Responses; c. Effects of Additional Degrees of Freedom – Internal and Combination Resonances
3. Lypunov Stability and Lypunov's Direct Method

Revision Date: 3/15/12

1. COURSE NUMBER AND NAME: ME 58000 Nonlinear Engineering Systems

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 75 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

J.F. Rhoads

4. TEXTBOOK: None

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Methods of analysis for nonlinear ordinary differential equations arising in engineering systems. Review of linear systems. Stability concepts. Phase plane methods. Perturbation and averaging methods of analysis. Self-excited and parametrically excited systems. Relaxation oscillations. Systems with more than one degree of freedom. Typically offered in the fall.

b. Prerequisites:
ME 56300 – Mechanical Vibrations

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Develop an understanding of the principles governing the motion of *nonlinear mechanical and engineering systems*.
2. Develop an ability to analyze *nonlinear dynamical system models* in the form of ordinary and partial differential equations.
3. Develop an ability to understand the various *nonlinear phenomena* in free as well as excited systems.
4. Develop ability to model and solve *nonlinear dynamics problems* of engineering interest.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: J. F. Rhoads

REVISION DATE: March 15, 2012

ME 58100
NUMERICAL METHODS IN MECHANICAL ENGINEERING

Course Outcomes

1. Introduce the student to *the classical and modern numerical methods* available for engineering problem-solving.
2. Familiarize the student with the *computer as an engineering tool* and to *improve programming skills*.
3. Emphasize *fundamental understanding* of the methods.
4. Importance of *errors* associated with scientific computing.

Systems of Linear Algebraic Equations (2 wks)

1. Review of linear algebra
2. Direct methods
3. Iterative methods

Solution of Nonlinear Equations (2 wks)

1. Closed methods
2. Open methods
3. Systems of nonlinear equations

Polynomial Approximation and Interpolation (2 wks)

1. Exact fits
2. Approximate fits
3. Orthogonal polynomials

Numerical Differentiation (2 wks)

1. Taylor series approach
2. Finite-difference approximations
3. Spectral methods

Numerical Integration (2 wks)

1. Newton-Cotes formulas
2. Romberg integration
3. Gauss quadrature
4. Multiple integrals

Ordinary Differential Equations (3 wks)

1. Initial value problems
2. Single-point methods
3. Multi-point methods
4. Adaptive methods
5. Stability and stiffness
6. Boundary value problems
7. Shooting method
8. Equilibrium method

Partial Differential Equations (PDEs) (2 wks)

1. Elliptic PDEs
2. Parabolic PDEs
3. Hyperbolic PDEs

Revision Date: 6/26/2012

1. COURSE NUMBER AND TITLE: ME 58100 Numerical Methods in Mechanical Engineering

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

S.H. Frankel

4. TEXTBOOK:

Brian Bradie, *A Friendly Introduction to Numerical Analysis*, Prentice Hall 2006

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: The solution of problems arising in mechanical engineering using numerical methods. Topics include nonlinear algebraic equations, sets of linear algebraic equations, eigenvalue problems, interpolation, curve fitting, ordinary differential equations, and partial differential equations. Applications are related to fluid mechanics, gas dynamics, heat and mass transfer, thermodynamics, vibrations, automatic control systems, kinematics, and design. Typically offered in the fall.

b. Prerequisites:
ME 31500 – Heat and Mass Transfer
ME 35200 – Machine Design I

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Introduce the student to the classical *numerical methods* available for engineering problem solving.
2. Familiarize the student with the computer as an engineering tool and to improve *programming skills*.
3. Emphasize *fundamental understanding* of the methods.
4. Importance of *errors* associated with scientific computing.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: S.H. Frankel

REVISION DATE: June 26, 2012

ME 58200
THERMAL STRESS ANALYSIS

Course Outcomes

1. Determine the effects of *temperature changes* on *structures and materials*.
2. Define *thermoelastic problems*.
3. Determine *thermal stresses* in beams and plates.
4. Determine *thermal deformation*.

Basic Formulations (4 wks)

1. Introduction to thermal stresses
2. Formulation of thermoelastic problems
3. Coupled thermoelasticity
4. Thermoelastic reciprocal theorems
5. Body force analogy
6. Equivalent thermal loads

→

2-D Problems (5 wks)

1. Plane strain, plane stress
2. Stress-free temperature distributions
3. Stress function approach
4. Energy methods
5. Thermal stresses in polar coordinates

→

Beams and Plates (4 wks)

1. Thermal stresses in beams
2. Thermal stresses in non-uniform beams
3. Beam theory vs. exact calculations
4. Thermoelastic plate equations and solutions
5. Thermoelastic buckling

→

Advanced Topics (2 wks)

1. Thermal fracture
2. Thermal fatigue

Revision Date: 6/19/2013

1. COURSE NUMBER AND NAME: ME 58200 Thermal Stress Analysis

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

K. Kokini

4. TEXTBOOK:

No Text Required

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Methods for determining the deformations and stresses due to temperature changes in materials. Fundamentals of thermoelasticity. Solutions to two-dimensional thermoelastic problems. Thermal stresses in beams and plates. Thermoelastic buckling. Introduction to thermal fracture and fatigue. Applications high-temperature materials in automotive structures, electronics, composites and advanced materials. Typically offered in the fall (alternate years).

b. Prerequisites:

ME 31500 – Heat and Mass Transfer
ME 32300 – Mechanics of Materials
Coursework in Ordinary Differential Equations

c. Status:

Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Determine the effects of *temperature changes* on *structures and materials*.
2. Define *thermoelastic problems*.
3. Determine *thermal stresses* in beams and plates.
4. Determine *thermal deformations*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: K. Kokini

REVISION DATE: June 19, 2013

ME 58500
INSTRUMENTATION FOR ENGINEERING MEASUREMENTS

Course Outcomes [Related ME Program Outcomes in Brackets]

1. Ability to *use* and *interpret information* from modern engineering instrumentation and measurement systems. [A1, A2, A3, A4, B1]
2. A discussion on the *design of modern engineering instrumentation*. [A3, A4, A5]
3. A chance to *design a measurement system* to meet the requirement of a given measurement problem. [A3, A5]

Static Instrument Characteristics (4 wks)

1. Calibration
2. Accuracy in steady-state
3. Error analysis

→

Dynamics Instrument Characteristics (4 wks)

1. Frequency response
2. System Identification
3. Transfer functions
4. Harmonic distortion

→

Loading Effects (2 wks)

1. Process loading
2. Inter-element loading
3. Impedance conditions
   a. matching
   b. low loading
   c. low noise

→

Sensing & Signal Conditioning (5 wks)

1. Self-generating sensors
2. Non Self-generating sensors
3. Filters
4. Modulation & demodulation
5. Sampling methods
6. Digital methods
7. Noise sources
8. Noise reduction methods
9. Software

Revision Date: 2/05/2013

1. COURSE NUMBER AND TITLE: ME 58500 Instrumentation for Engineering Measurements

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3.COURSE COORDINATOR OR INSTRUCTOR:

G. B. King

4. TEXTBOOK: Course Notes

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Fundamental concepts of static and dynamic measurements are reviewed. Transducers, signal conditioning, data transmission and digital data. Acquisition systems are discussed. Emphasis is on applications and dynamic measurements. Typically offered alternate years in the fall.

b. Prerequisites: First Semester Senior Standing or Higher

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]
This course is designed to give advanced Mechanical Engineering seniors and beginning graduate engineering students the following skills:

1. The ability to use and *interpret information* from modern engineering instrumentation and measurement systems. [A1, A2, A3, A4, B1]
2. A discussion on the *design of modern engineering instrumentation*. [A3, A4, A5]
3. A chance to *design a measurement system* to meet the requirement of a given measurement problem. [A3, A5]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: G.B. King

REVISION DATE: February 5, 2013

ME 58600
MICROPROCESSORS IN ELECTROMECHANICAL SYSTEMS

Course Outcomes

1. Introduce microprocessor architecture.
2. Discuss assembly language programming.
3. Describe interfacing (digital I/O, serial I/O, interrupts, analog I/O).
4. Introduce mixed-language programming (C and Assembly).
5. Review controller design.
6. Develop microprocessor-based control implementation.

Introduction (1 wk)

1. Number Systems
2. Registers & Memory

→

Microprocessor Architecture (1 wk)

1. Programming Model
2. Op Codes

→

Assembly Language Programming (1 1/2 wks)

1. Instruction Set
2. Addressing Modes
3. Control Structures
4. Subroutines & Stack

→

Interfacing (2 1/2 wks)

1. Digital I/O
2. Serial I/O
3. Interrupts & Timers
4. Analog I/O

→

Mixed-Language Programming (1 wk)

1. C Calling Conventions
2. C-callable Assembly Routines

→

Control Implementation (8 wks)

1. Control Design
2. Digital Control
3. Sampling & Aliasing
4. Actuators
5. Optical Encoders

Laboratory Experiments

1. PC Familiarization, Software Development Environment
2. Assembly Language Programming, Digital I/O
3. Keyboard & Console I/O Operations, Serial Communications
4. Interrupts: Application to Frequency Counting
5. Mixed-Language Programming
6. Digital-to-Analog and Analog-to-Digital Conversion
7. Digital Controller Implementation
8. } Electromechanical Control Projects
9. }

1. COURSE NUMBER AND NAME: ME 58600 Microprocessors in Electromechanical Systems

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

P.H. Meckl

4. TEXTBOOK:

V. Mahout, *Asssembly Language Programming: ARM Cortex-M3*, Wiley, 2012

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Architecture of microcomputers; I/O structure and interfacing; assembly language, manual assembly; software and hardware interrupts; data acquisition, serial and parallel communications; the role of high-level languages. Laboratory experiments on applications to electrical, mechanical and thermo-fluid systems. Typically offered in the fall.

b. Prerequisites:
First Semester Senior Standing or Higher

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Introduce *microprocessor architecture*.
2. Discuss assembly *language programming*.
3. Describe *interfacing* (digital I/O, serial I/O, interrupts, analog I/O).
4. Introduce *mixed-language programming* (C and Assembly).
5. Review *controller design*.
6. Develop *microprocessor-based control implementation*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: P.H. Meckl

REVISION DATE: August 3, 2012

ME 58700
ENGINEERING OPTICS

Course Outcomes [Related ME Program Outcomes in Brackets]

1. Provide a thorough knowledge of *optical phenomena* and important *optical devices*. [A1, A2, A4]
2. Develop the ability to utilize a variety of *calculation methods* for optical design and analysis. [A3, A4, A5]
3. Use the acquired knowledge and calculation skill to *design (synthesize) new optical systems*. [A2, A3, A5]

Geometrical Optics
(5 wks)

1. Fundamentals
2. Imaging Systems
3. Matrix Methods
4. Aberrations
5. Fiber Optics
6. Photometry
7. System Design

→

Physical Optics
(8 wks)

1. Maxwell Equations
2. Wave Propagation
3. Fresnel Equations
4. Interference
5. Diffraction
6. Polarization
7. Scattering
8. Physical optics effects on optical design

→

Modern Optics
(2 wks)

1. Laser Systems
2. Holography

Revision Date: 2/05/2013

1. COURSE NUMBER AND TITLE: ME 58700 Engineering Optics

2. CREDITS AND CONTACT HOURS: 3 credits

Lecture – 3 days per week for 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

G. B. King

4. TEXTBOOK:

Pedrotti, Pedrotti, and Pedrotti, *Introduction to Optics*, 3rd ed, Prentice Hall, 2007.

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Fundamentals of geometrical and physical optics as related to problems in engineering design and research. Characteristics of imaging systems; properties of light sources; optical properties of materials. Diffraction, interference, polarization, and scattering phenomena as related to optical measurement techniques. Introduction to lasers and holography. Typically offered in spring.

b. Prerequisites: First Semester Senior Standing or Higher

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

[Related ME Program Outcomes in Brackets]

1. Provide a thorough knowledge of optical phenomena and important *optical devices*. [A1, A2, A4]
2. Develop the ability to utilize a variety of *calculation methods* for optical design and analysis. [A3, A4, A5]
3. Use the acquired knowledge and calculation skill to *design* to (*synthesize*) *new optical systems*. [A2, A3, A5]

b. Related ME Program Outcomes:

[Related ABET Outcomes Listed in Brackets]

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: G. B. King

REVISION DATE: February 5, 2013

ME 58800
MECHATRONICS – INTEGRATED DESIGN OF ELECTRO MECHANICAL SYSTEMS

Course Outcomes

1. Provide the students with a working familiarity with the *electronics* and *interfacing techniques* needed in the *design* and *control of electro-mechanical systems*.
2. Introduce *operation principles* and *interfacing techniques* for *common electro-mechanical sensors* and *actuators*.
3. Provide the students with the experience of working in an *interdisciplinary team environment*.
4. Provide the students with the experience of *concurrent engineering* and *product development*.

Teamwork and Proj. Management (1 wk)

1. Communication
2. Conflict resolution
3. Planning
4. Time management

→

Basic Analog and Digital Design (6 wks)

1. Op-Amps
2. Diodes
3. Transistors
4. Binary logic
5. Combinational logic
6. Sequential logic

→

Interfacing Techniques (2 wks)

1. A/D and D/A
2. Embedded systems
3. Register transfer logic
4. Network and Communication protocols

→

Actuators (3.5 wks)

1. DC motors
2. Drivers for DC motors
3. Stepper motors
4. Drivers for stepper motors
5. Power amplifiers

→

Sensors (2.5 wks)

1. Position/displacement sensors
2. Velocity sensors
3. Opto-electronic sensors

Laboratory Experiments

1. Familiarity with instrumentation and computer aided tools for designing, modeling and simulating analog and digital electronics
2. Familiarity with computer aided tools for designing programmable digital and analog devices
3. Provide hands-on experience in and techniques for designing and debugging analog, digital and interfacing electronics
4. Provide experience in design and building 'intelligent' electro-mechanical system
5. Provide experience in product development from generating specifications and evaluation metrics to building functioning prototypes.
6. Provide experience in project planning, resource management, teamwork, and conflict resolution

Revision Date: 6/19/2013

1. COURSE NUMBER: ME 58800 Mechatronics – Integrated Design of Electro-Mechanical Systems

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

W. Peine

4. TEXTBOOK:

No Textbook Required

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Electronic and interfacing techniques for design and control of electro-mechanical systems. Basic digital and analog design with applications to electro-mechanical interfacing via hands-on laboratory experience. Commonly used actuators and sensors and corresponding interfacing techniques. Realistic and integrated product development experience provided through a comprehensive final project where working prototypes are built to defined specifications. Typically offered in the fall.

b. Prerequisites:
First Semester Senior Standing or Higher

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Provide the students with a working familiarity with the *electronics* and *interfacing techniques* needed in the *design* and *control of electro-mechanical systems*.
2. Introduce *operation principles* and *interfacing techniques* for *common electro-mechanical sensors and actuators*.
3. Provide the students with the experience of working in an *interdisciplinary team environment*.
4. Provide the students with the experience of *concurrent engineering* and *product development*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: W. Peine

REVISION DATE: June 19, 2013

ME 59200 (Old Temporary # **ME 59500W)**
FUNDAMENTALS OF PARTICLE IMAGE VELOCIMETRY

Course Outcomes

1. To learn the principles of *quantitative* flow visualization.
2. To study the physical phenomena underlying particle image velocimetry.
3. To understand the limitations of this flow measurement technique.
4. To explore advanced topics in particle image velocimetry.

Introduction (2 wks)

1. Historical background
2. Principles of operation
3. Recent developments

→

Tracer particles (2 wks)

1. Fluid/Particle dynamics
2. Light scattering behavior
3. particle generation and supply

→

Light sources (1 wk)

1. lasers
2. white light sources

→

Image Recording (2 wks)

1. Photographic recording
2. Digital imaging
3. Sources of error in imaging

→

Mathematical Background (3 wks)

1. Particle image locations
2. Image intensity field
3. auto/cross correlation

Advanced Topics (5 wks)

1. Adaptive window shifting
2. image correction
3. simultaneous temperature/velocity measurements
4. holographic and other 3D techniques
5. bio applications
6. micro applications

Revision Date: 6/19/2013

1. COURSE NUMBER: ME 59200 (Old Temporary # ME 59500W) Fundamentals of Particle Image Velocimetry

2. CREDITS AND CONTACT HOURS: 1 credit

a. Lecture – 1 day per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

S. Wereley

4. TEXTBOOK:

Raffel, Willert, Wereley, Kompenhans, *Particle Image Velocimetry: a practical guide*, 2nd edition, Spring (2007), ISBN# 978-3-540-72307-3

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Measurement of fluids in motion using the particle image velocimetry technique and related techniques through computer programming, laboratory experiments, and independent research in experimental fluids journals. Typically offered in the spring.

b. Prerequisites:
None

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcome:

1. Understand the various *scientific principles* underlying the particle image velocimetry technique – fluid dynamics, particle dynamics, optics, etc.
2. Gain an in-dept understanding of the *PIV technique* including its advantages over competing techniques, its limitations, and its future potential.
3. An ability to analyze a particular flow and determine the *optimal parameter space* for investigating that flow: particle size, time between exposures, imaging format, magnification, etc.
4. Exposure to several of the *commercial particle image velocimetry packages* in addition to writing their own basic software.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: S. Wereley

REVISION DATE: June 19, 2013

ME 59500M
COMPUTATIONAL METHODS FOR NANOSCALE THERMAL TRANSPORT

Course Outcomes

1. Provide an introductory understanding of numerical methods for solving phonon transport problems in spatially confined materials.
2. Develop ability to simulate transport atomistically with Green's function methods
3. Develop ability to simulate phonon transport in mesoscopic regime with finite volume (FV) and Monte Carlo (MC) methods.

Lattice Dynamics and Statistics (3 lectures)

- spring-mass systems
- general dispersion relations and phonon branches
- thin films and quantum wires
- lateral quantization and dispersion relations
- Bose-Einstein statistics
- phonon population statistics

Atomistic Green's function (AGF) method (3 lectures)

- Hamiltonian matrix
- self-energy matrices
- meaning of the Green's function
- matrix assembly for transport
- quantum of thermal conductance
- transport at interfaces

Boltzmann Transport Equation (2 lectures)

- governing equation
- phonon scattering

Finite Volume Method (3 lectures)

– mathematical formulations
– solution technique

Monte Carlo Method (3 lectures)

- statistical sampling
- transport modeling

Revision Date: 6/19/2013

1. COURSE NUMBER: ME 59500M Computational Methods for Nanoscale Thermal Transport

2. CREDITS AND CONTACT HOURS: 1 credit

a. Lecture – 5 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

T.S. Fisher

4. TEXTBOOK:

No Text Required

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: This one-credit course provides an introductory understanding of numerical methods for solving phonon transport problems in spatially confined materials. Methods to be studied include: the atomistic Green's function (AGF) method, the finite volume (FV) method, and the Monte Carlo (MC) method. Typically offered during Maymester.

b. Prerequisites:
ME 59700F – Micro and Nano-scale Energy Transport

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Provide an introductory understanding of numerical methods for solving phonon transport problems in spatially confined materials.
2. Develop ability to simulate transport atomistically with Green's function methods.
3. Develop ability to simulate phonon transport in mesoscopic regime with finite volume (FV) and Monte Carlo (MC) methods.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: T.S. Fisher

REVISION DATE: June 19, 2013

ME 59500R
INTRODUCTION TO ATOMIC FORCE MICROSCOPY

Course Outcomes

1. Develop a basic theoretical understanding of nanoscale forces acting between a scanning probe tip and a sample.
2. Develop a basic understanding of the commonly used operation modes of AFM.
3. Develop experimental skills to operate AFM's safely.
4. Develop skills to be able to perform basic imaging and material property measurements using static and dynamic AFM modes.
5. Develop an overview of the research uses of AFM.

Basic theory of AFM (7 hours)

1. Tip-sample interaction forces
2. Operating principle and instrumentation
3. Operating modes of AFM
4. Operation procedure

→

Experiments with static AFM modes (5 hours)

1. Contact mode imaging
2. Friction force imaging
3. Force distance curves
4. Image processing and metrology

→

Experiments with dynamic AFM modes (5 hours)

1. Tapping mode imaging with different feedbacks
2. Attractive vs. repulsive regime imaging
3. Phase contrast imaging
4. Dynamic force-distance curves
5. Interpretation of dynamic force-distance curves

→

Applications of AFM (2 hours)

Applications to Biology, Electronics, Material Science and Mechanics

Revision Date: 6/19/2013

1. COURSE NUMBER: ME 59500R Introduction to Atomic Force Microscopy

2. CREDITS AND CONTACT HOURS: 1 credit

a. Lecture – 1 day per week at 25 minutes for 16 weeks

b. Laboratory – 1 day per week at 25 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

A. Raman

4. TEXTBOOK:

No Text Required

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Theory of tip sample interactions, static AFM modes – including force-distance curves, contact mode imaging, set point and error signals , and friction force imaging; dynamic AFM modes – including tapping mode imaging with three different feedback modes (amplitude, phase and mean deflection), phase contrast imaging, effects of frequency tuning, dynamic-force distance curves. Typically offered in the spring and summer.

b. Prerequisites:
None

c. Status:
Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

1. Develop a basic theoretical understanding of *nanoscale forces* acting between a scanning probe tip and a sample.
2. Develop a basic understanding of the different commonly used *operation modes* of AFM.
3. Develop *experimental skills* to operate AFM's safely.
4. Develop skills to be able to perform *basic imaging* and *material property measurements* using static and dynamic AFM modes.
5. Develop an overview of the many *research uses* of AFM.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: A. Raman

REVISION DATE: June 19, 2013

ME 59700C
INDOOR ENVIRONMENT ANALYSIS AND DESIGN

Course Outcomes

1. Provide an introduction into and practical examples of *indoor environment*.
2. Present the basic theory of *thermal comfort*, *indoor air quality*, *visual comfort*, *acoustics comfort* and *HVAC systems.*
3. Introduce *advanced tools* to analyze and design indoor environment and energy use in buildings.
4. Conduct indoor environment *analysis and design* for a challenging problem.

Overview of Indoor Environment (1 wk)

1. Introduction of indoor environment
2. Examples of indoor environment

→

Theory (4 wks)

1. Psychrometrics
2. Thermal comfort
3. Indoor air quality
4. Visual and acoustics comfort
5. HVAC systems

→

Tools for indoor environment analysis (6 wks)

1. Introduction to flow computer programs
2. Governing indoor flow equations
3. Numerical techniques
4. Heat transmission

→

Analysis and design of indoor environment (4 wks)

1. Analysis
2. Design
3. Project presentation

Revision Date: 6/20/2013

1. COURSE NUMBER AND NAME: ME 59700C – ME 50200 Indoor Environment Analysis and Design

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 2 days per week at 75 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

Q. Yan Chen

4. TEXTBOOK:

None – lecture notes handed out in class

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Review of current trend of building and indoor environment design. Theory of thermal comfort, indoor air quality, and air distribution. Introduction of experimental techniques and advanced computer tools for indoor environment analysis and design. Typically offered in the spring.

b. Prerequisites:
ME 31500 – Heat and Mass Transfer

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Provide an *introduction* into indoor environment.
2. Present the *basic theory* of psychrometrics, thermal comfort, indoor air quality, visual comfort, acoustics comfort, and HVAC systems.
3. Introduce *advanced tools* to analyze and design indoor environment and energy use in buildings.
4. Conduct indoor environment *analysis and design* for a challenging problem.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals; B3. Prof/Ethical Responsibility;
A2. Analytical Skills; B4. Contemporary Issues;
A3. Experimental Skills; B5. Life-Long Learning;
A4. Modern Engr Tools; C1. Leadership,
A5. Design Skills; C2. Global Engineering Skills;
A6. Impact of Engr Solns; C3. Innovation;
B1. Communication Skills; C4. Entrepreneurship
B2. Teamwork Skills

7. LIST OF TOPICS: See following page.

PREPARED BY: Q. Yan Chen

REVISION DATE: June 20, 2013

ME 59700K
MODELING AND SIMULATION OF MULTIDISCIPLINARY SYSTEMS

Course Outcomes

1. Provide the students with a working ability to create system-level multidisciplinary models using virtual work, energy functions, and constraints.
2. Provide the students with the experience of designing complex engineered systems in the form of differential algebraic equations (DAEs).
3. Provide the students with the experience of numerically solving and assessing the reliability of the resulting system of DAEs.

Intro. to Modeling and Simulation of Complex Engineered Systems (0.5 wks)

1. What are complex systems
2. Tomorrow vs yesterday's complex systems
3. Overview of topics
4. Background & notation

Fundamentals of Unified System Dynamics (0.5 wks)

1. Unified set of variables
2. Discrete elements
3. Kinetic stores
4. Potential stores
5. Path-independent dissipators
6. Path-dependent dissipators

Representation of Motion, Constraints (1 wk)

1. Variable pairs
2. Configuration & state spaces
3. Displacement constraints
4. Flow constraints
5. Effort constraints
6. Dynamic constraints
7. Degrees of freedom

Variational Concepts, Geometry of Constraint (1 wk)

1. Types of displacement
2. Virtual work
3. Lagrange's principle
4. Effort classification
5. Holonomic constraints
6. Nonholonomic constraints
7. Effort constraints
8. Dynamic constraints
9. Virtual momentum

Lagrangian and Hamiltonian Differential Algebraic Equations of Motion (2 wks)

1. 1st law of thermodyn. in variational form
2. Work and energy
3. Lagrange equation
4. Euler-Lagrange eqn.
5. Lagrange multipliers
6. Lagrangian DAE
7. Underlying ODE
8. Legendre transform
9. Hamiltonian DAE
10. LDAE vs HDAE

Modeling Multidisciplinary Systems (3 wks)

1. Schematics, configuration
2. Formulating models
3. Model automation
4. Sensors & actuators
5. Nanoscale systems
6. Microscale systems
7. Robotic systems
8. Transport systems
9. Industrial systems

Simulating Multidisciplinary Systems (2 wks)

1. Software tools for DAEs
2. Software tools for PDEs
3. Reduced order modeling
4. Modeling from data

Special Topics (2 wks)

1. Optimization
2. Genetic programming
3. Hybrid systems

Numerical Methods (3 wks)

1. Differential index
2. Mathematical structure
3. Special DAE forms
4. DAE stability
5. Index reduction
6. Reformulation of higher-index DAEs
7. Modified Newton
8. Backward Difference Formulation
9. Implicit Runge-Kutta
10. DAE manifolds
11. Stabilization matrix

Final Project (7 wks)

1. Guidelines
2. Proposal
3. Modeling
4. Simulation
5. Analysis
6. Paper

Revision Date: 6/27/2012

1. COURSE NUMBER AND TITLE: ME 59700K Modeling and Simulation Multidisciplinary Systems

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

J. Clark

4. TEXTBOOK:

Course reader/Lecture notes

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Projects or special topics of contemporary importance or of special interest that are outside the scope of the standard graduate curriculum can be studied under the Mechanical Engineering Projects course. Interested students should seek a faculty advisor by meeting with individual faculty members who work in their area of special interest and prepare a brief description of the work to be undertaken in cooperation with their advisor. Typically offered in the spring.

b. Prerequisites:
Advanced undergraduate, or graduate standing

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Provide the students with a working ability to create system-level multidisciplinary models using virtual work, energy functions, and constraints.

2. Provide the students with the experience of designing complex engineered systems in the form of differential algebraic equations (DAEs).

3. Provide the students with the experience of numerically solving and assessing the reliability of the resulting system of DAEs.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: J. Clark

REVISION DATE: June 26, 2012

ME 59700N/ABE 59100
DESIGN AND MODELING OF FLUID POWER SYSTEMS

Course Outcomes

1. To learn to *design fluid power systems* and to understand the *function of components* and how to model their steady state and dynamic behavior.
2. To determine *steady state and dynamic characteristics of fluid power components and systems* based on measurements
3. To learn *how* to *model fluid power components and systems* based on physical laws and when *to use these models*.
4. To learn how to *design advanced energy saving hydraulic actuators* and to *predict their performance*.

Introduction (2 wks)

1. Overview Components, system design methods, applications of fluid power systems
2. Fluid properties
3. Modeling of transmission lines

Displacement Machines (4 wks)

1. Design principles
2. Steady state characteristics, measurement and modeling
3. Gap flow models
4. Flow and pressure pulsation,
5. Instantaneous cylinder pressure

Resistance Control (3 wks)

1. Hydraulic resistances, steady state and dynamic models
2. Pressure and flow control
3. Flow forces, pilot operated valves
4. Servo- and proportional valves , nonlinear and linear system models

Valve controlled systems (1.5 wks)

1. Modeling and design of linear actuators
2. Design example

Displacement controlled systems (3.5 wks)

1. Pump control system design
2. Pump controlled linear actuator, design and dynamic model
3. Design and modeling of hydrostatic transmissions
4. Secondary controlled actuators

System design- - special topics (1 wk)

1. Power supply systems
2. Load sensing
3. Energy aspects

Revision Date: 6/20/2013

1. COURSE NUMBER AND NAME: ME 59700N / ABE 59100 Design and Modeling of Fluid Power Systems

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

M. Ivantysynova

4. TEXTBOOK:

No Text Required

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Introduction to modeling and design of fluid power components and systems. Modeling techniques based on physical laws and measured performance characteristics applied to design and analysis of components and system performance. Fundamentals: design principles of displacement machines, flow and pressure control, motion control using resistance control, motion control using displacement controlled actuators, variable speed transmissions, modeling of flow in lubricating gaps, transmission line models, secondary controlled systems, load sensing systems. Typically offered in the fall.

b. Prerequisites:

ME 30900 – Fluid Mechanics
ME 37500 – System Modeling and Analysis

c. Status:

Elective

6. SPECIFIC GOALS FOR THE COURSE:

a. Course Outcomes:

To give seniors and graduate students in engineering the ability to design and analyze fluid power systems applying computational methods. The course is designed to teach students how to apply engineering fundamentals to develop mathematical models of fluid power components and systems so that advanced systems can be developed.

1. To learn to *design fluid power systems* and to understand the *function of components* and how to model their steady state dynamic behavior.
2. To determine *steady state* and *dynamic characteristics of fluid power components* and *systems* based on measurements.
3. To learn *how to model fluid power components* and *systems* based on physical laws and when *to use these models*.
4. To learn how to *design advanced energy saving hydraulic actuators* and to *predict their performance*.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;
A2. Analytical Skills;
A3. Experimental Skills;
A4. Modern Engr Tools;
A5. Design Skills;
A6. Impact of Engr Solns;
B1. Communication Skills;
B2. Teamwork Skills
B3. Prof/Ethical Responsibility;
B4. Contemporary Issues;
B5. Life-Long Learning;
C1. Leadership,
C2. Global Engineering Skills;
C3. Innovation;
C4. Entrepreneurship

7. LIST OF TOPICS: See following page.

PREPARED BY: M. Ivantysynova

REVISION DATE: June 20, 2013

ME 59700Z
SUSTAINABLE DESIGN AND MANUFACTURING

Course Outcomes

1. Provide *examples of polluting interactions* between engineering decisions and the environment.
2. Understand the *physical*, *chemical*, and *biological principles* of the *generation*, *transport*, and *fate of manufacturing pollution*.
3. Describe *concepts*, *processes*, and *technology* that *improve the environmental performance of a product or process*.
4. Provide *methodologies* and *quantitative tools* to *reduce the environmental impact* of engineering decisions.
5. *Complete an environmentally friendly design or manufacturing project* that has a measurable impact on research, education, society, or practice.

Incentives and Inhibitors for Environmental Sustainability (2 wks)

1. Global environmental problems
2. Air and water pollution
3. Market drivers and inhibitors
4. Financial decision making
5. Environmental regulations
6. Roundtable discussions

Generation and Prevention of Manufacturing Pollution (4 wks)

1. Primary metal production
2. Metal fabrication and finishing
3. Lean manufacturing
4. Plastic manufacturing
5. Electronics manufacturing
6. Power generation
7. Alternative energy

Transport and Fate of Manufacturing Pollutants (3 wks)

1. Wastewater treatment
2. Pollutant degradation in water
3. Atmospheric transport
4. Global warming
5. Smog and ozone
6. Solid waste and landfill
7. Emerging pollutants and fate

Design Methodologies and Tools (6 wks)

1. Introduction: Design for Environment
2. Life cycle assessment
3. Inventory database
4. Impact analysis
5. Material selection
6. Design for recycling/reuse
7. Disassembly and remanufacturing
8. Eco-design tools
9. Case studies

Term Projects (week 3 to week 14)

Typical projects
1. Eco re-design of cell phone housing
2. Green renovation of a residential building
3. Solar-powered irrigation system in Africa
4. Education module for high school students
5. Environmentally friendly vacuum cleaner

1. COURSE NUMBER AND NAME: ME 59700Z Sustainable Design and Manufacturing

2. CREDITS AND CONTACT HOURS: 3 credits

a. Lecture – 3 days per week at 50 minutes for 16 weeks

3. COURSE COORDINATOR OR INSTRUCTOR:

Fu Zhao

4. TEXTBOOK:

None – Class Notes

5. SPECIFIC COURSE INFORMATION:

a. Catalog Description: Generation and prevention of manufacturing pollution, Transport and fate of water/air pollutants, Environmentally friendly design methodologies and quantitative tools, Process-based and economic input output life cycle assessment (LCA), Uncertainty Analysis, Drivers and inhibitors for environmental sustainability, Case studies. Typically offered in the fall.

b. Prerequisites:

MA 26200 – Linear Algebra and Differential Equations
ME 20000 – Thermodynamics I

c. Status: Elective

6. SPECIFIC GOALS FOR THE COURSE

a. Course Outcomes:

1. Provide *examples of polluting interactions* between engineering decisions and the environment.
2. Understand the *physical*, *chemical* and *biological principles* of the *generation*, *transport* and *fate of manufacturing pollution.*
3. Describe concepts, processes and technology that improve the environmental performance of a product or process.
4. Provide methodologies and quantitative tools to reduce the environmental impact of engineering decisions.
5. Complete an environmentally friendly design or manufacturing project that has a measurable impact on research, education, society or practice.

b. Related ME Program Outcomes:

A1. Engineering Fundamentals;	B3. Prof/Ethical Responsibility;
A2. Analytical Skills;	B4. Contemporary Issues;
A3. Experimental Skills;	B5. Life-Long Learning;
A4. Modern Engr Tools;	C1. Leadership,
A5. Design Skills;	C2. Global Engineering Skills;
A6. Impact of Engr Solns;	C3. Innovation;
B1. Communication Skills;	C4. Entrepreneurship
B2. Teamwork Skills	

7. LIST OF TOPICS: See following page.

PREPARED BY: Fu Zhao

REVISION DATE: March 10, 2012

APPENDIX B: FACULTY VITAE

In this appendix, a two-page vitae for each faculty member in the School of Mechanical Engineering is presented alphabetically. Each vitae includes the following information: name, education, academic experience, non-academic experience, professional registrations and certifications, current memberships in professional organizations, honors and awards, service activities, top publications and presentations of past 5 years, and most recent professional development activities. In addition, a picture of each faculty member is provided to assist the reviewer in identifying key faculty for discussions.

John Abraham
Professor, School of Mechanical Engineering

Education
B Tech, Indian Institute of Technology, Kharagpur, 1981
MA, Princeton University, 1984
PhD, Princeton University, 1986

Academic Experience
Purdue University, Professor, 2002 – Present, Full Time.
Purdue University, Associate Professor, 1996 – 2002, Full Time
University of Minnesota, Assistant Professor, 1993 – 1995, Full Time

Non-Academic Experience
Princeton University, Member of Research Staff, Department of Mechanical and Aerospace Engineering, 1992 – 1993, Full-Time
John Deere Technologies International, Senior Engineer, Rotary Engine Division, 1986 – 1991, Full-Time

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Society of Automotive Engineers, 1986 – Present (Fellow since 2006)
American Physical Society, 2004 – Present
American Society of Mechanical Engineers, 1987 – Present
American Society of Engineering Education, 2009 – Present
American Institute of Aeronautics and Astronautics, 1987 – Present
Institute of Liquid Atomization and Sprays, 1996 – Present
The Combustion Institute, 1994 – Present

Honors and Awards
Outstanding Speaker Award from the Society of Automotive Engineers, 1991, 2002
Lloyd L. Withrow Distinguished Speaker Award, Society of Automotive Engineers, 2003
SAE Fellow, 2006
Solberg Teaching Award, School of Mechanical Engineering, Purdue University, 2000

Service Activities
Associate Editor, Combustion Science and Technology, 2007 – Present
Associate Editor, ASME Transactions, Journal of Fluids Engineering, 2011 – Present
Area Editor, Fluid Mechanics, Simulation Modeling Practice and Theory, 2008
Scientific Committee, International Conference on Mesoscopic Methods in Engineering and Science, 2004 – Present
Princeton University, Annual Giving Committee, 2001 – 2006
Purdue Horizons Student Support Program, 1996 – 2001
Purdue Engineering Academic Personnel Grievance Committee, 1997 – 1998, 2004 – 2005

Purdue Censure and Dismissal Procedures Committee, 1999 – 2000
ME Minority Engineering Program academic boot camp, 2006 – 2007
Faculty advisor, NASA reduced gravity education flight program project, 2009 – 2010
ME Communications Committee, 1997 – 1999
ME ad-hoc Committee on Teaching Dilemmas, 1999
ME Heat Transfer Search Committee, 1997 – 1998
ME Graduate Committee, 2002 – 2004
Computational Science and Engineering Graduate Committee, 2001 – 2011
Acting Chair, ME Combustion, Energy Utilization, and Thermodynamics Area, Spring 2007
ME General Faculty Search Committee, 2007
Co-Chair, ME Ad-hoc Committee on Ph.D. Teaching Practicum, 2007 – 2008
Chair, ME Combustion, Energy Utilization, and Thermodynamics Area, 2009 – 2011
ME Leadership Team, 2009 – 2011
ME Heat Transfer Search Committee, 2011 – 2012

Principal Publications and Presentations (Most important from past 5 years):

C. Bajaj, **J. Abraham**, L.M. Pickett, Vaporization Effects on Transient Diesel Spray Structure, *Atomization and Sprays*, 21(5):411-426, 2011

J. Abraham, A Computational Study of Charge Stratification in Early-Injection SCCI Engines under Light-Load Conditions, *Int. J. Automotive Technology*, 12(5):721-732, 2011

M. Sayeed, V. Magi, and **J. Abraham**, On the Efficiency of a High-Performance Parallel Solver for Turbulent Reacting Flow Simulations, *Num. Meth. Heat Trans. Part B*, 59(3):169-189, 2011

S. Mukhopadhyay and **J. Abraham**, Influence of Compositional Stratification on Autoignition in n-Heptane/Air Mixtures, *Comb. Flame*, 158(6):1064-1075, 2011

H. Reddy and **J. Abraham**, A Numerical Study of Vortex Interactions with Flames Developing from Ignition Kernels in Lean Methane/Air Mixtures, *Comb. Flame*, 158(3):401-415, 2011

J. Abraham and L. Pickett, Computed and Measured Fuel Vapor Distribution in a Diesel Spray, *Atomization and Sprays*, 20(3): 241-250, 2010

R. Owston, V. Magi and **J. Abraham**, Some Numerical Considerations in the Simulation of Low-Ma Number Hydrogen/Air Mixing Layers, *Int. J. of Hyd. Energy*, 35(23), 12936-12944, 2010

H. Reddy and **J. Abraham**, Ignition Kernel Development Studies Relevant to Lean-Burn Natural Gas Engines, *Fuel*, 89(11): 3262-3271, 2010

R. Owston and **J. Abraham**, Numerical Study of Hydrogen Triple Flame Response to Mixture Stratification, Ambient Temperature, Pressure, and Water Vapor Concentration, in press, *International Journal of Hydrogen Energy*, 35(10): 4723-4735, 2010

R. Owston and **J. Abraham**, Structure of Hydrogen Triples Flames and Premixed Flames Compared, *Combustion and Flame*, 157:1552-1565, 2010

Professional Development Activities (Past 5 years):

DoE Workshop on Predictive Simulation of Combustion Engine Performance in an Evolving Fuel Environment, Ann Arbor, MI, February 11, 2010

DoE Workshop to Identify Needs and Impacts in Predictive Simulation for Internal Combustion Engines (PreSICE), Arlington, VA, March 3, 2011

Douglas E. Adams
Kenninger Professor,
School of Mechanical Engineering

Education
BSME, University of Cincinnati, 1989
MSME, MIT, 1997
Ph.D.,ME, University of Cincinnati, 2000

Academic Experience
Purdue University, Kenninger Professor of Renewable Energy and Power Systems, Mechanical Engineering, 2010 – Present, Full-Time
Purdue University, Professor, Mechanical Engineering, 2009 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 2005 – 2009, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 2000 – 2005, Full-Time
University of Cincinnati, Adjunct Assistant Professor, 2000
University of Cincinnati, University Distinguished Graduate Research Assistant, 1997 – 2000
MIT, Research Assistant, 1995-1997
MIT, Teaching Assistant, 1995

Non-Academic Experience
Roush-Anatrol, Consultant Engineer, 1990 – 1993

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Member: American Society of Mechanical Engineers, Society of Experimental Mechanics

Honors and Awards
Army Research Office Young Investigator Award, 2002
Presidential Early Career Award for Scientists and Engineers, 2002
Structural Health Monitoring Person of the Year Award, 2003
School of Mechanical Engineering Research Discovery Award, 2003
College of Engineering Young Faculty Research Excellence Award, 2003
School of Mechanical Engineering Solberg Award for Undergraduate Teaching, 2003, 2007
Purdue University Murphy Award for Excellence in Undergraduate Teaching, 2004
Named Fellow of the Purdue Teaching Academy, 2005
Journal of Sound and Vibration, Elsevier, Names One of the Most Cited Authors, 2006
Purdue University Joel Spira Award for Excellence in Teaching and Commercialization of Research, 2006
Society of Experimental Mechanics, DeMichele Award, 2009
American Society of Mechanical Engineers Dynamic Systems & Controls Division, Outstanding Young Investigator Award, 2009
Best Paper from American Helicopter Society (HUMS Category), 2009
American Society of Mechanical Engineers, Elected Fellow, 2011
Purdue University Engineering Professional Education, Distance Faculty Award for Excellence in Teaching, 2011

Service Activities

Mechanics Area Committee, Mechanical Engineering, Purdue University, 2008 – Present

Manager Editor, Structural Health Monitoring: An International Journal, Sage Publication, 2010 – Present

Reviewer, National Science Foundation CAREER Panel, National Aeronautics and Astronautics Young Investigator Panel

Principal Publications (Most important from past 5 years)

Textbooks and Book Chapters

Adams, D. E., and Jata, K., "Part 17: Damage Prognosis in Metallic and Composite Structures," *Encyclopedia of Aerospace Engineering,* John Wiley & Sons, 2010.

Adams, D. E., "Health Monitoring of Structural Materials and Components," 2007, John Wiley & Sons, Chichester, U.K.

Refereed Journal Publications

DiPetta, T., Koester, D., Doherty, P., Fisher, K., and **Adams, D. E.**, "Study of an Instrumented Diagnostic Cleat for Diagnosing Vehicle Mechanical Faults using Off-Board Dynamic Response Measurements", 2012, *Journal of Condition Monitoring and Diagnostic Engineering Management,* in print

Mahulkar, V., and **Adams, D. E.**, "Derivative Free Filtering in Hydraulic Systems for Fault Identification", 2011, *Control Engineering Practice,* Vol. 19, Issue 7, pp. 649-657

Adams, D. E., White, J., Rumsey, M., and Farrar, C., "Structural Health Monitoring of Wind Turbines:Method and Application to a HAWT", 2011, *Wind Energy,* Vol. 14, Issue 4, pp. 603-623

Yoder, N. and **Adams, D. E**., "Vibro-Acoustic Modulation Utilizing a Swept Probing Signal for Robust Crack Detection," (invited paper) 2010, *Structural Health Monitoring: An International Journal,* Vol. 9, No. 3, pp. 257-267

Yoder, N. Haroon, M. **Adams, D. E**., and Triplett, M., "Multi-Dimensional Sensing for Impact Load and Damage Evaluation in a Carbon Filament Wound Canister," (invited paper) 2009, *Materials Evaluation,* Vol. 66, No. 7, pp. 756-763

Haroon, M. and **Adams, D., E**., "Component-Level Damage Evolution Laws for Mechanical Damage Prognosis," 2008, *American Society of Mechanical Engineering Journal of Applied Mechanics,* Vol. 74(2), DOI: 10.1115/1.2793137

Park, J.-I., Bilal, N., and **Adams, D. E**., "Numerical and Experimental Study of Gas Pulsations in the Suction Manifold of a Multi-Cylinder Automotive Compressor", 2008, *American Society of Mechanical Engineering Journal of Vibration and Acoustics,* Vol. 130(1), 011014

Kess, H., Sundararaman, S., Shah, C., **Adams, D. E**., Triplett, M., Walsh, S., and Pergantis, C., "Damage Identification in An S-2 Glass Composite Cylinder Using Vibration and Wave Propagation Methods," 2007, *Journal of Experimental Mechanics,* Vol. 47(4), pp. 497-509

Professional Development Activities (Past 5 years):

Marie Curie Action on Stability, Identification and Control in Nonlinear Systems, Belgium (lecturer), 2009

Workshop on Condition Monitoring of Wind Turbines, NREL (speaker), 2009

David C. Anderson
Professor, Mechanical Engineering and Computer Sciences
Associate Head for Graduate Studies,
School of Mechanical Engineering

Education
BSME, Purdue University, 1970
MSME, Purdue University, 1971
Ph.D., ME, Purdue University, 1974

Academic Experience
Purdue University, Associate Head for Graduate Studies, Mechanical Engineering, 2010 – Present, Full-Time
Purdue University, Professor, Mechanical Engineering and Computer Sciences, 1985 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering and Computer Sciences, 1979 – 1985, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering and Computer Sciences, 1975 – 1979; Full-Time

Non-Academic Experience
NSF Engineering Research Center for Collaborative Manufacturing, Deputy Director, 1994 – 2004
NSF Engineering Research Center for Intelligent Manufacturing Systems, Associate Director, 1985 – 1994
Control Data Corporation (on sabbatical leave from Purdue University), CAD/CAM Consultant, 1984 – 1985
Control Data Corporation (on leave from Purdue University), CAD/CAM Consultant, Jan. – May 1979

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow, American Society of Mechanical Engineering
Member, Association for Computing Machinery

Honors and Awards
Graduated with highest distinction, Purdue University
Recipient of the 1992 National Computer Graphics Association CAD Society Academic Award (which recognizes an individual from the academic community who has made a significant contribution to CAD education)

Service Activities
Purdue University Senate

Principal Publications and Presentations (Most important from past 5 years)

O. Morgan, G. Subbarayan and **D. C. Anderson**, "A Hybrid Hierarchical Procedure for Composing Trivariate NURBS Solids," *Computer-Aided Design and Applications,* Vol. 9, No.2, pp.215-226, 2012
Also appears in *Proceedings of CAD' 11*, Paper #92, June 27-30, 2011, Taipei, Taiwan

Professional Development Activities (Past 5 years)

Editorial Board Member, IIE Transactions on Design and Manufacturing, 1996 – Present
Editorial Board Member, Journal of Design and Manufacturing, 1991 – Present
Editorial Advisory Board Member, Journal of Research in Engineering Design, 1988 – Present

Kartik B. Ariyur
Assistant Professor
School of Mechanical Engineering

Education
BSME, IIT, Madras, 1996
MSME, UC, San Diego, 1999
Ph.D., ME, UC, San Diego, 2002

Academic Experience
Purdue University, Assistant Professor, Mechanical Engineering, 2008 – Present, Full-Time
U of MD, College Park, Instructor, 1996 – 1997, Part-Time

Non-Academic Experience
United Technologies Research Center, Engineering intern in the gas turbine division, Summer 1998, Full-Time
Qualcomm Inc., Engineering Intern, in the CDMA Technologies ASIC Division, 2001 – 2002, Part-Time
Honeywell Labs, Research Scientist in Guidance, Control, Navigation and Communications, 2002 – 2005, Full-Time
Honeywell Labs, Senior Research Scientist in Guidance, Control, Navigation and Communications, 2005 – 2008, Full-Time

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Institute of Electrical and Electronics Engineers, 1996 – Present
American Institute of Aeronautics and Astronautics, Senior Member, 2008 – Present
American Society of Mechanical Engineers, 2008 – Present
Institute of Navigation, 2008 – Present
Society of Industrial and Applied Mathematics, 2008 – Present
Society of Automotive Engineers, 2012

Honors and Awards
Marquis's Who's Who in Science, 2008 – Present
Marquis' Who's Who in the World, 2008 – Present
Marquis' Who's Who in America, 2007 – Present
SAE Power Systems Conference Outstanding Paper Award, 2004
Honeywell Technical Achievement Award, 2003

Service Activities
Purdue IP Committee, 2011 – Present
Purdue School of Mechanical Engineering Research Committee, 2011 – Present
Technical Editor, International Journal of Adaptive Control and Signal Processing, 2005 – Present
Program Committee, Hybrid Systems, Computation and Control, 2006
Program Committee, American Control Conference, 2008, 2009, 2013

Program Committee, IEEE MultiConference on Systems and Controls, 2011, 2012
IEEE-CSS Technical Committee on Power Generation, 2011 – Present
NSF, DoE, DoS review panels

Principal Publications and Presentations (Most important from past 5 years)

1. "On the Extremum Seeking of Model Reference Adaptive Control in Higher Dimensional Systems," P. Haghi and **K. B. Ariyur**, Proceedings of the *2011 American Control Conference*, San Francisco, CA, June 29—July1, 2011
2. "A Mathematical Foundation for TRIZ Methods," **K. B. Ariyur**, *Proceedings of the IEEE International Systems Conference (SysCon 2011)*, Montreal, Quebec, Canada, April 3—6, 2011
3. "Scalable Autonomy for Unmanned Aerial Vehicles," S.-H. Jung and **K. B. Ariyur**, *Proceedings of the AIAA Infotech@Aerospace 2011(Unleashing Unmanned systems)*, St. Louis, MO, March 29—31, 2011
4. "Properties of Laplacian Path Planning for UAVs," F. Yang and **K. B. Ariyur**, *Proceedings of the AIAA Infotech@Aerospace 2011(Unleashing Unmanned systems)*, St. Louis, MO, March 29—31, 2011
5. "Deception Robust Control for Automated Cyber Defense Resource Allocation," J. Lawson, R. Singh, M. Hultner, and **K. B. Ariyur**, *Proceedings of the IEEE Conference on Cognitive Methods in Situation Awareness and Decision Support (CogSIMA)*, Miami Beach, FL, February 22—24, 2011
6. "Accelerometer Based Inertial Measurement Units," P. Gullipalli and **K. B. Ariyur**, *Proceedings of the ION International Technical Meeting,* San Diego, CA, January 24—26, 2011
7. "Building thermal network model and application to temperature regulation," Qi Luo and **Kartik B. Ariyur**, *Proceedings of the 2010 IEEE Multi-conference on Systems and Control,* Yokohama, Japan, September 8-10, 2010
8. "Motion estimation and navigational drift correction with LIDAR data," *ION International Technical Meeting,* San Diego CA, January 25-27, 2010
9. "The use of natural signals for localization and navigation with application to centimeter sized UAVs," Gautam Sharma, Isabelle A. G. Laureyns, and **Kartik B. Ariyur**, to appear in the *Proceedings of the 2010 American Control Conference,* Baltimore, MD, June 30-July 2, 2010
10. "Region of attraction with performance bounds," Subhabrata Ganguli, **Kartik B. Ariyur**, and Dale F. Enns, *Proceedings of the AIAA Conference on Guidance, Control and Dynamics,* Chicago, IL, August 10—13, 2009
11. "Real-time energy management: cutting energy costs and the carbon footprint," Qi Luo, **Kartik B. Ariyur**, and Anoop K. Mathur, *Proceedings of the 2009 ASME Dynamic Systems and Control Conference,* Hollywood CA, October 12-14, 2009
12. "Analytic framework and QoS adaptive mechanisms for achieving transport capacity bounds in multi-hop statically routed IEEE 802.11 networks," S. Varadarajan, Y. Yi, **K. B. Ariyur**, *Annual Conference of ITA*, Adelphi, MD, September 2007
13. "A Nonlinear Hybrid Life Support System: Dynamic Modeling, Control Design, and Safety Verification," S. Glavaski, D. Subramanian, **K. B. Ariyur**, R. Ghosh, N. Lamba, A. Papachristodoulou, *IEEE Transactions on Control System Technology*, vol. 15, pp. 1003-1017, 2007

Professional Development (Past 5 years)

None

Euiwon Bae
Assistant Research Professor,
School of Mechanical Engineering

Education
BSME, Korea University, South Korea, 1999
MSME, KAIST, South Korea, 2001
Ph.D., ME, Purdue University, West Lafayette, 2006

Academic Experience
Purdue University, Assistant Research Professor, Mechanical Engineering, 2010 – Present
Purdue University, Post-Doctoral Research Associate, Mechanical Engineering, 2007 – 2010

Non-Academic Experience
Techmetrix, Seoul, Korea, 2000 – 2001
US Army, NCO 34th Support Group, 1995 – 1998

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Member, American Society of Mechanical Engineers
Member, Optical Society of America

Honors and Awards
Undergraduate Fellowship, Korea University, 1995
US Army commendation medal, 34th Support Group, 8th US Army, 1997
Graduate School Fellowship, KAIST, 2001
Finalist, Burton D. Morgan Business Plan competition, 2009

Service Activities
None

Principal Publications and Presentations (Most important from past 5 years)
Refereed Journal Publications
K. Huff, P. Banada, A. Aroonnual, **E. Bae**, B. Bayraktar, B. Rajwa, E.D. Hirleman, J.P. Robinson, G. P. Richards, and A.K. Bhunia "Detection and identification of Vibrio species using a novel optical forward light scattering sensor," Microbial Biotechnology, in press, 2012
E. Bae, V. Patsekin, B. Rajwa, A.K. Bhunia, C. Holdman, V.J. Davisson, E.D. Hirleman, and J.P. Robinson "Development of a microbial high-throughput screening instrument based on elastic light scatter patterns." Review of Scientific Instruments, Vol. 83, No.4, April 2012, 044304
E. Bae, N. Bai, and E.D. Hirleman "Application of sampling criterion on numerical diffraction from bacterial colonies," Applied Optics, Vol.50, No.15, May 2011, pp.2228-2238
E. Bae, A. Aroonnual, A.K. Bhunia, and E.D. Hirleman "On the sensitivity of forward scattering patterns from bacterial colonies to media composition", Journal of Biophotonics, Vol.4, No.4, April 2011, pp.236-243
E. Bae, N. Bai, A. Aroonnual, A.K. Bhunia, and E.D. Hirleman "Label-free identification of bacterial microcolonies via elastic scattering," Biotechnology and Bioengineering, Vol. 108, No. 3, March 2011, pp.637-644

E. Bae, N. Bai, A. Aroonnual, A.K. Bhunia, J.P. Robinson, and E.D. Hirleman "Modeling light propagation of light through bacterial colonies and their correlation to the forward scattering patterns," Journal of Biomedical Optics, Vol. 15, No.4, July 2010, 019004

E. Bae, A. Aroonnual, A.K. Bhunia, J.P. Robinson, and E.D. Hirleman "System automation for a bacterial colony detection and identification instrument via forward scattering," Measurement Science and Technology, Vol. 20, No. 1, January 2009, 015802

E. Bae, and E.D. Hirleman, "Computational analysis and diagonal preconditioning for the discrete dipole approximation on surface," Journal of Quantitative Spectroscopy and Radiative Transfer, Vol. 110, No.1, January 2009, pp.51-61

P.P. Banada, K. Huff, Amornrat Aroonnual, **E. Bae**, B. Rajwa, B. Bayraktar, A. Adil, J.P. Robinson, E.D. Hirleman, and A.K. Bhunia, "Label-free detection of multiple bacterial pathogens using light scattering sensor," Biosensors and Bioelectronics, Vol. 24, No. 6, Febuaray 2009, pp.1685-1692

E. Bae, H. Zhang, and E.D. Hirleman, "Application of discrete dipole approximation for dipoles embedded in film," Journal of Optical Society of America A, Vol. 25, No. 7, July 2008, pp.1728-1736

Professional Development Activities (Past 5 years)

None

Anil K. Bajaj
Professor and Head
School of Mechanical Engineering

Education
B Tech, Indian Institute of Technology, Kharagpur, India, 1973
MS, Indian Institute of Technology, Kanpur, India, 1976
Ph.D.,Mechanics, University of Minnesota, 1981

Academic Experience
Purdue University, William E. and Florence E. Perry Head, Mechanical Engineering, 2010 – Present, Full-Time
Purdue University, Associate Head for Research and Graduate Education, Mechanical Engineering, 1998 – 2010, Full-Time
Purdue University, Professor, Mechanical Engineering, 1991 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 1985 – 1991, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1981 – 1985, Full-Time
Swiss Federal Institute of Technology (ETH), Zurich, Switzerland, Visitor, Department of Applied Mathematics, July 7 – 13, 1991
University of Minnesota, Minneapolis, MN, Visiting Associate Professor, Department of Aerospace Engineering and Mechanics, June – July 1988
Indian Institute of Technology, Kanpur, India, Visiting Faculty, Department of Mechanical Engineering, February – April 1988
University of Minnesota, Minneapolis, MN, Visiting Research Associate, Department of Aerospace Engineering and Mechanics, June – August 1981

Non-Academic Experience
None

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow – ASME; Member: Sigma Gamma Tau, Sigma Xi, Society of Engineering Science, Society of Industrial and Applied Mathematics; ASME Technical Committee on Dynamics of Structure and Systems, Applied Mechanic Division; Founding Member, The Vibration Institute of India

Honors and Awards
College of Engineering Faculty Excellence Awards: Mentoring, 2008
College of Engineering Faculty Excellence Awards: Team Research, 2008
Provost's Award for Outstanding Graduate Mentor, 2006
Certificate of Appreciation, 'Symposium Organizer' DETC2003, Chicago, IL, Design Engineering Division, The ASME, 2003
Ruth and Joel Spira Award for Excellence in Service, 2002
B. Tech – Institute Silver Medal, 1973

Service Activities
Editorial Board: The Vibration Institute of India Journal, 2000 – Present
Contributing Editor: Nonlinear Dynamics, 1993 – Present

Principal Publications and Presentations (Most important from past 5 years)
Refereed Journal Publications

Wang, Fengxia and **Bajaj, Anil K.**, "Model Reduction for Discrete and Elastic Structures with Inertial Quadratic Nonlinearities", IMechE Journal of Mechanical Engineering Science, Vol. 225 (10), Oct. 2011, pp. 2422-2435

Joshi, Gauri A.*, **Bajaj, Anil K.** and Davies, Patricia, "Whole-body Vibratory Response Study using a Nonlinear Multi-Body Model of Seat Occupant System with Viscoelastic Flexible Polyurethane Foam", Industrial Health, Vol. 48, 2010, pp. 663-674

Wang, Fengxia* and **Bajaj, Anil K.**, "Nonlinear Dynamics of a Three-Beam-Tip-Mass Structure with Various Three-mode Interactions", Nonlinear Dynamics, Vol. 62, 2010, pp. 461-484

Huang, Jinchun*, Krousgrill, Charles M. and **Bajaj, Anil K.**, "An Efficient Approach to Estimate Critical Value of Friction Coefficient and Sensitivity Analysis for Brake Squeal", International Journal of Vehicle Design, Vol. 51, Numbers 1-2, 2009, pp. 21-38

Bidkar, Rahul A.*, Kimber, Mark, Raman, Arvind, **Bajaj, Anil K.** and Garimella, Suresh V., "Nonlinear Aerodynamic Damping of Sharp-edged Flexible Beams Oscillating at Low Keagulen-Carpenter Numbers", Journal of Fluid Mechanics, Vol. 634, 2009, pp. 269-289

Vyas, A.*, Peroulis, D. and **Bajaj, A.K.**, "A Microresonator Design Based on Nonlinear 1:2 Internal Resonance in Flexural Structural Modes", IEEE/ASME Journal of Microelectromechanical Systems, Vol. 18, June 2009, pp. 744-762

Wang, Fengxia* and **Bajaj, Anil K.**, "On the Formal Equivalence of Normal Form Theory and the Multiple Time Scales Method," ASME Journal of Computational and Nonlinear Dynamics, Vol. 4, April 2009, pp. 021005-1-11

Bidkar, Rahul*, Raman, Arvind and **Bajaj, Anil K.**, "Aeroelastic Stability of Wide Webs and Narrow Ribbons", ASME Journal of Applied Mechanics, Vol. 75, July 2008, pp. 041023-1- 9

Ippili, R.*, Davies, P., **Bajaj, A.K.**, and Hagenmeyer, "Nonlinear Multi-Body Dynamic Modeling of Seat-Occupant System with Polyurethane Seat and H-Point Prediction", International Journal of Industrial Ergonomics, Vol. 38, No. 5-6, 2008, pp. 368-383

Vyas, A.*, Peroulis, D. and **Bajaj, A.K.**, "Dynamics of a Nonlinear Microresonator Based on Resonantly Interacting Flexural-Torsional Modes", Nonlinear Dynamics, Vol. 54, 2008, pp. 31-52

Professional Development Activities (Past 5 years)
None

J. Stuart Bolton
Professor, School of Mechanical Engineering

Education
B.A.Sc., University of Toronto, Canada, 1974
M.Sc., Sound and Vibration, Southampton University, England, 1976
Ph.D, Southampton University, England, 1984

Academic Experience
Purdue University, Professor, Mechanical Engineering, 1997 – Present; Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 1992 – 1997, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1987 – 1992, Full-Time
Purdue University, Visiting Assistant Professor, Mechanical Engineering, 1984 – 1987, Full-Time
Southampton University, England, Visiting Professor, Institute of Sound and Vibration Research, 1999
Korean Advance Institute of Science and Technology, Taejon, Korea, Visiting Professor, 1998 – 1999

Non-Academic Experience
None

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow: Acoustical Society of America
Fellow: Institute of Noise Control Engineering

Honors and Awards
Arch T. Colwell Merit Award, Society of Automotive Engineers, 1997
Institute of Noise Control Engineering Outstanding Educator Award, 1999
Keynote Speaker INTER-NOISE 2003, Jeju Island, Korea, 2003
Plenary Speaker INTER-NOISE 2005, Rio di Janeiro, Brazil, 2005
Purdue University, Division of Engineering Professional Education Distance, Teaching Award, 2008
Keynote Speaker SAPEM, Bradford, UK, 2008
Keynote Speaker NOVEM, Oxford, UK, 2009
Keynote Speaker Korean Society of Noise and Vibration Engineering, Jeju, Korea, 2010
Keynote Speaker Acoustics 2012, Nantes, France, 2012

Service Activities
Technical Program Co-Chair and Proceedings Editor, Inter-Noise 2009, Ottawa, Canada, August 2009
Institute of Noise Control Engineering, Board of Directors, Vice President for Publications
Purdue University Senate, Member
Purdue University Senate, Vice-Chair, Faculty Affairs Committee
Purdue University Senate, Advisory Committee
Purdue University College of Engineering, Engineering Area Promotion Committee
Purdue University College of Engineering, Head Search Committees, Aeronautics and Astronautics and Mechanical Engineering
Purdue University, University Promotion Committee

Principal Publications and Presentations (Most important from past 5 years)

Refereed Journal Publications

S. Khandelwal, T. Siegmund, R.J. Cipra and **J.S. Bolton**, "Transverse Loading of Cellular Topologically Interlocked Materials," *International Journal of Solids and Structures*, http://dx.doi.org/10.1016/j.ijsolstr.2012.04.035, 2012

C. Bi and **J.S. Bolton**, "An Equivalent Source Technique for Recovering the Free Sound Field in a Noisy Environment," *Journal of the Acoustical Society of America*, Vol. 131(2), 1260-1270, 2012

Z. Yamaguchi, K. Sakagami, M. Morimoto, **J.S. Bolton** and I. Yamagiwa, "Reduction of Sound Radiation by using Extended Radiation Modes: Effects of Added Mass," *Acoustical Science and Technology*, Vol. 33, issue 1, 56-58, 2012

C.S. Bhat, P.H. Meckl, **J.S. Bolton** and J. Abraham, "Influence of fuel injection parameters on combustion-induced noise in a small diesel engine," *International Journal of Engine Research*, Published online 7 November 2011, DOI: 10.1177/1468087411428040, 17 pages, 2011

A.M. Jessop and **J.S. Bolton**, "Surface Vibration and Sound Radiation Resulting from the Tire Cavity Mode," *Tire Science and Technology*, Vol. 39(4), 245-255, 2011

Z. Yamaguchi, **J.S. Bolton** and K. Sakagami, "Reduction of Sound Radiation by using Force Radiation Modes," *Applied Acoustics*, Vol. 72, issue 7, 420-427, 2011

A.M. Jessop, K.M. Li and **J.S. Bolton**, "Reduction of low frequency noise transmitted through single pane windows,"*Acta Acustica united with Acustica*, Vol. 97, issue 3, 382-390, 2011

J. S. Bolton and N. Kim, "Use of CFD to calculate the dynamic resistive end correction for microperforated materials," *Acoustics Australia*, Vol. 38, issue 3, 134-139, 2010

Y.T. Cho, M.J. Roan and **J.S. Bolton**, "Dual surface beamforming and acoustical holography for sound field visualization in reverberant environments," *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, Vol. 224, Issue C1, 55-70, 2010

Y.T. Cho, **J.S. Bolton** and M.J. Roan, "Acoustic source property prediction based on near-field measurements in planar coordinates," *Journal of Sound and Vibration*, Vol. 324, 587-607, 2009

Professional Development Activities (Past 5 years)

None

James E. Braun
Herrick Professor of Engineering and
Professor of Mechanical Engineering,
School of Mechanical Engineering

Education
BSME, University of Massachusetts - Amherst, 1976
MSME, University of Wisconsin - Madison, 1980
Ph.D., ME, University of Wisconsin - Madison, 1989

Academic Experience
Purdue University, Herrick Professor of Engineering, Mechanical Engineering, 2011 – Present, Full-Time
Purdue University, Professor, Mechanical Engineering, 2001 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 1996 – 2001, Full Time
Purdue University, Assistant Professor, Mechanical Engineering, 1991 – 1996, Full-Time

Non-Academic Experience
Carrier Corporation, Syracuse, NY, Transicold Division, 1976 – 1978
University of Wisconsin, Madison, WI, Solar Energy Laboratory, 1980 – 1984
Johnson Controls, Inc., Milwaukee, WI, Research Group, 1989 – 1991

Current Membership in Professional Organizations
American Society of Heating, Air Conditioning, and Refrigerating Engineers (ASHRAE)

Honors and Awards
Best Paper Award: ASHRAE, 2007
ASHRAE Fellow, awarded at the ASHRAE winter meeting in 2006
E.K. Campbell Award of Merit, in recognition of outstanding service and achievement in teaching and/or research in subjects relating to the industry and professions represented by ASHRAE, 2005
Best Student Paper Award, International Building Performance Simulation Association – USA Conference, Boulder, CO, 2004
ASHRAE Distinguished Service Award, 2003
Best Paper Award, Noise Control and Acoustic Division, ASME International Mechanical Engineering Congress and Exposition, 2001

Service Activities
Purdue Campus Energy Efficiency Initiative, 2010
OnePurdue Applications Steering Committee, 2008
Advisory Committee to the University President, 2007 – 2011
Chair, Combustion, Energy Utilization, and Thermodynamics Area, 2006 – 2009
Purdue Faculty Senate, 2005 – 2011

Principal Publications (Most important from past 5 years)
Zhong Z. and **Braun, J.E**., "A Simple Method for Estimating Transient Heat Transfer in Slab-On Ground Floors, Building and Environment, Vol. 42, No. 3, pp. 1071-1080, 2007
Li, H. and **Braun, J.E**. An Overall Performance Index for Characterizing the Economic Impact of Faults in Direct Expansion Cooling Equipment," International Journal of Refrigeration, Vol. 30, No. 2, Pages 299-310, 2007

Li, H. and **Braun, J.E**. "A Methodology for Diagnosing Multiple-Simultaneous Faults in Vapor Compression Air Conditioners," HVAC&R Research, Vol. 13, No. 2, Pages 369-395, 2007

Li, H. and **Braun, J.E**. "Decoupling Features and Virtual Sensors for Diagnosis of Faults in Vapor Compression Air Conditioners," International Journal of Refrigeration, Vol. 30, No. 3, Pages 546-564, 2007

Zhou, X. and **Braun, J.E**., "A Simplified Dynamic Model for Chilled Water Cooling and Dehumidifying Coils – Part 1: Development," HVAC&R Research, Vol. 13, No. 5, Pages 785-804, 2007

Paek, I., **Braun, J.E**., and Mongeau, L., "Evaluation of Suitable Applications for Thermoacoustic Coolers," International Journal of Refrigeration, Vol. 30, No. 6, Pages 1059-1071, 2007

Lee, K.-H. and **Braun, J.E**., "Development of Methods for Determining Demand-Limiting Setpoint Trajectories in Buildings Using Short-Term Measurements," Building and Environment, Vol.43, Pages 1633-1646, 2008

Li, H. and **Braun, J.E**. "Development, Evaluation and Demonstration of a Virtual Refrigerant Charge Sensor," HVAC&R Research, Vol. 15, No. 1, Pages 117-136, 2009

Kim, J., **Braun, J.E**., and Groll, E.A., "A Hybrid Method for Refrigerant Flow Balancing in Multi Circuit Evaporators: Upstream versus Downstream Flow Control," International Journal of Refrigeration, Vol. 32, No. 6, Pages 1271-1282, 2009

Mathison, M., **Braun, J.E.**, Groll, E., "Performance Limit for Economized Cycles with Continuous Refrigerant Injection," International Journal of Refrigeration, Vol. 34, No. 1, Pages 234-242, 2011

Hengeveld, D.W., **Braun, J.E**., and Groll, E.A., "Optimal Placement of Electronic Components to Minimize Heat Flux Non-Uniformities," Vol. 48, No. 4, Pages 556-563, Journal of Spacecraft and Rockets, 2011

Li, H., Yu, D., and **Braun, J.E**., "A Review of Virtual Sensing Technology and Application in Building Systems," Vol. 17, No. 5, Pages 619-645, HVAC&R Research, 2011

Professional Development Activities (Past 5 years)

ASME Task force on Integrated/Efficient Building Equipment and Systems, 2010 – 2011

Project Advisory Committee for Joint Utility/California Public Utility Commission HVAC Quality Maintenance Study, 2010

Chairman, 2012 International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, IN, July, 2012

Scientific Committee, International Conference on Sustainable Urbanization, Hong Kong, Dec, 2010

Scientific Committee, System Simulation in Buildings 2010, Liege, Belgium, Dec, 2010

Chairman, 2010 International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, IN, July, 2010

Scientific Committee for the 2009 International Conference on Sustainable Development in Building and Environment, Chongqing University of China, 2009

Scientific Committee for 2009 Compressors – 7th International Conference on Compressors and Coolants, Papiernička, Slovak Republic, 2009

Chairman, 2008 International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, IN, July, 2008

Organizing Committee for the International Conference on Building Energy and Environment, Dalian, China, 2008

Chair of ASHRAE Research Administration Committee (RAC), 2010 – 2011

Vice-Chair of ASHRAE Research Administration Committee (RAC), 2009 -2010

Member of ASHRAE Research Advisory Panel (RAP), ASHRAE, 2009 – 2011

Member of ASHRAE Technology Council, 2009 – 2011

Editorial Board, Journal of Building Performance Simulation, 2008 -

Editorial Board, Building Simulation: An International Journal, 2007 -

Associate Editor, International Journal of HVAC&R Research, 1998 –

Richard O. Buckius
Vice President for Research
Professor of Mechanical Engineering
School of Mechanical Engineering

Education
BSME, University of California, Berkeley, 1972
MSME, University of California, Berkeley, 1973
Ph.D.,ME, University of California, Berkeley, 1975

Academic Experience
Purdue University, Vice President for Research, 2008 – Present
Purdue University, Professor of Mechanical Engineering, 2008 – Present
University of Illinois at Urbana-Champaign (UIUC), Head of the Department, Department of Mechanical and Industrial Engineering, 1998 – 2004
University of Illinois at Urbana-Champaign, Richard W. Kritzer Professor, 1992 – 1997
University of Illinois at Urbana-Champaign, Associate Vice Chancellor for Research, 1988-1991
University of Illinois at Urbana-Champaign, Associate Head of the Department, Department of Mechanical and Industrial Engineering, 1985-1987
University of Illinois at Urbana-Champaign, Professor of Mechanical Engineering, 1984 – 2008
University of Illinois at Urbana-Champaign, Associate Professor of Mechanical Engineering, 1980 – 1984
University of Illinois at Urbana-Champaign, Assistant Professor of Mechanical Engineering, 1975 – 1980

Non-Academic Experience
National Science Foundation, Assistant Director, Directorate for Engineering, 2006 – 2008
National Science Foundation (on leave from UIUC), Assistant Director (Acting), Directorate for Engineering, 2005 – 2006
National Science Foundation (on leave from UIUC), Division Director, Chemical and Transport Systems, 2004 – 2005
National Science Foundation (on leave from UIUC), Program Director, Thermal Systems and Engineering Program, 1987 – 1988

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Mechanical Engineers
American Society of Engineering Education
American Association for the Advancement of Science

Honors and Awards
Richards Memorial Award, American Society of Mechanical Engineers (ASME), 2007
Potter Gold Medal, ASME, 2006
Ralph Coats Roe Award, American Society for Engineering Education (ASEE), 2003
Fellow, ASME, 1988
Halliburton Engineering Education Leadership Award, College of Engineering, UIUC, 1987
Western Electric Fund Award, ASEE, 1981
Campus Award for Excellence in Undergraduate Teaching, UIUC, 1980
W. L. Everitt Undergraduate Teaching Excellence Award, College of Engineering, UIUC, 1980
Stanley H. Pierce Faculty Award, College of Engineering, UIUC, 1979
Dow Outstanding Young Faculty, Illinois-Indiana Section, ASEE, 1978
M&IE Alumni Teach Award, UIUC: 2 year award, 1980, 1987, 1994, 2000; 5 year award, 1982, 1989

Service Activities
Elsevier, Academic Executive Advisory Board, 2010-date
BioCrossroads, Board of Directors, 2009-date
Energy Systems Network, Technical Advisory Council, 2009-date
Regenstrief Foundation, Inc., Board of Directors, 2009-date
Alfred Mann Institute for Biomedical Development, Purdue University, Board of Directors, 2009-2012
Sandia Science Advisory Council, Sandia National Laboratory, 2010-date
External Review Panel, Engineering Sciences Research Foundation, Sandia National Laboratories, 2007-2009; Chair, 1997-1998, 2010-date
Technical Group Leader, Basic Engineering, ASME, 2005-2007
Editorial Advisory Board, *Nanoscale and Microscale Thermophysical Engineering*, 1996-date
Editorial Advisory Board, *Heat Transfer Research*, 1997-date
Editorial Advisory Board, *Heat Transfer-Japanese Research*, 1990-date
Vice President, Basic Engineering, ASME, 2004-2005
Associate Technical Editor, *AIAA Journal of Thermophysics and Heat Transfer*, 1999-2004
NSF Budget Task Force, ASME, 1992-2004
Organizing Committee, International Symposium on Radiative Transfer, 2000, 2001, 2004
ASME Basic Engineering Technical Operating Board, 1999-2002
ASME Board on Communications, 1997-1998
ASME Nominating Committee, 1997-1998
Chair, ASME Heat Transfer Division, 1995-1996
Technical Program Chair, ASME Heat Transfer Division, Winter Annual Meeting, 1993
First NSF Presidential Faculty Fellow Final Evaluation Committee, NSF, 1992
Associate Technical Editor, *ASME Journal of Heat Transfer*, 1988-1992
Executive Committee, Mechanical Engineering Division, ASEE, 1982-1985

Principal Publications and Presentations (Most important from past 5 years)
Howell, J. R., and **R. O. Buckius**, *Fundamentals of Engineering Thermodynamics*, 2nd Edition, McGraw-Hill Book Co., 1033 pp., 1992 (ISBN 0-07-909369-3)
Walters, D. V. and **R. O. Buckius**, "Monte Carlo Methods for Radiative Heat Transfer in Scattering Media," *Annual Review of Heat Transfer*, Vol. 5, pp. 131-176, 1994
Cohn, D. W., K. Tang and **R. O. Buckius**, "Bi-directional Reflection and Directional Emission from Microcontoured Surfaces," *Heat and Mass Transfer 95*, Tata McGraw-Hill Publishing Company Limited, pp. 3-8, 1995
Tang, K., Y. Yang and **R. O. Buckius**, "Theory and Experiments on Scattering from Rough Interfaces," *Annual Review of Heat Transfer*, Vol. 10, Chapt. 3, pp. 101-140, Begell House Inc., 1999
Buckius, R. O., "Thermal Radiative Scattering Properties of Microstructured Surfaces," *14^{th} Symposium on Thermophysical Properties*, Boulder, Co, 2000
Buckius, R. O., "C.L. Tien's Contributions to Radiation and Combustion," *Annual Review of Heat Transfer,* Vol. 14, Begell House Inc., (ISBN 1-56700-222-6) New York, 2005
Bement, A., James Collins, Jeannette Wing, **Richard Buckius**, Jarvis Moyers, David Lightfoot, Daniel Atkins, Karl Erb and Kathie Olsen, "NSF's Observing Systems: Platforms for Large-Scale Environmental Research," *The Full Picture*, Tudor Rose (ISBN 978-92-990047-0-8), 88-91, 2007
Buckius, R. O., "Advancing the Frontiers of Nanotechnology through Fundamental Academic Research," Testimony, US Senate Commerce, Science and Transportation Committee, Washington, DC, February 15, 2006

Professional Development Activities (Past 5 years)
Academic Leadership Fellow, Committee on Institutional Cooperation (Big Ten Universities and University of Chicago), 1989

Jun Chen
Assistant Professor of Mechanical Engineering
School of Mechanical Engineering

Education
BSAAE, Beijing University of Aeronautics and Astronautics, Beijing, China, 1994
MSAAE, Beijing University of Aeronautics and Astronautics, Beijing, China, 1997
Ph.D.,ME, John Hopkins University, Baltimore, MD, 2005
Post-doc, Los Alamos National Laboratories, Los Alamos, NM, 2005 – 2008

Academic Experience
Purdue University, Assistant Professor, Mechanical Engineering, Apr. 2008 – Present, Full-Time

Non-Academic Experience
Los Alamos National Laboratory, Postdoctoral Research Associate, Condensed Matter and Thermal Physics Group and Center for Nonlinear Study (CNLS), Los Alamos, NM, July 2005 – March 2008
Beijing Jia-Yin Technology Inc., R&D Engineer (part-time), Beijing, China, 1994 – 1997

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Physical Society (APS)
American Society of Mechanical Engineers (ASME)
American Society of Engineering Education (ASEE)

Honors and Awards
OUTSTANDING FLUID MECHANICS PAPER AWARD 2005, Measurement Science and Technology, Institute of Physics Publishing (awarded to J. Chen and J. Katz), Feb. 2006

Service Activities
None

Principal Publications and Presentations (Most important from past 5 years)
Selected Recent Publications
Xu, D. and **Chen, J**., "Experimental study of stratified jet by simultaneous measurements of velocity and density fields", ***Experiments in Fluids*** (in press)
Chen, J., Gu, Z., and Wang, Y., "Numerical Simulations of Noise Induced by Flow in HVAC Ventilation Ducts", ***SAE International Journal of Materials and Manufacturing***, 2011, 4, 696-707
Odier, P., **Chen, J**., and Ecke, R., "Understanding and Modeling Turbulent Fluxes and Entrainment in a Gravity Current", ***Physica D: Nonlinear Phenomena***, 2012, 241(3), 260-268
Odier, P., **Chen, J**., Rivera, M., and Ecke, R., "Mixing in stratified gravity currents: Prandtl mixing length", Physics Review Letter, 102, 134504, 2009
Chen, J. and Katz, J., "Elimination of peak-locking error in PIV analysis using the correlation mapping method", ***Measurement Science and Technology***, 2005, vol. 16, pp 1605-1618 (***Recipient of OutstandingFluid Mechanics Paper Award 2005***)

Other Significant Publications

Connell, S., Gao, J., **Chen, J**., and Shi, R., "Novel Model to Investigate Blast Injury in the Central Nervous System", ***Journal of Neurotrauma***, 2011, 28, 1229-1236

Kennington, J., Frankel, S., **Chen, J**., Rodefeld, M., and Giridharan, G., "Performance Assessment and Design Studies of a Viscous Impeller Pump for Powered Fontan in an Idealized Total Cavopulmonary Connection", ***Cardiovascular Engineering and Technology***, 2011, 1-7 10.1007/s13239-011-0058-2

Rodefeld, M., Coats, B., Fisher, T., Giridharan, G., *Chen, J*., Brown, J., and Frankel, S., "Cavopulmonary assist for the univentricular Fontan circulation: von Karman viscous impeller pump", ***Journal of Thoracicand Cardiovascular Surgery***, 2010, 140 (3), 529–537

Chen, J., Meneveau, C., and Katz, J., "Scale Interactions of Turbulence Subjected to a Straining-Relaxation-Destraining Cycle", ***Journal of Fluid Mechanics***, 2006, vol. 562, pp 123–150

Chen, J., Katz, J., and Meneveau, C., "The implication of mismatch between stress and strain-rate in turbulence subjected to rapid straining and destraining on dynamic LES models", ***Journal of Fluids Engineering***, 2005, vol. 127, No. 5, pp 840-850

Professional Development Activities (Past 5 years)

Article Reviewer – ***Applied Acoustics, Journal of Fluid Mechanics, Journal of Fluids Engineering, Journal of Thermophysics and Heat Transfer, Journal of Applied Fluid Mechanics, International Journal for Computational Methods in Engineering Science & Mechanics, Experimental Thermal and Fluid Science, Journal of Turbulence***

Session Chair – ***The Third International Symposium on Physics of Fluid***, June 2009

Organizer and Co-Chair – ***Forum on Fluid Measurement and Instrumentation***, ASME Fluids Engineering Division Summer Conference, 2010

Qingyan Chen,
Vincent P. Reilly Professor,
School of Mechanical Engineering

Education
BS: Engineering, Tsinghua University, China, 1983
MSME, Delft University of Technology, The Netherlands, 1985
Ph.D., ME, Delft University of Technology, The Netherlands, 1988

Academic Experience
Purdue University, Vincent P. Reilly Professor, Mechanical Engineering, 2011 – Present, Full-Time
Purdue University, Professor, Mechanical Engineering, 2002 – Present, Full-Time
RMIT University, Honorary Professor, 2011 – Present
Tokyo Polytechnic University, Honorary Professor, 2009 – Present
Harbin Institute of Technology, Honorary Professor, 2005 – 2011
Tianjin University, Changjiang Chair Professor, 2008 – Present
Technical University of Denmark, Otto Mönsted Visiting Professor, 2005
MIT, Associate Professor, 1998 – 2002
MIT, Assistant Professor, 1995 – 1998
Delft University of Technology, Associate Professor, 1991 – 1995
Delft University of Technology, Research Assistant, 1985 - 1988

Non-Academic Experience
TNO-TPD, Project Leader, 1991 – 1995
ETH-Zurich, Research Scientist, 1989 – 1991
TNO-TPD, Research Assistant, 1984

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow: American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE)
Fellow: International Society of Indoor Air Quality (ISIAQ)

Honors and Awards
Discovery in Mechanical Engineering Award, Purdue University, Mechanical Engineering, 2011
John Rydberg Gold Medal, Scandinavian Federation of Heating, Ventilating and Sanitary Engineering Associations in Denmark, Finland, Iceland, Norway and Sweden (SCANVAC), 2011
Vincent P. Reilly Professorship, Purdue University, 2011
Distinguished Lecturer, American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), 2011
Specially Invited Expert, Tianjin City, China, 2009 Most Cited Article, Published in Building and Environment between 2005-2008, Elsevier, 2011
Best Paper, International Building Performance Simulation Association – USA Branch (IBPSA-USA), 2007 Willis J. Whitfield Award, Institute of Environmental Sciences and Technology, 2009

Service Activities
Editor-in-Chief, Building and Environment, 2007-Pres., Editorial Board, Energy and Buildings, 2009-Present
Chair/Co-Chair/Scientific Committee Member of major conferences: 2012 Ventilation 2012, France; COBEE 2012, Colorado; Healthy Buildings 2012, Australia; 2011 Building Simulation 2011,

Australia; ISHVAC2011, China; SIMUL 2011, Spain; ROOMVENT 2011, Norway; Indoor Air 2011, Texas; World Renewable Energy Congress, Sweden; 2010 ASHRAE IAQ 2010, Malaysia; International Workshop on Ventilation, Comfort, and Health in Transport Vehicles, China; ISCC 2010, Japan; PALENC 2010, EPIC 2010, Greece; SIMUL 2010, France; ICBEST 2010, Canada; CLIMA 2010, Turkey; 2009 ISHVAC 09, China; Building Simulation 2009, UK; ROOMVENT 2009, Korea; Indoor Air 2008, Denmark; COBEE 2008, China; 2007 IAQVEC, Japan; Building Simulation 2007, China; ROOMVENT 2007, Finland; CLIMA 2007, Finland; 2006 Healthy Buildings 2006, Portugal; Ventilation 2006, Illinoise

Member, ASHRAE TC4.10, 5.3

Peer Reviewer: 30 journals and the funding organizations

Principal Publications and Presentations (Most important from past 5 years)

Rai, A.C. and **Chen, Q.** 2012. "Simulations of ozone distributions in an aircraft cabin using computational fluid dynamics," *Atmospheric Environment*, 54, 348-357

Gupta, J., Lin, C.-H., and **Chen, Q.** 2011. "Transport of expiratory droplets in an aircraft cabin," *Indoor Air*, 21(1), 3-11

Mazumdar, S., Yin, Y., Guity, A., Marmion, P., Gulick, B., **Chen, Q.** 2010. "Impact of moving objects on contaminant concentration distributions in an inpatient room with displacement ventilation," *HVAC&R Research*, 16(5), 545-564

Gupta, J.K., Lin, C.-H., and **Chen, Q.** 2009. "Flow dynamics and characterization of a cough," *Indoor Air*, 19, 517-525

Chen, Q. 2009. "Ventilation performance prediction for buildings: A method overview and recent applications," *Building and Environment*, 44(4), 848-858

Zuo, W. and **Chen, Q.** 2009. "Real time or faster-than-real-time simulation of airflow in buildings," *Indoor Air,* 19(1), 33-44

Zhang, Z., Chen, X., Mazumdar, S., Zhang, T., and **Chen, Q.** 2009. "Experimental and numerical investigation of airflow and contaminant transport in an airliner cabin mockup," *Building and Environment,* 44(1), 85-94

Zhang, Z. and **Chen, Q.** 2007. "Comparison of the Eulerian and Lagrangian methods for predicting particle transport in enclosed spaces," *Atmospheric Environment*, 41(25), 5236-5248

Zhang, T. and **Chen, Q.** 2007. "Identification of contaminant sources in enclosed environments by inverse CFD modeling," *Indoor Air*, 17(3), 167-177

Zhang, Z. and **Chen, Q.** 2006. "Experimental measurements and numerical simulations of particle transport and distribution in ventilated rooms," *Atmospheric Environment*, 40(18), 3396-3408

Professional Development Activities (Past 5 years)

Scientific Advisory Board, EoN Energy Center, RWTH Aachen University, Germany, 2011 – Present

Department Academic Advisor, Department of Building Service and Engineering, Hong Kong Polytechnic University, 2011 – Present

Evaluation Committee Member, Department of Building Service and Engineering, Hong Kong Polytechnic University, 2008 – 2011

Scientific Advisory Committee Member, Strategically Targeted Research in Intelligent Built Environmental Systems, Syracuse University, 2008 – 2009

George T.-C. Chiu
Professor, School of Mechanical Engineering

Education
BSME, National Taiwan University, 1985
MSME, University of California at Berkeley, 1990
Ph.D., University of California at Berkeley, 1994

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2008 – Present, Full Time
Purdue University, Associate Professor, Mechanical Engineering, 2002 – 2008, Full Time
Purdue University, Assistant Professor, Mechanical Engineering, 1996 – 2002, Full Time
Shanghai Jiao Tong University, Visiting Associate Professor, 2005, Full Time

Non-Academic Experience
National Science Foundation, Program Director, 2011 – Present, Full Time
Journal of Imaging Science and Technology, Editor, 2012 – Present, Part Time
Shuttleworth Inc., Board of Directors, 2011, Part Time
Hewlett-Packard Company, Hardware Design Engineer, 1994 – 1996, Full Time

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Mechanical Engineers (ASME), 1994 – Present
Institute of Electrical and Electronic Engineers (IEEE), 2001 – Present
Society for Imaging Science and Technology (IS&T), 1998 – Present

Honors and Awards
Fellow, The Society for Imaging Science and Technology (IS&T), 2011
2010 IEEE Transactions on Control Systems Technology Outstanding Paper Award, 2010
Faculty Engagement/Service Excellence Award, College of Engineering, Purdue University, 2010
Team Excellence Award, College of Engineering, Purdue University, 2006
The Ruth and Joel Spira Award, School of Mechanical Engineering, Purdue University, 2004
Teaching for Tomorrow Award, Purdue University, 2000

Service Activities
Global Engineering Program Team, 2009 – 2011
Perception-based Engineering (PBE) Signature Area Co-Chair, 2009 – 2011
CoE Strategic Plan Execution Team, 2009 – 2010
Systems, Measurements and Control (SMAC) Area Chair, 2010 – 2011
Facilities Planning and Space Management Committee, 2010 – 2011
ME Leadership Team, 2008 – 2011
Associate Editor, *Journal of Control Engineering Practice*, 2007 – Present
Associate Editor, *Journal of Electronic Imaging*, 2005-2011
Member, Executive Committee, ASME Dynamic Systems and Control Division, 2010 – Present

Member, International Federation of Automatic Control (IFAC) Technical Committee on Mechatronic Systems, 2005 – Present

Principal Publications and Presentations (Most important from past 5 years)

Y.-F. Kuo, C.-L. Yang, **G.T.-C. Chiu**, Y. Yih, J.P. Allebach, and D.A. Abramsohn, "Model-based Calibration Approach to Improve Tone Consistency for Color Electrophotography," *Journal of Image Science and Technology*, Vol. 56, No. 6, pp. 1-9, November/December 2011

P.-J. Chiang, J.P. Allebach, and **G.T.-C. Chiu**, "Extrinsic Signature Embedding and Detection in Electrophotographic Halftoned Images through Exposure Modulation," *IEEE Transactions on Information Forensics and Security*, Vol. 6, No. 3 Part 2, 10.1109/TIFS.2011.2156789, September 2011

F. Liu, **G.T.-C. Chiu**, E. Hamby, and Y. Eun, "Modeling and Control of a Hybrid Two-Component Development Process for Xerography," *IEEE Transactions on Control System Technology*, vol. 19, no.3, pp. 531-544, May 2011

V. Kumar, J.W. Boley, Y. Yang, H. Ekowaluyo, J.K. Miller, **G.T.-C. Chiu**, and J.F. Rhoads, "Bifurcation-based Mass Sensing using Piezoelectrically-actuated Microcantilevers," *Applied Physics Letters*, Vol. 98, Iss. 15, Article Number: 153510, DOI: 10.1063/1.3574920, April 2011

O-S. Kwon, H. N. Zelaznik, **G. Chiu**, and Z. Pizlo, "Human Motor Transfer is Determined by the Scaling of Size and Accuracy of Movement," *Journal of Motor Behavior*, Vol. 43, Iss. 1, pp. 15-26, 2011

P-J Chiang, N. Khanna, A.K. Mikkilineni, M.V. Ortiz Segovia, S. Suh, J.P. Allebach, **G.T.-C. Chiu**, and E.J. Delp, "Printer and Scanner Forensics," *IEEE Signal Processing Magazine*, Vol. 26, Iss. 2, pp. 72-83, March 2009

M. H.-M. Cheng, **G.T.-C. Chiu**, and R. Reifenberger, "Fractal Compression and Adaptive Sampling: Reducing the Image Acquisition Time in Scanning Probe Microscopy," *Scanning*, Vol. 30, Iss. 6, pp. 463-473, November 2008

C.-L. Chen and **G.T.-C. Chiu**, "Closed Loop Banding Artifact Reduction for a Class of Color Electrophotographic Printers with Underactuated Motor/Gear Configuration," *IEEE Transactions on Control Systems Technology*, Vol. 16, No. 4, pp. 577-588, July 2008. – *2010 IEEE Transactions on Control Systems Technology Outstanding Paper Award*

C.-Y. Chen and **G.T.-C. Chiu**, "H∞ Robust Controller Design of Media Advance Systems with Time Domain Specifications," *International Journal of Innovative Computing, Information and Control*, Vol. 4, No. 4, pp. 813-828, April 2008

C.-L. Chen and **G.T.-C. Chiu**, "Spatially Periodic Disturbance Rejection with Spatially Sampled Robust Repetitive Control," *ASME Journal of Dynamic Systems, Measurement and Control*, Vol. 130, Iss. 2, pp. 021002-1-021002-11, March 2008

Professional Development Activities (Past 5 years)

Registration Chair, The 2012 American Control Conference, Montreal, Canada, June 2012

Finance Chair, The 2011 American Control Conference, San Francisco, California, June 2011

Publication Chair, The 2010 Dynamic Systems and Control Conference (DSCC10), Boston, Massachusetts, October 2010

Publication Chair, The 2010 IFAC Symposium on Mechatronic Systems, Boston, Massachusetts, October 2010

Program Chair, The 2010 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM'10), Montreal, Canada, July 2010

Jong Hyun Choi
Assistant Professor, School of Mechanical Engineering

Education
BSME, Yonsei University, Seoul, Korea, 1999
MSME, Yonsei University, Seoul, Korea, 2001
Ph.D.,ME, University of California, Berkeley, 2005
Post-doc, ChE, MIT and University of Illinois, 2005 - 2008

Academic Experience
Purdue University, Assistant Professor, Mechanical Engineering, 2009 – Present, Full-Time

Non-Academic Experience
None

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Mechanical Engineers (ASME)
Materials Research Society (MRS)
American Chemical Society (ACS)

Honors and Awards
NSF Faculty Early CAREER Award, 2011
Shen Postdoctoral Fellowship, School of Chemical Sciences, UIUC, 2006
The Clyde Sanfred Johnson Memorial Fellowship, UC Berkeley, 2005
Air & Waste Management Associate (AWMA) Scholarship, 2004

Service Activities
Organizer, Symposiums on Carbon based Nanomaterials and Devices and Nanoengineering for Medicine and Biology, ASME International Mechanical Engineering Congress and Exposition (IMECE), Denver, CO, 2011
Co-organizer, Symposium on Nanobiomechanical systems, MEMS Division, ASME International Mechanical Engineering Congress and Exposition (IMECE), Vancouver, Canada, 2010
Program Committee, MEMS Division, ASME International Mechanical Engineering Congress and Exposition (IMECE), Orlando, FL, 2009
Reviewer for Journals, including Nano Letters, Advanced Materials, ACS Nano, Advanced Functional Materials, Journal of Physical Chemistry, International Journal of Nanomedicine, Nanoscale, Journal of Nanoparticle Research, Physica Status Solidi, Materials Chemistry and Physics
Reviewer of Research Proposals for National Science Foundation CBET, CMMI, DMR Divisions

Principal Publications and Presentations (Most important from past 5 years)
<u>Refereed Journal Publications</u>
T.G. Cha, B.A. Baker, M.D. Sauffer, J. Salgado, D. Jaroch, J.L. Rickus, D.M. Porterfield, and **J.H. Choi**, *Optical Nanosensor Architecture for Cell Signaling Molecules Using DNA Aptamer-Coated Carbon Nanotubes*, **ACS Nano**, 5, 4236-4244 (2011)

J. Shi, T.G. Cha, J.C. Claussen, A.R. Diggs, **J.H. Choi**, and M.D. Porterfield, *Microbiosensors based on DNA Modified Single-Walled Carbon Nanotube and Pt Black Nanocomposites*, **Analyst**, 136, 4916-4924 (2011)

M.H. Ham,* **J.H. Choi**,* A.A. Boghossian*, E.S. Jeng, R.A. Graff, D.A. Heller, A.C. Chang, A. Mattis, T.H. Bayburt, Y.V. Grinkova, A.S. Zeiger, K.V. Vliet, E.K. Hobbie, S.G. Sligar, C.A. Wraight, and M.S. Strano, *Photoelectrochemical Complexes for Solar Energy Conversion that Chemically and Autonomously Self-Regenerate*, **Nature Chemistry**, 2, 929-936 (2010)

J.H. Han, G.L.C. Paulus, R. Maruyama, D.A. Heller, W.J. Kim, P.W. Barone, C.Y. Lee, **J.H. Choi**, M.- H. Ham, C. Song, C. Fantini, and M.S. Strano, *Exciton Antennae and Concentrators from Core-Shell and Corrugated Carbon Nanotube Filaments of Homogeneous Composition*, **Nature Materials**, 9, 833-839 (2010)

B.A. Baker and **J.H. Choi**, *Oligonucleotide DNA and RNA as Direct Capping Ligand for Nanocrystals: An Emerging Method for Biological Diagnostics and Therapeutics*, **Nano**, 4, 189-199 (2009)

J.H. Choi, K.H. Chen, J.-H. Han, A.M. Chaffee, and M.S. Strano, *DNA Aptamer-Passivated Nanocrystal Synthesis: A Facile Approach for Nanoparticle-based Cancer Cell Growth Inhibition*, **Small**, 5, 672-675 (2009)

J.H. Choi, F.T. Nguyen, P.W. Barone, D.A. Heller, A.E. Moll, D. Patel, S.A. Boppart, and M.S. Strano, *Multimodal Biomedical Imaging with Asymmetric Single-Walled Carbon Nanotube/Iron Oxide Nanoparticle Complexes*, **Nano Letters**, 7, 861-867 (2007)

R. Sharma, C.Y. Lee, **J.H. Choi**, K. Chen, and M.S. Strano, *Nanometer Positioning, Parallel Alignment, and Placement of Single Anisotropic Nanoparticles Using Hydrodynamic Forces in Cylindrical Droplets*, **Nano Letters**, 7, 2693-2700 (2007)

J.H. Choi and M.S. Strano, *Solvatochromism in Single-Walled Carbon Nanotubes*, **Applied Physics Letters**, 90, Article 223114 (2007)

J.H. Choi, K.H. Chen, and M.S. Strano, *Aptamer-Capped Nanocrystal Quantum Dots: A New Method for Label Free Protein Detection*, **Journal of the American Chemical Society**, 128, 15584-15585 (2006)

<u>Books and Book Chapters</u>

Yamashita, Y. Saito, and J.H. Choi, ***Carbon Nanotubes and Graphene for Photonic Applications***, Woodhead Publishing Ltd. <u>In progress: scheduled to be published in 2012</u>

J. Pan, T.G. Cha, H. Zhang, H. Chen, and J.H. Choi, *Optical Sensors based on Carbon Nanotubes,* edited by S. Yamashita, Y. Saito, and J.H. Choi in **Carbon Nanotubes and Graphene for Photonic Applications**, Woodhead Publishing Ltd (2012)

B.A. Baker, H. Zhang, T.G. Cha, and J.H. Choi, *Carbon Nanotube based Solar Cells*, edited by S. Yamashita, Y. Saito, and J.H. Choi in **Carbon Nanotubes and Graphene for Photonic Applications**, Woodhead Publishing Ltd (2012)

M.H. Ham, A.A. Boghossian, J.H. Choi, and M.S. Strano, *Self-Repairing Photoelectrochemical Complexes based on Nanoscale Synthetic and Biological Components*, edited by B. Bhushan in **Encyclopedia of Nanotechnology**, Springer (2012)

A.A. Boghossian, M.H. Ham, J.H. Choi, and M.S. Strano, *Dynamic Self-assembly of Nanoscale Components for Solar Energy Conversion*, edited by V. Amendola and M. Meneghetti in **Self-Healing at the Nanoscale: Mechanisms and Key Concepts of Natural and Artificial Systems**, CRC Press, Taylor & Francis Group (2011)

Professional Development Activities (Past 5 years)

None

Raymond J. Cipra
Professor, School of Mechanical Engineering

Education:
BSME, University of Wisconsin-Madison, 1971
MSME, University of Wisconsin-Madison, 1972
Ph.D. ME, University of Wisconsin-Madison, 1978

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2011 – Present, Full Time
Purdue University, Associate Professor, Mechanical Engineering, 1984–2011, Full Time
Purdue University, Assistant Professor, Mechanical Engineering, 1978–1984, Full Time

Non-Academic Experience
NASA Jet Propulsion Laboratory, Engineering – Senior, Researcher in the Automation and Control Section, 2001 (summer), Full Time
Beloit Corporation, Research Engineer, Researcher in the Heat Transfer and Applied Mechanics Group, 1972-1974, Full Time

Certifications or Professional Registrations
Registered Professional Engineer, State of Wisconsin

Current Membership in Professional Organizations
American Society of Mechanical Engineers
Sigma Xi

Honors and Awards
NASA Tech Brief Award for NTR-45553: Tethered Axel: A Minimalist Rover for Exploring Steep Terrain, Caves and Disaster Sites, 2008
NASA Tech Brief Award for NPO-30890: A Novel Reconfigurable Robot for Navigation on Rough Terrain, 2007
NASA Certificate of Recognition for NASA Tech Brief NPO-21104, Compliant Gripping Device for a Robotic Manipulator, 2001
NASA/ASEE Summer Faculty Fellow, Jet Propulsion Laboratory, Pasadena, California, 2000
NASA/ASEE Summer Faculty Fellow, Jet Propulsion Laboratory, Pasadena, California, 1999
Boeing A.D. Welliver Faculty Summer Fellowship, 1995
Joel and Ruth Spira Award for Outstanding Contributions to the School of Mechanical Engineering and Its Students, 1992
Ralph R. Teetor Educational Award, Society of Automotive Engineers, 1982
Harry L. Solberg Award, Excellence in Teaching, School of Mechanical Engineering, 1981
Graduated with honors, BSME, University of Wisconsin-Madison, 1971

Service Activities
Faculty Affairs Committee, College of Engineering, 2008 – Present
Engineering Curriculum Committee, College of Engineering, (Chair, 2008 – 2012), 2006 – 2012

Mechanical Engineering Strategic Planning Committee, Chair, 2011 – Present
Mechanical Engineering Awards Committee, 2007 – Present
Mechanical Engineering Space Utilization and Needs Committee, 1999 – Present
Instructor and member of organizing committee, "Hands-On" Short Course for Mechanical Engineering students, 2001 – 2006
Technical Advisor, Indiana Bipartisan Task Force on Election Integrity, 2001
Advisor, Pi Tau Sigma Mechanical Engineering Design Contest, 1982 – 2002

Principal Publications and Presentations (Most important from past 5 years)

A. Mather, **R. J. Cipra**, and T. Siegmund, "Structural integrity during remanufacture of a topologically interlocked material," International Journal of Structural Integrity, Vol. 3, issue 1, pp. 61-78, 2012

B.E. Rimai and **R.J. Cipra**, "On the Spatial Modeling of a Vibratory Micro-Pin Feeder Using Rigid Body Dynamics," CD-Rom Proceedings of the ASME 2011 Design Engineering Technical Conferences, Paper No. DETC2011-48526, Washington, D.C., August 2011

T.L. Ringold and **R.J. Cipra**, "A Hybrid Grasp Matrix For Cooperative Robotic Object Manipulation," CD-Rom Proceedings of the ASME 2011 Design Engineering Technical Conferences, Paper No. DETC2011-48534, Washington, D.C., August 2011

I.A. Nesnas, D.M. Helmick, R.A. Volpe, P. Abad-Manterola, J.A. Edlund, **R. Cipra**, D. Sisk, R.H. Christian, and M.R. Clark, "Progress in Development of the Axial Rovers," (NPO-45553), NASA Tech Briefs, Vol. 34, No. 8, pp. 7a-8a, August 2010

D.E. Foster and R.J. Cipra, "Assembly Configurations of Spatial Single-Loop Single-DOF Mechanisms With Kinematic Limitations," ASME Journal of Mechanical Design, Vol. 131, No. 10, 15 pages, October 2009

K. A. Gunnerson, **R. J. Cipra**, and T. Siegmund, "Near-Net-Shape Manufacturing of Short Fiber Composite Parts via Discrete Depositions," ASME Journal of Manufacturing Science and Engineering, Vol. 130, No. 6, 10 pages, December 2008

K.C. Smith, C.A.C. Kemeny, **R. Cipra**, and B.S.D. Duerstock, "Vision Aid for Power Wheelchair Users," ASME Journal of Medical Devices, Vol. 2, No. 4, 7 pages, December 2008

B. Leonard, F. Sadeghi, and **R. Cipra**, "Gaseous Cavitation and Wear in Lubricated Fretting Contacts," Society of Tribologists and Lubrication Engineers, Tribology Transactions, Vol. 51, 3, pp. 351-360, May 2008

Professional Development Activities (Past 5 years)

Instructor, Design for Manufacturability Training (for Zimmer), 2012
Instructor, Purdue Engineering/Management Program (for industry), 2007, 2008

Jason V. Clark
Asst. Professor,
School of Mechanical Engineering, School of Electrical and Computer Engineering

Education
BS Physics, Cal State Hayward, 1996
Ph.D. Applied Science, University of California, Berkeley, 2005

Academic Experience
Purdue University, Assistant Professor, Mechanical Engineering, Electrical and Computer Engineering, 2006 – Present, Full-Time

Non-Academic Experience
Coventor, San Mateo, California, Summer 2000
Berkeley National Laboratories, Berkeley, California, Summer 1995
Lawrence Livermore National Laboratories, Livermore, California, Summer 1994

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Member: IEEE, ASME

Honors and Awards
Technical Chair of American Society of Mechanical Engineers (ASME) International Microelectronics and Packaging Society (IMAPS) Conference, March 2013 – March 2017
Session Chair of American Society of Mechanical Engineers (ASME) International Microelectronics and Packaging Society (IMAPS) Conference, March 2012
3rd place winner in the International National Nanotechnology Infrastructure Network software contest, Jan 2012
MIND Award, Spring 2011
Kozik Award (Honor and Research Award), Purdue – Electrical and Computer Engineering, 2007
Honorable mention in UC Berkeley's College of Engineering Magazine, *Forefront*, 2004
Winner in the 1st International MEMS Design Challenge, *Microfabrica,* 2003
License Award from Coventor™, 2003
GSR award from DARPA, 2001-2003
The UC Berkeley Applied Science and Technology Excellence Award, 2001
The Berkeley GOP fellowship, 1996 - 1999
The GAANN research fellowship, 2001
The UC Berkeley Applied Science and Technology Excellence Award, 2000
The Gracie Mae Academic Achievement Award, 1998
UC Berkeley EECS245 design contest winner, and unofficial world record
Honorable mention in *Micro/Nano R&D* magazine, 2003

Service Activities

Technical Chair of American Society of Mechanical Engineers (ASME) International Microelectronics and Packaging Society (IMAPS) Conference, 2013-2017

Session Chair of American Society of Mechanical Engineers (ASME) International Microelectronics and Packaging Society (IMAPS) Conference, 2012

Co-Chair, Society of Experimental Mechanics (SEM) Conference, June 2010

SEMI MEMS Materials Characterization Task Force

Network for Computational Nanotechnology

Reviewer for the Journal of Manufacturing Science and Engineering

Reviewer for the Journal of Microelectromechanical Systems

Reviewer for the Journal of Transactions on Education

Principal Publications and Presentations (Most important from past 5 years)

Refereed Journal Publications

J. V. Clark, K. S. J. Pister, "Modeling, Simulation, and Verification of an Advanced Microdevice Using Sugar," *Journal of Microelectro-mechanical Systems*, pp. 1524-1536, Aug 2007

F. Li, **J. V. Clark**, "An Online Tool for Simulating Electro-Thermo-Mechanical Flexures Using Distributed and Lumped Analyses" submitting to *Journal of Sensors and Transducers*, pp. 101-115, March 2009

R. Bansal, **J. V. Clark**, "Simplifying the Design, Analysis, and Layout of a N/MEMS Material Testing Device," *Sensors and Transducers Journal,* Vol.13, Special Issue, pp.87-97, December 2011

P. Marepalli, A. Magana, M. R. Taleyarkhan, N. Sambamurthy, and **J. V. Clark**, "SugarAid 0.2: An Online Learning Tool for Improving Engineering Exam Scores," *Journal of Online Engineering Education*, Vol. 2, No. 1, pp. 1-9, 2011

S. M. Musa, M. N. O. Sadiku, and **J. V. Clark**, "Finite Element Analysis for Electromagnetic Parameters of Multiconductor Interconnects in Multilayered Dielectric Media", International Journal of Research and Reviews in Computer Science, Vol. 2, No. 6, December 2011

F. Li, **J. V. Clark**, "Improved Modeling of the Comb Drive Levitation Effect by Using Schwartz-Christoffel Mapping," *Sensors and Transducers Journal,* Vol.139, Issue 4, pp.24-34 April 2012.

R. Bansal, **J. V. Clark**, "Lumped modeling of carbon nanotubes for M/NEMS simulation," *Journal of Microsystem Technologies,* (Accepted April 2012)

F. Li, **J. V. Clark**, "Self-Calibration for MEMS with Comb Drives: Measurement of Gap," *Journal of Microelectromechanical Systems Letters*, (Accepted May 2012)

F. Li, **J. V. Clark**, "Online Capacitance Modeling Tool for Conductors Represented as Simply-Connected Polygonal Geometries in 2.5D", *Journal of Sensor Technology*, (Accepted May 28th, 2012)

Professional Development Activities (Past 5 years):

None

Patricia Davies
Director, Ray W. Herrick Laboratories and Professor
School of Mechanical Engineering

Education
B.Sc., Mathematics Department, University of Bristol, Britain, 1977
M.Sc., Institute of Sound and Vibration Research, University of Southampton, Britain, 1981
Ph.D., Institute of Sound and Vibration Research, University of Southampton, Britain, 1985

Academic Experience
Purdue University, Director, Ray W. Herrick Laboratories, Mechanical Engineering, 2005 – Present, Full-Time
Purdue University, Professor, Mechanical Engineering, 2002 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 1994 – 2002, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1989 – 1994, Full-Time
Purdue University, Visiting Assistant Professor, Mechanical Engineering, 1987 – 1989, Full-Time

Non-Academic Experience
University of Southampton, Britain, Research Fellow, Institute of Sound and Vibration Research, 1984 – 1986
University of Southampton, Britain, Research Assistant, Institute of Sound and Vibration Research, 1981 – 1984
British Gas Corporation, Fulham, London, Scientific Officer II, London Research Station, 1980 – 1981
Jada Teachers College, Jada Gongola State, Nigeria, Voluntary service overseas teaching mathematics, 1977 – 1979

Certifications or Professional Registration
None

Current Membership in Professional Organizations
Acoustical Society of America
Institute of Noise Control Engineering (Fellow)
Institute of Electrical and Electronics Engineering
American Society of Engineering Education
Society of Automotive Engineering

Honors and Awards
Elvin Richards Award, for performance in Masters Examinations, 1980
Whirlpool Faculty Fellow, School of Mechanical Engineering, Purdue University, 1989 – 1990
Fedderson Faculty Fellow, School of Mechanical Engineering, Purdue University, 1997 – 1998
Ruth and Joel Spira Award for service to the School of Mechanical Engineering, 2001
Boeing Leadership Award, Purdue University, 2005

Service Activities

Director, Ray W. Herrick Laboratories, Graduate Committee, Mechanical Engineering, Mechanical Engineering Leadership Team, Mechanical Engineering Cabinet 2005 – Present

Phase I Construction of New Herrick Labs Building (Includes co-ordination of Herrick faculty input on design and construction, documentation for Purdue approvals, addressing budget issues, etc.)

Institute of Noise Control Engineering, President 2008 – 2010, Past President 2010 – 2012, President Elect 2007 – 2008, VP for Technical Activities 2005 – 2008

C3, Facilities Planning Committee, Purdue University, 2011 – Present

Member, Architecture Planning Committee, (1994 – 1998; 2003-); Parking Committee, (2010 – 2012); Information Technology Oversight Committee, (2010-)

Engineering Budget Contingency Planning Committee (2011 – 2012)

Chair, Herrick Professor Search Committee (2010 – 2011)

Member, Kenninger and Cummins Professor Search Committees (2009 – 2011)

Principal Publications (Most important from past 5 years)

Refereed Journal Publications

A.J. Marshall and **P. Davies**. *Noise Control Engineering Journal*, **59(6)**, 2011, 681-2011. Metrics including time-varying loudness models to assess the impact of sonic booms and other transient sounds. Reviewed, revised and accepted for publication in October Issue, July 31, 2011

S. More, **P. Davies**. *Noise Control Engineering Journal*, **58(4),** 2010, 420-440. Human responses to the tonalness of aircraft noise

G. A. Joshi, A.K. Bajaj, **P. Davies**, *Industrial Health*, **28(5)**, 2010, 663-674. Whole-body vibratory response study using a nonlinear multi-body model

M. Sullivan**, P. Davies**, K. K. Hodgdon, J. A. Salamone III and A. Pilon. *Noise Control Engineering Journal,* **56(2**), 2008, 141-157. Realism assessment of sonic boom simulators

R. D. Widdle Jr., A. K. Bajaj, P. Davies. *International Journal of Engineering Science*, **46**, 2008, 31–49. Measurement of the Poisson's ratio of flexible polyurethane foam and its influence on a uniaxial compression model

R. K. Ippili, **P. Davies**, A. K. Bajaj and L. Hagenmeyer. *International Journal of Industrial Ergonomics,* **38(5-6)** May-June 2008, 368-383. Nonlinear multi-body dynamic modeling of seat-occupant system with polyurethane seat and H-point prediction

Professional Development Activities (Past 5 Years)

None

Xinyan Deng
Assistant Professor
School of Mechanical Engineering

Education
B.S., Tianjin University, 1995
Ph.D., UC Berkeley, 2004

Academic Experience
Purdue University, Assistant Professor, Mechanical Engineering, 2009 – Present, Full Time
University of Delaware, Assistant Professor, Mechanical Engineering, 2004-2009, Full Time

Non-Academic Experience
None

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
ASME, 2004 – Present
IEEE, 2002 – Present

Honors and Awards
NSF CAREER Award, 2006 – 2011
2011 JEB Outstanding Paper Prize Finalist, Journal of Experimental Biology, 2011
Excellence in Teaching Award Nomination, University of Delaware, 2005
Best Student Paper Award Finalist, first author, IEEE International Conference on Robotics and Automation (ICRA), 2003

Service Activities
Co-Chair, *Technical Committee for Biorobotics*, IEEE Robotics and Automation Society, 2009 – 2012
Co-Chair, *Technical Committee for Prototyping and Automation*, IEEE Robotics and Automation Society, 2007 – 2008
Co-Chair, Workshop on Integration of Mechanics, Sensing, Actuation and Control in Biological and Bio-inspired Locomotion, Robotics: Science and Systems (RSS'12), Sidney, Australia, 2012
Co-Chair, 50 Years of Robotics Special Symposium on Biologically inspired Robots, IEEE/JRS International Conference on Intelligent Robots and Systems(IROS'11), San Francisco, CA, 2011
Co-Chair, Workshop on Biologically-inspired Robots, IEEE/JRS International Conference on Intelligent Robots and Systems (IROS'09), St. Louis, MO, 2009
Co-Chair, Workshop on Critical Impediments and Challenges for Multi-Modal Robotic Loco-motion, IEEE/JRS International Conference on Intelligent Robots and Systems (IROS'09), St. Louis, MO, 2009

Principal Publications and Presentations (Most important from past 5 years)

B. Cheng and **X. Deng**, ”Translational and Rotational Damping of Flapping Flight and Its Dynamics and Stability at Hovering”, *IEEE Transaction on Robotics*, vol. 27, number 5, Pages 849-864, 2011

B. Cheng, **X. Deng** and T. Hedrick, “The Mechanics and Control of Pitching Maneuvers in a Freely Flying Hawk Moth *Manduca Sexta*”, *Journal of Experimental Biology*, 214, Pages 4092-4106, 2011 (2011 JEB Outstanding Paper Prize Finalist)

L. Zhao, S. Sane and **X. Deng**, “Modulation of Leading Edge Vorticity on the Aerodynamic Forces in Flexible Flapping Wings”, *Journal of Bioinspiration and Biomimetics*, in 6(3), art. no. 036007, 2011

L. Zhao, Q. Huang, **X. Deng**, and S. Sane, “Aerodynamic effects of flexibility in flapping wings”, in *Journal of Royal Society Interface*, Volume 7, Issue 44, Pages 485-497, 2010

B. Cheng, S. Fry, Q. Huang, and **X. Deng**, “Aerodynamic damping during rapid flight maneuvers in the fruit fly Drosophila”, *Journal of Experimental Biology*, Volume: 213, Issue: 4, Pages: 602 612, 2010

T. Hedrick, B. Cheng and **X. Deng**, “Wingbeat Time and Scaling of Passive, Rotational Damping in Flapping Flight”, in *Science*, Vol. 324. no. 5924, pp. 252 - 255, 2009

C. DiLeo and **X. Deng**, “Design and Experiments on a Dragonfly-inspired Robot”, in *Advanced Robotics*, Volume 23, Issue: 7-8, Pages 1003-1021, 2009

L. Zhao and **X. Deng**, “Power distribution in the hovering flight of the hawk moth Manducasexta”, in *Journal of Bioinspiration and Biomimetics*, 4(4), art. no. 046003, 2009

D. Campolo, G. Barbera, L. Schenato, L. Pi, **X. Deng** and E. Guglielmelli, “Attitude Stabilization of a Biologically Inspired Robotic Housefly via Dynamic Multimodal Attitude Estimation”, *Advanced Robotics*, Volume: 23, Issue: 15, Pages 2113-2138, 2009

D. Campolo, L. Schenato, L. Pi, **X. Deng** and E. Guglielmelli, “Attitude Estimation of a Biologically Inspired Robotic Housefly via Multimodal Sensor Fusion”, in *Advanced Robotics*, Volume 23, Issue: 7-8, Pages 955-977, 2009

P. Kodati, A. Winn, J. Hinkle and **X. Deng**, “Micro Autonomous Robotic Ostraciiform: Stability, Hydrodynamics and Prototype Development”, in *IEEE Transaction on Robotics*, Volume 24, Issue 1, Page 105-117, 2008

X. Deng, L. Schenato, W. Wu and S. Sastry, “Flapping Flight for Biomimetic Robotic Insects, I: System Modeling”, in *IEEE Transactions on Robotics*, Volume 22, No. 4, Pages 776-788, 2006

X . Deng, L. Schenato and S. Sastry, “Flapping Flight for Biomimetic Robotic Insects, II: Flight Control”, in *IEEE Transactions on Robotics*, Volume 22, No.4, Pages 789-803, 2006

Professional Development Activities (Past 5 years)

None

Shirley J. Dyke
Professor, School of Mechanical Engineering
School of Civil Engineering

BS: Aeronautical Engineering, University of Illinois, 1991
Ph.D. Civil Engineering, University of Notre Dame, 1996

Academic Experience
Purdue University, Professor, Mechanical Engineering and Civil Engineering, 2009 – Present, Full-Time
Washington University, St. Louis, Missouri, Edward C. Dicke Professor of Engineering, Department Mechanical, Aerospace and Structural Engineering (until June 2007, Department of Civil Engineering), May 2004-September 2009, Associate Professor (2001- 2003), Assistant Professor (1996- 2001)
University of Southern California, Visiting Professor, Department of Civil Engineering, Spring 2004
University of Pavia, Pavia, Italy, Visiting Professor, Department of Structural Mechanics, Summer 1997, 1999
Universidad del Valle, Cali, Columbia, Visiting Researcher, Departamento de Mechanica Solidos, 1997

Non-Academic Experience
None

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Chair, NEES Data and Curation Subcommittee, 2009 – Present
President, US Panel on Structural Control and Monitoring, of the IASCM, May 2009 – May 2011

Honors and Awards
National Science Foundation PECASE Award, 1998
National Science Foundation CAREER Award, 1998
ANCRISST Young Investigator Award, 2007
Outstanding Alumna Award, Department of Aeronautical and Astronautics Engineering at the University of Illinois, 2005
International Association on Structural Safety and Reliability Junior Research Award, 2001
Short-term Invitation Fellowship, Japan Society for the Promotion of Science, 1998, 2002

Service Activities
Local Arrangements Chair, American Control Conference, St. Louis, Missouri, June 7-12, 2009
Chairperson and Organizer, Vision 2020 Workshop: An Open Space Technology Workshop on the Future of Earthquake Engineering, St. Louis, Missouri, January 25-26, 2010
Organizer, NEEShub Workshop, West Lafayette, Indiana, June 10-11, 2010
Co-chairperson, Connections: Bringing Together the Next Generation of Women Leaders in Science, Technology, Engineering and Mathematics, Saitama, Japan, July 5-7, 2010

Chairperson and Organizer, International Workshop on Bio-Inspired and Large Scale Structural Health Monitoring, NSF-CMMI Division, Tokyo, Japan, July 11-12, 2010

Co-organizer and Co-host, Emerging Opportunities in Real-time Hybrid Simulation, Purdue University, November 7-9, 2011

Principal Publications and Presentations (Most important from past 5 years)

Refereed Journal Publications

S.J. Dyke, R. Christenson, Z. Jiang, X. Gao and Z. Feinstein. "Tele-operation Tools for Bench-scale Shake Tables for Instruction in Earthquake Engineering," Seismological Research Letters, Seismological Society of America, Vol 78, Number 4, July-August, 2007

W. Song. **S.J. Dyke**, G.J. Yun and T. Harmon, "Improved Damage Localization and Quantification Using Subset Selection," Journal of Engineering Mech, ASCE, Volume 135, Issue 6, pp. 548-560, June 2009

Y. Wang and **S.J. Dyke**, "Smart System Design for a 3D Base Isolated Benchmark Building," Structural Control and Health Monitoring, Vol. 15, Issue 7, pp. 939-957, 2008

G.J. Yun, K.A. Ogorzalek, **S.J. Dyke** and W. Song. "A Two-Stage Damage Detection Approach Based on Subset Selection and Genetic Algorithms" Journal of Structural Control and Health Monitoring, Wiley, Vol. 5, No. 1, pp. 1-21, 2009

D. Giraldo, W. Song, **S.J. Dyke** and J.M. Caicedo. "Modal Identification Through Ambient Vibration: A Comparative Study," Journal of Engineering Mech, ASCE, Volume 135, Issue 8, pp. 759-770, 2009

N. Castaneda, **S.J. Dyke**, C. Lu, F. Sun and G. Hackmann. "Experimental Deployment and Validation of a Distributed SHM System Using Wireless Sensor Networks", Journal of Structural Engineering and Mechanics, Techno-Press, Volume 32, Number 6, August 2009

G. Yan, W. Guo, **S.J. Dyke** and C. Lu. "Experimental Validation of the Multi-Level Damage Localization Technique with Distributed Computation" Smart Structures and Systems: Special Issue on Wireless Sensor Advances and Applications to Monitoring of Civil Infrastructure, 6(5-6), July/August 2010

G. Yan, **S.J. Dyke** and A. Irfanoglu. "Experimental Validation of a Damage Detection Approach on a Full-Scale Highway Sign Support Truss" Mechanical Systems and Signal Processing: Special Issue on Interdisciplinary and Integration Aspects in Structural Health Monitoring, doi: 10.1016/j.ymssp.2011.10.008 (2011)

G. Hackmann, F. Sun, N. Castaneda, C. Lu and **S.J. Dyke**. "A Holistic Approach to Decentralized Structural Damage Localization Using Wireless Sensor Networks," Computer Communications, Elsevier (in press)

Y. Wang and **S.J. Dyke**, "Modal-based LQG for Smart System Design in Structural Response Control," Journal of Structural Control and Monitoring (in press)

Professional Development Activities (Past 5 years)

Local Arrangements Chair, Amer. Control Conf., St. Louis, Missouri, June 7-12, 2009

Chairperson and Organizer, Vision 2020 Workshop: An Open Space Technology Workshop on the Future of Earthquake Eng, St. Louis, Missouri, January 25-26, 2010

Organizer, NEEShub Workshop, West Lafayette, Indiana, June 10-11, 2010

Co-chairperson, Connections: Bringing Together the Next Generation of Women Leaders in Science, Technology, Engineering and Mathematics, Saitama, Japan, July 5-7, 2010

Chairperson, International Workshop on Bio-Inspired and Large Scale Structural Health Monitoring, NSF-CMMI Division, Tokyo, Japan, July 11-12, 2010

Timothy S. Fisher
Associate Professor, School of Mechanical Engineering

Education
BSME, Cornell University, 1991
Ph.D., ME with Minor in Elec. Engr., Cornell University, 1998

Academic Experience
Purdue University, Professor and Associate Professor, Mechanical Engineering, 2002 – Present, Full-Time
Purdue University, Visiting Assistant Professor, Mechanical Engineering, 2002, Full-Time
Vanderbilt University, Nashville, TN, Assistant Professor, Mechanical Engineering, 1998 – 2002
Cornell University, Ithaca, NY, Semiconductor Research Corporation Graduate Fellow, Mechanical & Aerospace Engineering, 1993 – 1998

Non-Academic Experience
Air Force Research Laboratory, WPAFB, OH, Research Scientist, Thermal Sciences & Materials Branch, 2009 – 2011, Part-Time
Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, India, Adjunct Professor, International Centre for Materials Science, 2008 – Present
Motorola Inc., Northbrook, IL, Design Engineer, Automotive & Industrial Electronics Group, 1991 – 1993, Full-Time

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Member, Institute of Biological Engineering
Member, American Society for Engineering Education
Member, American Society of Mechanical Engineers
Member, International Thermoelectric Society

Honors and Awards
ASME McDonald Mentoring Award, 2012
Semiconductor Research Corporation Inventor Recognition Award, 2003
Elected as Institute of Biological Engineering Councilor-at-Large, 2004 – 2006
NSF Faculty Early Career Development Award, 2000 – 2005
3M Nontenured Faculty Award, 1999
Semiconductor Research Corporation Graduate Fellowship, 1993 – 1998
Best Student Poster Award, Packaging Sciences, Semiconductor Research Corporation, 1996
Best Paper Award, 5th Intersociety Conference on Thermal Phenomena in Electronic Systems, 1996
Tau Beta Pi and Pi Tau Sigma honor societies, 1990
Robert C. Byrd Honor Scholarship, State of Illinois, 1998

Service Activities

Int'l Conference on Integration and Commercialization of Micro & Nanosystems, 2007
Micro and Nanoscale Phenomena in Energy Devices, Session Chair
International Mechanical Engineering Congress and Exposition, 2006
Heat Transfer in Hydrogen Energy Systems, Session Chair
Micro- and Nano-scale Heat Transfer, Session Co-Chair
Institute for Biological Engineering Annual Meeting, 2006
Biology-Inspired Nanotechnology, Chair
International Mechanical Engineering Congress and Exposition, 2005
Micro and Nano Scale Heat Transfer in Electronics, Chair
ASME Summer Heat Transfer Conference, 2005
Heat Transfer in Hydrogen Storage and Generation, Chair
Chaired or co-chaired 15 conference sessions prior to 2005

Principal Publications and Presentations (Most important from past 5 years)

<u>Related Publications</u>

K.C. Smith, **T.S. Fisher**, "Models for metal hydride particle shape, packing, and heat transfer," in review, International Journal of Hydrogen Energy

R. Paul, A. A. Voevodin, D. Zemlyanov, A. K. Roy, **T. S. Fisher**, "Microwave-assisted surface synthesis of boron-carbon-nitrogen foam and its adsorption enthalpy," accepted for publication, Advanced Functional Materials. doi:10.1002/adfm201200325

K.C. Smith, P.P. Mukherjee, **T.S. Fisher**, "Columnar order in jammed LiFePO4 cathodes: ion transport catastrophe and its mitigation," Physical Chemistry Chemical Physics, Vol. 14, pp. 7040-7050, 2012

K.C. Smith, **T.S. Fisher**, M. Alam, "Isostaticity of constraints in jammed systems of soft frictionless Platonic solids," Physical Review E, 84, 030301(R), 2011

R. Cross, B.A. Cola, **T.S. Fisher**, S. Graham, "A metallization and bonding approach for high performance carbon nanotube thermal interface materials," Nanotechnology, Vol. 21, art. no. 445705, 2010

<u>Other Publications</u>

A. Kumar, A. Voevodin, D. Zemlyanov, D. Zakharov, **T.S. Fisher**, "Rapid synthesis of fewlayer graphene over Cu foil," Carbon, Vol. 50, pp. 1546–1553, 2012

J.C. Claussen, J. Hengenius, M. Wickner, **T.S. Fisher**, D. Umulis, D.M. Porterfield, "Effects of Carbon nanotube-tethered nanosphere density on amperometric biosensing: simulation and experiment," Journal of Physical Chemistry C, Vol. 115, pp. 20896-20904, 2011

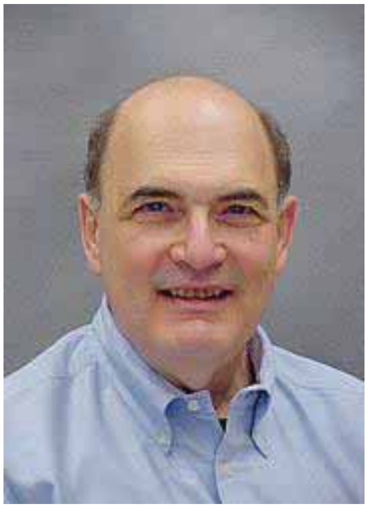
D. Singh, J.Y. Murthy, **T.S. Fisher**, "Spectral phonon conduction and dominant scattering pathways in graphene," Journal of Applied Physics, Vol. 110, art. no. 094312, 2011

T. Bhuvana, A. Kumar, A. Sood, R.H. Gerzeski, J.J. Hu, V.S. Bhadram, C. Narayana, **T.S. Fisher**, "Contiguous petal-like carbon nanosheet outgrowths from graphite fibers by plasma CVD," ACS Applied Materials & Interfaces, Vol. 2, pp. 644–648, 2010

J.C. Claussen, A.D. Franklin, A. ul Haque, D.M. Porterfield, **T.S. Fisher**, "Electrochemical biosensor of nanocube-augmented CNT networks," ACS Nano, Vol. 3, pp. 37-44, 2009

Professional Development Activities (Past 5 years):

Workshop Co-Organizer (US), International Workshop on Thermal Design and Management in Electronics, Bangalore, India, January 2006
Conference Organizer, ASME Region XI Graduate Student Technical Conference, March 2001
Conference Organizer, ASME Region VI Graduate Student Technical Conference, March 2003
Conference Organizer, ASME Region VI Graduate Student Technical Conference, March 2004



Sanford Fleeter
McAllister Distinguished Professor
School of Mechanical Engineering

Education
BSME, Case Institute of Technology, 1965
MSME, Case Institute of Technology, 1966
Ph.D., ME Case Institute of Technology, 1970

Academic Experience
Purdue University, McAllister Distinguished Professor, Mechanical Engineering, 1996 – Present, Full-Time
Purdue University, Professor, Mechanical Engineering, 1982 – 1996, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 1978 – 1982, Full-Time

Non-Academic Experience
Detroit Diesel Allison (Allison Gas Turbines), Division of General Motors Corporation, Indianapolis, Indiana (1968-1978)

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow, American Society of Mechanical Engineers
Fellow, American Institute of Aeronautics & Astronautics

Honors and Awards
NASA Lewis Research Center, Propulsion Systems Division Best Paper, 1985
NASA Lewis Research Center, Propulsion Systems Division Best Paper, 1986
NASA Lewis Research Center, Special Act/Service Award for Innovative Experimental Research, 1988
Best Paper - ASME Joint Propulsion Conference, 1996
Best Paper - ASME Joint Propulsion Conference, 1999
International Society of Rotating Machinery Research Award (ISROMAC) Award, 2000
Best Paper - ASME Joint Propulsion Conference 2000
Keynote Speaker, "Unsteady Aerodynamics of High Cycle Fatigue," DOD 6th National Turbine Engine High Cycle Fatigue Conference, 2001
ASME Propulsion Flag Award, 2001

Service Activities
International Society of Air Breathing Engines (ISOABE)- Executive Committee, Secretary-Treasurer 2002 – Present
Structures and Dynamics Technical Committee
ASME International Gas Turbine Institute
Turbomachinery Technical Committee
ASME International Gas Turbine Institute

Principal Publications and Presentations (Most important from past 5 years)

Refereed Journal Publications

Buhr, C.A., Franchek, M.A. and **Fleeter, S**., "Rotating Stall Control in an Axial Compressor Subject to Wheel Speed Transients," *AIAA Journal of Propulsion and Power*, Vol. 22, No. 2, March-April 2006, pp. 404-410

Ramakrishnan, K. and **Fleeter, S**., "Finite Element Simulation of Turbomachine Blade Row Viscous Interactions: Vane Vibratory Stress Predictions," *AIAA Journal of Propulsion and Power*, Vol. 23, No. 1, Jan.-Feb. 2007, pp. 212-220

Ramakrishnan, K. Gottfried, D.A., Lawless, P.B. and **Fleeter, S**., "Development And Application Of An Arbitrary Lagrangian Eulerian Solver For Turbomachinery Aeromechanics, *AIAA Journal of Propulsion and Power*, Vol. 25, No. 3, May-June 2009

Choi, Y.S., Gottfried, D.A. and **Fleeter, S**., "Resonant Response of Mistuned Bladed Disks Including Aerodynamic Damping Effects," *AIAA Journal of Propulsion and Power*, Vol. 25, No. 6, Nov-Dec, 2009, pp. 1240-1248

Key, N. Lawless, P.B., and **Fleeter, S**., "Vane Clocking in a Three-Stage Compressor : Frequency Domain Data Analysis," *AIAA Journal of Propulsion and Power*, Vol. 25, No. 5 Sept-Oct 2009, pp. 1100-1107

Key, N. Lawless, P.B., and **Fleeter, S**., An Experimental Study of Vane Clocking Effects on Embedded Compressor Stage Performance," *ASME Journal of Turbomachinery*, Vol 132, No. 1, Jan 2010, pp. 11018-11-11018-10

Choi, Y.S. and **Fleeter, S**., "Aerodynamic Effects on the Resonant Response of Mistuned IBRs," *AIAA Journal of Propulsion and Power*, Volume 26, Number 1, Jan/Feb 2010, pp. 16-24

Cukurel, B., Lawless, P.B. and **Fleeter, S**., "PIV Investigation of a High Speed Centrifugal Compressor Diffuser: Spanwise and Loading Variations" *ASME Journal of Turbomachinery*, Vol. 132, No. 2, April 2010, pp. 021010-1 -021010-9

Gallier, K., Lawless, P.B. and **Fleeter, S**., "Particle Image Velocimetry Characterization of High-Speed Centrifugal Compressor Impeller-Diffuser Interactions," *AIAA Journal of Propulsion and Power*, Vol.26, No. 4, July-August 2010, pp. 784-790

Choi, Y.S., Key, N. and **Fleeter, S**. "Vane Clocking Effects on the Resonant Response of an Embedded Rotor," *AIAA Journal of Propulsion and Power*, Vol. 27, No. 1, Jan-Feb 2011, pp. 71-77

Professional Development Activities (Past 5 years)

Developed new undergraduate and graduate courses on Wind Energy Engineering and Turbomachine Aeromechanics

Steven H. Frankel
Professor, School of Mechanical Engineering

Education
BSAAE. SUNY @ Buffalo, 1988
MSAAE, North Carolina State University, 1990
Ph.D., MAE, SUNY @ Buffalo, 1993

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2004 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 1999 – 2004, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1993 – 1999; Full-Time

Non-Academic Experience
Von Karman Institute of Fluid Dynamics, Brussels, Belgium, Intern, Summer 1998
NASA Langley Research Center, Research Associate, Researcher in Hypersonic Aerodynamics Branch, Summer 1989 – 1990
SUNY @ Buffalo, Research Lecturer, 1990 – 1993
Arnold Engineering Development Center, Tullahoma, TN, Research Associate, AFOSR Summer Faculty Research Program, Summer 1994

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Mechanical Engineers, 1993 – Present
American Institute of Aeronautics and Astronautics, 1985 – Present

Honors and Awards
Scholarship for summer training at von Karman Institute of Fluid Dynamics, 1988
AFOSR Summer Faculty Research Program, 1994
Office of Naval Research Young Investigator Award, 1995 – 1998
Letter of Outstanding Performance for Distance Learning Education from General Motors Technical Education Program, 1997
B.F.S. Schaefer Outstanding Young Faculty Scholar Award, 2000
Discovery in Mechanical Engineering Award, 2008
Cor Vitae Award, American Heart Association, Lafayette Heart Ball, 2011

Service Activities
School of Mechanical Engineering Combustion Faculty Search Committee, 1995
School of Mechanical Engineering Committee to develop Head evaluation process, 1997
School of Mechanical Engineering Graduate Committee, 1997 – 1999
School of Mechanical Engineering Advisory Committee, 1997 – 1999
School of Mechanical Engineering Head Search Committee, 1997 – 1999
School of Mechanical Engineering Fluids and Heat Transfer Search Committee, 1999
University Research Computing and Communications Advisory Committee, 1999 – 2001
School of Mechanical Engineering, Thermal Science Search Committee, 1999 – 2001

School of Mechanical Engineering, Computational Thermo-Fluids Search Committee, Chair, 2001
School of Mechanical Engineering, Acoustics Search Committee, 2003
School of Mechanical Engineering, Fluid Power Search Committee, 2006 – 2007
School of Mechanical Engineering Graduate Committee, Aug. 2010 – Dec. 2011

Currently serving on
School of Mechanical Engineering Computer Committee, 1996 – Present
School of Mechanical Engineering Combustion, Energy Utilization and Thermodynamics Committee, currently Chairman, 1993 – Present

Principal Publications and Presentations (Most important from past 5 years)

Fisher, T. C., Carpenter, M. H., Yamaleev, N., and **Frankel, S. H**., "Boundary Closures for Fourth-Order Energy Stable Weighted Essentially Non-Oscillatory Finite Difference Schemes", Journal of Computational Physics, **230**, pp. 3727-3752, 2011
Kennington, J. R., **Frankel, S. H**., Chen, Jun, Koenig, S. C., Sobeiski, M. A., Giridhiran, G. A., Rodefeld, M. D., "Design Optimization and Performance Studies of an Adult Scale Viscous Impeller Pump for Powered Fontan in an Idealized Total Cavopulmonary Connection", Cardiovascular Engineering and Technology, DOI: 10.1007/s13239-011-0558-2, 2011
Dittakavi, N., Chunekar, A., and **Frankel, S. H**.,"Large Eddy Simulation of Turbulent Cavitation Interactions in a Venturi Nozzle'', J. Fluids Eng., **132**(12), 2010
Rodefeld, M. D., Coats, B., Fisher, T., Giridharan, G. A., Chen, J., Brown, J. W., and **Frankel, S. H**., "Cavopulmonary Assist for Univentricular Fontan Circulation: von Karman Viscous Impeller Pump (VIP)", J. Thoracic and Cardiovascular Surgery, **140**(3), pp. 529-536, 2010
Shetty, D., Fisher, T., Chunekar, A., and **Frankel, S. H**., "High-Order Incompressible Large Eddy Simulation of Fully Inhomogeneous Turbulent Flows", Journal of Computational Physics, **229**(23), pp. 8802-8822, 2010

Professional Development Activities (Past 5 years)

Served as panel reviewer of proposals for NSF in combustion area, Nov. 2008
Served on DOE-SBIR proposal panel review for combustion, Feb. 2011

Suresh V. Garimella
Associate Vice President for Engagement
R. Eugene and Susie E. Goodson Distinguished Professor
School of Mechanical Engineering

Education
B.Tech., ME, Indian Institute of Technology, Madras, 1985
MSME, Ohio State University, 1986
Ph.D., ME, University of California, Berkeley, 1989

Academic Experience
Purdue University, Associate Vice President for Engagement, 2011 – Present, Full Time
Purdue University, R. Eugene and Susie E. Goodson Distinguished Professor, 2006 – Present, Full Time
Purdue University, R. Eugene and Susie E. Goodson Professor, 2006 – Present, Full Time
Purdue University, Professor, 2002 – Present (Chair, 2002 2004), Full Time
Purdue University, Associate Professor, 1999 – 2002, Full Time
UW-Milwaukee, Assistant and Cray-Research Associate Professor, 1990 – 1999, Full Time

Non-Academic Experience
Energy and Climate Partnership of the Americas (ECPA), U.S Department of State, Senior Fellow, August 2011 - Present, Part Time
U.S. Department of State, Jefferson Science Fellow, August 2010 – Present, Part Time
Technical University of Darmstadt, Germany, Center of Smart Interfaces, Fellow, July 2008 – Present, Part-Time

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Mechanical Engineers, Fellow, 2002
International Centre for Heat and Mass Transfer (ICHMT), Member, Scientific Council, 2009

Honors and Awards
Purdue University, Provost's Award for Outstanding Graduate Mentor, 2012
American Association for the Advancement of Science, Fellow, 2011
National Science Foundation Industry University Cooperative Research Center (IUCRC) Association, Alexander Schwarzkopf Prize for Technology Innovation, 2011
Purdue University College of Engineering, Faculty Award of Excellence for Mentoring, 2011
American Society of Mechanical Engineers, Heat Transfer Memorial Award, 2010
Indian Institute of Technology, Madras, Distinguished Alumnus Award of IIT Madras, 2010
American Society of Mechanical Engineers, Allan Kraus Thermal Management Medal, 2009
SemiTHERM, The Harvey Rosten Award for Excellence, 2009

Service Activities
Cooling Technologies Research Center, a National Science Foundation Industry/University Cooperative Research Center, Director, 1999 – Present.
Purdue University, Faculty of 2020, College of Engineering Strategic Plan, Team Co-Captain, 2009
Purdue University, Dean's Faculty Advisory Committee, 2006 – 2009
Purdue University, Engineering Named Professorship Committee, 2006 – 2009

International Journal of Micro-Nano Scale Transport, Editorial Board Member, 2009 – Present
ASME Thermal Science and Engineering Applications, Associate Editor, 2008 – 2011
Applied Energy, Editorial Board Member, 2008 – Present
Experimental Heat Transfer, Editor, 2005 – Present
Microelectronics Journal (2008, 2003), Heat Transfer Engineering (2008), Guest Editor
Thermal Challenges in Next Generation Electronic Systems, Conference Organizer/Chair, 2007
ASME Heat Transfer Division K-16 Committee on Heat Transfer in Electronic Equipment, Member 1990 – Present

Principal Publications and Presentations (Most important from past 5 years)

"Foundations for Sustainable Partnerships in Teaching and Research," Invited Plenary Session Panelist, U.S.-India Higher Education Summit hosted by U.S. Secretary of State Hillary Clinton and Indian Minister of Human Resource Development Kapil Sibal, Washington, D.C., October 13, 2011

"Electricity, Development and Emissions", White House (March 10, 2011) and U.S. Department of State (February 9, 2011), Invited Speaker

Z. Yang and **S. V. Garimella**, "Thermal Analysis of Solar Thermal Energy Storage in a Molten-Salt Thermocline," *Solar Energy*, 2010 (Listed as one of the **10 Most Downloaded Papers** for this journal, as of October 2010.)

N. Kumari, V. Bahadur and **S. V. Garimella**, "Electrical Actuation of Dielectric Droplets," *Journal of Micromechanics and Microengineering*, 2008 (included in **Highlights of 2008**)

S. S. Bertsch, E. A. Groll and **S. V. Garimella**, "Review and Comparative Analysis of Studies on Saturated Flow Boiling in Small Channels," *Nanoscale and Microscale Thermophysical Engineering*, 2008 (**10 Most Cited Papers** for this journal from 2009- 2011.)

B. D. Iverson and **S. V. Garimella**, "Recent Advances in Microscale Pumping Technologies: A Review and Evaluation," *Microfluidics and Nanofluidics*, 2008 (One of **5 Most Cited Papers** for this journal from 2008 and 2009)

Professional Development Activities (Past 5 years)

Patent: Free-particle Boiling Enhancement Technique, disclosed 2012
Patent: Controlled Flow of a Thin Liquid Film by Electrowetting, filed 2011
Patent: Superhydrophobic Surfaces, filed 2009
Patent: Microfluidic Pumping Based on Dielectrophoresis, filed 2008
Patent: Method of Bonding Carbon Nanotubes, filed 2008
Patent: Various Methods, Apparatuses, and Systems that use Ionic Wind to Affect HT, **issued** 2009
Patent: Micropump for Electronics Cooling, **issued** 2010
Subcommittee on Critical and Strategic Mineral Supply Chains, Committee on Environment, White House Office of Science and Technology Policy, 2011-2012
U.S.-Russia Bilateral Presidential Commission on Science and Technology, Nanotechnology & Energy Working Group, 2012
Committee on Energy Research and Technology (CERT), International Energy Agency, 2012
Washington Energy Seminar, Coordinator, 2011
Clean Energy Futures Working Group, Convenor and Chair, 2011-2012

Jay P. Gore
Reilly University Chair Professor
Purdue University School of Mechanical Engineering

BE: Mechanical Engineering, Poona University, India, 1978
MS: Mechanical Engineering, Pennsylvania State University, 1982
Ph.D. Mechanical Engineering, Pennsylvania State University, 1986

Academic Experience
Purdue University, Reilly University Chair Professor, Mechanical Engineering, 2000 – Present,
Purdue University, Professor (Courtesy Appointment), Aeronautics & Astronautics, 2006 – Present
Purdue University, Professor (Courtesy Appointment), Chemical Engineering, 2006 – Present
Purdue University, Associate Dean for Research and Entrepreneurship, College of Engineering, 2002 – 2007, Full-Time
Purdue University, Director, Energy Center, Discovery Park, 2005 – 2010
Purdue University, Associate Dean in Charge for Engineering Computing Network, College of Engineering, 2003 – 2007
Purdue University, Director, Institute for Interdisciplinary Studies, College of Engineering, 2002–2004
Purdue University, Professor, Mechanical Engineering, 1995 – 2000
Purdue University, Associate Professor, Mechanical Engineering, 1991 – 1995
Nagoya University, Nagoya, Japan, Visiting Professor, Mechanical Engineering, 1998 – 1998
University of Maryland, College Park, MD, Assistant Professor, Mechanical Engineering, 1987 – 1991
University of Maryland, Baltimore County, Catonsville, MD, Adjunct Assistant Professor, Mechanical Engineering, 1990 – 1991

Non-Academic Experience
National Institute of Standards and Technology, U.S. Department of Commerce, Gaithersburg, MD, Guest Researcher, 1988 – 1991
University of Michigan, Ann Arbor, MI, Research Fellow, Aerospace Engineering, 1985 – 1987
Penn State, University Park, PA, Research Assistant, Mechanical Engineering, 1980 – 1985

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow – American Institute of Aeronautics and Astronautics (AIAA) & American Society of Mechanical Engineers (ASME)
Member – American Association for Advancement of Science (AAAS), American Society of Engineering Education (ASEE), & The International Combustion Institute

Honors and Awards
Outstanding Team Award 2012, College of Engineering for the Summer Undergraduate Research Fellowship
Jefferson Science Fellow, S/Special Representative for Global Inter- Governmental Affairs, U. S. State Department
Fellow, American Institute of Aeronautics and Astronautics (AIAA), 2009
Global Employer of the Year Award (IAESTE) SURF program, 2007
Fellow, American Society of Mechanical Engineering (ASME), 2006

Academic Leadership Program Fellow, Council on Institutional Cooperation, 2005
Reilly University Chair Professor, Purdue University, 2000
U. S. DOE Advanced Gas Turbine Fellowship, 1998
Japanese Ministry of Education Faculty Fellowship, 1998
The Presidential Young Investigator Award, 1991

Service Activities

Director of Campus-wide Energy Center in Discovery Park

(a) Published Discover Energy™ newsletter, organized the Pioneers in Energy lectures, managed inquiries and requests for proposals from corporations and funding agencies, promoted research proposals, and organized symposia for research communities in biofuels, batteries, ground vehicle power, wind, nuclear, coal, building energy, energy conservation, and efficiency

(b) Helped Faculty Colleagues compete for large federally-funded centers such as Purdue Center for Direct Catalytic Conversion of Biomass to Biofuels (C3Bio); the Center for Prediction of Reliability, Integrity and Survivability of Microsystems (PRISM); and Indiana Electric Vehicle Training and Education Consortium (EVTec)

(c) Enjoyed promoting synergies with student energy clubs, campus physical plant and sustainability at Purdue initiatives, Center for the Environment, Climate Change Research Center, Water Community, and others interested in energy on campus.

Principle Publications and Presentations (Most important from past 5 years)

Qiao L., Xu, J., Sane, A., and **Gore J.**, "Multiphysics modeling of carbon gasification processes in a well-stirred reactor with detailed gas-phase chemistry," Combustion and Flame, 159(4), 1693-1707 (2012)

Rankin, B., Blunck D. L., Monfort, J., Kiel B. V., and **Gore J.** P., "Infrared Radiation and Acoustic Characteristics of Combustion Instabilities in Turbulent Premixed Flames," AIAA J. Propulsion and Power, DOI:10.2514/1.B34374 (2012)

Schuff M. M., **J. P. Gore**, and E. A. Nauman, "A Mixture theory model of fluid and solute transport in the microvasculature of normal and malignant tissues- I: Theory" Journal of Mathematical Biology, published online 13 April 2012 and in press, DOI 10.1007/s00285-012-0528-7

Gore J. P. and Sane, A. "Flame Synthesis of Carbon Nanotubes," Ch. 7, Carbon Nanotubes - Synthesis, Characterization, Applications, Edited by: Siva Yellampalli, InTech Publishers (2011), pp. 121-146

Blunck D. L. and **J. P. Gore**, "A Study of Narrow Band Radiation Intensity Measurements from Subsonic Exhaust Plumes," AIAA Journal of Propulsion and Power, Vol. 27, No. 1, 2011, 227-235

Professional Development Activities (Past 5 years)

S/Special Representative for Global Intergovernmental Affairs Jefferson Science Fellow at U. S. Department of State

The Governors' Global Climate Summit 3: Building the Green Economy 2010 held at Davis, CA, 11/15-16/2010

The United Nations Climate Change Conference COP16, Cancun, Mexico, 11/29/2010 to 12/10/2010

U. S. - China Governors Forum at the 2011 National Governors Association (NGA), Salt Lake City, UT, 7/11/2011

EcoPartnership announcement by Governor of Utah and Governor of Qinghai, Salt Lake City, UT, July
13, 2011

U. S. - India engagement by travelling to New Delhi and to the capital cities of seven states: 7/31/11-8/12/2011

Eckhard A. Groll, Dr. Eng.
Professor, School of Mechanical Engineering
Director of the Office of Professional Practice

Education:
German “Doktor-Ingenieur” (Doctorate) in Mechanical Engineering, University of Hannover, Germany, 1994
German “Diplom-Ingenieur” (Diploma) in Mechanical Eng., University of the Ruhr in Bochum, Germany, 1989
German “Diplom-Vorprüfung” (Pre-Diploma) in Mechanical Eng., University of the Ruhr in Bochum, Germany, 1986

Academic Experience
Purdue University, Interim Assistant Dean of Engineering for Research, College of Engineering, Jan. 2012 – August 2012
Purdue University, Director of the Office of Professional Practice, Sept. 2007 – Present
University of Karlsruhe, Institute of Turbomachinery, Karlsruhe, Germany, Guest Professor, Apr. 2007 – July 2007
Purdue University, Professor, Mechanical Engineering, Aug. 2005 – Present
Purdue University, Director of Global Initiatives, Cooperative Education and Professional Experiences in ME, July 2005 – July 2008
University of Karlsruhe, Institute of Technical Thermodynamics, Karlsruhe, Germany, Guest Professor,
Jan. 2003 – July 2003
Purdue University, Associate Professor, Mechanical Engineering, Aug. 2000 – July 2005
Purdue University, Assistant Professor, Mechanical Engineering, July 1994 – July 2000

Non-Academic Experience
Galil Medical, Minneapolis, MN, Consultant, Jan. 2010 – May 2010
Torad Engineering LLC, Alpharetta, GA, Consultant, Mar. 2008 – Present
International Institute of Refrigeration (IIR), Editor for the Americas, Jan. 2008 – Present

Current Membership in Professional Organizations
Fellow: American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
Member: American Society of Engineering Education (ASEE)
Member: American Society of Mechanical Engineers (ASME)
Member: Deutscher Kälte- und Klimatechnischer Verein (DKV - German Society of Refrigeration and Climate Technology)
Member: International Institute of Refrigeration (IIF/IIR)

Honors and Awards
Purdue University Research Acorn Award, 2011
ASHRAE Distinguished Lecturer, 2011
E. K. Campbell Award from ASHRAE, 2010
Faculty Advising Excellence Award, College of Engineering, Purdue University, 2009
Inductee Book of Great Teachers, Purdue University, 2008
Ruth and Joel Spira Award, 2007
Purdue University Faculty Scholar Award, 2007
Fellow of Purdue’s Teaching Academy, 2005
Wilbur T. Pentzer Achievement and Leadership Award, 2005
Charles B. Murphy Award, 2005

Team Excellence Award in the Schools of Engineering at Purdue University for developing the Global Engineering Alliance for Research and Education (GEARE), 2004
B.F.S. Schaefer Outstanding Young Faculty Scholar Award, School of Mechanical Eng., Purdue Univ., 2003 – 2005
ASHRAE Distinguished Service Award, 2003
Solberg Award for best teacher in Mechanical Engineering at Purdue University, 2002
ASHRAE New Investigator Award, 1997

Service Activities

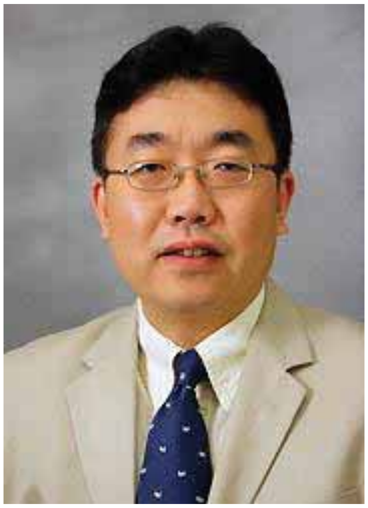
ASHRAE Board of Directors (10-13), ASHRAE Conferences and Exposition Committee (CEC) (08 – 10), ASHRAE Professional Development Committee (PDC) (07 – 10), Corresponding Member of 5 Technical Committees
USNC/IIR (U.S. National Committee of the Int'l Institute of Refrig.): Member (95 – present); Secretary (99 – 03), 2nd Vice-president (03 – present); Board of Directors (99 – present)
Purdue University Global Council: Member (2011 – present)
Campus Information Technology Planning Committee: Member (2010)
College of Engineering Strategic Plan Roadmap: Co-Captain of Team VIII A&B on Global Undergraduate Student Experiences (2009)
Vice Provost of Global Affairs Search Committee: Member (2009)
Karlsruhe House of Young Scientists (KHYS): Advisory Board Member (2009 – present)
Friends of Purdue Convocations: Advisory Board Member (2007 – present)
Organized and chaired 8 international conferences on topics of Refrigeration, Air Conditioning, Compressors, and Natural Working Fluids. In addition, he was Program Co-Chair of the 2003 Int'l Congress of Refrigeration in Washington, D.C.

Principal Publications and Presentations (Most important from past 5 years)

Authored or co-authored 80 archival journal articles and 130 conf. papers, holder of 3 patents
Hengeveld, D.W., Mathison, M.M., Braun, J.E., **Groll, E.A.**, and Williams, A.D., "Review of Modern Spacecraft Thermal Control Technologies," *Int'l J. HVAC&R Research*, Vol. 16, No. 2, 2010, pp. 189-220
Sathe, A.A., **Groll, E.A.**, and Garimella, S.V., "Dynamic analysis of an electrostatic compressor," *Int'l J. Refrigeration*, Vol. 33, No. 5, 2010, pp. 889-896
Bell, I.H., **Groll E.A.**, and König, H., "Experimental Analysis of the Effects of Particulate Fouling on Heat Exchanger Heat Transfer and Air Side Pressure Drop for a Hybrid Dry Cooler," *Int'l J. Heat Transfer Engineering*, Vol. 32, Issues 4&5, 2010, pp. 1-8
Bradshaw, C.R., **Groll, E.A.**, and Garimella, S.V., "A Comprehensive Model of a Miniature-Scale Linear Compressor for Electronics Cooling," *Int'l J. Refrigeration*, Vol. 34, No. 1, 2011, pp. 63-72
Bell, I.H., **Groll, E.A.**, and Braun, J.E., "Performance of Vapor Compression Systems with Compressor Oil Flooding and Regeneration," *Int'l J. Refrigeration*, Vol. 34, No. 1, 2011, pp. 225-233
Mathison, M.M., Braun, J.E., and **Groll E.A.**, "Performance Limit for Economized Cycles with Continuous Refrigerant Injection," *Int'l J. Refrigeration*, Vol. 34, No. 1, 2011, pp. 234-242
Haller, Y., **Groll, E.A.**, and Hirleman, E.D., "Best of Both Worlds: Foreign Language Preparation for Purdue University's Undergraduate Global Engineering Education Program," (MS#1047), *Online J. Global Engineering Education*, Vol. 6, Issue 1, 2011

Professional Development Activities (Past 5 years)

ACE Fellow, Georgia Institute of Technology, Office of the Vice Provost on International Initiatives, Atlanta, Georgia, Sept. 2010 – May 2011
CIC-ALP Fellow (Committee on Institutional Collaboration Academic Leadership Program), Aug. 2009 – May 2010



Bumsoo Han
Associate Professor
School of Mechanical Engineering

Education
BS, Seoul National University, Korea, 1993
MS, Seoul National University, Korea, 1996
Ph.D., University of Minnesota, 2001
Postdoc, University of Minnesota, 2001-2004

Academic Experience
Purdue University, Associate Professor, Mechanical Engineering, 2011 – Present
Purdue University, Assistant Professor, Mechanical Engineering, 2009 – 2011
University of Texas at Arlington, Assistant Professor, 2004 – 2009

Non-Academic Experience
None

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Member, American Society of Mechanical Engineers (ASME), 1996 – Present
Member, Society for Cryobiology, 2002 – Present
Member, Biomedical Engineering Society (BMES), 2008 – Present
Member, Tissue Engineering and Regenerative Medicine Int'l Society (TERMIS), 2010 – Present

Honors and Awards
Postdoctoral Award, Dept. of Defense, Congressionally Directed Medical Research Program, 2003
Faculty Early Career Development (CAREER) Award, National Science Foundation, 2008
Best Paper Award, ASME 2008 Summer Bioengineering Conference, 2008
Research Excellence Award, University of Texas at Arlington, 2008 – 2009
Richard Skalak Best Paper Award, ASME Journal of Biomechanical Engineering, 2010

Service Activities
Heat Transfer Area Committee, 08/2009 – Present, Member, School of Mechanical Engineering
Research Committee, 05/2010 – Present, Member, School of Mechanical Engineering
ASME Bioengineering/Heat Transfer Divisions, Biotransport Committee, 2004 – Present, Member
ASME NanoEngineering for Medicine and Biology Steering Committee, 2011 – Present, Member

Principal Publications and Presentations (Most important from past 5 years)
B. M. Ibrahim*, S. Park*, **B. Han** and Y. Yeo, 2011, "A strategy to deliver genes to cystic fibrosis lungs: A battle with environment," Journal of Controlled Release. (accepted)
K. Y. Teo, T. O. DeHoyos, J. C. Dutton, F. Grinnell, and **B. Han**, 2011, " Effects of freezing-induced cell-fluid-matrix interactions on the cells and extracellular matrix of engineered tissues," Biomaterials, vol. 32, pp.5380-5390. PMCID: PMC3119347
S. Park, P. A. L. Wijethunga, H. Moon, and **B. Han**, 2011 "On-chip characterization of cryoprotective agent mixtures using an EWOD-based digital microfluidic device," Lab on a Chip, vol. 11, pp.2212-2221

K. Bensalah, A. Tuncel, W. L. Hanson, J. M. Stern, **B. Han**, and J. A. Cadeddu, 2010 "Monitoring of thermal dose during ablation therapy using quantum dot-mediated fluorescence thermometry," Journal of Endourology, vol. 24, pp.1903-1908

L. Xu, B. J. Lee, W. L. Hanson, and **B. Han** 2010, "Brownian motion induced dynamic near-field interaction between quantum dots and plasmonic nanparticles in aqueous medium," Applied Physics Letters, vol. 96, 174101:1-3

K. Y. Teo, J. C. Dutton and **B. Han**, 2010, "Spatiotemporal measurement of freezing-induced deformation of engineered tissues," Journal of Biomechanical Engineering, vol. 132, 031003:1 8. PMCID: PMC2869480

B. Han, W. L. Hanson, K. Bensalah, A. Tuncel, J. M. Stern, and J. A. Cadeddu, 2009 "Development of quantum dot-mediated fluorescence thermometry for thermal therapies," Annals of Biomedical Engineering, vol. 37, pp.1230-1239

B. Han and K. Y. Teo, 2009, "Effects of freezing on intratumoral drug transport," Proceedings of 31st Annual International Conference of the IEEE Engineering in Medicine and Biology Society, pp. 246-249. PMCID: PMC2841974

B. Han, J. D. Miller and J. K. Jung, 2009, "Freezing-induced fluid-matrix interaction in poroelastic material," Journal of Biomechanical Engineering, vol. 131, 021002: 1-8. PMCID: PMC2703592 C.-L. Wang, K. Y. Teo, and B. Han, 2008, "An amino acid adjuvant to augment cryoinjury of MCF-7 breast cancer cells," Cryobiology, vol. 57, pp. 52-59

Professional Development (Past 5 years)

None

Stephen D. Heister,
James Raisbeck Distinguished Professor
Director, Maurice J. Zucrow Laboratories
School of Aeronautics and Astronautics

Education
BSAE, (Aero. Engineering), University of Michigan, Ann Arbor, 1981
MSAE, (Aero. Engineering), University of Michigan, Ann Arbor, 1983
Ph. D., (Aerospace Engineering), UCLA, 1988
`Transverse Jets in Compressible Crossflows,' Advisor: A. Karagozian

Academic Experience
Purdue University, Professor, School of Aeronautics & Astronautics, June 2004 – Present
Purdue University, Assistant Professor, School of Aeronautics & Astronautics, Aug. 1990 – June 2004
Purdue University, Associate Professor, School of Aeronautics & Astronautics, July 1994 – June 1999
Purdue University, Director, Maurice J. Zucrow Laboratory, School of Mechanical Engineering, April 2011 – Present

Non-Academic Experience
Rolls-Royce, Director, High Mach Propulsion University Technology Center, Feb. 2003 – Present
TRW Space Systems, Redondo Beach, CA, Sabbatical visit, Jan. 1997 – April 1997
Phillips Laboratory, Edwards Air Force Base, Air Force Office of Scientific Research Summer Faculty Researcher, May 1991 – Aug. 1991
The Aerospace Corporation, Manager, Propulsion Technology Section, May 1989 – Aug. 1990
The Aerospace Corporation, Member, Solid Motors Section of the Propulsion Department, Aug. 1983 – May 1989
Lockheed Aircraft Company, Member, Propulsion Installation Department, May 1981 – Sept. 1982

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Member, U.S. Air Force Scientific Advisory Board, 2010 – Present
Member, Tau Beta Pi National Honor Society
Member, Sigma Gamma Tau Engineering Society

Honors and Awards
Purdue University Faculty Scholar, 1998 – 2003
E.F. Bruhn Teaching Award, School of Aero. & Astro., 1993, 1996, 1999, 2001, 2011
C.T. Sun Departmental Research Award (with Dr. Anderson), 2005

Service Activities
Member, Air Force Scientific Advisory Board, 2010 – Present

Principal Publications and Presentations (Most important from past 5 years)
Professor Heister has published nearly 200 technical articles in journals and professional conferences dealing with rocket/propulsion system design, combustion, atomization, liquid jets and drops, and internal orifice flows. Dr. Heister's Ph.D. research dealt with simulation of transverse jet injectors in scramjet combustor conditions. A brief sampling of publications include:

Anderson, W.E., Long, M.R., and **Heister, S.D.**, "Liquid Bipropellant Injectors," Liquid Rocket Thrust Chambers: Aspects of Modeling, Analysis, and Design, Chapter 4, AIAA Progress in Astronautics and Aeronautics, Volume 200, 2004

Canino, J. and **Heister, S. D.**, "Contributions of Orifice Hydrodynamic Instabilities to Primary Atomization", Atomization and Sprays, V19, No. 1, pp91-102, 2008

Park, S. and **Heister, S. D.**, "Nonlinear Modeling of Drop Size Distributions Produced by Pressure-Swirl Atomizers", Intl. J. of Multiphase Flow, V36, pp 1-12, 2010

Ismailov, M. and **Heister, S.**, "Dynamic Response of Rocket Swirl Injectors, Part I: Wave Reflection and Resonance", AIAA J. Propulsion & Power, V27, No. 2, pp. 402-411, 2011

Professional Development Activities (Past 5 years)

None

Monika M. Ivantysynova
Maha Professor Fluid Power Systems
School of Mechanical Engineering

Education
MS: Slovak Technical University of Bratislava, Czechoslovakia, 1979
Ph.D. Slovak Technical University of Bratislava, Czechoslovakia, 1983
Dr.h.c. Slovak University of Technology, 2010

Academic Experience
Purdue University, Maha Professor Fluid Power Systems, Director of Maha Fluid Power Research Center, Mechanical Engineering and Agricultural and Biological Engineering, 2004 – Present, Full-Time
Technical University of Hamburg – Hamburg, Germany, Professor, Mechanical Engineering, Apr. 1999 – Aug. 2004
University of Duisburg, Germany, Professor, Mechanical Engineering, Apr. 1996 – Mar. 1999
Technical University of Bratislava, Czechoslovakia, Assistant Professor at Institute of Robotics, May 1998 – Aug. 1989 (Graduated summa cum laude)

Non-Academic Experience
Technical University of Hamburg – Hamburg, Germany, Senior Research Fellow and Deputy Director of the Institute for Aircraft Systems Engineering, Nov. 1990 – Mar. 1996
Commercial Hydraulics in Germany, Project Manager for Mobile Hydraulics, Sept. 1989 – Oct. 1990
ZTS VUHYM in Dubnica, Czechoslovakia, R & D Project Engineer, Sept. 1984 – Apr. 1988
VEB Elektronik Gera, Germany, Product Development, June 1983 – Aug. 1984

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Member: American Society of Mechanical Engineers, SAE member, Member of Scientific board of Fluid Power Net International FPNI

Honors and Awards
Seed of Success from Provost Dr. Sally Mason, Purdue University for attracting large sponsored programs to Purdue University, 2007
Backe Medal for Best Paper - 5th FPNI PhD Symposium, Cracow, Poland, 2008
FPMC Best paper Award - Bath ASME Symposium on Fluid Power and Motion Control, Los Angeles, 2009
2009 Joseph Bramah Medal awarded by the Institution of Mechanical Engineers' (UK) - Mechatronics Informatics and Control Group for outstanding commitment to international fluid power research and education, particularly in the field of hydrostatic pumps and motors, 2009
Honorary Doctorate Doctor Honoris Causa awarded from Slovak University of Technology, Bratislava, Slovak Republic, 2010
Best Paper Award - 8th JFPS International Symposium on Fluid Power, Okinawa, Japan, 2011

Service Activities

Editor-in-Chief, "International Journal of Fluid Power"

Member of Executive Committee of ASME Fluid Power Systems and Technology Division

Member of scientific board of Fluid Power Net International

Member Executive Board of NSF Center for Compact and Efficient Fluid Power

Member of scientific board of Chinese Journal of Mechanical Engineering

Chair of organizing committee of Technical Sessions on Fluid Power, SAE Commercial Vehicle Engineering Congress, Chicago, 2006-2010

Organizer 6th International FPNI PhD Symposium, June 2010

Chair of Scientific Advisory Board of Finnish Centre of Excellence (CoE) in Generic Intelligent Machines Research (2008-2013)

Panel Chair Mechanical Engineering and Automation of Aalto University Research Assessment Exercise 2009

Panel Chair of Lappeenranta University of Technology Research Assessment Exercise 2012

Panel member of European Research Council starting grant evaluation 2010-2012

Member of the Program Committee, ASME/Bath Symposium on Fluid Power and Motion Control 2008-2012

Referee for 17 different journals

Principal Publications and Presentations (Most important from past 5 years)

Seeniraj, G.K., Zhao, M. and **Ivantysynova, M.** Effect of Combining Precompression Grooves, PCFV and DCFV on Pump Noise Generation. International Journal of Fluid Power. International Journal of Fluid Power, Vol. 12, No. 3, pp. 53-64

Klop, R. and **Ivantysynova, M.** 2011. Investigation of noise sources on a series hybrid transmission. International Journal of Fluid Power. International Journal of Fluid Power, Vol. 12, No. 3, pp. 17-30

Schenk, A. and **Ivantysynova, M.** 2011. An investigation of the impact of elastohydrodynamic deformation on power loss in the slipper swashplate interface. 8th JFPS International Symposium on Fluid Power, Okinawa , Japan. Best paper award

Pelosi, M. and **Ivantysynova, M.** 2012. Heat Transfer and Thermal Elastic Deformation Analysis on the Piston/Cylinder Interface of Axial Piston Machines"; ASME Journal of Tribology

Pelosi, M. and **Ivantysynova, M.** 2012. A Geometric Multigrid Solver for the Piston-Cylinder Inter-face of Axial Piston Machines. Tribology Transactions, Vol. 55, Issue. 2, pp. 163 - 174

Professional Development Activities (Past 5 years)

Hydraulic Hybrid Power Trains - an Opportunity and Challenge for Fluid Power. **7th International Conference on Fluid Power,** April 7-10, 2009. Hangzhou, China. - Keynote Lecture

Fuel savings through advanced fluid power systems. **3rd Annual Purdue Systems Integrity for Defense Technology Summit 2010,** Purdue University, March 30-31, 2010

Energy savings through displacement control - an opportunity and challenge for Fluid Power. 13th International **Mechanical Engineering Conference, 70th anniversary Slovak Technical Universi-ty Bratislava,** October 21, 2010. Keynote Lecture

Modeling and Optimization of Piston Pumps and Motors. **52nd National Conference on Fluid Pow-er.** March 23-25, 2011. Las Vegas, NV. - Keynote Lecture

Displacement control – the future of fluid power systems. **International Conference on Mechanical Engineering and Mechanics.** August 10-12, 2011, Suzhou, P. R. China, Proceedings of the 4th ICMEM. pp. 21-30. - Keynote Lecture

The Piston Cylinder Assembly in Piston Machines – a long Journey of Discovery. **Proceedings of 8th IFK International Conference on Fluid Power,** Dresden, Germany, Vol. 3. pp. 307 332, Keynote Lecture

James (Jim) D. Jones
Associate Professor and Associate Head,
School of Mechanical Engineering

Education
BSME. Tennessee Technological University, 1981
MSME, Virginia Tech, 1982
Ph.D., ME Virginia Tech, 1987

Academic Experience
Purdue University, Associate Professor, Associate Head, Mechanical Engineering, 1998 – Present, Full Time
Purdue University, Associate Professor, Mechanical Engineering, 1991 – Present, Full Time
Purdue University, Assistant Professor, Mechanical Engineering, 1987 – 1991, Full Time
Virginia Tech, Instructor, 1983-1987, Part Time

Non-Academic Experience
NASA Langley Research Center, Research Associate, Researcher in the Acoustics and Noise Reduction Division, 1982-1983, Full Time
Oak Ridge National Laboratory, Engineering Intern, Researcher in the Metals and Ceramics Division, 1980 (summer), Full Time

Certifications or Professional Registrations
Board Certified Member of the Institute of Noise Control Engineering (INCE), INCE Board Certified (1992), No. 92002
Engineer in Training (EIT) Exam, No. 7234, Tennessee, June 30, 1981

Current Membership in Professional Organizations
American Society of Mechanical Engineers, 1982- Present
American Society of Engineering Education, 1986-Present

Honors and Awards
Advising Award, College of Engineering, Purdue University, 2012
Teaching Academy Fellow, Purdue University, 1999
Murphy Teaching Award, Purdue University, 1999
Solberg Teaching Award, School of Mechanical Engineering, Purdue University, 1998

Service Activities
Advising Steering Committee, Purdue University, 2011-2012
Undergraduate Chairs Committee, College of Engineering, 2007-Present
Academic Advisors Committee, College of Engineering, 2011-Present
Engineers of 2020 Committee, (Chair, 2004-2008), 2004-Present
Mechanical Engineering Curriculum Committee, Chair, 1998-Present
Mechanical Engineering Leadership Team (MELT), 1998-Present
Mechanical Engineering Study Abroad Liaison, 1998-Present
Mechanical Engineering Awards Committee, 1998-Present
First-Year Engineering Curriculum Committee, 1998-Present

Principal Publications and Presentations (Most important from past 5 years)

Jones, J., Meckl, P., Harris, M., Jamieson, L. “Purdue’s Engineer of 2020: The Journey”, *2009 American Society of Engineering Education Conference Proceedings*, New Learning Paradigms II Session, Paper No. AC 2009-1072, Austin, TX, June 14-17, 2009

Professional Development Activities (Past 5 years)

Big 10+ Associate Head’s Meeting, May 2001-20012 (annual meeting)
Best Assessment Practices Symposium, Rose-Hulman Institute of Technology, February 26-29, 2006
ABET Faculty Workshop on Assessment, Baltimore, MD, April 8, 2006

Nicole L. Key
Assistant Professor
School of Mechanical Engineering

Education
BS, Aeronautical Engineering, Purdue University, 2000
MSME, Purdue University, 2002
Ph.D., ME, Purdue University, 2007

Academic Experience
Purdue University, Assistant Professor, Mechanical Engineering, 2007 – Present, Full-Time

Non-Academic Experience
GE Aviation, Evendale, OH, Aeromechanics and Compressor Aero, summers of 1998, 1999, and 2000

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Senior Member, American Institute of Aeronautics and Astronautics
Member, American Society of Mechanical Engineers

Honors and Awards
Outstanding Graduate Student in Mechanical Engineering at Purdue, 2007
AIAA Foundation Gordon C. Oates Graduate Award for Studies in Air Breathing Propulsion, 2005
Hertz Fellowship Finalist, 2004
Von Karman Prize for Best Overall Results in Course Work and Research, 2003
Amelia Earhart Fellowship Recipient, 2002 & 2004
AIAA National Graduate Student Paper Competition Winner, 2002

Service Activities
ME Leadership Team, Purdue University, Fall 2011 – Present.
Fluid Mechanics Faculty Search Committee, ME, Purdue, 11/11 – 5/12
Department Head Search Committee, ME, Purdue, Fall 2010 – Spring 2011
Faculty Fellow, Earhart Hall, Women's Honors Engineering Floor, Purdue, Fall 2008 – Spring 2012
Judge for WIEP's Wadsworth Graduate Mentoring Fellowship, 2009 – Present
HORIZONS Mentor for a minority freshman engineer, Fall 2010 – Present
ME Graduate Committee, 1/2008 – 1/2010
WIEP Volunteer (EDGE Camp 2008 & Introduce a Girl to Engineering 2008 & Day on Campus 2007, 2008, 2009)
Air Breathing Propulsion Lifetime Achievement Award Organizer, AIAA, Spring 2010 – Spring 2012
Gas Turbine Engines Technical Committee, AIAA, Summer 2008 – Present
Turbomachinery Committee, ASME, Summer 2008 – Present
Session Chair for AIAA Aerospace Sciences Meeting, AIAA, 2010
Session Chair for Joint Propulsion Conference, AIAA, 2010 – 2012
Session Chair for Turbo Expo, ASME, 2008, 2010, 2012

Principal Publications and Presentations (Most important from past 5 years)

Refereed Journal Publications

Miller, K.L., **Key, N.L.**, Fulayter, R.D., 2012, "Lessons Learned from an Aggressive Outlet Vane Design for Axial Compressors," Accepted to the AIAA Journal of Propulsion and Power

Brossman, J.R., Smith, N.R., Talalayev, A., and **Key, N.L.**, 2011, "Tailoring Inlet Flow to Enable High Accuracy Compressor Performance Measurements", International Journal of Turbo and Jet Engines, Vol. 28, p 309-320

Salontay, J.D., **Key, N.L.**, and Fulayter, R.D., 2011, "An Investigation of the Flow Physics of Vane Clocking Effects on Rotor Resonant Response", AIAA Journal of Propulsion and Power, Vol. 27, No. 5, p 1001-1007

Choi, Y.S., **Key, N.L.**, and Fleeter, S., 2011, "Vane Clocking Effects on the Resonant Response of an Embedded Rotor," AIAA Journal of Propulsion and Power, Vol. 27, No. 1, p 71-77

Key, N.L., Lawless, P.B., and Fleeter, S., 2010, "Rotor Wake Variability in a Multistage Compressor," AIAA Journal of Propulsion and Power, Vol. 26, No. 2, p 344-352

Key, N.L., Lawless, P.B., and Fleeter, S., 2010, "An Experimental Study of Vane Clocking Effects on Embedded Compressor Stage Performance," ASME Journal of Turbomachinery, Vol. 132, No. 1, 011018 (10 pgs)

Key, N.L., Lawless, P.B., and Fleeter, S., 2009, "Vane Clocking in a Three-Stage Compressor: Frequency Domain Data Analysis," AIAA Journal of Propulsion and Power, Vol. 25, No. 5, p 1100-1107

Key, N.L. and Arts, T., 2006, "Comparison of Turbine Tip Leakage Flow for Flat Tip and Squealer Tip Geometries at High-Speed Conditions," ASME Journal of Turbomachinery, Vol. 128, No. 2, p 213-220

Key, N.L., Lawless, P.B. and Fleeter, S., 2004, "Rotor Generated Vane Row Off-Design Unsteady Aerodynamics Including Dynamic Stall: Part I," AIAA Journal of Propulsion and Power, Vol. 20, No. 5, p 835-841

Peer-Reviewed Conference Proceedings

Key, N.L., Lawless, P.B., and Fleeter, S., 2008, "An Investigation of the Flow Physics of Vane Clocking Using Unsteady Flow Measurements," Proceedings of the ASME Turbo Expo, Berlin, Germany, ASME Paper GT2008-51091

Professional Development Activities (Past 5 years)

Turbomachinery Short Course, Cambridge University, U.K., 2008

Sangtae Kim
Donald W. Feddersen Distinguished Professor
School of Chemical Engineering
School of Mechanical Engineering

Education
BSc: Chemical Engineering, CalTech, 1979
MSc: Chemical Engineering, CalTech, 1979
Ph.D. Chemical Engineering, Princeton, 1983

Academic Experience
Purdue University, Distinguished Professor, Mechanical Engineering & Chemical Engineering, 2003 – Present
University of Wisconsin-Madison, Madison, WI, Distinguished Professor, Chemical Engineering, 1991 – 1997
University of Wisconsin-Madison, Madison, WI, Professor, Chemical Engineering, 1990 – 1991
University of Wisconsin-Madison, Madison, WI, Associate Professor, Chemical Engineering, 1987 – 1990
University of Wisconsin-Madison, Madison, WI, Assistant Professor, Chemical Engineering, 1983 – 1987

Non-Academic Experience
National Science Foundation, Arlington, CA, Director, Division of Shared Cyberinfrastructure (on loan from Purdue), Feb. 2004 – Sept. 2005
Eli Lilly & Company, Lilly Research Laboratories, Indianapolis, IN, Vice President and Information Officer, Oct. 2000 – 2003
Warner Lambert Company, Parke-Davis Pharmaceutical Research Laboratories, Ann Arbor, MI, Vice President, R&D IT, Dec. 1997 – Sept. 2000

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow, American Institute of Medical and Biological Engineering
Member, American Chemical Society
Member, American Institute of Chemical Engineering
Member, American Institute of Physics Division of Fluid Dynamics
Member, Society of Rheology

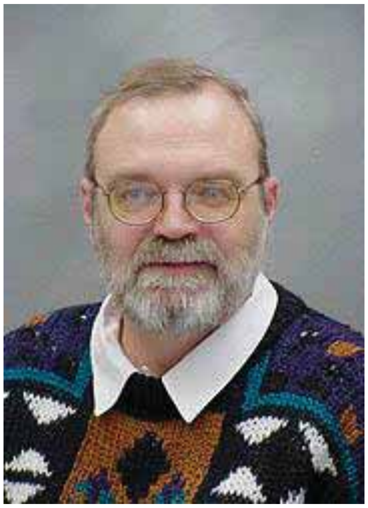
Honors and Awards
Presidential Young Investigator Award, National Science Foundation, 1985
Outstanding Instructor in Chemical Engineering, Polygon Engineering Student Council, 1991 - 1992
William O. Baker Award for Initiatives in Research, National Academy of Sciences, 1992
Allan P. Colburn Award, American Institute of Chemical Engineers, 1993
Stanley Corrsin Lecture in Fluid Mechanics, Johns Hopkins University, 1996
Induction, National Academy of Engineering, 2001
Julian C. Smith Lecture, Cornell University, 2002
Britton Chance Distinguished Lecture in Engineering and Medicine, University of Pennsylvania, 2002

Barnett F. Dodge Lecture, Yale University, 2005
Microhydrodynamics: Principles and Selected Applications recognized by the Dover Editorial Board as having "enduring value", 2005
Arnie G. Fredrickson Lecture, University of Minnesota, 2006

Service Activities
FDA Centennial Science and Technology Review Group, Science Board, Food and Drug Administration, Washington, DC, 2006
Consulting Editor (Information Technology) Amer. Inst. of Chem. Engineers Journal, 2003 – Present
Chair, Awards Committee, SuperComputing06, Tampa, FL, December 2005 to November 2006
Executive Review Board, Pharmaceutical Achievements Awards, 2004 and 2005
Co-Chair, U.S. Papers, International Conference on Theoretical and Applied Mechanics, 2004
National Academy of Engineering, Special Peer Review Committee for Bioinformatics, 2002 – 2003
National Research Council, Board on Chemical Science and Technology, June 200 – June 2003

Principal Publications and Presentations (Most important from past 5 years)
Karrila, S.J., Fuentes, Y.O. and **Kim, S.** (1989) Parallel Computational Strategies for Hydrodynamic Interactions between Rigid Particles of Arbitrary Shape in a Viscous Fluid, J. Rheology **33**, 913-47
Kim, S. (1992) A Course in Parallel Computing, Chemical Engineering Education **26**, 172-74
Brune, D.A. and **Kim, S.** (1994) Hydrodynamic Steering Effects in Protein Association, Proc. Natl. Acad. Sci. USA **91**, 2930-34. *This paper played an influential role in the development of fluidic self assembly process for manufacturing of RFID tags*
Traenkle, F., Hill, M.D. and **Kim, S.** (1995) Solving Microstructure Electrostatics on a Proposed Parallel Computer, Computers and Chemical Engineering **19**, 743-757
Huber, G. and **Kim, S.** (1996) Weighted-Ensemble Brownian Dynamics Simulations for Protein Association Reactions, Biophysical J. **70**, 97-110
Rojnuckarin, A., **Kim, S.** and Subramaniam, S. (1998) Brownian Dynamics Simulations of Protein Folding: Access to Millisecond Time Scales and Beyond, Proc. Natl. Acad. Sci. USA **95**, 4288-92
Mustakis, I. and **Kim, S.** (1998) Microhydrodynamics of Sharp Corners and Edges: Traction Singularities, American Inst. Chemical Engineers J. **44**, 1469-83
Yariv, E., Brenner, H. and **Kim, S.** (2004) Curvature-Induced Dispersion in Electro-Osmotic Serpentine Flows, SIAM J. Appl. Math. **64**, 1099-1124
Kim, S. and Karrila, S.J. (2005) *Microhydrodynamics: Principles and Selected Applications,* Dover Publications (reprint edition of the 1991 Butterworth-Heinemann edition)
Kim, S. and Heller, M. (2006) Emerging Cyberinfrastructure: Challenges for the Chemical Process Community, Computers and Chemical Engineering **30**, 1497-1501

Professional Development Activities (Past 5 years)
National Science Foundation "Bootcamp for Program Directors", Berkeley Springs, WV, Oct. 2004



Galen B. King
Associate Professor, School of Mechanical Engineering

Education
BS, Physics, Wichita State University, 1976
MS, Physics, Wichita State University, 1978
Ph.D., Engineering, Kansas State University, 1983

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2007 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 1990 – 2007, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1983 – 1984, Full-Time
Post Doctoral Research Associate, 1983 – 1984

Non-Academic Experience
Air Force Research Laboratory, ASEE Summer Faculty Fellow, 2005 – 2008
Air Force Research Laboratory, NRC Summer Faculty Fellow, 2003 – 2004

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Optical Society of America
American Society of Mechanical Engineering
American Society for Engineering Education

Honors and Awards
NEC Faculty Fellowship, NEC Corporation, 1989
Ruth and Joel Spira Award, "For Outstanding Contributions to the School of Mechanical Engineering and its Students," May, 1990
American Society of Mechanical Engineers Council of Education, Honorable Mention Award in the ASME Curriculum Innovation Awards Program, November, 1990
National Research Council (NRC) Summer Faculty Fellowship, Summer 2003, Summer 2004
American Society of Engineering Education Summer Faculty Fellowship, Summer 2005, Summer 2006

Service Activities
Faculty Advisor Purdue Solar Racing Team (20 years)

Principal Publications and Presentations (Most important during past 5 years)
Refereed Journal Publications
Zhang, J., **King, G. B.**, Laurendeau, N.M., and Renfro, M.W., "Two-point time-series measurements of hydroxyl concentration in a turbulent nonpremixed flame," Applied Optics, Vol. 46, No. 23, May, 2007

Meyers, T. R., **King, G. B.**, Gluesenkamp, M., and Gord, J. R., "Simultaneous high-speed measurements of temperature and lifetime-corrected OH laser-induced fluorescence in unsteady flames," Optics Letters, Vol. 32, No. 15, August 1, 2007

Venkatesan, K. K., Zhang, J., **King, G. B.**, Laurendeau, N. M., and Refro, M. W., "Hydroxyl space-time correlation measurements in partially premixed turbulent opposed-jet flames," Appl. Phys. B 89, 129-140, 2007

Joshi, A.A., James, S., Meckl, P., **King, G.**, and Jennings, K, "Comprehensive physics-based model for turbocharged diesel engine with EGR," Proceedings of the 2007 ASME International Mechanical Engineering Congress and Exposition, No. 42119, 1-10, 2007

Kopp-Vaughn, Kristin M., Tuttle, Steven G., Renfro, Michael W. And **King, Galen B.**, "Heat Release and Flame Structure Measurements of Self-Excited Acoustically Driven Premixed Methane Flames," Combustion and Flame, Vol. 156, 1971-1982, 2009

Zhang, J., **King, G. B.**, and Laurendeau N. M., "Characterization of fluctuating hydroxyl concentrations in a turbulent nonpremixed hydrogen-nitrogen jet flame," Applied Physics B published online October 23 2009

Noble, Andrew C., Venkatesan, Krishna K., **King, Galen B.**, Laurendeau, Normand M. and Renfro, Michael W., "Singular Spectrum Analysis Applied to Time-Series Measurements in a Self-Excited Tube Combustor," Journal of Propulsion and Power, Vol. 25, No. 5, 1148-1151, 2009

Hu, Wenqian, Shin, Yung C., and **King, Galen**, "Energy transport analysis in ultrashort pulse laser ablation through combined molecular dynamics and Monte Carlo simulation," Physical Review B Vol. 82, 094111 (2010)

Hu, Wenqian, Shin, Yung C., and **King, Galen**, "Micromachining of Metals, Alloys, and Ceramics by Picosecond Laser Ablation," ASME Joural of Manufacturing Science and Engineering, Vol. 132 February 2010 11009-1 11009-7

Hu, Wenqian, Shin, Yung C., and **King, Galen**, "Modeling of multi-bust mode pico-second laser ablation for improved material removal rate," Applied Physics A Vol 98 407-415, (2010)

Hu, Wenqian, Shin, Yung C., and **King, Galen**, "Effect of air breakdown with a focusing lens on ultrashort laser ablation," Applied Physics Letters 99, 234104 (2011)

Noble, Andrew C., **King, Galen B.**, Laurendeau, Normand C., Gord, James R., and Roy, Sukesh, "Nonlinear Thermoacustic Instability Dynamics in a Simple Rijke Tube," Combusion Science and Technology 184: 1-30, 2012

Professional Development Activities (Past 5 years)

National Instruments NI week Educational Session Keynote Speaker

Klod Kokini
Associate Dean for Academic Affairs
Professor, School of Mechanical Engineering,
Materials Engineering, and Biomedical Engineering

BS, Bogazici University (former Robert College) Istanbul, Turkey 1
MS, Syracuse University 1978
Ph.D., Syracuse University 1982

Academic Experience
Purdue University, Associate Dean, Academic Affairs for the College of Engineering, 2004 – Present
Purdue University, Assistant Dean, Strategic Initiatives, School of Engineering, 2001 – 2004
Purdue University, Professor, Biomedical Engineering (by courtesy), 2000 – Present
Purdue University, Professor, Materials Engineering (by courtesy), 1996 – 2010
Purdue University, Professor, Mechanical Engineering, 1994 – Present
Purdue University, Associate Professor, Mechanical Engineering, 1990 – 1994
Purdue University, Assistant Professor, Mechanical Engineering, 1985 – 1990
University of Pittsburgh, Assistant Professor, 1983 – 1985

Non-Academic Experience
Syracuse University, Research Assistant, 1976 – 1982
Syracuse University, Teaching Assistant, 1976 – 1982
Bogazici, Turkey, Teaching Assistant, 1974 – 1976
ENEL Cenrale Termoellectrica, Chivasso, Italy, Engineering Trainee, Summer 1975
Dizelsan Injection Nozzles, Izmir, Turkey, Engineering Trainee, Summer 1974

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow, American Society of Mechanical Engineers (ASME)
Fellow, American Institute of Medical and Biological Engineering
Society of Women Engineers
Women in Engineering ProActive Network

Honors and Awards
Seed for Success Award, Purdue University, 2009
ASME Johnson and Johnson Consumer Companies, Inc. Medal, 2008
Violet Haas Award, Purdue University Award for contributions to the success of women, 2007
Dreamer Award, Purdue University Diversity Award honoring Martin Luther King, 2005
Chorafas Prize, Best Doctoral Student, Alaina Pizzo, 2005

Service Activities
ASME Nominating Committee, 2007 – 2009
ASME Board of Diversity and Outreach, 2003 – 2005
International Advisory Committee, Functionally Graded Materials Forum, 1990 – Present

Principle Publications and Presentations (Most important from past five years)

P. M. Buzzanell, **K. Kokini**, J. Hoffman, L.B. Anderson and Z. Long, "Episodic Mentoring for Engineering Faculty", *Proceedings of the 2012 Mentoring Conference,* Albuquerque, New Mexico, October, 2012

K. Kokini, "The Strategic Oversight Committee: A Best Practice for Faculty Hiring and Diversity", *Proceedings of the WEPAN National Conference*, Columbus OH, June 2012

K. Kokini, P. M. Buzzanell, C. C.S. Chapple, A. S. Hirsch and K. Howell, "Diversity Catalysts: Educating the STEM Community", *Proceedings of the WEPAN National Conference*, Columbus, OH, June 2012

M. Susilo, B.A. Roeder, S.L. Voytik-Harbin, **K. Kokini** and E.A. Nauman, "Evaluation of a Unit Cell Model to Characterize the Micromechanical Response of a Collagen-Based Extracellular Matrix", *Acta Biomateriala*, **6 (4)**, 1471-1486, 2010

B.A. Roeder, **K. Kokini** and S.L. Voytik-Harbin, "Fibril Microstructure Affects Strain Transmission within Collagen Extracellular Matrices", ASME *Journal of Biomechanical Engineering*, **131 (3), Number 031004, 2009** (Top 10 most downloaded article, January 2009)

A. Gilbert, **K. Kokini** and S. Sankarasubramanian, "Thermal Fracture of Zirconia-Mullite Composite Thermal Barrier Coatings Under Thermal Shock: An Analytical Study", *Surface and Coatings Technology*, **203 (1-2)**, 91-98, **2008**

S. Sankarasubramanian and **K. Kokini**, "Micromechanical and Compositional Design of Thermal Barrier Coatings for Modifying Time-dependent Behavior", Proceedings of *Mechanics of Time-dependent Materials Conference*, Monterrey, CA, April, 2008

A. Gilbert, **K. Kokini** and S. Sankarasubramanian, "Thermal Fracture of Zirconia-Mullite Composite Thermal Barrier Coatings Under Thermal Shock: An Experimental Study", *Surface and Coatings Technology*, **202 (10)**, 2152-2161, **2008**

Professional Development Activities (Past 5 years)

None

Marisol Koslowski
Associate Professor
School of Mechanical Engineering

Education
BS, Physics, University of Buenos Aires, Argentina, 1997
MS, Aeronautics, California Institute of Technology, 1999
Ph.D., Aeronautics, California Institute of Technology, 2003

Academic Experience
Purdue University, Assistant Professor, Mechanical Engineering, 2006 – Present, Full-Time

Non-Academic Experience
Los Alamos National Laboratory, Staff Member, Theoretical Division, T-1, 2005 – 2006, Full-Time
Los Alamos National Laboratory, Postdoctoral Fellow, Theoretical Division, T-12, 2003 – 2004, Full-Time
California Institute of Technology, Graduate Research Assistant, Graduate Aeronautical Laboratories, 1998 – 2002
Techint Corporation, Buenos Aires, Argentina, Research Assistant, FUDETEC, 1996 – 1998

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Member, The Minerals, Metals and Materials Society
Member, International Association of Computational Mechanics
Member, U. S. Association of Computational Mechanics
Member, Society for Women in Engineering

Honors and Awards
Purdue Seeds of Success Award, NSF research grant *"Cyber-enabled Predictive Models for Polymer Nanocomposites: Multiresolution Simulations and Experiments"*, 2009
Purdue Seeds of Success Award, Boeing Co. research grant *"Atoms to aircraft program"*, 2009
Purdue University, College of Engineering Faculty Excellence Award, Team: PRISM, 2009
Leon Heller Postdoctoral Publication Prize, Los Alamos National Laboratory, 2006
Graduate student presentation award, Materials Research Society Fall meeting. Boston, MA, 2001

Service Activities
Coordinator of the Midwest Mechanics Seminar (2006 – 2010)
Graduate Area Exams: Chair for: ME Solid Mechanics (2007), ME Mathematics (2010 – 2011)
Member of: ME Solid Mechanics (2008-2009, 2012)
Member of the School of Engineering Strategic Plan: Support Team, 2009

Principal Publications and Presentations (Most important from past 5 years)

Defect induced amorphization of molecular crystals, Lei Lei, T. Carvajal and **M. Koslowski**, *Journal of Applied Physics*, 111, 073505 (2012)

A systematic method to study slip planes in molecular crystals by nanoindentation, Y. Jing, Y. Zhang, J. Blendell, and **M. Koslowski**, *Crystal Growth and Design*, **11** (12) 5260-5267, 2011

Validation of strain invariant failure analysis in an open hole off axis specimen, A.J. Mendoza Jasso, J.E. Goodsell, R.B. Pipes, and **M. Koslowski**, *JOM*, **63** (9) 43-48, 2011

A parametric study of fiber volume fraction distribution on the failure initiation location in open hole off-axis tensile specimen, A.J. Mendoza Jasso, J.E. Goodsell, A. Ritchey, R.B. Pipes, and **M. Koslowski**, *Composites Science and Technology*, **71**, (16) 1819-1825, 2011

Influence of the stacking fault energy surface on extended partials with a 3D phase field dislocations model, A. Hunter, I. Beyerlein, T. Germann, and **M. Koslowski**, *Physical Review B*, **84**, 144108, 2011

An experimental and theoretical investigation of creep in ultrafine crystalline nickel RF-MEMS devices, H.H. Hsu, **M. Koslowski**, and D. Peroulis, *IEEE Transactions on Microwave Theory and Techniques*, **59** (10) 2655-2664, 2011

Multiscale propagation of uncertainty quantification, **M. Koslowski** and A. Strachan, *Reliability Engineering and System Safety*, **96** (9) 1161-1170, 2011

Role of the grain boundary energetics on the maximum strength of nanocrystalline nickel, **M. Koslowski**, D.W. Lee, and Lei Lei, *Journal of the Mechanics and Physics of Solids*, **59**, 1427 1436, 2011

Effect of core energy on mobility in a continuum dislocation model, D.W. Lee, H. Kim, A. Strachan, and **M. Koslowski**, *Physical Review B*, **83** (10) 104101, 2011

Mesoscale modeling of dislocations in molecular crystals, Lei Lei and **M. Koslowski**, *Philosophical Magazine*, **91** (6) 865-878, 2011

Professional Development Activities (Past 5 years)

None

Rebecca K. Kramer
Assistant Professor,
School of Mechanical Engineering

Education
B.S. Johns Hopkins University, 2007
M.S. University of California Berkeley, 2008
Ph.D. Harvard University, 2012

Academic Experience
Purdue University, Assistant Professor, Mechanical Engineering, Jan 2013 – Present, Full Time
Harvard University, Postdoctoral Fellow, SEAS, June 2012 – Dec 2012, Full Time

Non-Academic Experience:
None

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Physical Society (APS)
Materials Research Society (MRS)

Honors and Awards
National Science Foundation Fellow, 2007 – 2010
American Society of Highway Engineers (ASHE) Scholarship Recipient, Fall 2004
Johns Hopkins University Scholarship Recipient, Fall 2004

Service Activities
Graduate Review Committee, School of Mechanical Engineering, Purdue University, Spring 2013
Reviewer, NSF NRI Panel, Spring 2013
Volunteer, Women in Engineering Program (WIEP), Purdue University, Spring 2013 – Present

Principal Publications and Presentations (Most important from past 5 years)

Frank L. Hammond, **Rebecca K. Kramer**, Qian Wan, Robert D. Howe, Robert J. Wood. "Soft Tactile Sensor Arrays for Micro-manipulation." IEEE Int. Conference on Intelligent Robotics and Systems, Vilamoura, Algarve [Portugal], 2012

Rebecca K. Kramer, Carmel Majidi, Ranjana Sahai, Robert J. Wood. "Soft Curvature Sensors for Joint Angle Proprioception." IEEE Int. Conference on Intelligent Robotics and Systems, San Francisco USA, 2011

Jamie K. Paik, **Rebecca K. Kramer**, Robert J. Wood. "Stretchable Circuits and Sensors for Robotic Origami." IEEE Int. Conference on Intelligent Robotics and Systems, San Francisco USA, 2011

Carmel Majidi, **Rebecca Kramer**, Robert J. Wood. "Non-Differential Elastomer Curvature Sensor for Softer-than-Skin Electronics." Smart Materials and Structures, 2011, v. 20 pp. 105017

Rebecca K. Kramer, Carmel Majidi, Robert J. Wood. "Wearable Tactile Keypad with Stretchable Artificial Skin." IEEE Int. Conference on Robotics and Automation, Shanghai China, May, 2010

Yong-Lae Park, Carmel Majidi, **Rebecca Kramer**, Phillipe Berard, and Robert J. Wood. "Hyperelastic Pressure Sensing with a Liquid-Embedded Elastomer." Journal of Micromechanics and Microengineering, 2010, v. 20 pp. 125029

Rebecca K. Kramer, Carmel Majidi, Robert J. Wood. "Shear-mode Contact Splitting for a Microtextured Elastomer Film." Advanced Materials, 2010, v. 22 pp. 3700

R K Kramer, N Pholchai, V J Sorger, T J Yim, R Oulton, X Zhang. "Positioning of Quantum Dots on Metallic Nanostructures." Journal of Nanotechnology, 2010, v. 21 pp. 145307

Professional Development Activities (Past 5 years)

None

Charles M. Krousgrill
Professor,
School of Mechanical Engineering

Education
BSME, Purdue University, 1975
MS, Applied Mechanics, Caltech, 1976
PhD., Caltech, 1980

Academic Experience
Purdue University, Professor, Mechanical Engineering, 1997 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 1987 – 1997, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1980 – 1987, Full-Time
Caltech, Graduate Research Assistant, 1975 – 1980

Non-Academic Experience
Exxon Production Research, Summer Faculty Researcher, May 1981 – August 1981, Part Time
Kinemetrics, Inc., Pasadena, CA, Engineering Analyst, 1978 – 1979, Part Time
Martin Marietta Aerospace, Denver, CO, Engineering Analyst, June 1974 – August 1974, Full Time
National Aeronautics and Space Administration, Marshall Space Flight Center, Engineering Coop, 1971 – 1974

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Engineering Education, 2010 – Present

Honors and Awards
H.L. Solberg Teaching Award, School of Mechanical Engineering, Purdue University, 1985, 1989, 1993, 1997, 2001, 2007, 2012
A.A. Potter Teaching Award, College of Engineering, Purdue University, 1993, 1997, 2001, 2012
Charles B. Murphy Teaching Award, Purdue University, 1994
Ruth and Joel Spira Teaching Award, School of Mechanical Engineering, Purdue University, 1998
Book of Great Teachers, Purdue University, 1999
Founding Fellow, Teaching Academy, Purdue University, 1999
Helping Students Learn Award, Purdue University, 2009
Special Boilermaker Award, Purdue University, 2010
Archie Higdon Distinguished Educator Award, Mechanics Division, American Society of Engineering Education, 2011

Service Activities
Member, University Grade Appeals Committee, 1993-1995, 2010 – Present
Member, Mechanical Engineering Graduate Committee, 1994-1997, 2001 – 2004
Member, University Faculty Senate, 1995-1997, 2011 – Present
Member, University Faculty Affairs Committee, 1995 – 1997
Director, Engineering Professional Education, 2004 – 2008
Member, Graduate Advisors Committee, College of Engineering, 2007 – 2008

Member, University Graduate Council, 2007 – 2010
Chair, Mechanical Engineering Honors Committee, 2006 – Present
Chair, Mechanics Academic Area, School of Mechanical Engineering, 2007 – Present
Mechanical Engineering Leadership Team (MELT), 2007 – Present
Member, College of Engineering Grade Appeals Committee, 2009 – 2011
Chair, Academic Advisory Committee, Engineering Professional Education, 2004 – 2008
Member, Department head search committee, College of Engineering, 2009 – 2010
Member, Academic Advisory Committee, Engineering Professional Education, 2010 – Present
Member, Teaching Academy Executive Council, 2009 – Present

Principal Publications and Presentations (Most important from past 5 years)

Huang, J., **Krousgrill, C.M.** and Bajaj, A.K., "An Efficient Approach to Estimate Critical Value of Friction Coefficient in Brake Squeal Analysis", Journal of Applied Mechanics, Vol. 74, pp. 534-541, 2007

Kang, J., **Krousgrill, C.M.** and Sadeghi, F. "Wave Pattern Motion and Stick-slip Limit Cycle Oscillation of a Disc Brake" Journal of Sound and Vibration, Vol. 325, pp. 552-564, 2008

Kang, J., **Krousgrill, C.M.** and Sadeghi, F. "Oscillation Pattern of Stick-slip Vibrations" International Journal of Nonlinear Mechanics, *Vol. 44, pp. 820-828*, 2008

Kang, J., **Krousgrill, C.M.** and Sadeghi, F. "Dynamic instability of a thin circular plate with friction interface and its application to disc brake squeal" Journal of Sound and Vibration, Vol. 316, pp. 164-179, 2008

Kang, J., **Krousgrill, C.M.** and Sadeghi, F., "Analytical Formulation of Mode-Coupling Instability in Disc-Pad Coupled System" International Journal of Mechanical Science, Vol. pp. 52-63. 2008

Kang, J., **Krousgrill, C.M.**, and Sadeghi, F. ,"Comprehensive Stability Analysis of Disc Brake Vibrations including Gyroscopic, Negative Friction Slope and Mode-Coupling Mechanisms" Journal of Sound and Vibration, Vol. 324, pp. 387-407, 2008

Conley, W.G., **Krousgrill C.M.** and Raman A, "Stick-slip motions in the friction force microscope: Effects of tip compliance", Tribology Letters, Vol. 29m pp, 23-32, 2008

Harris D.A. and **Krousgrill C.M.**, "Distance education: New technologies and new directions", Proceedings of the IEEE, Vol. 96, pp. 917-930, 2008

Conley, W.G., Raman, A. and **Krousgrill, C.M.**, "Nonlinear and nonplanar dynamics of suspended nanotube and nanowire resonators", Nano Letters, Vol. 8, pp. 1590-1595, 2008

Huang, J., **Krousgrill, C.M.** and Bajaj, A.K., "An efficient approach to estimate critical value of friction coefficient and sensitivity analysis for brake squeal", International Journal of Vehicle Design, Vol. 51, pp. 21-38, 2009

Kang, J. and **Krousgrill, C.M.**, "The onset of friction-induced vibration and spragging", Journal of Sound and Vibration, Vol. 329, pp. 3537-3549, 2010

Professional Development Activities (Past 5 years)

None

Kai Ming Li
Professor, School of Mechanical Engineering

Education
BSME, Queen Mary College, University of London, UK, 1979
Ph.D., ME, University of Cambridge, UK, 1987

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2007 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 2005 – 2007, Full-Time
The Hong Kong Polytechnic University, Professor, Mechanical Engineering, 2005
The Hong Kong Polytechnic University, Associate Professor, Mechanical Engineering, 1998 – 2005
The Open University, UK, Lecturer, Dept. of Engineering Mechanics, 1991 – 1998

Non-Academic Experience
British Rail Engineering Limited, UK, Senior Engineer, 1990 – 1991
Aircraft Research Association, UK, Project Supervisor, 1989 – 1990
The Open University, Postdoctoral Research Fellow, Dept. of Engineering Mechanics, 1986 - 1989

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow: Institution of Mechanical Engineers (UK)
Fellow: Acoustical Society of America

Honors and Awards
None

Service Activities
Chairman, Research Committee of the School of Mechanical Engineering, August, 2009 – May 2012 (three year term)
Member of University Committee on the Censure and Dismissal Procedures
Chairman of two Search Committee for 2 research assistant professors
Associate Editor for Applied Acoustics (an international premiere journal in acoustics)
Associate Editor for the Journal of the Acoustical Society of America
Serve in (a) Committee on Regional Chapters and (b) Membership sub-Committee for the Acoustical Society of America
Organize special sessions for the bi-annual meetings of the Acoustical Society of America, and International – Institute of Noise Control Engineering

Principal Publications and Presentations (Most important from past 5 years)
Refereed Journal Publications
K. M. Li, S. Liu, 2011. “Fast asymptotic solutions for sound field above and below a rigid porous ground,” Journal of the Acoustical Society of America **130**, 1103-1114
A. J. Jessop, **K. M. Li**, and J. S. Bolton, 2011. “Reduction of low frequency noise transmitted through a single-pane window,” ACTA ACUSTICA united with ACUSTICA **97**, 382-390

K M Li and W K Lui, 2010. "The scattering of sound by a long cylinder above an impedance boundary," *Journal of the Acoustical Society of America*, **127**, 664-674

K M Li and C Y C Lai, 2009. "A note on noise propagation in street canyons," *Journal of the Acoustical Society of America*, **126**, 644-655

K M Li and Z Yu, 2009. "A simple formula for predicting resonant frequencies of a rectangular plate with uniformly restrained edges," *Journal of Sound and Vibration*, **327**, 254-268

M K Law and **K M Li** and C W Leung, 2008. "Noise reduction in tunnels by hard rough surfaces," *Journal of the Acoustical Society of America*, **124**, 961-972

K M Li, M K Law, M P Kwok, 2008. "Absorbent parallel noise barriers in urban environments," *Journal of Sound and Vibration*, **315**, 239-257

K M Li, M P Kwok and M K Law, 2008. "A ray model for hard parallel barriers in high-rise cities," *Journal of Acoustical Society of America*, **123**, 121-132

K M Li, 2008. "An analytical formulation for predicting the attenuation of sound in a porous ground from an airborne source," *Journal of the Acoustical Society of America*, **123**, 1352-1363

W K Lui, **K M Li**, W M Leung and G H Frommer, 2007. "An energy approach for modeling the characteristics of wheel/rail rolling noise," *Acta Acustica* **93**, 742-749

Book

K Attenborough, **K M Li** and K V Horoshenkov, 2007. "Predicting outdoor sound" E&FN Spon, (ISBN 0419235108)

Professional Development Activities (Past 5 years)

Attendance of seminars organized by the School for Engineering Education and School of Engineering Professional Education, Purdue University

Teaching experience in distant learning education for a graduate class in Engineering Acoustics

Robert P. Lucht
Ralph and Bettye Bailey Professor of Combustion,
School of Mechanical Engineering

Education
BSNE, Purdue University, 1977
MSME, Purdue University, 1979
Ph.D., ME, Purdue University, 1981

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2002 – Present, Full-Time
Purdue University, Ralph & Bettye Bailey Professor of Combustion, Mechanical Engineering, 2007 – Present
Purdue University, Professor, Mechanical Engineering, 2002 – 2007, Full-Time
Texas A&M University, Professor, Mechanical Engineering, 1998 – 2002, Full-Time
University of Illinois at Urbana/Champaign, Professor, Mechanical Engineering, 1996 – 1998, Full-Time
University of Illinois at Urbana/Champaign, Associate Professor, Mechanical Engineering, 1992 – 1996, Full-Time
Purdue University, Postdoctoral Research Associate, Mechanical Engineering, 1981 – 1983

Non-Academic Experience
Sandia National Laboratories, Livermore, CA, Manager, Diagnostics Research Department, 1991 – 1992, Full-Time
Sandia National Laboratories, Livermore, CA, Supervisor, Reacting Flow Division, 1987 – 1991
Sandia National Laboratories, Livermore, CA, Member of Technical Staff, 1983 – 1987

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow, Optical Society of America
Fellow, American Society of Mechanical Engineers
Associate Fellow, American Institute of Aeronautics and Astronautics
Member, Combustion Institute.

Honors and Awards
Fellow of the American Society of Mechanical Engineers, 2011
American Institute of Aeronautics & Astronautics Aerodynamic Measurement Technology Award, 2008
Ralph and Bettye Bailey Professor of Combustion, Purdue University, 2007
G. Paul Pepper Professor at Texas A&M University, 1999 – 2002
Fellow of the Optical Society of America, 1998
National Science Foundation Graduate Fellowship, 1977 – 1980
Graduated with Highest Distinction, 1977

Service Activities
AIAA Journal, Associate Editor, 1997 – 2012
Reviewer for numerous archival journals
Frequent proposal reviews for NSF, DOE, and AFOSR

Principal Publications and Presentations (Most important from past 5 years)

Refereed Journal Publications

S. Roy, P. J. Kinnius, **R. P. Lucht**, and J. R. Gord, "Temperature Measurements in Reacting Flows By Time-Resolved Femtosecond Coherent Anti-Stokes Raman Scattering (fs-CARS) Spectroscopy," *Optics Communications* **281**, 319-325 (2008)

W. D. Kulatilaka, S. V. Naik, and **R. P. Lucht**, "Development of High-Spectral-Resolution Planar Laser-Induced Fluorescence Imaging Diagnostics for High-Speed Gas Flows," *AIAA Journal (Aerospace Letters)* **46**, 17-20 (2008)

N. Chai, S. V. Naik, N. M. Laurendeau, **R. P. Lucht**, S. Roy, and J. R. Gord, "Single-Laser-Shot Detection of Nitric Oxide in Reacting Flows Using Electronic Resonance-Enhanced Coherent Anti-Stokes Raman Scattering," *Applied Physics Letters* **93**, 091115 (2008)

A. H. Bhuiyan, D. R. Richardson, S. V. Naik, and **R. P. Lucht**, "Development of an Injection-Seeded Optical Parametric Generator/Pulsed Dye Amplifier System for High-Resolution Spectroscopy," *Applied Physics B* **94**, 559-567 (2009)

S. Roy, D. R. Richardson, W. D. Kulatilaka, **R. P. Lucht**, and J. R. Gord, "Gas-Phase Thermometry at 1-kHz Using Femtosecond Coherent Anti-Stokes Raman Scattering (fs-CARS) Spectroscopy," *Optics Letters* **34**, 3857-3859 (2009)

M. P. Thariyan, V. Ananthanarayanan, A. H. Bhuiyan, S. V. Naik, J. P. Gore, and **R. P. Lucht**, "Dual Pump CARS Temperature and Major Species Concentration Measurements in Counter-Flow Methane Flames Using Narrowband Pump and Broadband Stokes Lasers," *Combustion and Flame* **157**, 1390-1399 (2010)

N. Chai, **R. P. Lucht**, W. D. Kulatilaka, S. Roy, and J. R. Gord, "Electronic-Resonance-Enhanced Coherent Anti-Stokes Raman Scattering Spectroscopy of Nitric Oxide: Nonperturbative Time Dependent Modeling and Saturation Effects," *Journal of Chemical Physics* **133**, Article Number 084310 (2010)

D. R. Richardson, **R. P. Lucht**, S. Roy, W. D. Kulatilaka, and J. R. Gord, "Single-Laser-Shot Femtosecond Coherent Anti-Stokes Raman Scattering Thermometry at 1000 Hz in a Driven H_2 Air Flame," *Proceedings of the Combustion Institute* **33**, 839-845 (2011)

M. P. Thariyan, A. H. Bhuiyan, S. E. Meyer, S. V. Naik, J. P. Gore, and **R. P. Lucht**, "Dual-Pump Coherent Anti-Stokes Raman Scattering (DP-CARS) System for Temperature and Species Measurements in an Optically-Accessible High-Pressure Gas Turbine Combustor Facility," *Measurement Science and Technology* **22**, Article Number 015301 (2011)

T. D. Hedman, K. Y. Cho, A. Satija, L. J. Groven, **R. P. Lucht**, and S. F. Son, "Experimental observation of the flame structure of a bimodal ammonium perchlorate composite propellant using 5 kHz PLIF," *Combustion and Flame* **159**, 427-437 (2012)

Professional Development Activities (Past 5 Years)

None

Peter H. Meckl
Professor, School of Mechanical Engineering

Education
BSME, Northwestern University, 1981
MSME, Massachusetts Institute of Technology, 1984
Ph.D., ME, Massachusetts Institute of Technology, 1988

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2008 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 1994 – 2008, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1988 – 1994, Full-Time
University of Karlsruhe (Germany), Institute of Measurement and Control Engineering, 2005

Non-Academic Experience
Dolan-Jenner Industries, Inc., evaluated dynamics of mechanical speed reducer, Summers of 1984, 1985

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Mechanical Engineers
Institute of Electrical and Electronics Engineers
American Society for Engineering Education
SAE International
Tau Beta Pi
Pi Tau Sigma
Sigma Xi

Honors and Awards
DuPont Faculty Assistance Grant ($10,000), 1988
Caterpillar Foundation Young Faculty Development Grant ($5,000), 1989
NEC Faculty Fellow ($50,000), July 1, 1990 - June 30, 1992
Ruth & Joel Spira Award for Excellence in Teaching, 2000
DAAD (German Academic Exchange Service) Visiting Professorship ($26,000), 2005
Best Paper Award in the HUMS (Health and Usage Monitoring System) category at the American Helicopter Society Meeting, May 2009

Service Activities
Engineer of 2020 Committee, 2007 – 2008
Co-Chair, Engineer of 2020 Committee, 2009 – 2011
Co-Chair, Grand Challenge Design Strategic Planning Initiative, 2010 – 2012
Chair, Systems, Measurements, and Controls Area, 2011 – Present
Associate Editor, IEEE Transactions on Control Systems Technology, 2006 – Present
Member, International Program Committee, IASTED International Conference on Control and Applications (CA 2008), Quebec, Canada, May 26-28, 2008
Vice-Chair, Invited Sessions, 2008 Dynamic Systems and Control Conference (DSCC)

Session Organizer and Chair, "Command Shaping for Vibration Suppression," 2008 – 2010 American Control Conferences
Chair, ASME Dynamic Systems and Control Division Conference Editorial Board, 2009 – 2012
Finance Chair, 2013 American Control Conference, Washington, DC, June 2013

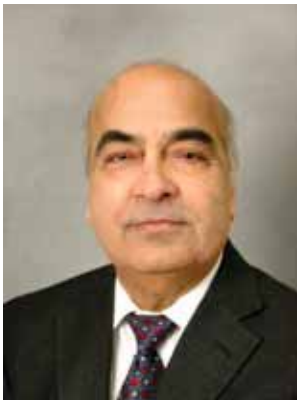
Principal Publications and Presentations (Most important from past 5 years)

Refereed Journal Publications

- Shin, Y.J., and **Meckl, P.H**., "Controller Design Procedure for Two-Mass Systems with Single Flexible Mode," ASME J. of Dynamic Systems, Measurement, and Control, Vol. 130, No. 3, May 2008
- Reynolds, M., and **Meckl, P.H.**, "The Application of Command Shaping to the Tracking Problem," ASME J. of Dynamic Systems, Measurement, and Control, Vol. 130, No. 3, May 2008
- Chatlatanagulchai, W., and **Meckl, P.H.**, "Model-Independent Control of a Flexible-Joint Robot Manipulator," ASME J. of Dynamic Systems, Measurement, and Control, Vol. 131, No. 4, July 2009
- Joshi, A.A., James, S., **Meckl, P**., King, G., and Jennings, K, "Assessment of Charge-Air Cooler Health in Diesel Engines using Nonlinear Time Series Analysis of Intake Manifold Temperature," ASME J. of Dynamic Systems, Measurement, and Control, Vol. 131, No. 4, July 2009
- Joshi, A.A., **Meckl, P.H.**, King, G.B., and Jennings, K., "Data-dimensionality Reduction Using Information-Theoretic Stepwise Feature Selector," ASME J. of Dynamic Systems, Measurement, and Control, Vol. 131, No. 4, July 2009
- Subrahmanya, N., Shin, Y.C., and **Meckl, P.H.**, "A Bayesian machine learning method for sensor selection and fusion with application to on-board fault diagnostics," Mechanical Systems and Signal Processing, Volume 24, Issue 1, Jan. 2010, pp. 182-192
- Yadav, A., Shaver, G., and **Meckl, P.**, "Lessons learned: Implementing the case teaching method in a mechanical engineering course," ASEE J. of Engineering Education, Jan. 2010
- Shin, Y.J., and **Meckl, P.H.**, "Application of Combined Feedforward and Feedback Controller with Shaped Input to Benchmark Problem," ASME J. of Dynamic Systems, Measurement, and Control, Vol. 132, No. 2, March 2010
- Schultz, R., and **Meckl, P.**, "Degradation of Nonmethane Hydrocarbon Oxidation Efficiency of a Catalyzed Diesel Particulate Filter during Aging," SAE International Journal of Engines, Vol. 4, No. 1, June 2011, pp. 1776-1783
- Satkoski, C.A., Shaver, G.M., More, R., **Meckl, P.**, Memering, D., Venkataraman, S., Syed, J., and Carmona-Valdes, J., "Dynamic Modeling of a Piezoelectric Actuated Fuel Injector," ASME Journal of Dynamic Systems, Measurement, and Control, Vol. 133, No. 5, Sept. 2011
- Bhat, C.S., **Meckl, P.H.**, Bolton, J.S., and Abraham, J., "Influence of fuel injection parameters on combustion-induced noise in a small diesel engine," The International Journal of Engine Research, Vol. 13, Issue 2, April 2012, pp. 130-146

Professional Development Activities (Past 5 years)

None



Hukam C. Mongia
Professor of Mechanical Engineering
School of Mechanical Engineering

Education
BS, Aeronautical Engineering, Punjab Engineering College, Chandigarh, India, 1965
MS, Aerospace and Mechanical Engineering, University of Massachusetts, Amherst, 1968
Ph.D., Aerospace and Mechanical Engineering, University of Massachusetts, Amherst, 1971

Academic Experience
Purdue University, Professor, School of Mechanical Engineering, 2009 – Present, Full-Time
University of Massachusetts, Research Assistant Professor, Sept. 1971 – May 1972
Birla Institute of Technology, Ranchi, India, Aug. 1965 – Aug. 1967

Non-Academic Experience
GE Aviation, Cincinnati, OH, Executive Engineering Manager, Jan. 1994 – Jan. 2009
Allison Gas Turbines (now Rolls Royce of North America), Indianapolis, IN, Senior Engineering Manager, Jan. 1984 – Jan. 1984
Garrett Turbine Engines (now Honeywell Aerospace), Phoenix, AZ, positions held – Sr. Engineer, Team Leader, Manager, and Sr Engineering Manager, May 1972 – Jan. 1984

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow, AIAA
Fellow, American Society of Mechanical Engineers

Honors and Awards
AIAA Air Breathing Propulsion Award, 2008
The AIAA Best Terrestrial Energy Systems Paper, 2008
GE Edison Award, 2003
GE Aircraft Engines Perry T. Egbert Jr. Award, 2003
NASA's Turning Goals into Reality Objective Award, 2000
AIAA Propellant and Combustion Award, 1997
ASME/IGTI Combustion and Fuels Committee Best Technical Paper Award, 1993
ASME/IGTI Combustion and Fuels Committee Best Technical Paper Award, 1992
ASME/IGTI Combustion and Fuels Committee Best Technical Paper Award, 1990
125 Alumni to Watch, University of Massachusetts 125th Anniversary Celebration, 1988

Service Activities
Point of Contact for organizing the AIAA Terrestrial Energy Systems sessions, 2010
Chairing of Technical sessions
Reviewer for several journal articles and ASME/IGTI technical papers

Principal Publications and Presentations (Most important from past 5 years)
<u>Book or Refereed Journal Publications</u>
Mongia, Hukam C., "Commercial Propulsion Engines Emissions," Encyclopedia of Aerospace Engineering, Edited by Richard Blockley and Wei Shyy, 2010 John Wiley & Sons, Ltd. ISBN: 978-0-470-75440-5

Dhanuka, Sulabh K., Jacob E. Temme, James F. Driscoll and **Hukam C. Mongia**, "Vortex-shedding and mixing layer effects on periodic flashback in a lean premixed prevaporized gas turbine combustor," Proceedings of the Combustion Institute 32 (2009), pp. 2901–2908

Peer Reviewed Conference Publications

Mongia, Hukam C., 2008, "Recent Progress in Comprehensive Modeling of Gas Turbine Combustion," AIAA Paper 2008-1445--The AIAA Best Terrestrial Energy Systems Paper, 2008

Mongia, Hukam C., 2007, "GE Aviation Low Emissions Combustion Technology Evolution," SAE Paper 2007-01-3924, AeroTech Congress & Exhibition, September 2007, Los Angeles, CA, USA, Session: Emissions

Mongia, Hukam C., "Engineering Aspects of Complex Gas Turbine Combustion Mixers Part I: High ΔT," AIAA Paper 2011-0107, 49th AIAA Aerospace Sciences Meeting, Orlando, Florida, January 4-7, 2011

Mongia, Hukam C., "Engineering Aspects of Complex Gas Turbine Combustion Mixers Part II: High T3," AIAA Paper 2011-0106, ibid

Mongia, Hukam C., "Engineering Aspects of Complex Gas Turbine Combustion Mixers Part III: 30 OPR," AIAA Paper 2011-5525, 9th Annual International Energy Conversion Engineering Conference (IECEC), San Diego, CA, 31 July - 3 August, 2011

Mongia, Hukam C., "Engineering Aspects of Complex Gas Turbine Combustion Mixers Part IV: Swirl cup," AIAA Paper 2011-5526, ibid

Mongia, Hukam C., "Engineering Aspects of Complex Gas Turbine Combustion Mixers Part V: 40 OPR," AIAA Paper 2011-5527, ibid

Mongia, Hukam C., "On Initiating 3rd Generation of Correlations for Gaseous Emissions of Aero-Propulsion Engines," AIAA Paper 2010-1529, 48th AIAA Aerospace Sciences Meeting, Orlando, Florida, January 4-7, 2010

Professional Development Activities (Past 5 years)

None

Issam Mudawar
Professor, School of Mechanical Engineering

Education
BA, American University of Beirut, Lebanon, 1978
MS, Massachusetts Institute of Technology, 1980
Ph.D., Massachusetts Institute of Technology, 1984

Academic Experience
Purdue University, Professor, Mechanical Engineering, 1993 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 1989 – 1993, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1984 – 1989, Full-Time
Purdue University, Director of Boiling and Two-Phase Flow Laboratory (BLTPFL), 1984 – Present
Purdue University, Director of International Electronic Cooling Alliance (PUIECA), 1999 – Present

Non-Academic Experience
None

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow, ASME
Member, ASM International
Senior Member, AIAA
Member, Sigma Xi

Honors and Awards
Certificate of Recognition in testimony of distinguished achievement of research in thermal engineering and service to engineering profession, The Japanese Society of Mechanical Engineers (JSME) and the American Society of Mechanical Engineers (ASME), 2011
Keynote Speaker, "Two-Phase Micro-Channel Heat Sinks: Theory, Applications and Limitations," ASME/JSME 2011 8th Thermal Engineering Joint Conference, Honolulu, Hawaii, March 2011
Certificate of Recognition for 25 years of sustained contributions to the advancement of the arts, sciences and technology of aeronautics and astronautics, American Institute of Aeronautics and Astronautics (AIAA)
Certificate of Recognition for 25 years of Service, American Society of Mechanical Engineer (ASME)
Certificate of Recognition, Department of the Navy, Office of Naval Research, Small Business Innovation Program, June 7, 2010
The most cited article for the years 2005-2008, International Journal of Heat and Mass Transfer, for the paper "Two-Phase Flow in High-Heat-Flux Micro-Channel Heat Sink for Refrigeration Cooling Applications: Part I – Pressure Drop Characteristics," by J. Lee and I. Mudawar, Vol. 48, pp. 928-940, 2005. Source: SCOPUS, Oct. 1, 2009
The second most cited article for the years 2005-2008, International Journal of Heat and Mass Transfer, for the paper "Two-Phase Flow in High-Heat-Flux Micro-Channel Heat Sink for Refrigeration Cooling Applications: Part I – Heat Transfer Characteristics," by J. Lee and I. Mudawar, Vol. 48, pp. 941-955, 2005. Source: SCOPUS, Oct. 1, 2009

Rolls-Royce Milestone Award for design of air-to-fuel heat exchanger for high Mach aircraft turbine engines, LibertyWorks, North American Technologies operations of Rolls-Royce, February 2009

Best Paper Award in Thermal Management, for the paper "Single-Phase and Two-Phase Hybrid Cooling Schemes for High-Heat-Flux Thermal Management of Defense Electronics," by M. Sung and I. Mudawar, Orlando, 11th Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems (ITherm 2008), FL, May 28-31, 2008

Top 1% citation in research field, for the paper "Experimental and Numerical Study of Pressure Drop and Heat Transfer in a Single-Phase Micro-Channel Heat Sink," by W. Qu and I. Mudawar, International Journal of Heat and Mass Transfer, Vol. 46, pp. 2737-2753, 2003. Compiled by Essential Science Indicators, Thomson Publishing, 2005

Top 1% citation in research field, for the paper "Flow Boiling Heat Transfer in Two-Phase Micro-Channel Heat Sinks – I. Experimental Investigation and Assessment of Correlation Methods," by W. Qu and I. Mudawar, International Journal of Heat and Mass Transfer, Vol. 46, pp. 2755-2771, 2003. Compiled by Essential Science Indicators, Thomson Publishing, 2005

The Solberg Award for Best Teacher in the School of Mechanical Engineering, 2003-2004

The Ruth and Joel Spira Award for "outstanding contributions to the School of Mechanical Engineering and its students," 1999

Inaugural member of the Purdue University Book of Great Teachers for lasting tribute to those 200 teachers "who have defined Purdue teaching excellence since the institution's birth," 1999

Founding Fellow of The Purdue University Teaching Academy, 1997

Service Activities

None

Principal Publications and Presentations (Most important from past 5 years)

Kim, S.M., Kim, J. and **Mudawar, I.**, 2012, "Flow Condensation in Parallel Micro-Channels – Part 1: Experimental Results and Assessment of Pressure Drop Correlations," ***International Journal of Heat and Mass Transfer***, Vol. 55, pp. 971-983

Kim, S.M. and **Mudawar, I.**, 2012, "Flow Condensation in Parallel Micro-Channels – Part 2: Heat transfer Results and Correlation Technique," ***International Journal of Heat and Mass Transfer***, Vol. 55, pp. 984-994

Visaria, M. and **Mudawar, I.**, 2012, "Coiled-Tube Heat Exchanger for High-Pressure Metal Hydride Hydrogen Storage Systems– Part 1. Experimental Study," ***International Journal of Heat and Mass Transfer***, Vol. 55, pp. 1782-1795

Visaria, M. and **Mudawar, I.**, 2012, "Coiled-Tube Heat Exchanger for High-Pressure Metal Hydride Hydrogen Storage Systems– Part 2. Computational Model," ***International Journal of Heat and Mass Transfer***, Vol. 55, pp. 1796-1806

Visaria, M. and **Mudawar, I.**, 2012, "Experimental Investigation and Theoretical Modeling of Dehydriding Process in High-Pressure Metal Hydride Hydrogen Storage Systems," ***International Journal of Hydrogen Energy***, Vol. 37, pp. 5735-5749

Mascarenhas, N. and **Mudawar, I.**, 2012, "Methodology for Predicting Spray Quenching of Thick-Walled Metal Alloy Tubes," ***International Journal of Heat and Mass Transfer***, Vol. 55, pp. 2953-2964

Kim, S.M. and **Mudawar, I**., 2012, "Universal Approach to Predicting Two-Phase Frictional Pressure Drop for Adiabatic and Condensing Mini/Micro-Channel Flows," ***International Journal of Heat and Mass Transfer***, Vol. 55, pp. 3246-3261

Kim, S.M. and **Mudawar, I.**, 2012, "Consolidated Method to Predicting Pressure Drop and Heat Transfer Coefficient for both Subcooled and Saturated Flow Boiling in Micro-Channel Heat Sinks," ***International Journal of Heat and Mass Transfer***, Vol. 55, pp. 3720-3731

Kharangate, C.R. and **Mudawar, I.** and Hasan, M.H., 2012, "Photographic Study and Modeling of Critical Heat Flux in Horizontal Flow Boiling with Inlet Vapor Void," ***International Journal of Heat and Mass Transfer***, Vol. 55, pp. 4154-4168

Northcutt, B. and **Mudawar, I.**, 2012, "Enhanced Design of Cross-Flow Micro-Channel Heat Exchanger for High-Performance Aircraft Gas Turbine Engines," ***ASME Journal of Heat Transfer***, Vol. 134, 061801-1

Professional Development Activities (Past 5 years)

None

Eric A. Nauman
Assistant Professor, School of Mechanical Engineering

Education
BSME, University of Delaware, 1995
MSME, University of California, Berkeley, 1998
Ph.D., ME, University of California, Berkeley, 2000

Academic Experience
Purdue University, Associate Professor, Mechanical Engineering, Biomedical Engineering and Basic Medical Sciences, 2007 – Present, Full-Time
Purdue University, Assistant Professor, Basic Medical Sciences, 2005 – 2007
Purdue University, Assistant Professor, Mechanical Engineering and Biomedical Engineering, 2004 – 2007, Full-Time
Tulane University, New Orleans, LA, Assistant Professor, Biomedical Engineering, 2000 – 2004
Tulane University, New Orleans, LA, Adjunct Assistant Professor of Orthopaedic Surgery, 2001 – 2004

Non-Academic Experience
Co-Founder of IFoundation, a non-profit that provides specialized assistive technologies, 2012 – Present
BioRegeneration Technologies, West Lafayette, IN, Director of New Technologies, 2009 – Present
NASA Ames Research Center, Moffett Field, CA, NASA Consultant, 1998 – 2000

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Member, American Society of Mechanical Engineers
Member, Biomedical Engineering Society
Member, American Society of Bone and Mineral Research
Member, American Society for Engineering Education
Member, Tau Beta Pi National Engineering Honor Society
Member, Pi Tau Sigma Mechanical Engineering Honor Society
Member, National Society of Black Engineers
Member, National Neurotrauma Society
Member, Association for Research in Vision and Ophthalmology

Honors and Awards
Purdue College of Engineering Early Career Research Award of Excellence, 2010
Purdue University Faculty Scholar, 2010
B.F.S. Schaefer Outstanding Young Faculty Scholar, School of Mechanical Engineering, Purdue University, 2010
Biomedical Engineering "Teacher of the Year" Award – Tulane University, 2002, 2004
Outstanding Graduate Student Instructor Award–University of California, Berkeley, 1996
National Defense Science and Engineering Graduate Fellowship, 1995

Taylor Award (Outstanding Male Graduating Student) – University of Delaware, 1995
Barry M. Goldwater Scholarship, 1992

Service Activities
Advisor to Biomedical Engineering Society Student Club (Spring 2004 – 2007)
Advisor for EPICS – St. Vincent Advancement Team (Fall 2005 – Present)
Biomedical Sciences Doctoral Track (BSDT) Advisory Committee (Spring 2006 – 2010)

Principal Publications and Presentations (Most important from past 5 years)
Refereed Journal Publications

Galle, B. , Ouyang, H., Shi, R., and **Nauman, E.** *Correlations Between Tissue Level Stress and Cellular Damage within the Guinea Pig Spinal Cord White Matter*. J Biomech. Vol. 40, No. 13, 3039-3043, 2007

Feng, B., Li, B.Y., **Nauman, E.A**., and Schild, J.H. *Theoretical and Electrophysiological Evidence for Axial Loading about Aortic Baroreceptor Nerve Terminals in Rats*. Am J Physiol Heart Circ Physiol. Vol. 293, No. 6, H3659-H3672, 2007

Dickerson, D.A., Sander, E.A., and **Nauman, E.A.** *Modeling the Mechanical Consequences of Vibratory Loading in the Vertebral Body: Microscale Effects*. Biomechanics and Modeling in Mechanobiology. Vol. 7, No. 3, 191-202, 2007

Ouyang, H., Galle, B., Li, J., **Nauman, E**., and Shi, R. *Biomechanics of Spinal Cord Injury: A Multimodal Investigation Using Ex Vivo Guinea Pig Spinal Cord White Matter*. Journal of Neurotrauma. Vol. 25, No. 1, 19-29, 2008

Cook, D.D., **Nauman, E.,** and Mongeau, L. *Reducing the Number of Vocal Fold Mechanical Properties: Evaluating the Incompressibility and Planar Displacement Assumptions*. Journal of the Acoustical Society of America. Vol. 124, No. 6, 3888-3896, 2008

Ouyang, H., Galle, B., **Nauman, E.A.,** Shi, R. *Critical Roles of Decompression in Functional Recovery of Ex Vivo Spinal Cord White Matter.* Journal of Neurosurgery: Spine. Vol. 10, No. 2, 161-170, 2009

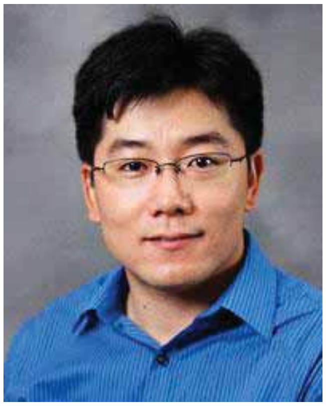
Talavage, T.M., **Nauman, E.A.,** Breedlove, E.L., Yoruk, U., Dye, A.E., Morigaki, K., Feuer, H., Leverenz, L.J. *Functionally-detected cognitive impairment in high school football players without clinically-diagnosed concussion*. Journal of Neurotrauma. In Press

Breedlove, E.L., Robinson, M., Talavage, T.M., Morigaki, K.E., Yoruk, U., O'Keefe, K., King, J., Leverenz, L.J., Gilger, J.W., **Nauman, E.A**. *Biomechanical Correlates of Symptomatic and Asymptomatic Neurophysiological Impairment in High School Football.* Journal of Biomechanics (in press; Accepted 30 January 2012)

Schaffer, J.E., **Nauman, E.A.,** and Stanciu, L.A. *Cold-Drawn Bioabsorbable Ferrous and Ferrous Composite Wires: An Evaluation of Mechanical Strength and Fatigue Durability.* Metallurgical and Materials Transactions B (in press)

Schuff, M.M., Gore, J.,P., and **Nauman, E.A.** *A Mixture Theory Model of Fluid and Solute Transport in the Microvasculature of Normal and Malignant Tissues, I, Theory.* .Journal of Mathematical Biology, In Press

Professional Development Activities (Past 5 years)
Frontiers of Engineering Education, 2011
Purdue IMPACT Program, 2011 – 2012



Liang Pan
Assistant Professor,
School of Mechanical Engineering

Education
BE, ME. University of Science and Technology of China, 2001
MS, ME, University of Science and Technology of China, 2004
ME, ME, University of California at Berkeley, 2009
PhD, ME University of California at Berkeley, 2010

Academic Experience
Purdue University, Assistant Professor, Mechanical Engineering, 2012 – Present, Full-Time
Postdoc, Mechanical Engineering, University of California at Berkeley, 2010 – 2012

Non-Academic Experience
None

Certifications or Professional Registrations
Institute Fellow, the 2009 Summer Institute for Preparing Future Faculty, UC Berkeley

Current Membership in Professional Organizations
Materials Research Society (MRS)

Honors and Awards
None

Service Activities
Graduate Review Committee, School of Mechanical Engineering, Purdue University, 2012 – 2013
Mentor for Undergraduate Students, the NSF Educational Outreach Program, 2008 – 2011

Principal Publications and Presentations (Most important from past 5 years)

Selected Publications:

1. **Pan L**, Park Y, Xiong Y, Ulin-Avila E, Wang Y, Zeng L, Xiong S, Rho J, Sun C, Bogy D, Zhang X, "Maskless Plasmonic Lithography at 22 nm Resolution", *Scientific Reports*, 1, 175, 2011
2. **Pan L**, Bogy D, "Heat-assisted magnetic recording", *Nature Photonics*, 3(4), 7186, 2009
3. Srituravanich W, Pan L (*Equal Contribution*), Wang Y, Sun Y, Bogy D, Zhang X, "Flying plasmonic lens in the near field for high-speed nanolithography", *Nature Nanotechnology*, 3(12), 733, 2008
4. **Pan L**, Park Y, Xiong Y, Ulin-Avila E, Zeng L, Sun C, Bogy D, Zhang X, "High-throughput maskless nanolithography using flying plasmonic lens", Proc. of SPIE Vol. 7637, 763713-1
5. **Pan L**, Park Y, Ulin-Avila E, Xiong Y, Zeng L, Sun C, Bogy D, Zhang X, "Parallel high-speed plasmonic nano-lithography", ICALEO Conf. Proc. 2010. (*invited*)
6. Samad M, Xiong S, **Pan L**, Yang H, Sinha S, Bogy D, Bhatia C, "A Novel Approach of Carbon Embedding in Magnetic Media for Future Head/Disk Interface", IEEE Transaction On Magnetics, 48(5), 1807, 2012

Invited Talks & Seminars:

1. **Pan L**, "Heat Assisted Scalable Plasmonic Nanomanufacturing", Nanomanufacturing Summit, Sept 2012, Boston, MA

2. **Pan L**, et al., Paper presented at the 28th& 29th International Congress on Applications of Lasers and Electro-Optics (ICALEO 2009-2010)
3. **Pan L**, Seminars at Seagate Technology, 2010, MN;
4. Bogy B, Pan L, "Plasmonic Lithography for Nano-manufacturing", Nanomanufacturing Summit, May 2009, Boston, MA
5. **Pan L**, et al., Seminar at Hitachi Global Storage Technologies (HGST), 2009, CA

Professional Development Activities (Past 5 years)

The Summer Institute for Preparing Future Faculty, UC Berkeley, 2009
New graduate faculty mentoring workshop by the Purdue Graduate School, 2012
Felder teaching workshop: effective college teaching, 2012
College of Engineering Diversity Workshop, 2012
FAST workshop for Faculty Professional Development by Purdue Provost Office, 2012-2013

Jitesh H. Panchal
Assistant Professor,
School of Mechanical Engineering

Education
BTech. Indian Institute of Technology, 2000
MSME, Georgia Tech, 2003
Ph.D., Georgia Tech, 2005

Academic Experience
Purdue University, Assistant Professor, Mechanical Engineering, 2012 – Present, Full-Time
Washington State University, Assistant Professor, 2008 – 2012
Georgia Tech, Visiting Assistant Professor, 2006 – 2008

Non-Academic Experience
Collaborative Product Development Associates (CPDA), Research Analyst, May 2004 – Aug 2004
Interra Information Technologies, Noida, India, Software Engineer, July 2000 – June 2001

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Mechanical Engineers (ASME), 2003 – Present
American Society of Engineering Education, 2010 – Present

Honors and Awards
NSF CAREER Award, April 2010 – March 2015
Reid Miller Outstanding Teaching Faculty Award, Washington State University, 2012
Teaching Excellence Award, School of Mechanical and Materials Engineering, Washington State University two consecutive years, 2011 and 2012
Young Engineer Award, ASME Computers and Information in Engineering Division, 2010
Robert E. Fulton EIM Best Paper Award at the ASME CIE conference, 2004
NSF/ASME Essay Competition Winner at ASME DETC conference, 2004
Woodruff School Doctoral Teaching Fellowship, 2005, Georgia Institute of Technology
University Silver Medal, Indian Institute of Technology, 2000

Service Activities
Chair, ASME CIE Computer Aided Product and Process Design Technical Committee, 2012 – 2013
Conference Co-Chair, ASME 10th International Conference on Design Education (DEC), 2012 – 2013
Co-chair, ASME CIE Computer Aided Product & Process Design Technical Committee, 2011 – 2012
Member of the graduate studies committee, undergraduate studies committee and the laboratory and computing committee, Mechanical and Materials Engineering, Washington State University, August 2008 – Present
Member, Program Committee, Woodruff School Savannah. Developed a web-based tool for ABET 2008 assessment

Principal Publications and Presentations (Most important from past 5 years)

McDowell, D. L., **Panchal, J. H**., Choi, H.-J., Seepersad, C. C., Allen, J. K., and Mistree, F., 2009, *Integrated Design of Multiscale, Multifunctional Materials and Products*, Elsevier. ISBN: 9781856176620

Mistree, F., **Panchal, J.H**., and Schaefer, D., 2012, "Mass-Customization: From Personalized Products to Personalized Engineering Education," *Supply Chain Management*, InTech Publishing, pp. 149-173. ISBN: 978-953-51-0367-7

Panchal, J. H., Kalidindi, S. R., McDowell, D. L., 2013, "Key Computational Modeling Issues in Integrated Computational Materials Engineering," *Journal of Computer Aided Design*, Vol. 45, No. 1, pp. 4-25

Le, Q. and **Panchal, J. H.**, 2012, "Analysis of the Interdependent Co-evolution of Product Structures and Community Structures Using Dependency Modeling Techniques," *Journal of Engineering Design (special issue on Dependency Modeling in Complex System Design)*, Vol. 23, Nos. 10-11, pp. 804-825

Panchal, J.H., Olusola, A., Malak, R., 2012, "Designing Undergraduate Design Experiences – A Framework based on the Expectancy-Value Theory," *International Journal of Engineering Education*, Vol. 28, No. 4, pp. 871-879

Schaefer, D., **Panchal, J. H.**, Thames, J. L., Haroon, S., Mistree, F., 2012, "Innovative Design Education in a Global Distance Learning Setting," *International Journal of Engineering Education*, Vol. 28, No. 2, pp. 381-396

Sinha, A., Bera, N., Allen, J. K., **Panchal, J. H.**, Mistree, F., 2012, "Uncertainty Management in the Design of Multiscale Systems," *Journal of Mechanical Design*, in press

Le, Q. and **Panchal, J. H**., 2012, "Building Smaller-Sized Surrogate Models of Complex Bipartite Networks based on Degree Distributions," *IEEE Transactions on Systems, Man, and Cybernetics – Part A: Systems and Humans*, Vol. 42, No. 5, pp. 1152 - 1166. DOI: 10.1109/TSMCA.2012.2183589

Panchal, J. H., Messer, 2011, "Extracting the Structure of Design Information from Collaborative Tagging," *Journal of Computing and Information Science in Engineering*, Vol. 11, No. 4, 041007(1-11)

Huang, H-Y, Le, Q., and **Panchal, J. H.**, 2011, "Analysis of the Structure and Evolution of an Open Source Community," *Journal of Computing and Information Science in Engineering*, Vol. 11, No. 3, 031008 (1-14)

Messer, M., **Panchal, J. H**., Allen, J. K., Mistree, F., 2011, "Model Refinement Decisions Using the Process Performance Indicator," *Engineering Optimization*, Vol. 43, No. 7, pp. 741-762

Le, Q. and **Panchal, J. H**., 2011, "Modeling the Effect of Product Architecture on Mass-Collaborative Processes," *Journal of Computing and Information Science in Engineering*, Vol. 11, No. 1, (011003)1-12

Professional Development Activities (Past 5 years)

None

Gordon R. Pennock
Associate Professor, School of Mechanical Engineering

Education
B.Sc.(Hons), Heriot-Watt University, Edinburgh, Scotland, 1971
M.Eng. Sc., University of New South Wales, Sydney, Australia, 1978
Ph.D., ME, University of California, Davis, 1983

Academic Experience
Purdue University, Associate Professor, Mechanical Engineering, 1989 – Present, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1983 – 1989, Full-Time
University of California, Davis, Teaching Associate, Mechanical Engineering, 1978 – 1982
University of South Wales, Australia, Lecturer, Applied and Theoretical Mechanics, 1974 – 1978

Non-Academic Experience
Balgowlah Boy's High School, Sydney, Australia, Teacher, 1972 – 1974
British Royal Navy, Northern Ireland, Airframe and Engine Apprenticeship, 1964 – 1969

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow: Institute of Mechanical Engineers, United Kingdom. Fellow: American Society of Mechanical Engineers. Fellow: Society of Automotive Engineers. Senior Member: The Institute of Electrical and Electronics Engineers. Senior Member: Robotics International, Society of Manufacturing Engineers. Member: International Association of Science and Technology for Development; American Association for the Advancement of Science; American Society for Engineering Education; Pi Tau Sigma, and Sigma Xi, The National Scientific Research Honorary Society

Honors & Awards
ASME Faculty Advisor of the Year Award, Region VI, 1998
The Central Indiana Section of ASME established the Gordon R. Pennock Outstanding ASME Student Member Award, 1999
ASME Outstanding Student Section Advisor, Region VI, 2001
ASME Dedicated Service Award, 2002
The Ruth and Joel Spira Award for Excellence in Teaching, School of Mechanical Engineering, Purdue University, 2003
A.T. Yang Memorial Award, ASME Mechanism and Robotics Conference, 2005
Chairman, Mechanisms and Robotics Committee, American Society of Mechanical Engineers, 2008

Service Activities
Member, Board of Directors, Center for Education, American Society of Mechanical Engineers. 2007 – 2010
Member, International Federation of the Theory of Machines and Mechanisms, IFToMM Permanent Commission (A) for Standardization of Terminology, 2007 - 2014

Member, International Program Committee, ASME/IFToMM International Conference on Reconfigurable Mechanisms and Robots, King's College, London, England, June 22 - 24, 2009
Member, International Program Committee, The Fourteenth International Conference on Advanced Robotics, Munich, Germany, June 24 - 26, 2009
Member, International Program Committee, The Fifteenth IASTED International Conference on Robotics, Telematics and Applications, Beijing, China, October 12 - 14, 2009
Member, International Program Committee, The Seventeenth IASTED International Conference on Robotics and Applications, Cambridge, MA, USA. November 2 - 4, 2009
Member, International Program Committee, The Eighteenth IASTED International Conference on Robotics and Applications, Cambridge, MA, USA, November 1 - 3, 2010
Member, International Program Committee, The First IASTED International Conference on Robotics, Phuket, Thailand, November 24 - 26, 2010
Member, The International Reviewers Group of the Journal of Mechanical Engineering, Strojniški vestnik - Journal of Mechanical Engineering, University of Ljubljana, 2010-2014
Member, International Program Committee, The Nineteenth IASTED International Conference on Robotics and Applications, Vancouver, BC, Canada, June 1 - 3, 2011
Member, International Program Committee, The Second IASTED International Conference on Robotics, Pittsburgh, PA, USA, November 7 - 9, 2011
Member, International Program Committee, The Second ASME/IEEE International Conference on Reconfigurable Mechanisms and Robots, Tianjin University, Tianjin, China, June 9 - 11, 2012

Principal Publications and Presentations (Most important from past 5 Years)

Refereed Journal Publications

Pennock, G.R., "Curvature Theory for a Two-Degree-of-Freedom Planar Linkage," *Mechanism and Machine Theory*, Vol. 43, No. 5, May 2008, pp. 525-548
Hung, C.C., Yan, H.S., and **Pennock, G.R.**, "A Procedure to Count the Number of Planar Mechanisms Subject to Design Constraints from Kinematic Chains," *Mechanism and Machine Theory*, Vol. 43, No. 6, June 2008, pp. 676-694
Pennock, G.R., and Israr, A., "Kinematic Analysis and Synthesis of an Adjustable Six-Bar Linkage," *Mechanism and Machine Theory*, Vol. 44, No. 2, February 2009, pp. 306-323
Zanni, G., and **Pennock, G.R.**, "A Unified Graphical Approach to the Static Analysis of Axially Loaded Structures," *Mechanism and Machine Theory*, Vol. 44, No. 12, December 2009, pp. 2187-2203
Foster, D.E., and **Pennock, G.R.**, "A Study of the Instantaneous Centers of Velocity for Two-Degree-of-Freedom Planar Linkages," *Mechanism and Machine Theory*, Vol. 45, No. 4, April 2010, pp. 641-657
Rodriguez-Leal, E., Dai, J.S., and **Pennock, G.R.**, "Kinematic Analysis of a 5-RSP Parallel Mechanism with Centralized Motion," *Meccanica*, Springer Science+Business Media, Vol. 46, No. February 2011, pp. 221-237
Foster, D.E., and **Pennock, G.R.**, "A Study of the Instantaneous Centers of Velocity for the 3-dof Planar Six-Bar Linkage," *Mechanism and Machine Theory*, Vol. 46, No. 9, September 2011, pp. 1276-1300
Rodriguez-Leal, E. Dai, J.S., and **Pennock, G.R.**, "On the Mobility of 3-DOF Parallel Manipulators via Screw Theory," *Robotics: State of the Art and Future Trends*, pp. 59-93. Editors: G. Legnani and I. Fassi, Nova Science Publishers, Inc., January 2012

Professional Development Activities (Past 5 Years)

Chairman, Frank von Flue Award Committee, American Society of Mechanical Engineers, 2005-2007
Chairman, Student Section Advisor Development Task Force, American Society of Mechanical Engineers, 2007 – 2010
Symposium Chairman, ASME/IFToMM International Conference on Reconfigurable Mechanisms and Robots, King's College, London, England, 2009

Arvind Raman
Professor, School of Mechanical Engineering

Education
BS, Technology, Indian Institute of Technology, 1991
MSME, Purdue University, 1993
PhD., ME, University of California, Berkeley, 1999

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2009 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 2005 – 2009, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 2000 – 2005, Full-Time
University of Oxford, UK, Visiting Professor, Department of Physics, Jan. 2010 – June 2010
Universidad Autonoma de Madrid, Spain, Visiting Professor, Department of Condensed Matter Physics, May 2005 – July 2005

Non-Academic Experience
Technical University-Darmstadt, Germany, Visiting Researcher, June 1999 – Dec. 1999
University of California, Berkeley, Graduate Research Assistant, Jan. 1994 – Dec. 1999

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
ASME (Design engineering and Applied Mechanics Divisions)

Honors and Awards
Fellow, American Society of Mechanical Engineers (ASME), 2012
ASME Gustus Larson Memorial Award, 2011
Keeley Fellow, Wadham College, University of Oxford, UK, 2010
University Faculty Scholar, 2008 – 2012
B. F. S Schaefer Faculty Fellow, 2006 – 08
College of Engineering Young Researcher Excellence Award, 2005
Discovery in Mechanical Engineering Award, Purdue University, 2003
National Science Foundation Early Career Development (CAREER) Award, 2002 – 2007
Purdue Teaching for Tomorrow Award, 2002

Service Activities
Associate Editor, ASME Journal of Applied Mechanics, 2006 – 2012
Associate Editor, Journal of Fluids and Structures, 2006 – 2009
Co-Founder, past Chair of the ASME Technical Committee on Micro- and Nanosystems, Member, ASME Technical Committee on Sound and Vibration, 2003-2009
Guest Editor, ASME Journal of Dynamic Systems Measurement and Control, for special issue on dynamic modeling, measurement and control in nanoscale systems, 2008

Reviewed papers for: Journal of Sound and Vibration, Nonlinear Dynamics, Journal of the Acoustical Society of America, Journal of Fluids and Structures, International Journal of Non-linear Mechanics, Journal of Vibration and Control, ASME Journal of Applied Mechanics, ASME Journal of Vibration and Acoustics, ASME Journal of Dynamic Systems, Measurement and Control, Zeitschrift für Angewandte Mathematik und Physik (ZAMP), Journal of Physical Chemistry, Proceedings of the Royal Society of London, Ultramicroscopy, Nature, Applied Physics Letters, Physical Review Letters, Physical Review B, Proc. Natl. Acad. Sci.

Principle Publications and Presentations (Most important from past 5 years)

J. Gomez-Herrero, D. Martinez-Martin, C. Carrasco, M. Hernando-Perez, P. J. de Pablo, R. Perez, M. Garcia-Mateu, J. L. Carrascosa, D. Kiracofe, J. Melcher, **A. Raman**, "Resolving structure and mechanical properties at the nanoscale of Viruses with frequency modulation atomic force microscopy", *PLoS One*, **7**(1), e30204, 2011

D. Kiracofe, J. Melcher, **A. Raman**, "Gaining insight into the physics of dynamic atomic force microscopy in complex environments using the VEDA simulator", *Review of Scientific Instruments*, **83**(1), 013702, 2012

D. Kiracofe and **A. Raman**, "Quantitative force and dissipation measurements in liquids using piezo excited atomic force microscopy: a unifying approach", *Nanotechnology*, **22**, 485502, 2011 (Chosen as Editor's pick, and online interview and tutorial shown on Nanotechnology website)

A. Raman, S. Trigueros, A. Cartagena, A. Stevenson, M. Susilo, E. Nauman, S. Contera, "Mapping the nanomechanical properties of live cells using multi-harmonic atomic force microscopy", *Nature Nanotechnology*, 2011

J-L. Lozano, D. Kiracofe, J. Melcher, R. Garcia, **A. Raman**, "Calibration of higher-eigenmode spring constants of atomic force microscope cantilevers", *Nanotechnology*, **21**(46), 465502, 2010

J-W Lee, A. Mahopatro, D. Peroulis, **A. Raman**, "Vibration based monitoring and diagnosis of dielectric charging in RF-MEMS switches", *IEEE-ASME Journal of Micro-electromechanical Systems*, **19**(6), 1490, 2010

J. Melcher, C. Carrasco, X. Xu, J. L. Carrascosa, J. Gomez-Herrero, P. J. de Pablo, **A. Raman**, "Origins of phase contrast in the atomic force microscope in liquids", *Proceedings of the National Academy of Sciences of the USA*, (Direct submission), **106**(33), 13655-13660, 2009

Bidkar, R., Kimber, M., Garimella, S., Bajaj, A. K., **Raman, A.**, "Nonlinear aerodynamic damping of sharp-edged flexible beams oscillating at low Keulegan-Carpenter numbers", **634**, 269-289, *Journal of Fluid Mechanics,* 2009

J. Melcher, S. Hu, **A. Raman**, "VEDA: a web-based virtual environment for dynamic atomic force microscopy", featured cover article, *Review of Scientific Instruments,* **79**, 061301, 2008

Strus, M. C., Zalamea, L, **Raman, A.**, Pipes, R. B., Stach, E. A., "Peeling force spectroscopy: exposing the adhesive nanomechanics of one dimensional nanostructures", *Nano Letters,* **8**(2), 544, 2008

Professional Development Activities (Past 5 years)

None

Karthik Ramani
Professor, School of Mechanical Engineering

Education
BS, Technology in ME, Indian Institute of Technology, 1985
MSME, Ohio State University, 1986
Ph.D., ME (Design Division), Stanford University, 1991

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2001 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 1997 – 2001, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1991 – 1997, Full-Time
Stanford University, Visiting Professor, Computer Science, Jan. 2008 – June 2008

Non-Academic Experience
PARC (Formerly Xerox PARC), Visiting Scientist, Intelligent Systems Group, Jan. 2008 – June 2008
UCLA, Fellow, Institute of Pure and Applied Mathematics, Aug. 2007 – Dec. 2007
National Science Foundation, Industrial Innovation & Partnerships, Advisory Board, Aug. 2007 – Pres.
Imaginestics (Chief Scientist: 05 – 08), Technical Advisor, Aug. 2005 – Present

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
ASME, Society for Manufacturing Engineers, Association of Computing Machinery

Honors and Awards
Best Paper Award, ASME International Design Engineering Technical Conference, Computers and Information in Eng, All Conference Best Paper Award, 2012
Best Paper Award, ASME International Design Engineering Technical Conference, Computers and Information in Eng./Systems Engineering, 2011
Donald W. Feddersen Professor of Mechanical Engineering, 2011
Fellow of the American Society of Mechanical Engineers, 2010
Best Student Paper Award, Computer-Aided Design and Applications, 2010
Outstanding Commercialization Award for Purdue University Faculty, 2009 – 2010
Best Paper Award, ASME International Design Engineering Technical Conference, Computers and Information in Eng./CAPPD, 2009
Most Highly Cited Paper in the Journal of Computer-Aided Design, 2007
Thomas French Award, Ohio State University, 2007
Purdue University, College of Engineering's Research Excellence Award, 2007

Service Activities
Design-Innovation Development, School of Mechanical Engineering, 2009 – Present
Dean's Strategic Plan Execution Team on "Creativity/Innovation Development", 2009
Search Committee Chair, Design Search, School of Mechanical Engineering, 2009 – Present
Search Committee Chair, Cyber and Information Systems, 2006 – 2007
Manufacturing Area Chair, Mechanical Engineering, 2004 – Present
Manufacturing Program Committee, 2004 – Present
Search Committee, Information, Communications and Perception Technologies (ICPT), 2003 – Pres.

Materials and Manufacturing Processes Committee, School of Mechanical Engineering, 1993 – Present

Principal Publications and Presentations (Most important from past 5 years)

Refereed Journal Publications

Walthall, C.J.. Devanathan, S., Kisselburgh, L.G., **Ramani, K.**, Hirleman, E.D., and Yang, M.C., "Evaluating Wikis as a Communicative Medium for Collaboration Within Colocated and Distributed Engineering Design Teams," *J. Mech. Des.* 113,071,0011 (2011), DOI: 10.1115/1.400411

Benjamin, W., Wood Polk, A., Vishwanathan, S.V.N., **Ramani, K.**, "HeatWalk: Robust Salient Segmentation of Non-rigid Shapes," *Computer Graphics Forum,* Vol. 30 (7), 2011

Fang, Y., Benjamin, W., Sun, M., and **Ramani, K.**, "Global Geometric Affinity for Revealing High Fidelity Protein Interaction Network," *PLoS ONE* 6 (5): e19349, doi:10.1371/journal.pone.001934

Devanathan, S., and **Ramani, K.**, "Creating Polytope Representations of Design Spaces for Visual Exploration Using Consistency Techniques," *J. Mech. Des.* 132 (8), 2010

Liu, Y., Fang, Y., and **Ramani, K.**, "IDSS: Deformation Invariant Shape Signatures of Flexible Proteins," *BMC Bioinformatics* 10:157, 2009

Fang, Y., Liu, Y., and **Ramani, K.**, "Three-dimensional Shape Comparison of Flexible Proteins Using the Local-diameter Descriptor," *BMC Structural Biology,* 9:29, 2009

Liu, M., Liu, Y., and **Ramani, K.**, "Computing the Global Visibility Maps for Surfaces on Polyhedra Using Minkowski Sums," *Computer-Aided Design*, Vol. 41 (2009) pp. 668-680

Liu, Y., Fang, Y., and **Ramani, K.**, "Using Least Median of Squares for Structural Superposition of Flexible Proteins," *BMC Bioinformatics*, 10:29, 2009

Liu, Y., and **Ramani, K.**, "Robust Principal Axes Determination for Point-based Shapes Using Least Median of Squares," *Computer-Aided Design*, 41(4) 2009 pp. 293-305

Choi, J.K., Nies, L.F., and **Ramani, K.**, "A Framework for the Integration of Environmental and Business Aspects Toward Sustainable Product Development," *Journal of Engineering Design*, 19(5) 2008 pp. 431-446

Professional Development Activities (Past 5 years)

International Editorial Advisory: Computer-Aided Design and Applications, 2010 – Present
International Editorial Board, Journal of Mechanical Design, ASME, 2008 – Present
International Editorial Board, Concurrent Engineering Research and Applications, 2006 – Present
International Editorial Board, Journal of Computer-Aided Design, Elsevier, 2005 – Present
Guest Editor, Journal of Advanced Engineering Informatics, Special Issue-Design Informatics, 2009
Guest Editor, ASME Journal of Mechanical Design, Special Issue on Sustainable Design, 2009
Guest Editor, Computer Aided Design, Special Issue-Computer Support for Conceptual Design, 2008
Conference Chair, USA, Product Lifecycle Management, Seoul, Korea, July 2008
Organizing Committee, IEEE, Solid Modeling International, 2008
Advisory Board, NSF–Industrial Innovation & Partnerships, Subcommittee to Engineering Advisory Committee, 2007 – 2010
Advisory Board, NSF–Industrial Innovation & Partnerships, Subcommittee - Industry/University Relationships, 2007 – 2008
Organizing Committee, Association of Computing Machinery, Solid & Physical Modeling, 2007 – 08
Mini-Symposium Organizer, Association of Computing Machinery, Bio-Geometry, University of Stony Brooke, 2007
Int'l Editorial Advisory Board: Tools & Methods for Competitive Engineering, TMCE 2006 – 09
Int'l Editorial Advisory Board: Computer-Aided Design & Applications, 2006 – 2009
Program Committee, Assoc. of Computing Machinery, Solid & Physical Modeling Symposium, 2006 – 09
Program Committee, IEEE Shape Modeling International, 2006 – 2009
Program Committee, Sketch-based Interfaces and Modeling, 2006 – 2009

Tahira N. Reid
Assistant Professor,
School of Mechanical Engineering

Education
BSME, Rensselaer Polytechnic Institute, 2000
MSME, Rensselaer Polytechnic Institute, 2004
Ph.D., Design Science (ME & Psych), University of Michigan, 2010
Postdoctoral Fellow in ME, Iowa State University, 2010-2011

Academic Experience
Purdue University, Assistant Professor, Mechanical Engineering, 2011 – Present, Full Time.
Iowa State University, Instructor, Spring 2011, Full Time
University of Michigan, Lecturer, Spring 2010, Full Time

Non-Academic Experience:
Ford Motor Company, Visiting Intern, VIRTTEX driving simulator laboratory, Summer 2008, Part-Time
Jump Dreams, Inc., Founder, product development and public speaking, 2000 – 2004, Part Time
Pratt & Whitney, Manufacturing Engineer, 1999 (Jan-Aug – COOP), Full Time
Delphi Automotive Systems, Manufacturing Intern, 1997 (summer), Full Time

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Mechanical Engineers, 2009 – Present
Association for Computing Machinery, May 2012 – Present

Honors and Awards
Mentor/Advisor to winners of Spring 2012 Mallott Innovation Award
College of Engineering Distinguished Leadership Award, 2009
AGEP Scholar, 2006 – 2009
National Technical Association (NTA) – Engineering, Technical Achiever of the Year, 2001
Martin Luther King Service Award, 1998

Service Activities
Graduate Review Committee, School of Mechanical Engineering, Purdue University, Spring 2012
Committee member, ASME's Design Engineering Division Broadening Participation Committee, 2010 – Present
DTM Session Co-Chair, International Design and Engineering Technical Conferences (IDETC), 2012
Workshop Chair, International Design and Engineering Technical Conferences (IDETC), 2012
Reviewer, NSF CMMI Panel, Spring 2012
Reviewer, ASME's Journal of Mechanical Design
Reviewer, Design Studies
Reviewer, ASME's IDETC Conference

Principal Publications and Presentations (Most important from past 5 years)

Taborda, E., Chandrasegaran, S., Kisselburgh, L., **Reid, T.**, and Ramani, K.. (2012). Enhancing Visual Thinking In a Toy Design Course Using Freehand Sketching, *Accepted* for ASME 2012 International Design Engineering Technical Conference, August 12-15, 2012, Chicago, IL

Reid, T., MacDonald, E., and Du, P. (2012). Impact of Product Design Representation on Customer Judgment with Associated Eye Gaze Patterns, *Accepted* for ASME 2012 International Design Engineering Technical Conference, August 12-15, 2012, Chicago, IL

Reid, T., Frischknecht, B, and Papalambros, P., (2012). Perceptual Attributes in Product Design: Fuel Economy and Silhouette-Based Perceived Environmental Friendliness Tradeoffs in Automotive Vehicle Design, Journal of Mechanical Design, 134(4), 041006

Reid, T., Gonzalez, R., and Papalambros, P., (2010). Quantification of Perceived Environmental Friendliness for Vehicle Silhouette Design, Journal of Mechanical Design, 132(10), 101010

Gonzalez, R., Cho, S., **Reid, T**., and Papalambros, P. (2010). Models from Psychology and Marketing Applied to Kansei Engineering," International Conference on Kansei Engineering and Emotion Research March 2 – 4, 2010, Paris, France

Reid, T., Gonzalez, R., and Papalambros, P. (2009). A Methodology For Quantifying The Perceived Environmental Friendliness of Vehicle Silhouettes in Engineering Design, Proceedings of the ASME 2009 International Design Engineering Technical Conference, August 30 – September 2, 2009, San Diego, CA

Professional Development Activities (Past 5 years)

Effective Teaching Workshop, lead by Richard Felder, Purdue University, March 20, 2012
CAREER Grant Writing Workshop, Purdue University, May 03, 2012
P.U.R.P.O.S.E Institute, North Carolina State University, June 2011
Navigating Change, IDETC, Washington, DC, 2011
Networking, IDETC, Montreal, Canada, 2010
Negotiations, IDETC, San Diego, CA, 2009

Jeffrey F. Rhoads
Associate Professor
School of Mechanical Engineering

Education
BSME, Michigan State University, 2002
MSME, Michigan State University, 2004
PhD., ME, Michigan State University, 2007

Academic Experience
Purdue University, Associate Professor, Mechanical Engineering, 2012 – Present, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 2007 – 2012, Full-Time

Non-Academic Experience
Michigan State University, East Lansing, Michigan, Graduate Research and Teaching Assistant, 2002 – 2007

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Member: American Society of Mechanical Engineers
Member: American Society for Engineering Education

Honors and Awards
Purdue University Seed for Success Award (given to grantees with awards in excess of $1M), 2011
Ferdinand P. Beer and E. Russell Johnston, Jr. Outstanding New Mechanics Educator Award (Awarded by the ASEE Mechanics Division), 2011
National Science Foundation CAREER Award, 2009
Harry L. Solberg Best Teacher Award (selected by the student body), 2009
Finalist for the Mechanical Engineering Division Best Paper Award at the 2007 ASEE Annual Conference & Exposition, 2007
MSU Excellence-in-Teaching Citation, 2007

Service Activities
Past Instructor: Women in Engineering Program EDGE Campand various other K12 Engineering Outreach Programs
Committee Member: American Society of Mechanical Engineers (Micro/Nanosystems Technical Committee, Technical Committee on Sound and Vibration, and Student Design Committee)
Regular Reviewer for the Journal of Computational and Nonlinear Dynamics, Journal of Micromechanics and Microengineering, Journal of Sound and Vibration, Journal of Vibration and Acoustics, Journal of Microelectromechanical Systems, Nanotechnology, Nonlinear Dynamics, a variety of other journals and numerous ASME, IEEE, and ASEE conferences
Co-Organizer of numerous international symposia on the Dynamics of MEMS and NEMS
Program/Conference Chair of the 2012/2013 ASME International Design Engineering Technical Conferences, 6th/7th International Conference on Micro- and Nanosystems
Developer of ME 597: Mechanics of MEMS and NEMS. Co-Developer, with C. M. Krousgrill, of ME 297: Roller Coaster Dynamics. Co-Developer, with C. M. Krousgrill and E. A. Nauman, of the Purdue Mechanics Freeform Classroom

Principal Publications and Presentations (Most important from past 5 years)

Refereed Journal Publications

D. F. Berdy, P. Srisungsitthisunti, B. Jung, X. Xu, **J. F Rhoads**, and D. Peroulis. *Low-Frequency Meandering Piezoelectric Vibration Energy Harvester*. IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control. 2012. 59(5): p. 846-858

A. B. Sabater and **J. F. Rhoads**. *On the Dynamics of Two Mutually-Coupled, Electromagnetically Actuated Microbeam Oscillators*. Journal of Computational and Nonlinear Dynamics. 2012. 7(3): 031012

V. Kumar, Y. Yang, J. W. Boley, G. T.-C. Chiu, and **J. F. Rhoads**. *Modeling, Analysis, and Experimental Validation of a Bifurcation-Based Microsensor*. Journal of Microelectromechanical Systems. 2012. 21(3): p. 549-558

N. J. Patterson, **J. F. Rhoads**, and S. Kim. *The Effects of RFID and EDI Technologies on Supply Chain Dynamics*. International Journal of Modelling and Simulation. 2012. 32(1): p. 10-17

M. R. Nelis, L. Yu, W. Zhang, Y. Zhao, C. Yang, A. Raman, S. Mohammadi, and **J. F. Rhoads**. *Sources and Implications of Resonant Mode Splitting in Silicon Nanowire Devices*. Nanotechnology. 2011. 22(45): 455502

A. K. Vallabhaneni, **J. F. Rhoads**, J. Y. Murthy, and X. Ruan. *Observations of Nonclassical Scaling Laws in the Quality Factors of Cantilevered Carbon Nanotube Resonators*. Journal of Applied Physics. 2011. 110(3): 034312

V. Kumar, J. K. Miller, and **J. F. Rhoads**. *Nonlinear Parametric Amplification and Attenuation in a Base-Excited Cantilever Beam*. Journal of Sound and Vibration. 2011. 330(22): p. 5401-5409.

J. F. Rhoads and S. W. Shaw. *The Impact of Nonlinearity on Degenerate Parametric Amplifiers*. Applied Physics Letters. 2010. 96(23): 234101

J. F. Rhoads, S. W. Shaw, and K. L. Turner. *Nonlinear Dynamics and Its Applications in Micro- and Nanoresonators*. Journal of Dynamical Systems, Measurement and Control. 2010. 132(3): 034001.

B. E. DeMartini, **J. F. Rhoads**, M. A. Zielke, K. G. Owen, S. W. Shaw, and K. L. Turner. *A Single Input-Single Output Coupled Microresonator Array for the Detection and Identification of Multiple Analytes*. Applied Physics Letters. 2008. 93(5): 054102

Professional Development Activities (Past 5 years)

The National Academy of Engineering's 2011 Frontiers of Engineering Education Symposium in Irvine, California, 2011

Xiulin Ruan
Assistant Professor, School of Mechanical Engineering

Education
BS, Engineering Thermophysics, Tsinghua University, 2000
MS, Engineering Thermophysics, Tsinghua University, 2002
MS, Electrical Engineering, University of Michigan at Ann Arbor, 2006
Ph.D., ME, University of Michigan at Ann Arbor, 2006

Academic Experience
Purdue University, Assistant Professor, 2007 – Present, Full Time

Non-Academic Experience:
Air Force Research Laboratory, Summer Faculty Fellow in the Thermal Sciences Branch, Summer 2010 & 2011, Full-Time

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Mechanical Engineers, 2004 – Present
SPIE, 2009 – Present

Honors and Awards
NSF CAREER Award, 2012
Air Force Summer Faculty Fellowship, 2010, 2011
Best Student Presentation Award, the 2008 Energy Nanotechnology International Conference (awarded to student Bo Qiu), 2008

Service Activities
Heat Transfer Faculty Search Committee, 2008, 2009, 2012
Mechanical Engineering Curriculum Committee, 2009 – Present
Mechanical Engineering Graduate Committee, 2007 – 2009
Heat Transfer Area Exam Chair, 2007 – 2009
ASME Heat Transfer Division K6 Heat Transfer in Energy Systems Committee, 2009 – Present
ASME Heat Transfer Division K8 Theory and Fundamental Research Committee, 2009 – Present
Session/Topic organizer for 8 ASME Conference session/topics, 2009 – Present
Journal reviewer for 18 journals, 2005 – Present

Principal Publications and Presentations (Most important from past 5 years)
B. Qiu, Y. Wang, Q. Zhao, and **X.L. Ruan**, "The effects of diameter and chirality on the thermal transport in free-standing and supported carbon-nanotubes", *Appl. Phys. Lett*. **100**, 233105, 2012
K. G. S. H. Gunawardana, K. Mullen, J.N. Hu, Y. Chen, and **X.L. Ruan**, "Tunable thermal transport and thermal rectification in strained graphene nanoribbons", *Phys. Rev. B* **85**, 245417, 2012
Y. Wang, **X.L. Ruan**, and A.K. Roy, "Two-temperature nonequilibrium molecular dynamics simulation of thermal transport across metal-nonmetal interfaces", *Phys. Rev. B* **85**, 205311, 2012

L.L. Chen, Q. Zhao, and **X.L. Ruan**, "Facile synthesis of ultra-small Bi2Te3 nanoparticles, nanorods, and nanoplates and their morphology dependent Raman spectroscopy", *Mat. Lett.* **82**, 112-115, 2012

H. Bao, B. Qiu, Y. Zhang, and **X.L. Ruan**, "A first-principles molecular dynamics approach for predicting optical phonon lifetimes and far-infrared reflectance of polar materials", *Journal of Quantitative Spectroscopy and Radiative Transfer*, 2012

B. Qiu and **X.L. Ruan**, "Reduction of Spectral Phonon Relaxation Times from Suspended to Supported Graphene", *Appl. Phys. Lett.* **100**, 193101, 2012

Y. Wang, S.Y. Chen, and **X.L. Ruan**, "Tunable Thermal Rectification in Graphene Nanoribbons through Defect Engineering: A Molecular Dynamics Study", *Appl. Phys. Lett.* **100**, 163101, 2012

B. Qiu, H. Bao, G.Q. Zhang, Y. Wu and **X.L. Ruan**, "Molecular Dynamics Simulations of Lattice Thermal Conductivity and Spectral Phonon Mean Free Path of PbTe: Bulk and Nanostructures", *Comput. Mater. Sci.* **53**, 278-285, 2012

J.N. Hu, Y. Wang, A. Vallabhaneni, **X.L. Ruan**, and Y.P. Chen, "Nonlinear thermal transport and negative differential thermal conductance in graphene nanoribbons," *Appl. Phys. Lett.* **99**, 113101, 2011

A. Vallabhaneni, J.F. Rhoads, J.Y. Murthy, and **X.L. Ruan**, "Observation of Nonclassical Scaling Laws in the Quality Factors of Cantilevered Carbon Nanotube Resonators," *J. Appl. Phys.,* **110**, 034312, 2011

L.L. Chen, H. Bao, T.Z. Tan, O.L. Prezhdo, and **X.L. Ruan**, "Shape and Temperature Dependence of Hot Carrier Relaxation Dynamics in Spherical and Elongated CdSe Quantum Dots," *J. Phys. Chem. C* **115**, 11400–11406, 2011

B. Qiu, L. Sun, and **X.L. Ruan**, "Lattice thermal conductivity reduction in Bi_2Te_3 quantum wires with smooth and rough surfaces: A molecular dynamics study," *Phys. Rev. B* **83**, 035312, 2011

B. Qiu and **X.L. Ruan**, "Thermal conductivity prediction and analysis of few-quintuple Bi_2Te_3 thin films: a molecular dynamics study," *Appl. Phys. Lett.*, **97**, 183107, 2010

J.N. Hu, S. Schiffli, A. Vallabhaneni, **X.L. Ruan**, and Y.P. Chen, "Tuning the thermal conductivity of graphene nanoribbons by edge passivation and isotope engineering: A molecular dynamics study", *Appl. Phys. Lett.* **97**, 133107, 2010

H. Bao and **X.L. Ruan**, "Enhanced optical absorption in disordered vertical silicon nanowire arrays for photovoltaic applications," *Opt. Lett.* **35**, 3378-3380, 2010

W.Z. Wu, Z.R. Zheng, and **X.L. Ruan**, "Luminescence dynamics of Te doped CdS quantum dots at different doping levels," *Nanotechnology* **21**, 265704, 2010

H. Bao, **X.L. Ruan**, and T.S. Fisher, "Optical properties of ordered vertical arrays of multiwall carbon nanotubes", *Optics Express* **18**, 6347-6359, 2010

H. Bao and **X.L. Ruan**, "Ab initio calculations of thermal radiative properties: the semiconductor GaAs," *Int. J. Heat and Mass Transfer* **53**, 1308–1312, 2010

B. Qiu and **X.L. Ruan**, "Molecular dynamics simulations of the thermal conductivity of Bi_2Te_3 using two-body interatomic potnetials," *Phys. Rev. B* **80**, 165203, 2009

J.N. Hu, **X.L. Ruan** and Y.P. Chen, "Thermal Conductivity and Thermal Rectification in Graphene Nanoribbons: a Molecular Dynamics Study", *Nano Lett.* **9**, 2730-2735, 2009

H. Bao, B.F. Habenicht, O.V. Prezhdo, and **X.L. Ruan**, Temperature dependence of hot carrier relaxation in a PbSe nanocrystal: an ab initio study, *Phys. Rev. B* **79**, 235306-1-7, 2009

H. Bao, **X.L. Ruan**, and M.Kaviany, Theory of the broadening of vibrational spectra induced by lowered symmetry in yttria nanostructures, *Phys. Rev. B* **78**, 125417-1-7, 2008

Professional Development Activities (Past 5 years)

ASME Summer Heat Transfer Conference, July 2008 – 2012 (annual meeting)
ASME International Mechanical Engineering Congress and Exhibition, November 2009 – 2012
Consultant for Grade 6 students science project, 2011
Lecturer for Indiana 4-H Youth Career Day, 2008, 2009

Farshid Sadeghi
Cummins Professor,
School of Mechanical Engineering

Education
BSME, University of Tennessee, 1979
MSME, University of Tennessee, 1981
Ph.D., North Carolina State University, 1985

Academic Experience
Purdue University, Cummins Professor, Mechanical Engineering, 2010 – Present, Full-Time
Purdue University, Professor, Mechanical Engineering, 1996 – 2010, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 1991 – 1996, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1986 – 1991, Full-Time
North Carolina State University, Research Assistant, 1983 – 1985
North Carolina State University, Teaching Assistant, 1981 – 1985
University of Tennessee at Chattanooga, Research Assistant, 1979 – 1981
University of Tennessee at Chattanooga, Teaching Assistant, 1979 – 1981

Non-Academic Experience
Tennessee Valley Authority, Research Engineer, 1979 – 1981

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Mechanical Engineers
American Society of Engineering Education
Society for Tribologists and Lubrication Engineers
Society of Manufacturing Engineers
Society of Automotive Engineers

Honors and Awards
Purdue University, College of Engineering Research Excellence Award, 2012
ASME Mayo D. Hersey Award: "Award is bestowed on an individual in recognition of distinguished and continued contributions over a substantial period of time to the advancement of the science and engineering of tribology", 2011
Society of Tribologists and Lubrication Engineers (STLE) International Award: "This is the Society's highest technical honor. It recognizes the recipient's outstanding contributions to tribology, lubrication engineering or allied fields. The Award bestows lifetime honorary membership on the recipient, who need not have been a member of STLE.", 2011
K. L. Johnson Best Paper Award, Weinzapfel, N., Sadeghi, F., Bakolas, V., and Liebel, A., "A 3D Finite Element Study of Fatigue Life Dispersion in Rolling Line Contacts" *ASME Journal of Tribology* 133 (4), 042202, 2011
ASME Research Committee on Tribology Creative Research Award, 2008
STLE Best Paper Award Bolander, N. W. and Sadeghi, F., "Deterministic Modeling of Honed Cylinder Liner Friction," from the STLE, Tribology Transactions, Vol. 50, No. 2, pp. 248-256, 2007

Service Activities
Chairman, Engineering Faculty Affairs Committee 2005 to 2007
Chairman, Academic Program Reviews 2004
Member, Engineering Area Promotion Committee 2003 to 2005
Member, University Senate 2002 to 2005

Principle Publications and Presentations (Most important from past 5 years)
(Total of 115 Archival Publications)

Ashtekar, A., **Sadeghi, F**., and Stacke, L. E., "A New Approach to Modeling Surface Defects in Bearing Dynamics Simulations," *ASME Journal of Tribology*, Vol. 130(4), 041103, 2010

Ashtekar, A., Kovacs, A., **Sadeghi, F**., and Peroulis, D., "Bearing Cage Telemeter for the Detection of Shaft Imbalance in Rotating Systems," *Proc. 2010 IEEE Radio and Wireless Symposium (RWS 2010)*, pp. 5-8, 2010

Slack, T. S., and **Sadeghi, F**., "Explicit Finite Element Modeling of Subsurface Initiated Spalling in Rolling Contacts," *Tribology International*, Vol. 43, pp. 1693-702, 2010

Warhadpande, A., and **Sadeghi, F**., "Effects of Surface Defects on Rolling Contact Fatigue of Heavily Loaded Lubricated Contacts," *Proc. I. Mech. E. Part J: J. Engineering Tribology,* Vol. 224(J10), pp. 1061-77, 2010

Weinzapfel, N., **Sadeghi, F**., and Bakolas, V., "An Approach for Modeling Material Grain Structure in Investigations of Hertzian Subsurface Stresses and Rolling Contact Fatigue," *ASME Journal of Tribology*, Vol. 132(4), 041404, 2010

Jalalahmadi, B., **Sadeghi, F**., and Bakolas, V., "Material Inclusion Factors for Lundberg-Palmgren-Based RCF Life Equation," *STLE Tribology Transactions*, Vol. 53(3), pp. 457-69, 2011

Leonard, B. D., Patil, P., Slack, T. S., **Sadeghi, F**., Shinde, S., Mittleback, M., "Fretting Wear Modeling of Coated and Uncoated Surfaces using the Combined Finite-Discrete Element Method," *ASME Journal of Tribology*, Vol. 133(2), 021601, 2011

Ashtekar, A., **Sadeghi, F**., Powers, G., Griffith, R., "Experimental Investigation of Turbocharger Rotor-Bearing Systems," *Proceedings of the ASME Turbo Expo 2011: Power for Land, Sea and Air*, GT2011-45999, 2011

Slack, T., and **Sadeghi, F**., "Cohesive Zone Modeling of Intergranular Fatigue Damage in Rolling Contacts," *Tribology International*, Vol. 44(7-8), pp. 797-804, 2011

Wang, C., **Sadeghi, F**., Wereley, S.T., Rateick, R.G., and Scott, R., "Experimental Investigation of Lubricant Extraction from a Micropocket," *STLE Tribology Transactions,* Vol. 54(3), pp. 404-16, 2011

Warhadpande, A., **Sadeghi, F**., Kotzalas, M. N., and Doll, G., "Effects of Plasticity on Subsurface Initiated Spalling in Rolling Contact Fatigue," *International Journal of Fatigue*, Vol. 36, pp. 80-95, 2012

Ashtekar, A., and **Sadeghi, F**., "Experimental and Analytical Investigation of High Speed Turbocharger Ball Bearings," *ASME J. Gas and Turbine Power*, Vol. 133(12), 122501, 2011

Weinzapfel, N., **Sadeghi, F**., Bakolas, V., and Liebel, A., "A 3D Finite Element Study of Fatigue Life Dispersion in Rolling Line Contacts," *ASME J. of Tribology*. Vol. 133(4), 042202, 2011

Matthew D. Brouwer, Lokesh A. Gupta, **Farshid Sadeghi**, Dimitrios Peroulis, Douglas Adams, "High temperature dynamic viscosity sensor for engine oil applications," *Sensors and Actuators A: Physical,* Vol. 173(1), pp. 102-7, 2012

Professional Development Activities (Past 5 years)
Editor-in-Chief of Tribology Transactions, 2009 – Present

Cagri A. Savran
Associate Professor, School of Mechanical Engineering

Education
BSME, Purdue University, 1998
S.M., MIT, 2000
Ph.D., MIT, 2004

Academic Experience
Purdue University, Associate Professor, Mechanical Engineering (with tenure), 8/2010 – Present, Full-Time
Purdue University, Associate Professor, Biomedical Engineering (by courtesy), 8/2010 – Present
Purdue University, Associate Professor, Electrical &Computer Engineering (by courtesy), 8/2010 – Present
Purdue University, Assistant Professor, (same affiliations as above), 8/2004 – 8/2010

Non-Academic Experience
National Aeronautics and Space Administration (NASA), NASA Glenn (Lewis) Research Center, Cleveland, OH 44135, Silencer design and noise control projects, May 1998 – Aug. 1998
Procter & Gamble Co., NALS-ANNEX, 5430 Cornell Rd, Cincinnati, OH 45242, Product Supply Engineering: Developed computer simulations of high and low vacuum systems for paper products converters, May 1997 – August 1997

Certifications or Professional Registrations
Engineer in Training (EIT) Exam, Indiana, 1998

Current Membership in Professional Organizations
American Society of Mechanical Engineers, American Chemical Society

Honors and Awards
Graduated with highest distinction and honors, Purdue University
Motorola PhD Fellowship at MIT, 2001 – 2004
NASA Educational and Research Collaborative Internship Program Selectee, 1998
NSF U.S.-Japan Young Researchers Exchange Program Selectee, 2007
#1 News in Analytical Chemistry, March 2007 issue
#1 News in JACS weekly press-pack, December 17, 2007
'News' in Analytical Chemistry, February 1, 2008
'Currents' in Journal of Proteome Research, Vol. 7, No 2, 2008
News Headlines in LabTechnologist.com, December 13, 2007
News articles in Science Daily, Medical News Today, Clinical Lab Products
News article in Bioscience Technology, March 2008
Hydrogel Sensor featured in about 20 online news agencies (including Science Daily, Smart Planet) and in Lafayette Journal and Courier, 2010 – 2011
Microtweezer featured on "Future of Technology" in MSNBC, January 2012

Service Activities
Mechanical Engineering Research Committee, 2004 – 2008
Biomedical Engineering Admissions Committee, 2004 – 2007

Principal Publications and Presentations (Most important from past 5 years)

C-L. Chang, Z. Ding, V. Patchigolla, B. Ziaie and **C.A. Savran**, "Reflective Diffraction Gratings from Hydrogels as Biochemical Sensors," *IEEE Sensors,* vol. 99, pp. 1, 2012

B-D. Chan, F. Mateen, C-L. Chang, K. Icoz, and **C.A. Savran**, "A Compact Manually Actuated Micromanipulator," *Journal of Microelectromechanical Systems,* vol. 99, pp. 1-3, 2011

G. Chitnis, Z. Ding, C-L. Chang, **C.A. Savran** and B. Ziaie, "Laser-treated hydrophobic paper: an inexpensive microfluidic platform," *Lab on a Chip,* vol. 11, no. 6, pp. 1161-5, 2011

K. Icoz, **C.A. Savran**, "Nanomechanical Biosensing with Immunomagnetic Separation," *Applied Physics Letters*, vol. 97, 123701, 2010

J. Lee, K. Icoz, A. Roberts, A.D. Ellington and **C.A. Savran**, "Diffractometric Detection of Proteins Using Microbead-Based Rolling Circle Amplification", *Analytical Chemistry*, vol. 82, no 1, pp. 197-202, 2010

T.J. Lee, H. Zhang, C-L. Chang, **C.A. Savran**, and P. Guo "Engineering of the Fluorescent-Energy-Conversion Arm of Phi29 DNA Packaging Motor for Single-Molecule Studies", *Small*, vol. 5, no 21, pp. 2453-2459, 2009

C.L. Chang, H. Zhang, D. Shu, P. Guo, **C.A. Savran**, "Bright-field analysis of phi29 DNA packaging motor using a magneto-mechanical system", *Applied Physics Letters,* vol. 93, pp. 153902, 2008

K. Icoz, B. D. Iverson, and **C.A. Savran**, "Noise analysis and sensitivity enhancement in immunomagnetic nanomechanical biosensors", *Applied Physics Letters*, vol. 93, 013902, 2008

J. Lee, J. Jang, D. Akin, **C.A. Savran**, R. Bashir, "Real-time detection of airborne viruses on a mass-sensitive device", *Applied Physics Letters*, vol. 93, pp. 013901-3, 2008

G. Acharya, C-L. Chang, D. Holland, D.H. Thompson, **C.A. Savran**, "Rapid Detection of S-Adenosyl Homocysteine Using Self-Assembled Optical Diffraction Gratings", *Angewandte Chemie International Edition*, vol 47, no 6, pp 1051-1053, 2008

G. Acharya, C.L. Chang, D.D. Doorneweerd, E. Vlashi, W.A. Henne, L.C. Hartmann, P.S. Low, **C.A. Savran**, "Immunomagnetic Diffractometry for diagnostic serum markers", *Journal of the American Chemical Society* vol 129, pp 15824-9, 2007

C.L. Chang, G. Acharya and **C.A. Savran**, "In situ fabricated diffraction grating for biomolecular detection", *Applied Physics Letters*, vol. 90, pp. 233901-3, 2007

G. Acharya, D.D. Doorneweerd, C.L. Chang, W.A. Henne, P.S Low and **C.A. Savran**, "Label-Free Optical Detection of Anthrax-Causing Spores", *Journal of American Chemical Society,* vol. 129, no. 4, pp. 732 -733, 2007

Professional Development Activities (Past 5 years)

None

Justin Seipel
Assistant Professor
School of Mechanical Engineering

Education
BS, University of Wisconsin-Milwaukee, 2001
MA, Princeton University, 2003
Ph.D., Princeton University, 2006

Academic Experience
Purdue University, Assistant Professor, Mechanical Engineering, 2009 – Present, Full-Time
University of California-Berkeley, Postdoctoral Fellow, 2006 – 2009

Non-Academic Experience
None

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Mechanical Engineers, 2008 – Present

Honors and Awards
Goldwater Scholar, 2000 – 2001
National Science Foundation Graduate Fellow, 2001 – 2006
Intelligence Community Postdoctoral Fellow, 2006 – 2009
Phi Kappa Phi Fellow, 2001 – 2002
ASHRAE Society Scholar, 2000

Service Activities
Member, Common Reading Selection Committee, Purdue, 2010 – Current
Member, Spira Lab Planning Committee, Purdue, 2011 – Current
Session Organizer and Presenter, Presidents Council Back to Class Event, Purdue, 2010
Faculty Advisor of "Makers: A Society for Innovation"
Service to the Design Area Faculty Search Committee, 2012

Principal Publications and Presentations (Most important from past 5 years)
J. Seipel, P. Holmes. A Simple Model for Clock-Actuated Legged Locomotion. Regul. Chaotic Dyn. 12, 502-520, 2007
A.J. Spence, S. Revzen, **J. Seipel**, C. Mullins, R.J. Full. Insects running on elastic surfaces. J. Exp. Biology. 213(11):1907-1920, 2010
J. Ackerman, **J. Seipel** (to appear). Energetic Efficiency of Legged Robot Locomotion with Elastically Suspended Loads. IEEE Trans. Robotics

Professional Development Activities (Past 5 years)
None

Gregory M. Shaver
Assistant Professor, School of Mechanical Engineering

Education
BSME, Purdue University, 2000 (with highest distinction)
MSME, Stanford University, 2004
Ph.D., ME, Stanford University, 2005

Academic Experience
Purdue University, Associate Professor, Mechanical Engineering, July 2011 – Present, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, Aug. 2006 – June 2011, Full-Time

Non-Academic Experience
Entelos, Inc., Foster City, CA, Dynamics Engineer, 2005
Palomar Technologies, Vista, CA, Systems Engineer, Summer 2000
AlliedSignal, Inc. (now Honeywell) Aerospace, Purdue Co-Op Education Student, 1996 – 1999

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Mechanical Engineers
SAE
ASME Dynamic Systems and Control Division (DSCD)

Honors and Awards
Graduated with highest distinction, Purdue University 2000
(4.0 in Mechanical Engineering coursework)
American Control Conference - best presentation in session award, 2003 – 2005
Best paper in Journal of Dynamic Systems Measurement and Control for year 2005
Max Bentele Award for Engine Technology Innovation, 2012

Service Activities
Safety Committee (member), Herrick Labs, School of Mechanical Engineering, Spring 2007 – Present
Communications Committee (member), School of Mechanical Engineering, Fall 2006 – Spring 2008
Grade Appeals Committee (member), College of Engineering, Spring 2007 – Spring 2009
Graduate Committee (member), School of Mechanical Engineering, Fall 2009 – Present
Mechanical Engineering Leadership Team (MELT), Fall 2011 – Present
Faculty advisor, Theta Tau Engr. Fraternity (Organizer of Rube Goldberg Machine Contest Competitions)
Faculty advisor, Purdue University EcoCAR team
Associate Editor, IFAC) Control Engineering Practice Journal, March 2009 – Present
Vice Chairman, Automotive and Transportation Panel, ASME Division of Dynamic Systems and Control, July 2009 – Present

Principal Publications and Presentations (Most important from past 5 years)

Gregory M. Shaver*, Matthew J. Roelle, J. Christian Gerdes, Patrick A. Caton and Christopher F. Edwards, *Dynamic Modeling of HCCI Engines Utilizing Variable Valve Actuation*, ASME Journal of Dynamic Systems, Measurement and Control, vol. 127, no. 3, pp. 374-381, September 2005 (Selected as the best paper published in the Journal of Dynamic Systems, Measurement and Control, 2005)

Gregory M. Shaver*, Matthew J. Roelle, J. Christian Gerdes, Jean-Pierre Hathout, Jasim Ahmed, Aleksandar Kojic, Patrick A. Caton and Christopher F. Edwards, *A Physics-Based Approach to Control of HCCI Engines with Variable Valve Actuation*, International Journal of Engine Research, vol. 6, no. 4, pp. 361-375(15), July 2005

Gayatri Adi*, Carrie Hall*, David Snyder*, Mike Bunce, Chris Satkoski, Shankar Kumar, Phanindra Garimella, Donald Stanton and **Gregory M. Shaver**, *Soy-Biodiesel Impact on NOx Emissions and Fuel Economy for Diffusion Dominated Combustion in a Turbo-Diesel Engine Incorporating EGR and Common Rail Fuel Injection*, Energy and Fuels, 23 (12), pp.5821–5829, October 2009

Aman Yadav*, **Gregory M. Shaver***, and Peter Meckl, *Lessons learned: Implementing the case teaching method in a mechanical engineering course*, J. of Engr. Education, **99(1), pp. 55-69**, Jan 2010

Mike Bunce*, David Snyder*, Gayatri Adi*, Carrie Hall, Jeremy Koehler, Bernie Davila, Shankar Kumar, Phanindra Garimella, Don Stanton, and **Greg Shaver**, *Stock and Optimized Performance and Emissions with 5 and 20% Soy-Biodiesel Blends in a Modern Common Rail Turbo-Diesel Engine*, Energy and Fuels, *24* (2), pp. 928–939, February 2010

Chris Satkoski*, **Greg Shaver**, *Piezoelectric Fuel Injection - Pulse-to-Pulse Coupling and Flow Rate Estimation*, ASME/IEEE Transactions on Mechatronics, volume 16, issue 4, August 2011

Chris Satkoski*, **Greg Shaver**, Ranjit More, Peter Meckl, Douglas Memering, Shankar Venkataraman, Jalal Syed, and Jesus Carmon-Valdes, *Dynamic Modeling of a Piezoelectric Actuated Fuel Injector*, ASME Journal of Dynamic Systems, Measurement, and Control, vol. 133 (5), 2011

Rajani Modiyani*, Lyle Kocher*, Dan Van Alstine*, Ed Koeberlein, Karla Stricker, Paul Meckl, and **Gregory M. Shaver**, *Effect of Intake Valve Closure Modulation on Effective Compression Ratio and Gas Exchange in Modern, Multi-Cylinder Diesel Engines*. Intl. J. of Engine Research, vol. 12(6), 2011

David Snyder*, Gayatri Adi, Carrie Hall, Michael Bunce, and **Gregory M. Shaver**, *Control-Variable-Based Accommodation of biodiesel blends*. International Journal of Engine Research, vol. 12 (6)

Lyle Kocher, Ed Koeberlein, Dan Van Alstine, Karla Stricker, and **Gregory M. Shaver**, Physically-Based Volumetric Efficiency Model for Diesel Engines Utilizing Variable Intake Valve Actuation, International Journal of Engine Research, In Press, appeared online Nov. 21, 2011

Professional Development Activities (Past 5 years)

Participant of the Stanford University New Century Scholars Program, 2002 – 2003

Yung C. Shin
Donald A. & Nancy G. Roach Professor of Advanced Manufacturing
School of Mechanical Engineering

Education
BSME, Seoul National Univ, 1976
MSME, KAIST, 1978
Ph.D., ME, University of Wisconsin, Madison, 1984

Academic Experience
Purdue University, Director, Center for Laser-Based Manufacturing, Mechanical Engineering, 2003 – Present
Purdue University, Chairman of Systems, Measurement and Control Area, Mechanical Engineering, 1999 – 2010
Purdue University, Professor, Mechanical Engineering, 1997 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 1993 – 1997, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1990 – 1993, Full-Time
Pennsylvania State University, Assistant Professor, 1988 – 1990

Non-Academic Experience
General Motors Technical Center, Senior Project Engineer, 1984 – 1988
University of Wisconsin – Madison, Research Assistant, Course Instructor, 1981 – 1984
Korea Institute of Machinery and Metals, Research Engineer, Instructor, 1978 – 1981

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow, American Society of Mechanical Engineers
Member, Society of Manufacturing Engineers
Member, American Society of Metals
Member, TMS
Member, Laser Institute of America

Honors and Awards
GM faculty fellow, 1993 – 1995
Listed in Who's Who Among Asian Americans, Gale Research Inc.
Listed in Who's Who in America
Listed in Who's Who in Science and Engineering
University Seeds of Excellence Award, 2005
Blackall Machine Tool and Gage Award, ASME, 2007
Donald A. and Nancy G. Roach Endowed Chair Professor of Advanced Manufacturing, 2008
Outstanding Achievement Award for the 2008 Indiana 21st Century Research & Technology Fund
Fellow, ASME, 2010
Best paper award, ASME Manufacturing Science and Engineering Conference, 2011, Corvallis, Oregon

Service Activities

Conference Organizing Chair, 2009 ASME International Conference on Manufacturing Science and Engineering

Associate Editor for the ASME Journal of Manufacturing Science and Engineering

Chair of the 30th North American Manufacturing Research Conference, 2002

Member, SME Machine Tools and Machining Systems Technical Committee

Scientific Committee Member, Trans. of North American Manufacturing Research Institution of SME, 1998 – 2005

Organizing Committee, CIRP Modeling Workshop, May 20-21, 2002, West Lafayette

Organizing Committee, Japan - USA Symposium on Flexible Automation, Hiroshima, Japan, July 15-17, 2002

Organizing Committee, Japan - USA Symposium on Flexible Automation, Denver, Colorado, USA, July 19-21, 2004

Organizing Committee, Japan - USA Symposium on Flexible Automation, Japan, July 19-21, 2006

Principal Publications (Most significant 10 during past 5 years):

<u>Refereed Journal Publications</u>

Lakhkar, R., **Shin, Y.C.** and Krane, M., "Modeling of Laser Hardening and Backtempering of 4140 Steel and Optimization of Overlapping Patterns" Materials Science and Engineering A, 480, pp. 209–217, 2008

Dandekar, C. and **Shin, Y.C.**, "Multi-Phase Finite Element Modeling of Machining Unidirectional Composites: Prediction of Debonding and Fiber Damage", Trans. of the ASME, J. of Manufacturing Science and Engineering, Vol.130, Iss.5, 051016, October 2008

Wu, B. and **Shin, Y.C.**, "A Simplified Model for High Fluence Ultra-short Pulsed Laser Ablation of Semiconductors and Dielectrics", Applied Surface Science, Volume 255, Issue 9, 4996-5002, February 2009

Bailey, N., Tan, W. and **Shin, Y.C.**, "Predictive Modeling and Experimental Results for Residual Stresses in Laser Hardening of AISI 4140 Steel by a High Power Diode Laser", Surface and Coatings Technology, Volume 203, Issue 14, 15, pages 2003-2012, April 2009

Subrahmanya, N. and **Shin, Y.C.**, "Adaptive Divided Difference Filtering for Simultaneous State and Parameter Estimation", Automatica, 45, 1686-1693, 2009

Dandekar, C. and **Shin, Y.C.**, "Multi-step 3D Finite Element Modeling of Subsurface Damage in Machining Particulate Reinforced Metal Matrix Composites", Composites, Part A, 40, pp. 1231 1239, 2009

Wen, S., **Shin, Y.C.**, Murthy, J.Y. and Sojka, P.E., "Modeling of Coaxial Powder Flow for the Laser Direct Deposition Process", International J. of Heat and Mass Transfer, 52, Issues 23-24, 5867 5877, 2009

Hu, W., **Shin, Y.C.** and King, G.B., "Modeling of Multi-burst Mode Pico-Second Laser Ablation for Improved Material Removal Rate", Applied Physics, A, Volume 98, Number 2, pp. 407-415, February, 2010

Dandekar, C. and **Shin, Y.C.**, "Machinability Improvement of Ti6Al4V Alloy via LAM and Hybrid Machining", International Journal of Machine Tools and Manufacture, Volume 50, Issue 2, pp. 174-182, February 2010

Subrahmanya, N. and **Shin, Y.C.**, "Sparse Multiple Kernel Learning for Signal Processing Applications", IEEE Trans. on Pattern Analysis and Machine Intelligence, Vol. 32 Issue: 5, pp. 788 – 798, May 2010

Professional Development Activities (Past 5 years):

Workshop Co-Organizer, NSF Summer Institute Laser Micro and Nanomanufacturing Workshop, Evanston, IL, June 1-4, 2010

Thomas H. Siegmund
Professor, School of Mechanical Engineering

Education
BS, University of Leoben, Austria, 1987
MS, University of Leoben, Austria, 1990
Ph.D., University of Leoben, Austria, 1994

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2008 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 2004 – 2008, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1999 – 2004, Full-Time

Non-Academic Experience
Indiana University School of Medicine, Visiting Scientist, Fall 2005
GKSS Research Center, Geesthacht, Germany, Research Associate, 1996 – 1998
Brown University, Research Associate, 1995 – 1996

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Member, American Society of Mechanical Engineers
Member, Society of Engineering Science

Honors and Awards
Fellow of ASME, 2012
Best Paper Award with P. Bhattacharya for Bioengineering Research using Abaqus/FEA, Simulia Inc., 2011
Best Poster Award with J. Kelleher, COST Action Conference: Modeling and Assessment of the Human Voice, Erlangen, Germany – September 9, 2010, 2010
ITherm Conference Best Paper Award, with S. Kanuparthi and G. Subbarayan, 2008
Purdue University Faculty Scholar, 2004 – 2008
Discovery in Mechanical Engineering Award, Purdue University, 2004
2003 Purdue Junior Teach for Tomorrow Award
2003 Best Paper Award of the American Society of Composites
1997-1999 Lecturer of the Federation of European Materials Societies (FEMS)
1994-1995 Erwin Schrödinger Fellowship, Austrian Science Foundation
1993 Travel Award, University of Leoben, Leoben, Austria
1990 Honors Graduation Award, University of Leoben, Leoben, Austria

Service Activities
Chair, IUTAM Summer School on Biomechanics of Tissue and Tissue-Cell Interaction, 2012
Member, Purdue University Faculty Senate, 2011 – Present
Associate Editor, ASME Journal of Materials Engineering and Technology, since 2006

Member, International Scientific Advisory Committee, 20th International Workshop on Computational Mechanics of Materials IWCMM 2010 on 8-10 September 2010 at Loughborough University, UK
Member, International Scientific Advisory Committee, 21st International Workshop on Computational Mechanics of Materials, August 22-24, 2011, University of Limerick, Ireland
Organizer, ICTAM 2008 Congress, Minisymposium Cohesive Zone Models of Fracture and Failure

Principal Publications and Presentations (Most important from past 5 years)

K. Srinivasan, S. Goyal, **T. Siegmund**, G. Subbarayan, Q. Lin, "Thermally induced wrinkling in thin film stacks on patterned substrates," IBM Journal of Research and Development 53 (2009) paper 12

S. Brinckmann, G. Gao, **T. Siegmund**, "A combined numerical-experimental study on the compaction behavior of NaCl," Powder Technology, 194 (2009) 197–206

J. Han, **T. Siegmund**, "A computational model for delamination wear," Wear, 267 (2009) 1680-1687

K. Zhang, R.W. Chan, **T. Siegmund**, "Biomechanics of fundamental frequency regulation: constitutive modeling of the vocal fold lamina propria," Logopedics Phoniatrics Vocology, 6 (2009) 181-189

S. Goyal, K. Srinivasan, G. Subbarayan, **T. Siegmund**, "Thermally-driven buckling delamination test to measure interfacial fracture toughness of thin film systems," Thin Solid Films, 518 (2010) 2056-2064

T. Siegmund, M.R. Allen, D.B. Burr, "Can deterministic size effects contribute to fracture and microdamage accumulation in trabecular bone?" Journal of Theoretical Biology 265 (2010) 202-210

J. Kelleher, R.W Chan, **T. Siegmund**, "Spatially varying properties of the vocal ligament contribute to its eigenfrequency response," Journal of the Mechanical Behavior of Biological Materials 3 (2010) 600-609

S. Goyal, K. Srinivasan, G. Subbarayan, **T. Siegmund**, "Estimating the yield strength of thin metal films through elastic-plastic buckling-induced debonding," IEEE Transactions on Device and Materials Reliability 11 (2011) 358-361

J. Kelleher, R.W Chan, **T. Siegmund**, E. Henslee, "Optical measurements of vocal fold tensile properties: implications for phonatory mechanics," Journal of Biomechanics 44 (2011) 1729 1734

S. Brinckmann, **T. Siegmund**, "A model for the strength of nanopillars," International Journal of Materials Research 103 (2012)3-8

Professional Development Activities (Past 5 years)

Participant, Oberwolfach Workshop Mechanics of Materials, Organisers: R. Kienzler, D.L. McDowell, S. Mueller, E.A. Werner, March 18-24, 2012,
Purdue University, Study in a Second Discipline Program, Fall 2011.
Lecturer, CISM Course, Nonlinear Fracture Mechanics Models, Udine, Italy, July 7-11, 2008.

Paul E. Sojka
Professor,
School of Mechanical Engineering

Education
BS, Physics, Michigan State University, 1976
MSME, Michigan State University, 1978
Ph.D., ME, Michigan State University, 1983

Academic Experience
Purdue University, Professor, Mechanical Engineering, 1999 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 1989 – 1999, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1983 – 1989, Full-Time

Non-Academic Experience
None

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Institute for Liquid Atomization and Spray Systems
American Society of Mechanical Engineers, Fluids Division

Honors and Awards
None

Service Activities
College of Engineering Financial Rightsizing Committee member, May 2012 – Present
Provost Fellow assigned to the Office of the Vice President for Research, Aug. 2010 – May 2011
College of Engineering Finance Committee Chair, Aug. 2010 – July 2011
Head of ME School Search Committee member, Aug. 2010 – Apr. 2011
College of Engineering Budget Contingency Design Committee Member, Aug. 2010 – Jan. 2011
College of Engineering Finance Committee Member, Aug. 2008 – July 2011
Visiting Professor at Korea University Mechanical Engineering Department, June 2009 – July 2009
Visiting Professor at ITT and ITS, Technical University of Karlsruhe, Jan. 2008 – July 2008
Strategic Needs Search Committee Chair, School of Mechanical Engineering, 2005 – 2006
Research Committee Chair, School of Mechanical Engineering, 2001 – 2005
CENUT Area Chair, School of Mechanical Engineering, 2000 – 2005
Co-Director, Purdue University Center for Bio-Sprays, 2000 – Present

Principle Publications and Presentations (Most important from past 5 years)
"Spatially Resolved Characteristics of Pharmaceutical Sprays," with A.R. Mulidai, 10.1002/aic.12775 and in press AIChE Journal (2012)

"Non-Dimensional Scaling Laws for Controlling Pharmaceutical Spray Uniformity: Understanding and Scale-Up," with A.R. Muliadi, in press Journal of Pharmaceutical Sciences (2012)
"Threshold wavelength on filaments of complex fluids," with Muddu, R. J. Lu, J. and Corvalan, Carlos M., Chemical Engineering Science **69**(1), 602-606 (2012)
"Drop impact and agglomeration under static powder bed conditions," with A.C.S. Lee, AIChE Journal **58**(1), 79-86 (2012)
"An Experimental Investigation on the Breakup of Surfactant-Laden non-Newtonian Jets," with A. Dechelette, O. Campanella, and C. Corvalan, Chemical Engineering Science **66**(24), 6367-6374 (2011)
"A Review of Pharmaceutical Tablet Coating," with A.R. Muliadi, Atomization and Sprays **20**(7), 611-638 (2010)
"An Experimental Study of Swirling Supercritical Hydro-Carbon Fuel Jets," with R.R. Rachedi and L.C. Crook, ASME Journal of Gas Turbines and Power **132**(8), 081502 (2010)
"Non-Newtonian Drops Impacting Pharmaceutical Tablet Surfaces: Theoretical Analysis with Experimental Verification," with A. Dechelette and C.R. Wassgren," ASME Journal of Fluids Engineering **132**(10), 101302 (2010)
"Secondary Breakup of Electrostatically Charged Drops," with D.R. Guildenbecher, Atomization and Sprays **21**(2), 139-147 (2011)
"A Comparison of Particle Dynamics Analyzer (dual-PDA) and Optical Patternator Data for Twin-fluid and Pressure-swirl Atomizer Sprays," with A.R. Muliadi, Y.R. Sivathanu and J. Lim, ASME Journal of Fluids Engineering **132**(6) 061402-1 (2010)

Professional Development Activities (past 5 years)
Session Chairman, ICLASS-09, Vail, CO (July 2009)
Reviewer, Atomization and Sprays

Steven F. Son
Professor, School of Mechanical Engineering

Education
BSME, Brigham Young University, 1989
MSME, Brigham Young University, 1989
Ph.D., ME, University of Illinois at U-C, 1993

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2011 – Present, Full Time
Purdue University, Associate Professor, Mechanical Engineering, 2006 – 2011, Full Time
The Pennsylvania State University, Visiting Scientist/Professor, 2005 – 2006, Full-Time
(sabbatical from Los Alamos National Laboratory

Non-Academic Experience
Los Alamos National Laboratory, Project Leader, Lead research teams on advanced energetic materials and combustion synthesis, 1996 – 2006, Full Time
Los Alamos National Laboratory, Technical Staff Member, Researcher studying combustion of energetic materials, combustion synthesis, and nanoenergetics, 1996 – 2006, Full Time
Los Alamos National Laboratory, J. Robert Oppenheimer Fellow, Researcher studying deflagration-to detonation transition, and convective burning, 1993 – 1996, Full Time

Certifications or Professional Registrations None

Current Membership in Professional Organizations
American Society of Mechanical Engineers, 1989 – Present
American Institute of Aeronautics and Astronautics, 1993 – Present

Honors and Awards
Named Purdue Faculty Scholar, 2010 – 2015
Paper selected as Editor's Suggested Article for Physical Review B, 2009
Purdue's Seed for Success Award (Acorn Awards), 2009
Distinguished Paper Award in Colloquium Detonations, Explosions and Supersonic Combustion at the Thirty-first International Symposium on Combustion, 2007
R&D 100 Award Winner, "A Metal-Nanofoam Fabrication Technique: nanoFOAM", 2005
Named to An Incomplete List of Teachers Ranked as Excellent by Their Students for the Spring Semester of 1993 in the Daily Illini
Alumni Board Teaching Fellowship, 1993

Service Activities
Colloquium Chair of the Heterogeneous Combustion area for the International Combustion Symposium, 2012
Joint Propulsion Conference Technical Area Organizer for Energetic Components & Systems, 2012
Elected and served as Conference Chair for 2010 Gordon Research Conference on Energetic Materials (2010)
Joint Propulsion Conference Technical Area Organizer for Energetic Components & Systems, 2011
Serving as an Associate Editor of the AIAA Journal of Propulsion and Power (2005 – Present)
Serving as an Associate Editor of the International Journal of Energetic Materials and Chemical Propulsion, 2009 – Present

Served on the editorial Advisory Board of the journal Propellants, Explosives, Pyrotechnics, 2010 – 2012
Serving on the National Academies Panel on Armor and Armaments for Army Research Laboratory (ARL), 2009 – Present
Session Chair at the American Physical Society's 16th APS Topical Conference on Shock Compression of Condensed Matter, 2009
Session Chair at the AIAA Joint Propulsion Meeting, 2009
Taught professional short course on, "Combustion of Nanoenergetic Materials,", 2010
Taught professional short course on, "Combustion of Energetic Materials,", 2009
Served on Graduate Committee (School of Mechanical Engineering), 2008 – 2010
Served on Honors Program Committee (School of Mechanical Engineering), 2007 – 2008
Served on Grievance Committee (Purdue University), 2008 – 2009
Served as Conference Vice-Chair for 2008 Gordon Research Conference on Energetic Materials, 2008

Principal Publications and Presentations (Most important from past 5 years)

T. D. Hedman, K. Y. Cho, A. Satija, L. J. Groven, R. P. Lucht, and **S. F. Son**, "Experimental Observation of the Flame Structure of a Bimodal Ammonium Perchlorate Composite Propellant Using 5 kHz PLIF", Combust. Flame 159 (2012) 427-437
A. H. Yan, **S. F. Son**, T. L. Jackson, and P. Venugopal, "Validation of Numerical Simulations for Nano-Aluminum Composite Solid Propellants," J. Propulsion, Vol. 27(6), pp. 1280-1287, 2011
M. D. Alley, B. R. Schimizze, and **S. F. Son**, "Experimental modeling of explosive blast-related traumatic brain injuries," Neurimage, Vol. 54(1), pp. S45-S54, 2011
R. V. Reeves, A. S. Mukasyan and **S. F. Son**, "Thermal and Impact Reaction Initiation in Ni/Al Heterogeneous Reactive Systems," J. Phys. Chem. C, Vol. 114(35), pp. 14772-14780, 2010
C. D. Yarrington, **S. F. Son**, and T. J. Foley, "Combustion of Silicon/Teflon/Viton and Aluminum/Teflon/Viton Energetic Composites," J. Propulsion, Vol. 26(4), pp. 734-743, 2010
J. D. E. White, R. V. Reeves, **S. F. Son**, and A. S. Mukasyan, "Thermal Explosion in Al-Ni System: Influence of Mechanical Activation," Journal of Physical Chemistry A, Vol.113, iss.48, p.13441-13447, 2009
R. V. Reeves, **S. F. Son**, J. White, A. S. Mukasyan, E. M. Dufrensene and K. Fezzaa, "Microstructural transformations and kinetics of high-temperature heterogeneous gasless reactions by high-speed x-ray phase-contrast imaging," Physical Review B, Vol.80, iss.22, p. 224103, 2009
R. A. Yetter, G. A. Risha, and **S. F. Son**, "Metal Particle Combustion and Nanotechnology," Proceedings of the Combustion Institute, Vol. 32, pt.2, p.1819-1838, 2009
S. F. Son, B. W. Asay, T. J. Foley, R. A. Yetter, M. H. Wu, and G. A. Risha, "Combustion of Nanoscale Al/MoO3 Thermite in Microchannels," Journal of Propulsion and Power, Vol. 24(3), pp. 715-721, 2007
V. I. Levitas, B. W. Asay, **S. F. Son**, and M. Pantoya, "Mechanochemical Mechanism for Fast Reaction of Metastable Intermolecular Composites Based on Dispersion of Liquid Metal," Journal of Applied Physics, Vol. 101(8), p. 83524-1, 2007
J. Y. Malchi, R. A. Yetter, **S. F. Son**, and G. A. Risha, "Nano-Aluminum Flame Spread with Fingering Combustion Instabilities," Proceedings of the Combustion Institute, Vol. 31, pp. 2617-2624, 2007
G. A. Risha, **S. F. Son**, B. C. Tappan, R. A. Yetter, and V. Yang, "Combustion of Nano-Aluminum and Liquid Water," Proceedings of the Combustion Institute, Vol. 31, pp. 2029-2036, 2007
M. H. Wu, M. P. Burke, **S. F. Son**, R. A. Yetter, "Flame Acceleration and the Transition to Detonation of Stoichiometric Ethylene/Oxygen in Microscale Tubes," Proceedings of the Combustion Institute, Vol. 31, pp. 2429-2436, 2007

Professional Development Activities (Past 5 years)

None

John M. Starkey
Associate Professor,
School of Mechanical Engineering

Education
BSME, Ohio State University, 1978
MSME, Ohio State University, 1979
Ph.D., ME, Michigan State University, 1982

Academic Experience
Purdue University, Associate Professor, Mechanical Engineering, 1989 – Present, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1982 – 1989, Full-Time

Non-Academic Experience
Cummins Engine Company, Summer Faculty Intern, Summer 1993
Battelle Columbus Laboratories, Researcher, Summer 1980
Patent Litigation Expert, 1999 – 2003
PEARL (Product Engineering and Realization Laboratory), Director, in charge of Senior Design, 2011 – Present

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Member, Society of Automotive Engineers
Member, American Society of Mechanical Engineers

Honors and Awards
Graduated summa cum laude, BSME, Ohio State University, 1978
SAE Ralph R. Teetor Award, for significant teaching and research contributions in the area of mobility technology, 1995
Outstanding SAE Faculty Advisor, 1998
Harry L. Solberg Award, April 2006 (Presented annually to an outstanding teacher in the Purdue University School of Mechanical Engineering)
Harry L. Solberg Award, April 2010 (Presented annually to an outstanding teacher in the Purdue University School of Mechanical Engineering)

Service Activities
None

Principal Publications and Presentations (Most important from past 5 years)
Talbot, Michael S., and **Starkey, John M.**, "An Experimentally Validated Physical Model of a High-Performance Automotive Mono-Tube Damper," SAE 2002 Transactions – Journal of Passenger Cars: Mechanical Systems.Vol ?? No. ??, 2002, pp 2422 – 2439
Talbot, Michael, and **Starkey, J. M.**, "An Experimentally Validated Physical Model of a High Performance Automotive Monotube Damper," Proceedings of the 2002 Motorsports Engineering Conference, Indianapolis Indiana, December 2002

Manes, Nino Enrico, and **Starkey, John M.**, "Derivation of the Three-Dimensional Installation Ratio for Dual A-Arm Suspensions," ," SAE Paper #2004-01-3535, Proceedings of the 2004 Motorsports Engineering Conference, Dearborn Michigan, December 2004, pp. 291 – 300

Manes, Nino Enrico, and **Starkey, John M.**, "Novel Force-Based High-Speed Three-Dimensional NASCAR Vehicle Model," SAE Paper #2004-01-3525, Proceedings of the 2004 Motorsports Engineering Conference, Dearborn Michigan, December 2004, pp. 199 – 211

Professional Development Activities (Past 5 years)

None

Ganesh Subbarayan
Professor, School of Mechanical Engineering

Education
BTech, ME, Indian Institute of Technology, Madras, India, 1985
Ph.D., ME, Cornell University, Ithaca, NY, 1991

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2005 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 2002 – 2005, Full-Time
University of Colorado, Boulder, CO, Associate Professor, Mechanical Engineering, 1999 – 2002
University of Colorado, Boulder, CO, Assistant Professor, Mechanical Engineering, 1994 – 1999

Non-Academic Experience
IBM Corporation, Endicott, NY, Development Staff Member, 1990 – 1993

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow, American Society of Mechanical Engineers
Fellow, Institute of Electrical and Electronics Engineers

Honors and Awards
Ruth and Joel Spira Award for Excellence in Teaching, 2011
Intel Best Student Paper Award, 2011 IEEE 61st Electronic Components and Technology Conference, 2011
Elected Fellow, IEEE, 2011
Best Paper of the Year Award, *ASME Journal of Electronic Packaging, 2008 – 2009*
Outstanding Paper Award, Thermal Track, IEEE Eleventh Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems (Itherm 2008), 2008
Fellow, ASME, 2006
University Faculty Scholar Award, Purdue University, 2005 – 2010
"Mechanics Award," Electronic and Photonic Packaging Division, ASME, November 2005
Discovery in ME Award, School of Mechanical Engineering, Purdue University, 2005
Best in Session Award, Modeling and Metrology, Semiconductor Research Corporation (SRC) Technical Conference, October 2005
Charles E. Ives Outstanding Paper Award (honorable mention, one of two papers selected for this mention), J. Imaging Science and Technology, 2003
Highly Commended Award, Soldering & Surface Mount Technology Journal, 2002
Best Paper Award, IEEE Seventh Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems, (Itherm 2000)
NSF CAREER Award, April 1998
Peter A. Engel Best Paper Award, Journal of Electronic Packaging, 1996
IBM University Partnership Project Award, September 1995
NSF Research Initiation Award, July 1994
Invention Achievement Award, IBM Corporation, July 27, 1993

An Outstanding Teaching Assistant Award, Cornell University, 1988

Service Activities

Topical Editor, Advanced Packaging, 2011-12, Encyclopedia of Electrical and Electronics Engineering, John Wiley & Sons

Editor-in-Chief, *IEEE Transactions on Advanced Packaging, 2002 – 2010*

Member of Editorial Board, *International Journal for Computational Methods in Engineering Science and Mechanics, 2008 – Present*

Program Track Chair (Modeling and Simulation), ASME/Pacific Rim 2011 International Intersociety Electronics and Photonics Packaging Conference (Interpack '11), July 2011

Program Committee Chair (Thermomechanical and MEMS), IEEE International Reliability Physics Symposium, April 2011

Program Track Chair (Modeling and Simulation), ASME/Pacific Rim 2009 International Intersociety Electronics and Photonics Packaging Conference (Interpack '09), July 19-23, 2009

Awards Committee Chair, ASME EPP Division, 2010

Awards Committee Member, ASME EPP Division, 2007 – 2009

Principal Publications and Presentations (Most important from past 5 years)

<u>Refereed Journal Publications</u>

A.Tambat and **G. Subbarayan**. "Isogeometric Enriched Field Approximations," *Computer Methods in Applied Mechanics and Engineering,* in press

N. Bajaj, **G. Subbarayan** and S. Garimella, "Topological Design of Channels for Squeeze Flow Optimization of Thermal Interface Materials." *International Journal of Heat and Mass Transfer*, vol. 55, pp. 3360-3575, 2012

D. Chan, **G. Subbarayan**, and L. Nguyen. "Maximum Entropy Principle for Modeling Damage and Fracture in Solder Joints: Enabling Life Predictions under Microstructural Uncertainty," Invited Paper, *Journal of Electronic Materials,* vol. 41, no. 2, pp. 398-411, 2012

S. Goyal, K. Srinivasan, **G. Subbarayan** and T. Siegmund "On Instability-Induced Debond Initiation in Thin Film Systems," *Engineering Fracture Mechanics*, vol. 77, pp. 1298-1313, 2010

V. Srinivasan, S. Radhakrishnan and **G. Subbarayan**, "Coordinated Synthesis of Hierarchical Engineering Systems," *Computer Methods in Applied Mechanics and Engineering*, vol. 199, pp. 392-404, 2010

K. Srinivasan, S. Goyal, T. Siegmund, **G. Subbarayan** and Q. Lin, "Thermally-Induced Wrinkling in Thin-Film Stacks on Patterned Substrates," *IBM Journal of Research and Development*, vol. 53, no. 3, pp. 12:1-12:10, 2009

S. Kanuparthi, M. Rayasam, **G. Subbarayan**, B.G. Sammakia, A. Gowda, and S. Tonapi,. "Hierarchical Compositions for Simulations of Near-Percolation Thermal Transport in Particulate Materials." *Computer Methods in Applied Mechanics and Engineering*, vol. 198, pp. 657-668, 2009

S. Mahajan, **G. Subbarayan** and B.G. Sammakia, "Estimating Thermal Conductivity of Amorphous Silica Nano-Particles and Nano-Wires using Molecular Dynamics Simulations," *Physical Review E*, 76, 056701, 2007

M. Rayasam, V. Srinivasan, and **G. Subbarayan**. "CAD Inspired Hierarchical Partition of Unity Constructions for NURBS-based Meshless Design, Analysis and Optimization." *International Journal for Numerical Methods in Engineering*, vol. 72, pp. 1452-1489, 2007

Y. Luo and **G. Subbarayan**. "A Study of Multiple Singularities in Multi-Material Wedges and their Use in Analysis of Microelectronic Interconnect Structures." *Engineering Fracture Mechanics*, vol. 74, no. 3, pp. 416-430, 2007

Professional Development Activities (Past 5 years)

None

John W. Sutherland, Ph.D.
Professor and Fehsenfeld Family Head of Environmental and Ecological Engineering and Professor of Mechanical Engineering
Purdue University

Education
BSIE, University of Illinois at Urbana-Champaign, 1980
MSIE, University of Illinois at Urbana-Champaign, 1982
Ph.D., ME, University of Illinois at Urbana-Champaign, 1987

Academic Experience
Purdue University, Professor & Fehsenfeld Family Head, Environmental & Ecological Engineering, 2009 – Present
Michigan Technological University, Director, Sustainable Futures Institute, 2003 – 2009
Michigan Tech. University, Henes Chair Professor, Mechanical Engineering, 2002 – 2009
Michigan Tech. University, Professor & Associate Chair, Mechanical Engineering, 1997 – 2001
Michigan Tech. University, Associate Professor, Mechanical Engineering, 1995 – 1997
Michigan Tech. University, Assistant Professor, Mechanical Engineering, 1991 – 1995
University of Illinois, Various Adjunct/Visiting Appointments, Mechanical & Industrial Engineering, 1985 – 1991

Non-Academic Experience
Process Design and Control, Inc., Champaign, Illinois, Vice-President, 1989 – 1991

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow, American Society of Mechanical Engineers, College International pour la Recherche en Productique (CIRP – International Academy for Production Engineering), Society of Manufacturing Engineers
Member, American Society for Quality, Institute of Industrial Engineers, Society of Automotive Engineers, Association of Environmental Engineering and Science Professors, Alpha Pi Mu, Phi Kappa Phi, Pi Tau Sigma, Sigma Xi, Tau Beta Pi

Honors & Awards
SAE International John Connor Environmental Award, 2010
Outstanding Lifetime Service Award from NAMRI/SME, 2010
ASME Dedicated Service Award, 2009
SME Education Award, 2009
ASME Manufacturing Engineering Division Outstanding Service Award, 2001 and 2004
Recipient of the Michigan Technological University Research Award, 2000
SAE Ralph R. Teetor Educational Award, 1999
Presidential Early Career Award for Scientists and Engineers, 1996
National Science Foundation Career Development Award, 1995
Honored by the Michigan Association of Governing Boards of State Universities as a Distinguished Faculty Member, 1993
Recipient of the Michigan Technological University Distinguished Teaching Award, 1992
Outstanding Young Manufacturing Engineer Award (SME), 1992

Andersen Consulting Award for Excellence in Undergraduate Advising, College of Engineering, UIUC, 1989

Service Activities

Various committees, Environmental and Ecological Engineering, 2009 – Present
Search Comm. for Feddersen Professorship in Mech. Engr. and Information Technology, 2009 – 2010
College of Engineering: Leadership Team (2009-present), Committee on Committees (2010), Finance Committee (2010 – Present)
Purdue: ESE Governance Committee (2009-present), Review Committee for Director of the Center for the Environment (2011), Search Committee for Director of the Center for the Environment (2012)
Member, Scientific Committee of NAMRI/SME
Member, Merchant Medal Selection Committee, ASME/SME
Committee Chair, ASME/CRTD Research Committee on Sustainable Products and Processes
Secretary, Scientific and Technical Committee (STC-A): Life Cycle Engineering and Assembly
Member, numerous program/scientific/steering committees for conferences

Principal Publications and Presentations (Most important from past 5 years)

Haapala, K. R., J. L. Rivera, and **J. W. Sutherland**, "Application of Life Cycle Assessment Tools to Sustainable Product Design and Manufacturing," International Journal of Innovative Computing, Information and Control, Special Issue on Recent Advances in Flexible Automation, Vol. 4, No. 3, 2008, pp. 577-591
Sutherland, J. W., D. P. Adler, K. R. Haapala, and V. Kumar, "A Comparison of Manufacturing and Remanufacturing Energy Intensities with Application to Diesel Engine Production," Annals of CIRP, Vol. 57, No. 1, 2008, pp. 5-8
Kumar, V. and **J. W. Sutherland**, "Sustainability of the Automotive Recycling Infrastructure: Review of Current Research and Identification of Future Challenges," International Journal of Sustainable Manufacturing, Vol. 1, Nos. 1/2, 2008, pp. 145-167
Hutchins, M. J. and **J. W. Sutherland**, "An Exploration of Measures of Social Sustainability and Their Application to Supply Chain Decisions," Journal of Cleaner Production, Vol. 16, No. 15, 2008, pp.1688-1698
Ju, C., J. Sun, D. J. Michalek, and **J. W. Sutherland**, "Development of an Imaging System and Its Application in the Study of Cutting Fluid Atomization in a Turning Process," Particulate Science and Technology: An International Journal, Vol. 26, No. 4, 2008, pp. 318-336
Kumar, V., **J. W. Sutherland**, "Development and Assessment of Strategies to Ensure Economic Sustainability of the U.S. Automotive Recovery Infrastructure," Resources, Conservation & Recycling, Vol. 53, No. 8, June 2009, pp. 470-477
Sun, J., C. Ju, D. J. Michalek, and **J. W. Sutherland**, "Evaporation and Settling Behavior of Metalworking Fluid Aerosols," Particulate Science and Technology: An International Journal, Vol. 27, No. 3, 2009, pp. 245-262
Sutherland, J. W., T. L. Jenkins, and K. R. Haapala, "Development of a Cost Model and its Application in Determining Optimal Size of a Diesel Engine Remanufacturing Facility," Annals of CIRP, Vol. 59/1, 2010, pp. 49-52
Ramani, K., D. Ramanujan, W. Z. Bernstein, F. Zhao, **J. Sutherland**, C. Handwerker, J-K Choi, H. Kim, and D. Thurston, "Integrated Sustainable Life Cycle Design: A Review," Trans. of ASME, Journal of Mechanical Design, Vol. 132, Issue 9, Sept. 2010
Fang, K., N. Uhan, F. Zhao, and **J. W. Sutherland**, "A New Approach to Scheduling in Manufacturing for Power Consumption and Carbon Footprint Reduction," SME J. of Manufacturing Systems, Vol. 30/4, 2011, pp. 234-240

Professional Development Activities (Past 5 years) None

Andrea Vacca
Assistant Professor, Dept. of Agricultural & Biological Engineering
School of Mechanical Engineering

Education
BS, Engineering Science, University of Michigan, 1979
MSME, University of Parma, Italy, 1999
(5 years degree, with honor)
Ph.D.,ME, Energy Systems, University of Florence, Italy, 2005

Academic Experience
Purdue University, Assistant Professor, Agricultural and Biological Engineering, Mechanical Engineering, 2010 – Present, Full-Time

Non-Academic Experience
University of Parma, Italy, Assistant Professor, 2005 – 2010, Full-Time

Consulting and Industrial Collaboration (Past 5 years):
Case New Holland (USA), Casappa (Italy), Walvoil (Italy), Parker Hannifin (USA), NEM (Italy), Parmafluid (Italy), Tigieffe (Italy), MGI Coutier (France), GEA (Italy)

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Member: American Society of Mechanical Engineers (ASME), Society of Automotive Engineers (SAE), Fluid Power Net International (FPNI), Italian Fluid Power Association (ASSOFLUID), Centro Interuniversitario di Ricerca e Trasporti (CIRT)

Honors and Awards
Graduated summa cum laude, University of Parma, 1999
SAE Excellence in Oral Presentation Award, SAE Commercial Vehicle Conference, ‘08

Service Activities
SAE – Fluid Power and Hydraulic Division Chair (SAE COMVEC), 2011 – Present
Associate Editor for International Journal of Fluid Power, 2011 – Present
Faculty member of CCEFP (Center for Compact and Efficient Fluid Power, NSF Engineering Research Center), 2010 – Present
Member of Purdue ABE Graduate Committee, 2010 – Present
SAE – Fluid Power and Hydraulic Division Co-Chair (SAE COMVEC), 2010 – 2011
Reviewer for: International Journal of Fluid Power, Simulation; Modelling Practice and Theory (Elsevier); International Journal of Heat & Technology; Journal of Visualization (Springer); Mechatronics (Elsevier); Strojniški vestnik - Journal of Mechanical Engineering; International Journal of Engineering, Science and Technology.

Principal Publications and Presentations (Most important from past 5 years)

Refereed Journal Publications

Dhar S., **Vacca A.**, 2012, *A Novel CFD- Axial Motion Coupled Model for the Axial Balance of Lateral Bushings in External Gear Machines,* Elsevier Simulation Modelling Practice and Theory, 26 (2012) 60–76

Cristofori D., **Vacca A.**, 2012, *The Modeling of Electro-Hydraulic Proportional Valves, ASME Journal of Dynamic Systems, Measurement and Control,* Vol.134, Issue 2, 021008

Vacca A., Guidetti M., 2011, *Modelling and Experimental Validation of External Spur Gear Machines for Fluid Power Applications,* Elsevier Simulation Modelling Practice and Theory, 19 (2011) 2007–2031

Vacca, A., Klop, R., Ivantysynova, M., 2010, *A Numerical Approach for the Evaluation of the Effects of Air Release and Vapour Cavitation on Effective Flow Rate of Axial Piston Machines,* International Journal of Fluid Power, Vol. 11, N.1, March 2010

*Casoli, P., **Vacca, A**., Berta, G.L., 2009,* A Numerical Procedure for Predicting the Performance of High Pressure Homogenizing Valves, *Elsevier SIMPAT journal - Simulation Modelling Practice and Theory 18 (2010) 125–138*

***Vacca, A**., Franzoni, G., Bonati, F., 2008,* An Inclusive, System-Oriented Approach for the Study and the Design of Hydrostatic Transmissions: The Case of an Articulated Boom Lift, *SAE Int. Journal of Commercial Vehicles vol. 1, April 2009 pp. 488-494*

***Vacca, A**., Cerutti, M., 2007,* Analysis and Optimization of a Two-Way Valve Using Response Surface Methodology, *International Journal of Fluid Power, Vol. 8, N. 3, November 2007, pp. 43-59*

Refereed Conference Proceedings

Schweiger W., Scheofman W., **Vacca A**., 2011, *A Omni-Comprehensive Approach for the Design and Simulation of Gerotor Pumps*, 8IFK International Fluid Power Conference, 26th - 28th March 2012, Dresden, Germany

***Vacca A**., Dhar S., Opperwall T., 2011,* A Coupled Lumped Parameter and CFD Approach for Modeling External Gear Machines, *SICFP2011 The Twelfth Scandinavian International Conference on Fluid Power, May 18-20, 2011, Tampere, Finland*

Klop, R., **Vacca, A**., Ivantysynova, M., 2009, *A Method of Characteristics Based Coupled Pump/Line Model to Predict Noise Sources of Hydrostatic Transmission*, ***Bath**/**ASME*** Symposium on Fluid Power & Motion Control (FPMC ***2009***). 12-14 October ***2009***, Hollywood, California

Professional Development Activities (Past 5 years)

2012: Invited seminar on "Research Trends and Modeling of Gear Machines for Hydraulic Applications", March 29, 2012, Wroclaw University of Technology, Poland

2012: Session organizer for SAE 2012 Commercial Vehicle Engineering Congress and Exhibition, *October 2-4,* **2012**, *Rosemont, IL, USA*

2012: Member of Scientific Committee and Session organizer for 7th FPNI (Fluid Power Net International) – PhD Symposium, June 27-30 2012, Reggio Emilia, Italy

2012: Session chair for 8th International Fluid Power Conference, March 26-28 2012, Dresden, Germany

2011: Session organizer for SAE 2011 Commercial Vehicle Engineering Congress and Exhibition, *September 13-14,* **2011**, *Rosemont, IL, USA*

2010: Session organizer for 6th FPNI (Fluid Power Net International) – PhD Symposium, June 15-19 2010, West Lafayette (IN), USA

Carl R. Wassgren, Jr.
Professor, School of Mechanical Engineering

Education
BSAAE, University of Illinois at Urbana-Champaign, 1990
MSME, California Institute of Technology, 1992
Ph.D., ME, California Institute of Technology, 1997

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2010 – Present, Full-Time
Purdue University, Professor, Department of Industrial and Physical Pharmacy (by courtesy), 2010 – Present, Part-Time
Purdue University, Associate Professor, Mechanical Engineering, 2004 – 2010, Full-Time
Purdue University, Associate Professor, Department of Industrial and Physical Pharmacy (by courtesy), 2005 – 2010, Part-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1998 – 2004, Full-Time

Non-Academic Experience
Assistant Professor, Clemson University (1996 – 1998); Member of Technical Staff-Systems Engineering Laboratory, Hughes Aircraft Company – Space and Communications Group (1990-1991)

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Affiliate, American Institute of Chemical Engineers, AIChE

Honors and Awards
Byars' Prize (Clemson University, 1997)
NSF CAREER Award recipient, 1999
Purdue University Teaching for Tomorrow Award recipient, 2004
Spira Award for Outstanding Contributions to the School of Mechanical Engineering and its Students, 2005
Member of the 2010 College of Engineering Team Excellence Award
Solberg Award for the Best Teacher in Mechanical Engineering, 2010
Fellow of the Teaching Academy of Purdue University (elected May 2012)

Service Activities
Session Organizer and Chair of "Dynamics and Modeling of Particulate Systems I&II," 2009 Annual AIChE Meeting; Reviewer for: *Chemical Engineering Science*, *Industrial and Engineering Chemistry Research*, *AIChE Journal*, *Powder Technology*, *Journal of Engineering Tribology*, *Physics of Fluids*; ME Fluid Mechanics and Propulsion Area Chairman, ME Curriculum Committee, ME Graduate Committee, College of Engineering Team on Developing Passionate and Effective Teachers, ME Head Search Committee, ME Fluid Mechanics Faculty Search Committee; Purdue Education and Outreach Director for the Center on Structured Organic Particulate Systems

Principal Publications and Presentations (Most important from past 5 years)

Refereed Journal Publications

Kodam, M., Bharadwaj, R., Curtis, J., Hancock, B., and **Wassgren, C.**, 2010, "Cylindrical object contact detection for use in discrete element method simulations. Part I: Contact detection algorithms," *Chemical Engineering Science*, Vol. 65, No. 22, pp. 5852 - 5862

Kodam, M., Bharadwaj, R., Curtis, J., Hancock, B., and **Wassgren, C.**, 2010, "Cylindrical object contact detection for use in discrete element method simulations. Part II: Experimental Validation," *Chemical Engineering Science*, Vol. 65, No. 22, pp. 5863 - 5871

Freireich, B., Ketterhagen, W.R., and **Wassgren, C.**, 2011, "Intra-tablet coating variability for several pharmaceutical tablet shapes," *Chemical Engineering Science*, Vol. 66, No. 12, pp. 2535 – 2544

Freireich, B., Li, J., Litster, J., and **Wassgren, C.**, 2011, "Incorporating particle flow information from discrete element simulations in population balance models of mixer-coaters," *Chemical Engineering Science*, Vol. 66, No. 16, pp. 3592 – 3604

Li, J., Freireich, B., **Wassgren, C**., and Litster, J., 2011, "A general compartment-based population balance model for particle coating and layered granulation," *AIChE Journal*, DOI: 10.1002/aic.12678

Rao, A., Hancock, B., **Wassgren, C.**, and Curtis, J.S., 2011, "Numerical simulation of dilute turbulent gas-particle flow with turbulence modulation," *AIChE Journal*, DOI: 10.1002/aic.12563

Kodam, M., Curtis, J., Hancock, B., and **Wassgren, C.**, 2011, "Discrete element method modeling of bi-convex pharmaceutical tablets: Contact detection algorithms and validation," *Chemical Engineering Science*, Vol. 69, No. 1, pp. 587 – 601

Muliadi, A., **Wassgren, C.**, Litster, J., 2012, "Modeling the powder roll compaction process: Comparison of 2-D finite element method and the rolling theory for granular solids (Johanson's model)," *Powder Technology*, Vol. 221, pp. 90 – 100

Li, J., Freireich, B.J., **Wassgren, C.R.**, and Litster, J., 2012, "Experimental validation of a 2-D population balance model for spray coating processes," *Chemical Engineering Science*, doi: 10.1016/j.ces.2012.02.036

Sarkar, A. and **Wassgren, C.R**., 2012, "Comparison of flow microdynamics for a continuous granular mixer with predictions from periodic slice DEM simulations," *Powder Technology*, Vol. 221, pp. 325 – 336

Professional Development Activities (Past 5 years):

Participated in four on-campus College Teaching Workshops

Steven T. Wereley
Professor, School of Mechanical Engineering

Education
BA, Physics, Lawrence University, 1990
BSME, Washington University, 1990
MSME, Northwestern University, 1992
Ph.D., ME, Northwestern University, 1997

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2010 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 2005 – 2010, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1999 – 2005, Full-Time
University of California, Santa Barbara, CA, Post Doctoral Scholar, Experimental Microfluidics, 1997 – 1999

Non-Academic Experience
None

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
None

Honors and Awards
3rd Prize, ASME-IMECE Society-Wide Micro/Nano Technology Forum Best Poster Competition, HS Chuang, A Kumar, and ST Wereley, - Rapid Electrokinetic Pattering of Colloidal Particles with Optical Landscapes, Lake Buena Vista, Florida, 2009
Alexander von Humboldt Fellow, 3/2007-8/2007, 6/2008-7/2008, 6/2009-7/2009
1st Place, Gold Division, Burton D. Morgan Business Plan Competition. Ahmed M. Amin, S.C. Jacobson, M. Thottethodi, T.N. Vijaykumar and S.T. Wereley. ―Microfluidic Innovations., Purdue University, West Lafayette, IN, February 2009
2nd Place, Gold Division, Burton D. Morgan Business Plan Competition. SJ Williams, H.-S. Chuang and A Kumar. Liquid Qinetics. Purdue University, West Lafayette, IN, Feb. 24, 2009
1st Place Poster, Engineering Sciences, SJ Williams, A Kumar, and ST Wereley, ―Rapid electrokinetic patterning of colloids using optical landscapes‖ , 2009 Graduate Student Poster Competition sponsored by Sigma Xi, Purdue University, West Lafayette, IN, Feb. 2009
3rd Place, 2008 Ecological Science and Engineering Poster Competition. H.-S. Chuang and Steven T. Wereley. ―Open Optolelectrowetting Droplet Actuation for Lab-on-a-Chip Applications., Dec. 5, 2008
Outstanding Video, Gallery of Fluid Motion at Amer. Phys. Soc./Div. Fluid Dyn. Annual Meeting, SJ Williams, A Kumar, and ST Wereley, ―Optically induced electrokinetic pattering and manipulation of particles,, San Antonio, TX, Nov. 2008. Note: Most downloaded video from eCommons@Cornell for the month of December, 2008 (**http://hdl.handle.net/1813/11399**)

"2008 Highlight" distinction conferred by the journal Measurement Science and Technology to the article ―Three-dimensional particle tracking using micro-particle image velocimetry hardware by Peterson, Chuang, and Wereley

Young Researcher Poster Award Winner at Proc. 12th International Conference on Miniaturized Systems for Chemistry and Life Sciences (μTAS 2008), A Kumar, SJ Williams and ST Wereley, ―Rapid electrokinetic patterning of colloids using optical landscapes, San Diego, USA, Oct 12-16, 2008

Best Poster Award at the 2nd Annual Birck Nanotechnology Research Review, S. Williams, A. Kumar, and S.T. Wereley, ―Rapid electrokinetic patterning of colloidal particles with optical landscapes, April 14, 2008

Service Activities

Member of the US Government Flow Rate Technical Group responsible for measuring flow rate of oil related to the BP Macondo Oil Spill in the Gulf of Mexico (2010)

Section editor for Encyclopedia of Microfluidics and Nanofluidics (Springer 2008) which, for the first time, collected many disparate microfluidic topics in one volume

Member of Purdue Engineering-wide group reforming the first year curriculum to include nano science and nanotech topics

Collaborated with an electrical engineering professor at Nanyang Technical University in Singapore to write a microfluidics textbook currently being used at several universities to instruct micro systems/fluidics classes

Developed a micro-Particle Image Velocimetry (μPIV) software package that is currently used in many university and industrial locations

Principal Publications and Presentations (Most important from past 5 years)

5 Related Publications

Lehr W, et al. "Deepwater Horizon Release, Estimate of Rate by PIV," Plume Team report to the Flow Rate Technical Group. July 21, 2010. Seattle,WA. 215 pp. Available at www.doi.gov/deepwaterhorizon

ST Wereley and CD Meinhart, "Recent Advances in Micro Particle Image Velocimetry," Annual Review of Fluid Mechanics, Vol . 42 (2010)

S.J. Williams, A. Kumar and **S.T. Wereley**, "Electrokinetic patterning of colloidal particles with optical landscapes," Lab on a Chip (2008). DOI: 10.1039/b810787d

M. Raffel, C. Willert, **S. Wereley**, J. Kompenhans, Particle Image Velocimetry: A Practical Guide, Springer, New York (2007)

N.T. Nguyen and **S.T. Wereley**, Fundamentals and Applications of Microfluidics *(2nd edition)*, Artech House, Boston, 2006

5 Other Papers

A. Kumar, S.J. Williams and **S.T. Wereley,** "Experiments on opto-electrically generated vortices," Microfluidics and Nanofluidics (2008). DOI: 10.1007/s10404-008-0339-8

H.S. Chuang, A. Kumar, and **S.T. Wereley**, "Open Optoelectrowetting Droplet Actuation," Applied Physics Letters, Vol. 93, 064104 (2008)

H. Sagi, Y. Zhao, and **S.T. Wereley**, "Wide Range Flow Sensor—Vacuum through Viscous Flow Conditions," J. Vac. Sci. and Tech. A, Vol. 22, No. 5, pp. 1992-1999 (2004)

C.D. Meinhart, **S.T. Wereley**, and J.G. Santiago, "Micron-Resolution Velocimetry Techniques," Developments in Laser Techniques and Applications to Fluid Mechanics, R. J. Adrian et al. (Eds.), Springer-Verlag, Berlin, pp. 57-70, (2000)

S.T. Wereley and R.M. Lueptow, "Inertial particle motion in a Taylor Couette rotating filter," Phys. Fluids, Vol. 11, No. 2, 325-333, (1999)

Professional Development Activities (Past 5 years)

None

Xianfan Xu
James J. and Carol L. Shuttleworth Professor of Mech. Engr
School of Mechanical Engineering

Education
BS, Engineering Thermophysics, University of Science and Technology of China, China, 1989
MSME, University of California, Berkeley, 1991
Ph.D., ME, University of California, Berkeley, 1994

Academic Experience
Purdue University, Professor, Mechanical Engineering, July 2004 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, July 2000 – June 2004, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, Nov. 1994 – June 2000, Full-Time
University of Science and Technology of China, Hefei, China, Guest Professor, February 2006 - Present

Non-Academic Experience
National Institute of Standards and Technology, Gaithersburg, MD, Visiting Scientist, July 2002 – Dec. 2002

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Mechanical Engineers
The International Society for Optical Engineering (SPIE)
The Optical Society of America

Honors and Awards
GM Faculty Fellow, 1995, 1996
The National Science Foundation Faculty Early Career Award, 1996
The Office of Naval Research Young Investigator Award, 2000
B.F.S. Schaefer Young Faculty Scholar Award, 2002
Purdue University, School of Mechanical Engineering Discovery in Mechanical Engineering (DME) Award, October 2009
Keynote and Invited speaker at the Gordon Research Conference on Laser Interactions with Materials; OSA - Frontiers in Optics; AIAA Thermophysics Conference; Colloquium on the Physics of Quantum Electronics; SPIE Annual Meeting, Photonics West, Photonics North, and Optics East; the MRS Meeting; IEEE/OSA Conference on Lasers and Electro-Optics(CLEO), many academic institutes, national labs, and companies (95 total).
Fellow, the American Society of Mechanical Engineers, 2006
Fellow, SPIE - the International Society for Optical Engineering, 2009
James J. and Carol L. Shuttleworth Professor, 2010

Service Activities
Co-Chair, ASME International Conference on Integration and Commercialization of Micro- and Nano-systems, January 07, Sanya, China
Co-chair, Nanomanufacturing Conference at the International Congress on Applications of Lasers and Electro-Optics (ICALEO), October 2011, Orlando, FL, October, 2012, Anaheim, CA
Co-Chair, Conference on Laser Applications in Microelectronic and Optoelectronic Manufacturing (LAMOM), January, 2011, San Francisco, CA; January 2012, San Francisco, CA

Co-Chair, NanoTrends – the 1st Forum on Trends in Nano-manufacturing, October 2011, Hefei, Anhui, China; the 2nd Forum on Trends in Nano-manufacturing, October 2012, Suzhou, Jiangsu, China

Member of the Program Committee, SPIE Photonics West, Conference on the Synthesis and Photonics of Nanoscale Materials, 2005, 2006, 2007, 2008, San Jose, CA; 2010, 2011, 2012, San Francisco, CA

Member of the Program Committee, Nano Photonics & Cell Technologies for Photovoltaics at the SPIE Optics and Photonics, August 2008, August 2009, August 2010, August 2011, August 2012, San Diego, CA

Member of the Program Committee, ASME 2nd and 3rd Energy Nanotechnology International Conference, September 2007, Santa Clara, CA; September 2008, Jacksonville, FL

Member of the Technical Committee, ASME Micro/nano Heat Transfer International Conference, January 2008, Tainan, Taiwan; December 2009, Shanghai, China

Member of the International Steering Committee, International Conference on Laser Ablation, Tenerife, Spain, September 2007; Singapore, November 2009, Cancun, November 2011

Member of the Program committee, the 6th Asia-Pacific Conference on Near-field Optics, June 2007, Auhui, China

Member of the International Advisory Committee, the International Conference on Photo Excited Processes and Applications (ICPEPA5), September 2006, Charlottesville, Virginia; September 2008, Sapporo, Hokkaido, Japan; August, 2010, Copenhagen, Denmark, August 2012, Rochester, NY

Chairman of the technical session "Lattice Phenomena," at the 2004 Gordon Research Conference on Laser Interactions with Materials, Proctor Academy, Andover, NH

Principal Publications and Presentations (Most important from past 5 years)

Wei, D., Mitchell, J.I., Transarawiput C., Nam, W., Qi, M., Ye, P.E., and **Xu, X.**, “Laser direct synthesis of graphene on quartz,” submitted

Wei, D., **Xu, X.**, 2012, "Laser direct growth of graphene on silicon substrate", Appl. Phys. Lett., Vol. 100, pp. 023110

Uppuluri, S.M.V., Kinzel, E.C., Li, Y., and **Xu, X.**, 2010, “Parallel optical nanolithography using nanoscale bowtie aperture array”, Opt. Exp., Vol. 18, pp. 7369-7375

Mitchell, J. I., Park, S. J., Watson, A. C., Srisungsitthisunti, P., Tansarawiput, C., Qi, M., Stach, E. A., Yang, C., and **Xu, X.**, 2011, " Laser direct write of silicon nanowires ", Opt. Eng., Vol. 50(10), pp. 104301-1-5

Kinzel, E.C., **Xu, X.**, 2009, "High efficiency excitation of plasmonic waveguides with vertically integrated resonant bowtie apertures", Opt. Exp., Vol. 17, Issue 10, pp.8036-8045

Murphy-DuBay, N., Wang, L., **Xu, X.**, 2008, Nanolithography using high transmission nanoscale ridge aperture probe, Appl. Phys. A, 93, pp. 881 – 884

Wang, L., Jin, E.X., Uppuluri, S.M., and **Xu, X.**, 2006, “Contact optical nanolithography using nanoscale C-shaped apertures,” Opt. Exp., Vol. 14, pp. 9902-9908

Wang, L., Uppuluri, S.M.V., Jin, E.X., and **Xu, X.**, 2006, "Nanolithography using High Transmission Nanoscale Ridge Apertures”, Nanoletters. Vol. 6, pp. 361-364

Jin, E.X., and **Xu, X.**, 2005, "Obtaining super resolution light spot using surface plasmon assisted sharp ridge nano-aperture," Appl. Phys. Lett. Vol. 86, pp.111106-08

Jin, E.X., and **Xu, X.**, 2004, "Finite –difference Time-Domain Studies on Optical Transmission through Planar Nano-Apertures in a Metal Film," Jpn. J. Appl. Phys., Vol. 43, pp. 407 – 417

Professional Development Activities (Past 5 years)

None

Bin Yao
Professor, School of Mechanical Engineering

B.Eng, Applied Mechanics, Beijing University of Aeronautics and Astronautics, China, 1987
M.Eng., Electrical and Electronic Engineering, Nanyang Technological University, Singapore, 1992
Ph.D., ME, University of California, Berkeley, 1996

Academic Experience
Purdue University, Professor, Mechanical Engineering, 2007 – Present, Full-Time
Purdue University, Associate Professor, Mechanical Engineering, 2002 – 2007, Full-Time
Purdue University, Assistant Professor, Mechanical Engineering, 1996 – 2002, Full-Time
Zhejiang University, China, Changjiang Chair Professor (2010 – Present), Responsible Scientist (2007 – 2010), Kuang-piu Professor (2005 – 2008), Institute of Mechatronic Control Engineering
Harbin Institute of Technology, China, Guest Professor, Shenzhen Graduate School, 2004 – 2007
University of California at Berkeley, Postdoctoral Researcher, Mechanical Engineering, Feb. 1996 – May 1996
University of California at Berkeley, Graduate Student Instructor (Aug. 1995 – Dec. 1995), Graduate Student Researcher (Aug. 1992 – Jan. 1996), Mechanical Engineering
Hong Kong Polytechnic, Research and Teaching Assistant, Electrical Engineering, Feb. 1990 – Jun. 1991, Full-Time

Non-Academic Experience
Caterpillar, Inc, Joliet Plant, Summer Faculty (Sabbatical Leave), Advanced Hydraulics Group, 1997

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Member, American Society of Mechanical Engineers
Senior Member, Institute of Electrical and Electronic Engineers

Honors and Awards
Changjiang Chair Professorship Award, Ministry of Education of China, 2010
Outstanding Young Investigator Award, ASME Dynamic Systems and Control Division (DSCD), 2007
Overseas Young Scholars Collaboration Award, National Natural Science Foundation of China, 2005
O. Hugo Schuck Best Paper (Theory) Award, American Automatic Control Council, 2004
CAREER Award, National Science Foundation, 1998
Caterpillar Engineering Young Faculty Development Award, Caterpillar Inc., 1997
Regents Fellowship, University of California at Berkeley, 1992 – 1993
Research Scholarship, Nanyang Technology University, 1991 – 1992
Honor of Excellence for Graduate Study, BUAA, 1989
Scholarship, BUAA, 1983 – 1986
First Prize Winner, BUAA Advanced Mathematics competition, 1985

Service Activities

Member of Management Committee, the IEEE/ASME Transactions on Mechatronics, 2012 – Present
Associate Editor, the ASME Journal of Dynamic Systems, Measurement, and Control, 2006 – 2010
Member of Editorial Board, the International Journal of Control, Automation, and Systems (ICASE), 2003 – Present
Member of Selection Committee of the ASME FPST Division for the ASME Robert E. Koski Medal, 2007 – Present
Member of Selection Committee for Mechatronics Prizes of International Federation of Automatic Control, 09-2011
General Chair, the IEEE/ASME Int. Conf. on Advanced Intelligent Mechatronics, Montreal, Canada, July, 2010
Award Committee Chair, (2011-2012), Chair, (2010-2011), Vice-Chair, (2006-2009), the Mechatronics Technical Committee of ASME Dynamic Systems and Control Division
Chair or co-chair of 16 sessions for various ASME, IEEE, and IFAC conferences
Member of International Program Committee of more than 10 IEEE, IFAC, and IASTED conferences
23 invited talks in North America as well as in Asia and Europe
Reviewer of

- National Science Foundation, panel review member for the Dynamic Systems & Control Program
- Proposal review for the Natural Sciences and Engineering Research Council of Canada
- Proposal review for the Research Grants Council of Hong Kong, China

Principal Publications and Presentations (Most important from past 5 years)

<u>Refereed Journal Publications</u>

B. Yao, C. Hu, and Q. Wang, "An orthogonal global task coordinate frame for contouring control of biaxial systems," the IEEE/ASME Transactions on Mechatronics, Vol.17, No.4, 622-634, August 2012

C. Hu, **B. Yao**, and Q. Wang, "Global task coordinate frame based contouring control of linear-motor driven biaxial systems with accurate parameter estimations," IEEE Transactions on Industrial Electronics, Vol.58, No.11, 5195-5205, November 2011

S. Gayaka and **B. Yao**, "Accommodation of unknown actuator faults using output feedback based adaptive robust control," International Journal of Adaptive Control and Signal Processing, Vol.25, No.11, 965-982, November 2011

B. Yao, C. Hu, L. Lu, and Q. Wang, "Adaptive robust precision motion control of a high-speed industrial gantry with cogging force compensations," the IEEE Transactions on Control Systems Technology, Vol.19, No.5, 1149-1159, September 2011

A. Mohanty and **B. Yao**, "Integrated direct/indirect adaptive robust control of hydraulic manipulators with valve deadband," IEEE/ASME Transactions on Mechatronics, Vol.16, No.4, 707-715, August 2011

L. Lu and **B. Yao**, "Adaptive robust control of a class of nonlinear systems in semi-strict feedback form with non-uniformly detectable unmeasured internal states," International Journal of Adaptive Control and Signal Processing, Vol.24, No.11, pp.961-981, November 2010

V. Agrawal, W.J. Peine, and **B. Yao**, "Modeling of transmission characteristics across a cable Conduit system," the IEEE Transactions on Robotics, Vol. 26, No.5, pp.914 - 924, October 2010

S. Liu and **B. Yao**, "Coordinate control of energy-saving programmable valves," the IEEE Transactions on Control Systems Technology, Vol.16, No.1, pp.34 – 45, Jan. 2008

J. Zhong and **B. Yao**, "Adaptive robust precision motion control of a piezoelectric positioning stage," the IEEE Transactions on Control Systems Technology, Vol.16, No.5, pp.1039-1046, 2008

Professional Development Activities (Past 5 years) None

Fu Zhao
Assistant Professor
School of Mechanical Engineering

Education
BSME, Tsinghua University, Beijing, 1993
MSME, Tsinghua University, Beijing, 1996
MS, EE, University of Michigan, 2001
Ph.D., ME, University of Michigan, 2005

Academic Experience
Purdue University, Assistant Professor, Mechanical Engineering, 2007 – Present, Full-Time

Non-Academic Experience:
University of Michigan, Research Fellow, Department of Civil and Environmental Engineering, 2005-2006, Full Time
State Key Laboratory of Clean Coal Combustion, Research Engineer, 1996-1999, Full Time

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
American Society of Mechanical Engineers, 2007 – Present
Association of Environmental Engineering and Science Professors, 2007 – Present
American Center of Life Cycle Assessment, 2010 – Present

Honors and Awards
Robert Caddell Memorial Fellowship, University of Michigan, 2002
Rackham International Institute Travel Award, University of Michigan, 2002
Department of Mechanical Engineering Fellowship Award, University of Michigan, 1999
Department of Thermal Engineering Fellowship Award, Tsinghua University, 1994, 1995
Academic Excellence Award, Tsinghua University, 1989, 1990, 1991, 1992

Service Activities
Technical Committee, American Center of Life Cycle Assessment, 2011 – Present
Life Cycle Engineering Technical Committee, ASME Manufacturing Engineering Division, Co-chair, 2007 – 2088; Chair, 2008 – 2010
Student Service Committee, Association of Environmental Engineering and Science Professors, 2008 – Present
Curriculum Committee, Environmental and Ecological Engineering, 2008 – Present
Governance Committee, Ecological Science and Engineering Program, 2000 – Present

Principal Publications and Presentations (Most important from past 5 years)

Zhao, F., Ogaldez, J., Sutherland, J.W., Quantifying the Water Inventory of Machining Processes, CIRP Annals - Manufacturing Technology, Volume 61, Issue 1, 2012, Pages 67–70
Hang, Y., Qu, M., **Zhao, F**., Economic and Environmental Life Cycle Analysis of Solar Hot Water Systems in the United States, Energy and Buildings, 2012, 45(2), pp.181–188
Agusdinata, D.B., **Zhao, F**., Delaurentis, D., Sustainability of Bio-jet Fuels: A Multi-Actor Life Cycle Assessment Approach, IEEE Potentials, 2012, 31(1), pp.27-33

Agusdinata, D.B., **Zhao, F**., Ileleji, K., Delaurentis, D., Life Cycle Assessment of Potential Bio-jet Fuel Production in the United States, Environmental Science and Technology, 2011, 45 (21), pp 9133–9143

Kou, N, **Zhao, F**., Techno-Economical Analysis of A Thermo-Chemical Biofuel Plant with Feedstock and Product Flexibility Under External Disturbances, Energy, 2011, 36(12), pp.6745–6752

Fang, K., Uhan, N., **Zhao, F**., Sutherland, J.W., A New Approach to Scheduling in Manufacturing for Power Consumption and Carbon Footprint Reduction, Journal of Manufacturing Systems, 2011, 30 (4):pp. 234-240

Kou, N., **Zhao, F**., Effect Of Multiple Feedstock Strategy on the Economic and Environmental Performance of Thermochemical Ethanol Production under Extreme Weather Conditions, Biomass and Bioenergy, Vol.35, Issue 1, 2011, pp. 608-616

Mu, D., Seager, T., Rao, S., Park, J., **Zhao, F**., A Resilience Perspective of Biofuel Production, Integrated Environmental Assessment and Management, Volume 7, Issue 3, pp. 348–359, 2011

Hang, Y., Qu, M., **Zhao, F**., Economical and Environmental Assessment of an Optimized Solar Cooling System for a Medium-sized Benchmark Office Building in Los Angeles, California, to appear, Volume 36, Issue 2, 2011, Pages 648-658

Devanathan, S., Bernstein, W.Z., Ramanujan, D., **Zhao, F**., Ramani, K., 2010, Integration of Sustainability Into Early Design Through the Function Impact Matrix, ASME Journal of Mechanical Design, Volume 132, Issue 8, 081004

Ramani, K., Bernstein, W.Z., Ramanujan, D., **Zhao, F**., Sutherland, J., Handwerker, C., Choi, J.K., Kim, H., and Thurston, D., 2010, Integrated Sustainable Lifecycle Design: A Review, ASME Journal of Mechanical Design, Volume 132, Issue 9, 091004

Zhao, F., Naik, G., Cheng, G., Environmental Assessment of Laser-Assisted Manufacturing: Case Studies On Laser Shock Peening and Laser Assisted Turning, Journal of Cleaner Production, Volume 18, Issue 13, 2010, Pages 1311-1319

Mu, D., Seager, T., Rao, P.S.C., **Zhao, F**, 2010, "Comparative Life Cycle Assessment of Lignocellulosic Ethanol Production: Bio-chemical vs. Thermo-chemical Conversion", Environmental Management, Volume 46, Number 4, 565-578

Zhao, F., Hayes, K.F., Skerlos, S.J., "Formulation Design of Metalworking Fluid Microemulsions Using Bio-based Surfactants", in Bio-Based Surfactants and Detergents, Edited by Douglas G. Hayes, Daniel Solaiman, Richard Ashby, and Dai Kitamono, AOCS Press/Taylor and Francis, 2009

Professional Development Activities (Past 5 years)

Engaged Interdisciplinary Learning in Sustainability Summer Institute, University of California-Santa Cruz, June 25-28, 2012

NSF Center for Sustainable Engineering Workshop, Austin, TX, July 23-25, 2007

Chenn Q. Zhou
Professor by Courtesy
Professor of Mechanical Engineering, Purdue Calumet

BS & MS: Nanjing University of Aeronautics & Astronautics, Nanjing, P.R. China, 198 & 1984
Ph.D., ME, Carnegie Mellon University, Pittsburgh, PA, 1991

Academic Experience
Purdue University Calumet, Director, Engineering Outreach, 2011 – Present
Purdue University Calumet, Director, Center for Innovation through Visualization & Simulation, 2009 – Present
Purdue University, Professor by Courtesy, Mechanical Engineering, 2008 – Present
Purdue University Calumet, Department Head, Mechanical Engineering, 2005 – 2011
Purdue University Calumet, Interim Department Head, Electrical & Computer Engineering, 2005 – 2009
Central South University, China, Guest Professor & PhD Student Advisor, 2002 – Present
Purdue University Calumet, Engineering Graduate Program Director, 2001 – 2005
Purdue University Calumet, Professor, Mechanical Engineering, 2000 – 2001
Purdue University Calumet, Associate Professor, Mechanical Engineering, 1997 – 2000
Purdue University Calumet, Assistant Professor, Mechanical Engineering, 1994 – 1997
Nanjing University, Lecturer, Aeronautics and Astronautics, 1984 – 1987

Non-Academic Experience
Argonne National Lab, Summer Faculty or Special Team Appointment, 1995 - 2006
NOXSO Corporation, Pittsburgh, PA, Senior Research Engineer, 1991 – 1994

Certifications or Professional Registrations
None

Current Membership in Professional Organizations
Fellow, American Society of Mechanical Engineers (ASME)
Member, American Society of Engineering Education (ASEE)
Member, Association of Iron and Steel Technology (AIST)

Honors and Awards
J. Keith Brimacombe Memorial Lecture Award by (AIST) Association, 2010
Computer Applications Best Paper Award by AIST Association, 2006
American Iron and Steel Institute Medal Award, 2005
AIST Josef Kapitan Best Paper Award, 2005
R&D 100 Award for "Glass Furnace Modeling" (with 4 collaborators at Argonne national lab), 2004

Service Activities
AIST Foundation Trustee, 2011 – Present
Associate Editor, J. of Thermal Science and Engineering Applications, 2008 – Present
Technical Program Chair for the Heat Transfer Division participation in the 2012 ASME Joint Heat Transfer, Fluids and Nano, Micro and Minichannels Conference (HTFNMM 2012), June 2012

Chair of Fire and Combustion (K-11) Committee, Heat Transfer Division, American Society of Mechanical Engineering (ASME), 2007 – 2010

ASME Chinese Thermal Engineering Association, President (2007 – 2008) and Vice President (2006 – 2007)

Director, Center for Innovation through Visualization and Simulation (CIVS), 2—9 – Present

Principal Publications and Presentations (Most important from past 5 years)

Refereed Journal Publications

Ai, Z.T., C. M. Mak, J.L. Niu, Z.R. Li and **Q. Zhou** "The Effect of Balconies on Ventilation Performance of Low-rise Buildings", *Indoor and Built Environment December 2011 20: 649-660*

Yang, D., J. Pan, Y. Wu, T. Chen, **C.Q. Zhou**, "Numerical simulation of flow boiling for organic fluid with high saturation temperature in vertical porous coated tube", *International Journal of Heat and Fluid Flow*, Volume 32, Issue 4, August 2011, Pages 818–825

Yang, D., J. Pan, **C.Q. Zhou**, X. Zhu, Q. Bi, T. Chen, "Experimental investigation on heat transfer and frictional characteristics of vertical upward rifled tube in supercritical CFB boiler," *Journal of Experimental Thermal and Fluid Science*, Vol. 35, pp. 291-300. Feb, 2011

Gu, M., G. Chen, M. Zhang, D. Huang, P. Chaubal, **C.Q. Zhou**, "Three-dimensional simulation of the pulverized coal combustion inside blast furnace tuyere", *Applied Mathematics Modeling* Volume 34, Issue 11, November 2010, Pages 3536-3546

Zhou, C.Q., D. Huang, Y. Zhao, and P. Chaubal, "CFD Analysis of 3-D Hot Metal Flow Characteristics", *J. of Thermal Science and Engineering Applications*, March 2010 –Vol. 2, Issue 1, 011006 (10 pages)

Ma, W.W, X. Liu, L. Li, X. Shi and **C.Q. Zhou**, "Research on the waiting time of passengers and escalator energy consumption at the railway station", *Energy and Buildings*, Volume 41, Issue 12, Pages 1313 1318, December 2009

Fu, D., D. Huang, A. Juma, C. Schreiber, X. Wang, and **C. Zhou**, "Numerical Simulation of Thermal Stress for a Liquid-Cooled Exhaust Manifold", *Journal of Thermal Science and Engineering Applications*, September 2009 -- Volume 1, Issue 3, 031010 (10 pages)

Li, Baokuan, Hongbin Yin, **Chenn Q. Zhou** and Fumitaka Tsukihashi, "Modeling of Three-phase Flows and Behavior of Slag/Steel Interface in an Argon Gas Stirred Ladle", ISIJ International, Vol. 48 (2008), No. 12, pp. 1704–1711

Gu,M., M. Zhang, N. K. C. Selvarasu, Y. Zhao and **C. Q. Zhou**, "Numerical Analysis of Pulverized Coal Combustion inside Tuyere and Raceway", *Steel Research International* , Vol. 79 No. 1, 17 24, (2008)

Zhang, Y.; Deshpande, R.; Huang, D., Chaubal; D.; **Zhou, C.Q.**; "Numerical analysis of blast furnace hearth inner profile by using CFD and heat transfer model for different time periods", *International Journal of Heat and Mass Transfer*, v 51, n 1-2, January, 2008, p 186-197

Professional Development Activities (Past 5 years)

Attended a large number of conferences in the US and other countries

APPENDIX C:

EQUIPMENT USED IN UNDERGRADUATE PROGRAM

Computer Labs

Of the 157 computer workstations installed in the instructional laboratories, 83 are quad core machines with 8GB of RAM and nVidia Quadro graphics with 24" LCD displays running Windows Vista 64 bit operating system. The remaining are dual core machines running Windows Vista 64 bit operation systems using 19" LCD displays. In addition to the windows based operating system, 5 quad core workstations run the Red Hat Enterprise Linux operating system. The department also provides a 24-processor 48GB computational server running the Red Hat Enterprise Linux operating system.

In each of the instructional laboratories, a high volume black and white laser printer and a high volume color laser printer are provided. In our 2nd floor laboratory, an 11"x17" black and white laser printer is provided. Students also have access to a HP laserjet T7100 42" inkjet plotter through the Electronics Shop.

The computer labs offer students access to a wide variety of software packages including: Catia; Solidworks; ProEngineer; NX; Matlab; MathCAD; Mathematica; Maple; Ansys; Ansys-Fluent; Abaqus; AutoCAD; AutoCAD inventor; Microsoft Office suite; EES; FEHT; LabVIEW; Microsoft Visual Studio; Patran; Nastran; Cosilab; Simapro; MasterCAM.

Laboratory Facilities

ME 30900 Fluid Dynamics Lab (ME 1030D, ME 1030F, ME 1030H - 3555 sq. ft.)

1. Two low-speed wind tunnels equipped for wake survey and drag force measurements
2. 1 water Channel Facility for flow visualization and optical diagnostics
3. Particle Image Velocimetry (PIV)
4. Converging-diverging nozzle facility
5. Test apparatus pipe flow and pump performance testing
6. Instrumentation available - manometers, flow meters, pressure transducers, pitot-static probes, and a hot-wire anemometry system.
7. Fluid Power test bench for pump characterization and valve characterization experiments
8. PC with National Instruments PXI data acquisition system

ME 31500 Heat Transfer Lab (ME 1030B – 956 sq. ft.)

1. Ten computer workstations equipped with data acquisition equipment
2. Two 'high channel count' data acquisition workstations
3. Infrared camera
4. Radiant lamps
5. Balance, blowers
6. Multimeters
7. Thermocouple fabrication station
8. National Instruments hardware and LabVIEW software
9. Agilent Hardware and Software for high channel count thermocouple measurements

ME 36500 Systems and Measurements Lab (ME 1030A – 1036 sq. ft.)

1. Thirteen workstations each containing personal computers with data acquisition boards, Agilent Digital oscilloscopes, Agilent digitial multimeter/power supplies and Agilent function generators.
2. Temperature-measuring setup, including RTD and thermocouple
3. Force transducers, consisting of a cantilever beam with strain gages, proximity probe, and LVDT
4. Analog to digital and digital to analog conversion trainer with variable sampling rates
5. Musical keyboard for generating different acoustic signals
6. Electromechanical shaker for measuring the physical properties of foam
7. National Instruments hardware and LabVIEW software.

ME 47500 Automatic Controls Lab (ME 1030E – 1155 sq. ft.)

1. Seven workstations each containing personal computers, Agilent Oscilloscopes, and Agilent function generators.
2. Seven National Instruments Compact Rio real time controllers with cDAQ modules including Digital Input/Output, Analog Input, Analog Output and a Brushed motor servo drive.
3. Electromechanical servo-system that rotates a platter using a dc motor with potentiometer feedback.
4. Electromechanical servo system that rotates a platter with inverted pendulum using a DC motor with feedback.
5. Track-based inverted pendulum apparatus using a powered cart with pendulum.
6. Non-powered cart connected via spring and a teeter-totter mounting system for the track.
7. “Black box” that can be configured to represent a variety of physical systems.

ME 26003 Design Lab(ME 2036 – 782 sq. ft.)

1. 32 Labtop computers split between two portable carts.

The Innovation Instructional Facility (ME 1185 – 800 sq. ft.)

1. Dedicated computer and large projections system for presentations.

Fabrication and Assembly rooms (ME 1178, 1202, and 1203 – 1200 sq. ft. each)

1. Storage space and lockers
2. Work benches
3. Overhead power
4. Industrial sink
5. Emergency Shower and Eye Wash Station
6. First kit
7. Assortment of hand tools.

Seven Breakout rooms (ME 1186, 1188, 1190, 1192, 1194, 1196, 1198, 1200 – 132-160 sq. ft. each)

1. Three of these rooms are equipped with a 60 inch monitors on the wall for projection of project documents for discussion.

Rapid Prototyping Laboratory (ME 1191 – 600 sq. ft.)
The Rapid Prototyping Lab is used to rapidly design and fabricate small parts used in mechanical engineering. The lab includes Windows, 64-bit PC and its own server to communicate with the following machines:

1. 2 Model SLA 150/30 Laser Stereo Lithography rapid prototyping machine
2. 1 Product curing oven
3. ProJet 5000 3-D Printer large format
4. 3-D Curing Oven
5. Pro-Jet Finisher XL
6. LABCONCO Protector Laboratory Hood
7. Sink and cabinet space
8. Display cases to showcase a variety of prototype projects

Machine Shop (ME G039 – 3284 sq. ft.)
The machine shop facilities available in the Department of Mechanical Engineering occupy 3284 sq. ft. and contain the following machinery:

1. 5 manual lathes
2. 7 manual “Bridgeport type” manual milling machines
3. 2 CNC vertical milling machines
4. 1 CNC Lathe
5. 1 surface grinder
6. Bead blasters, and assorted auxiliary equipment
7. 1 90 Watt laser cutter 24” x 36”
8. 1 Vacuum forming machine
9. 5 ton arbor press
10. 100 ton hydraulic press
11. Shear and Box & Pan Break
12. 2 Band Saws
13. Toolmakers microscope
14. 1 cutoff saw
15. Buffer & belt sanders
16. sand blaster
17. 1 table saw
18. Assortment of smaller hand tools & precision measuring equipment

D – Institutional Summary

Programs are requested to provide the following information.

1. **The Institution**
   a. Purdue University
      Hovde Hall of Administration
      West Lafayette, IN 47907-2040

   b. Mitchell E. Daniels, President

   c. Dr. James D. Jones, Associate Professor and Associate Head, School of Mechanical Engineering

   d. Accredited by the Higher Learning Commission of the North Central Association of Colleges and Schools
      Initial accreditation: 1913
      Most recent evaluation: 2009-2010

2. **Type of Control**
   State of Indiana

3. **Educational Unit**
   Dr. Anil K. Bajaj, William E. and Florence E. Perry Head of Mechanical Engineering & Alpha P. Jamison Professor Of Mechanical Engineering, School of Mechanical Engineering

   Leah H. Jamieson
   John A. Edwardson Dean of Engineering
   Ransburg Distinguished Professor of Electrical & Computer Engineering

   Timothy D. Sands
   Executive Vice President for Academic Affairs and Provost
   Basil S. Turner Professor of Engineering

   Mitchell E. Daniels
   President

4. **Academic Support Units**

   David Radcliffe
   Kamyar Haghighi Head of the School of Engineering Education
   Epistemology Professor of Engineering Education

   Laszlo Lempert, Head
   Distinguished Professor of Mathematics

Paul Shepson, Head
Department of Chemistry

Nicholas Giordano, Head
Hubert James Distinguished Professor of Physics

Nancy Peterson, Head
Department of English

Howard Sypher, Head
Brain Lamb School of Communication

Richard Kuhn, Head
Department of Biological Sciences
Gerald and Edna Mann Director of the Bindley Bioscience Center

Sunil Prabhakar, Head
Department of Computer Science

5. Non-Academic Support Units

James L. Mullins
Dean of Libraries

Gerry McCartney
Vice President for Information Technology & CIO

Melissa Exum
Vice President for Student Affairs

Beth McCuskey
Associate Vice President for Housing and Food Services

Pam Horne
Associate Vice Provost of Enrollment Management
Dean of Admissions

Jared Tippets
Director of Student Access, Transitions and Success Programs

6. Credit Unit

Using the 16-week semester, the semester credit hour, and the 50-minute class hour, Purdue University course offerings are measured under the following guidelines.

Credit Guidelines

One semester credit hour is assigned in the following ratio of component hours per week devoted to the course of study:

Non-Laboratory Instruction

Lecture, Recitation - Normally, one credit hour is associated with a class meeting for 50 minutes per week for an entire semester (or the equivalent 750 semester-minutes, excluding final exams). Another widely repeated standard states that each in-class hour of college work should require two hours of preparation or other outside work.

Presentation – 1/2 credit hour is associated with a class meeting for 50 minutes per week for an entire semester (or the equivalent 750 semester-minutes, excluding final exam).

Laboratory Class Instruction

Laboratory – Normally, one credit hour is associated with a class meeting for 50 to 200 minutes per week for an entire semester (or the equivalent 750 to 3,000 semester-minutes, excluding final exam, in other meeting formats). Two semester credit hours could be earned for a class meeting for 150 to 300 minutes per week over the semester. (The overlap in minutes in class allows for departmental discretion.)

Lab Prep –One semester credit hour is associated with a class meeting 50 to 150 minutes per week over the semester.

Clinic –One semester credit hour is associated with a class meeting 100 to 300 minutes per week over the semester.

Studio -One semester credit hour is associated with a class meeting 100 to 300 minutes per week over the semester.

Independent Study

Experiential, Research, Individual Study –Credit hours associated with this type of instruction will be assigned credit depending upon the amount of activity associated with the course, faculty supervision, and students outside work activity.

Distance – Credit hours associated with this organizational type of a course should be equivalent to credit hours when a course is delivered in another format on campus.

Non-Directed Study

Practice/Study/Observation –No credit hours or staff effort are directly associated with these learning situations.

Types of Credit Awarded in the Purdue University System

Regular Credit: Credit earned for regularly offered collegiate courses of instruction that meet the requirements of a degree program.

Thesis Credit: Credit awarded to students for research toward completion of a research project, or a degree thesis or dissertation. This credit allows measure of the expected amount of work and the resources used, while the student actually earns zero degree credit hours. The benefit obtained is primarily to account for the resources provided, to use in reporting to governments, and in maintaining the students' financial aid position. Example: Senior Research Project, Master's Thesis, Doctoral Dissertation.

Equivalent Credit: Hours are assigned to courses to reflect the value of resources used to provide the class, such as rooms, instructors, equipment, etc. Equivalent hours are used in the registration process but revert to zero when posted to the student's academic history. Example: A seminar with a visiting professor, over and above existing degree requirements. The benefit obtained is primarily to account for the resources provided, to use in reporting to governments, and in maintaining the students' financial aid position.

Continuing Education Units (CEU): These units of credit are usually assigned to continuing education work accomplished during short courses and conferences. Typically, this is not work used to complete requirements for a degree but may contribute to maintaining licensing or other certification.

Procedure for Exceptions

Many situations and new developments may cause a given department or faculty member to vary from the guidelines listed above in the assigning of credit. If this situation should arise, a Registrar Form 40 should be submitted creating or revising the course, specifying the type of variance to be applied, and the expected benefit. This formal notification will allow the Office of the Registrar to document such variances, continuously synchronize the faculty's pedagogical expectations, and will assist in acknowledging interdepartmental preferences that may logically be converted to needed revisions of the guidelines and policies.

7. Tables

Tables D-1 Program Enrollment and Degree Data and Table D-2 Personnel have been completed and are provided below.

Table D-1. Program Enrollment and Degree Data

Mechanical Engineering

	Academic Year		Enrollment Year					Total Undergrad	Total Grad	Degrees Awarded			
			1st	2nd	3rd	4th	5th			Associates	Bachelors	Masters	Doctorates
Current Year	’12-‘13	FT	29	278	458	444		1209	408	0	287	106	31
		PT	0	0	0	23		23	115				
1	’11-‘12	FT	27	270	378	409		1084	386	0	284	96	44
		PT	0	0	1	17		18	127				
2	’10-‘11	FT	35	248	318	380		981	387	0	266	103	35
		PT	0	1	1	18		20	124				
3	’09-‘10	FT	22	242	319	389		972	364	0	302	70	31
		PT	0	1	0	21		22	93				
4	’08-‘09	FT	22	223	303	371		919	306	0	224	57	37
		PT	0	0	0	10		10	89				

Give official fall term enrollment figures (head count) for the current and preceding four academic years and undergraduate and graduate degrees conferred during each of those years. The "current" year means the academic year preceding the fall visit.

FT--full time
PT--part time

Table D-2. Personnel
Mechanical Engineering
Year[1]: 2012

	HEAD COUNT		FTE
	FT	PT	
Administrative[2]	10	4	10.83
Faculty (tenure-track)[3]	48	8	51.66
Other Faculty (excluding student Assistants)	19	16	22.26
Student Teaching Assistants[4]	0	82	67.5
Technicians/Specialists	18	9	21.47
Office/Clerical Employees	17	3	19
Others[5]	0	0	0

Report data for the program being evaluated.

1 Data on this table should be for the fall term immediately preceding the visit. Updated tables for the fall term when the ABET team is visiting are to be prepared and presented to the team when they arrive.

2 Persons holding joint administrative/faculty positions or other combined assignments should be allocated to each category according to the fraction of the appointment assigned to that category.

3 For faculty members, 1 FTE equals what your institution defines as a full-time load.

4 For student teaching assistants, 1 FTE equals 20 hours per week of work (or service). For undergraduate and graduate students, 1 FTE equals 15 semester credit-hours (or 24 quarter credit-hours) per term of institutional course work, meaning all courses — science, humanities and social sciences, etc.

5 Specify any other category considered appropriate, or leave blank.

Signature Attesting to Compliance

By signing below, I attest to the following:

That Mechanical Engineering has conducted an honest assessment of compliance and has provided a complete and accurate disclosure of timely information regarding compliance with ABET's *Criteria for Accrediting Engineering Programs* to include the General Criteria and any applicable Program Criteria, and the ABET *Accreditation Policy and Procedure Manual.*

Leah H. Jamieson
Dean of Engineering
Purdue University at West Lafayette

Leah H. Jamieson 6/21/13

Signature **Date**

APPENDIX E: FUNDAMENTALS OF ENGINEERING (FE) EXAM TOPICAL RESULTS

Figures E.1- E.38 shows the longitudinal topical results of the Fundamentals of Engineering (FE) Exam for Purdue ME students as compared with the national ME average for the years of 2005-2012, including both the April and October offerings. These results include both the FE General Exam results as well as the ME Specific exam results. While in some offerings the number of Purdue ME students was not sufficient to provide statistically significant results, we have chosen to include all of the results for completeness. As discussed earlier under Criterion 4, the minimum level of expectation was to perform at least 1.28σ above the ME national average representing a 90% confidence level that the difference is statistically significant. To exceed expectations, students had to perform at least 3.1σ above the national ME average, representing a 99.9% confidence level that the difference is statistically significant.

Reviewing these results will show that in the vast majority of the topics, especially those with a statistically significant number of participants, Purdue ME students are not only meeting expectations the vast majority of time, but exceeding expectations. These results illustrate that Purdue ME students have met or exceeded expectations in all topical subjects covered by the Fundamental of Engineering exam. In virtually every case where expectations are not met, the number of Purdue ME participants in that exam offering (typically the October exam offering) was so low that the statistical significance of the results is in question. Yet, when the number of participants is high (typically the April exam offering), Purdue ME students far outperformed the national average.

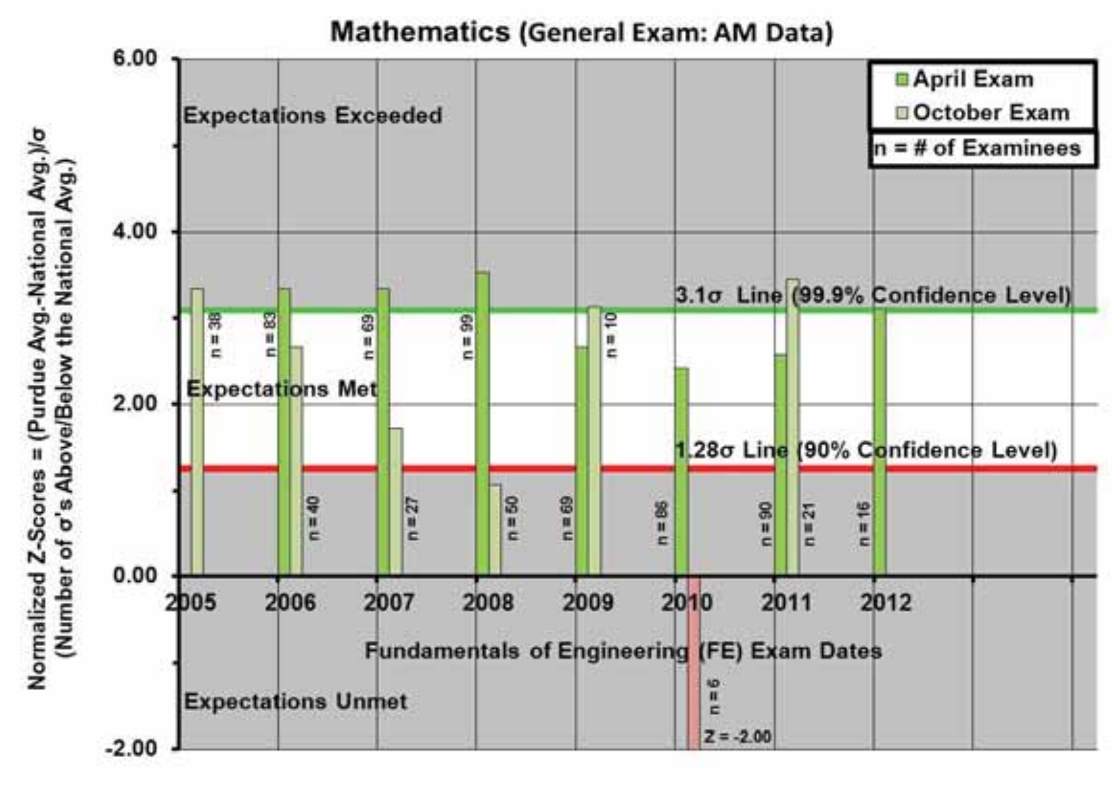


Figure E.1 Longitudinal Normalized Z-Scores of the FE Exam for the Mathematics Topic.

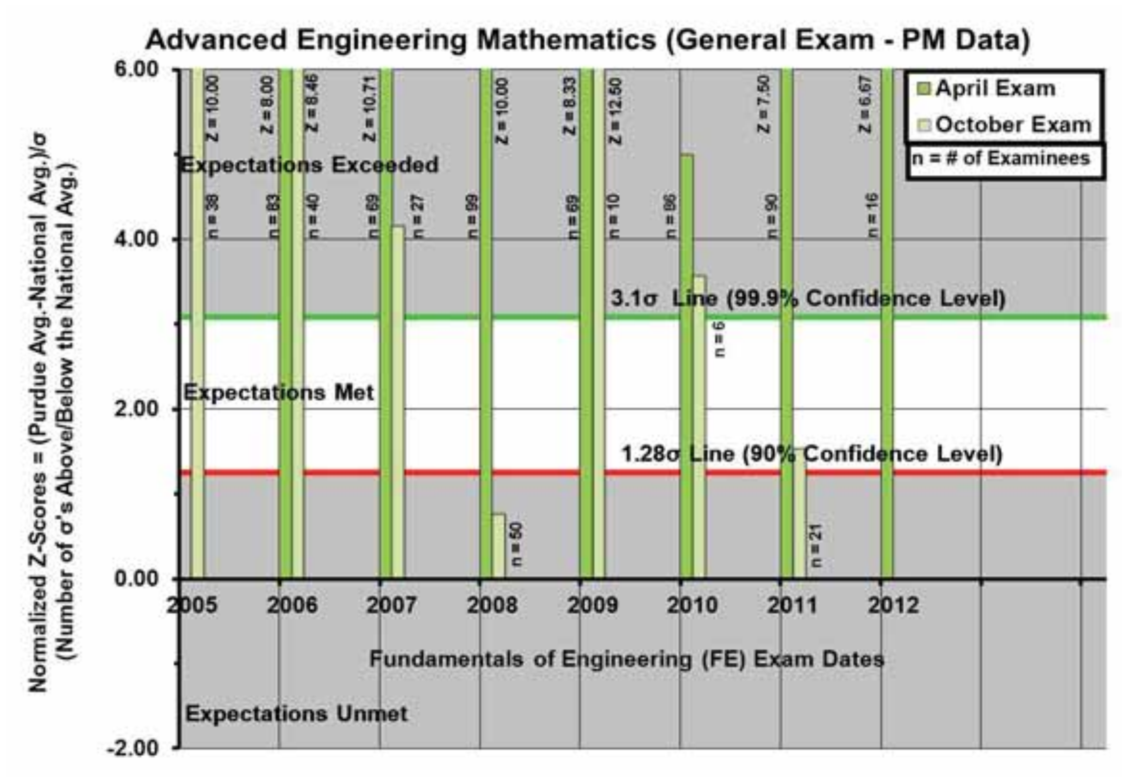


Figure E.2 Longitudinal Normalized Z-Scores of the FE Exam for the Advanced Engineering Mathematics Topic.

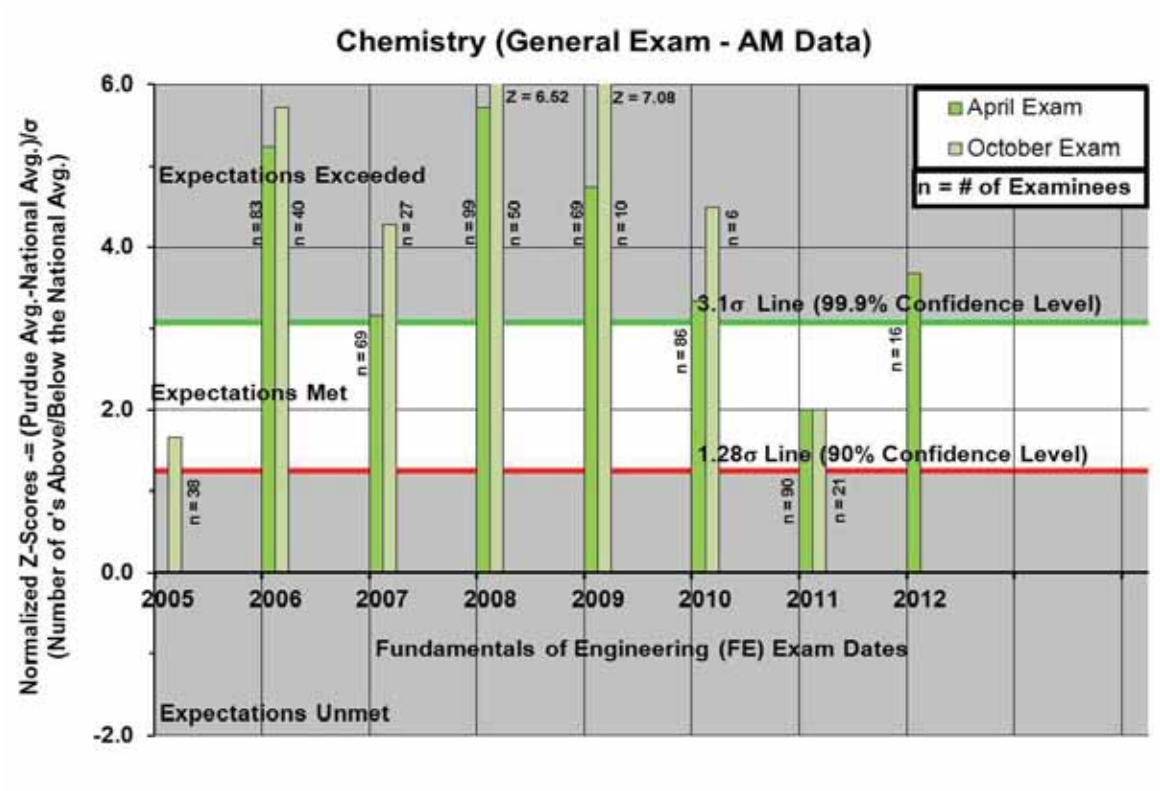


Figure E.3 Longitudinal Normalized Z-Scores of the FE Exam for the Chemistry Topic.

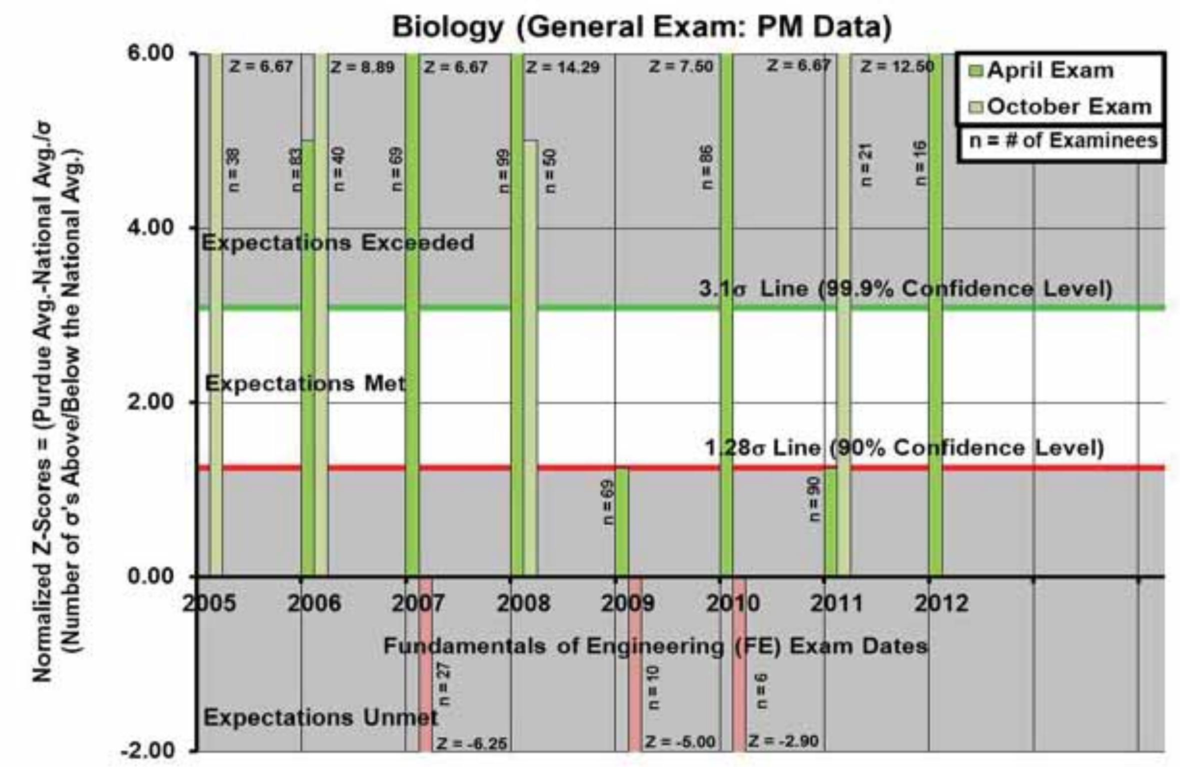


Figure E.4 Longitudinal Normalized Z-Scores for the FE Exam for the Biology Topic.

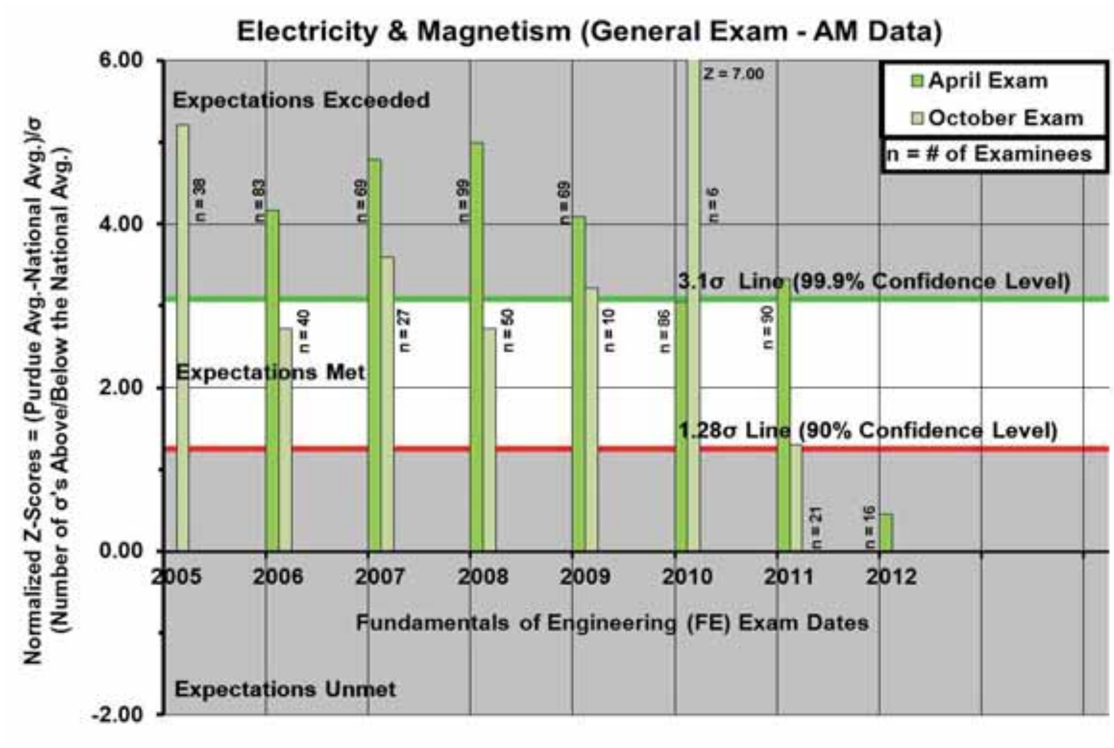


Figure E.5 Longitudinal Normalized Z-Scores for the FE Exam for the Electricity and Magnetism Topic.

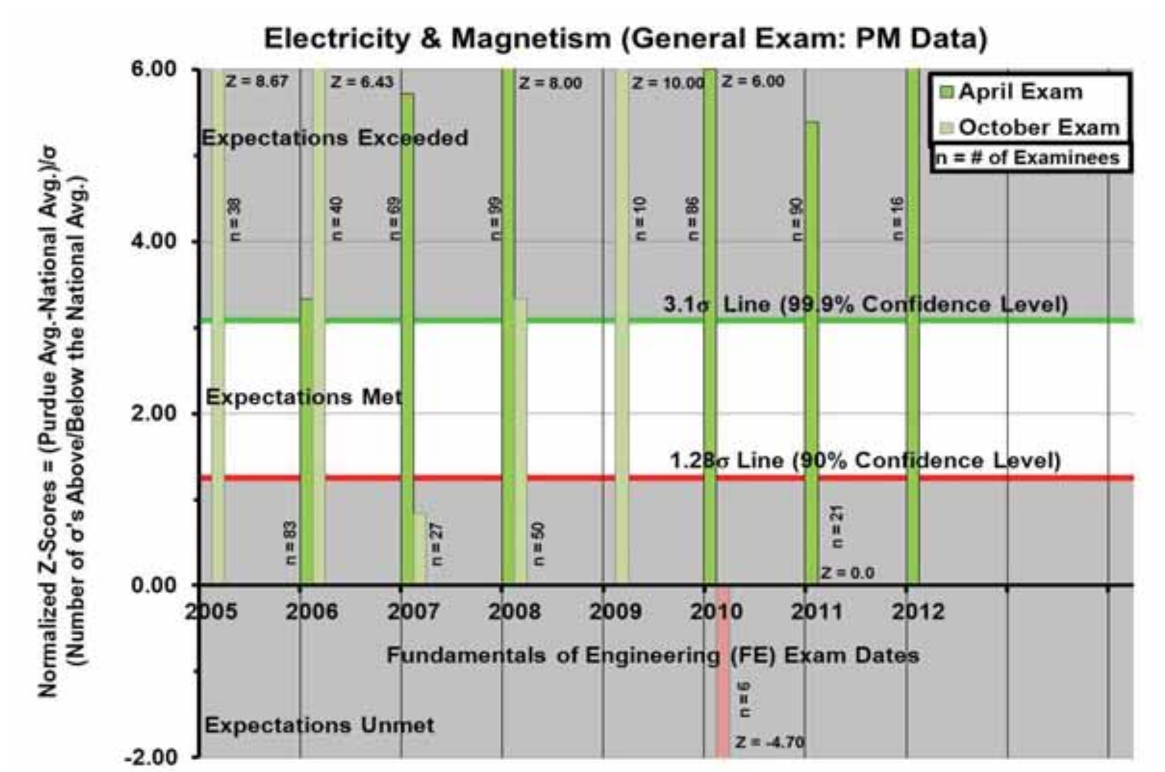


Figure E.6 Longitudinal Normalized Z-Scores for the FE Exam for the Electricity and Magnetism Topic.

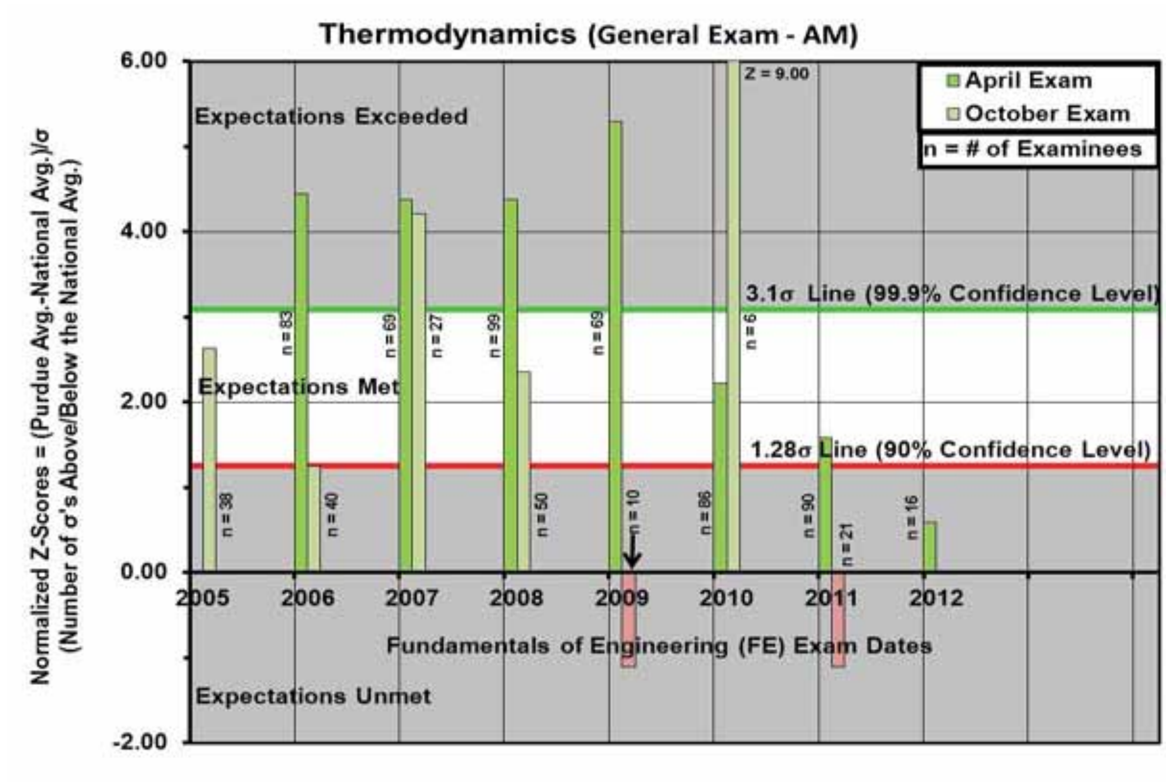


Figure E.7 Longitudinal Normalized Z-Scores for the FE Exam for the Thermodynamics Topic.

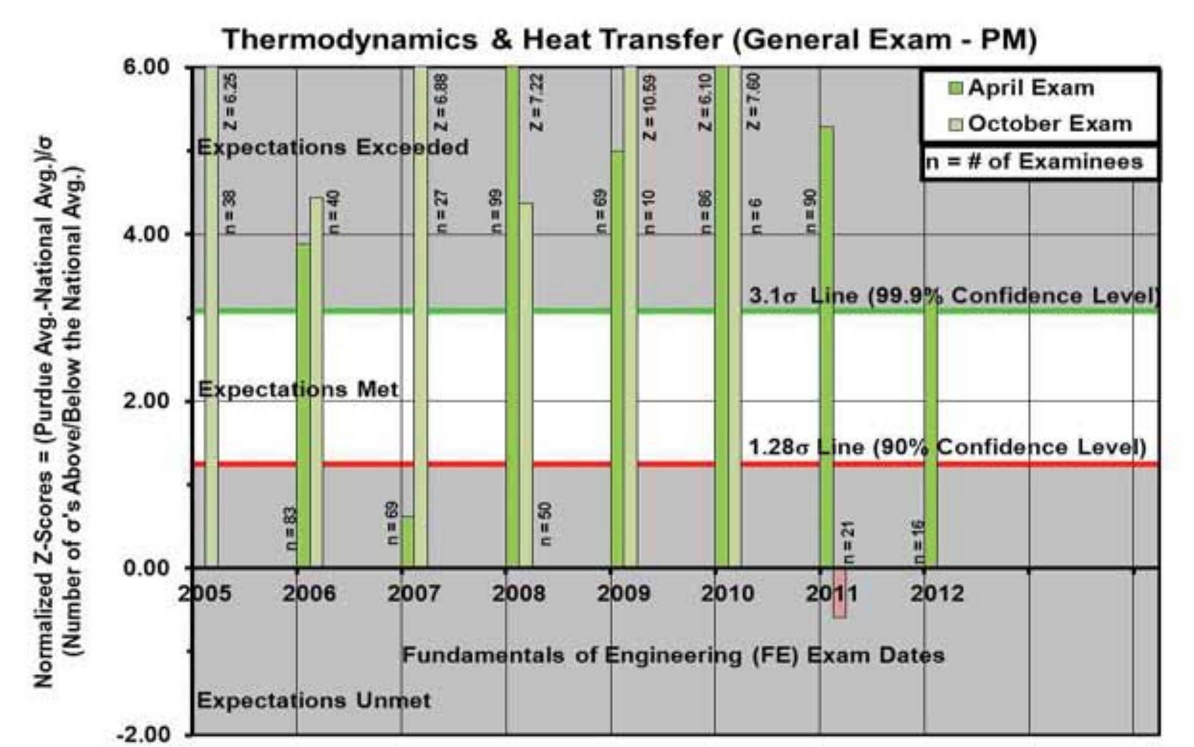


Figure E.8 Longitudinal Normalized Z-Scores for the FE Exam for the Thermodynamics and Heat Transfer Topic.

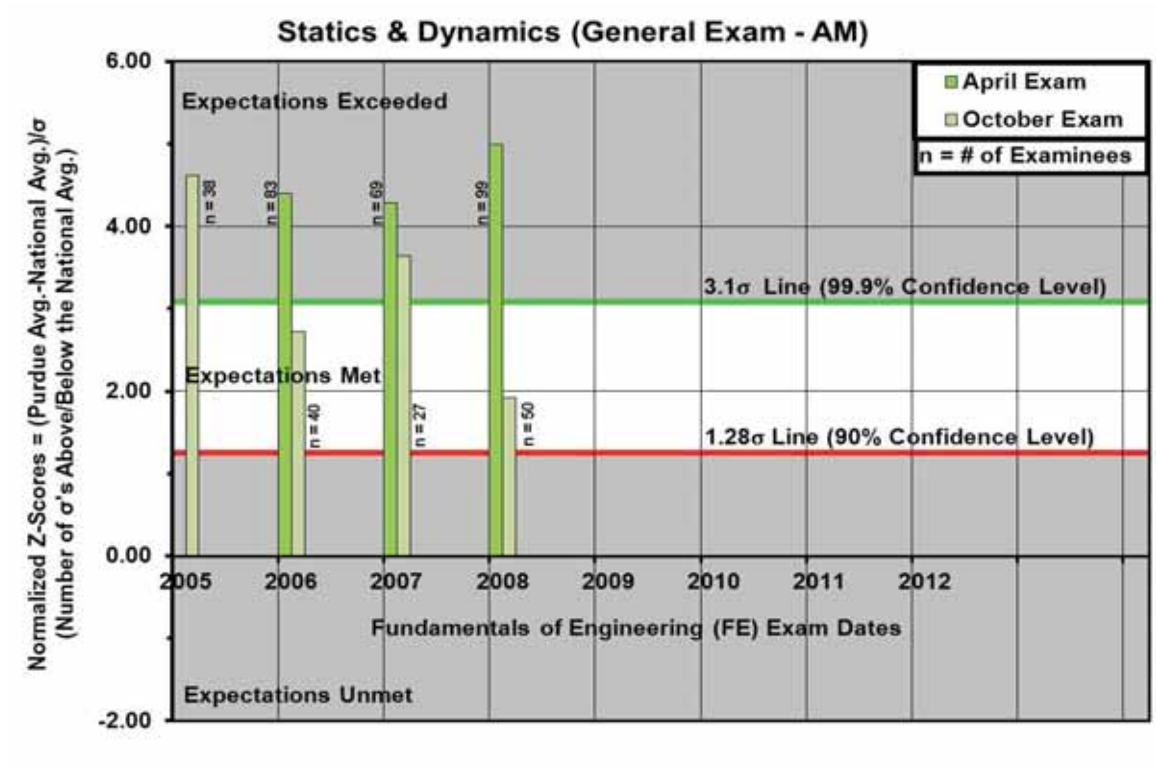


Figure E.9 Longitudinal Normalized Z-Scores for the FE Exam for the Statics and Dynamics Topic.

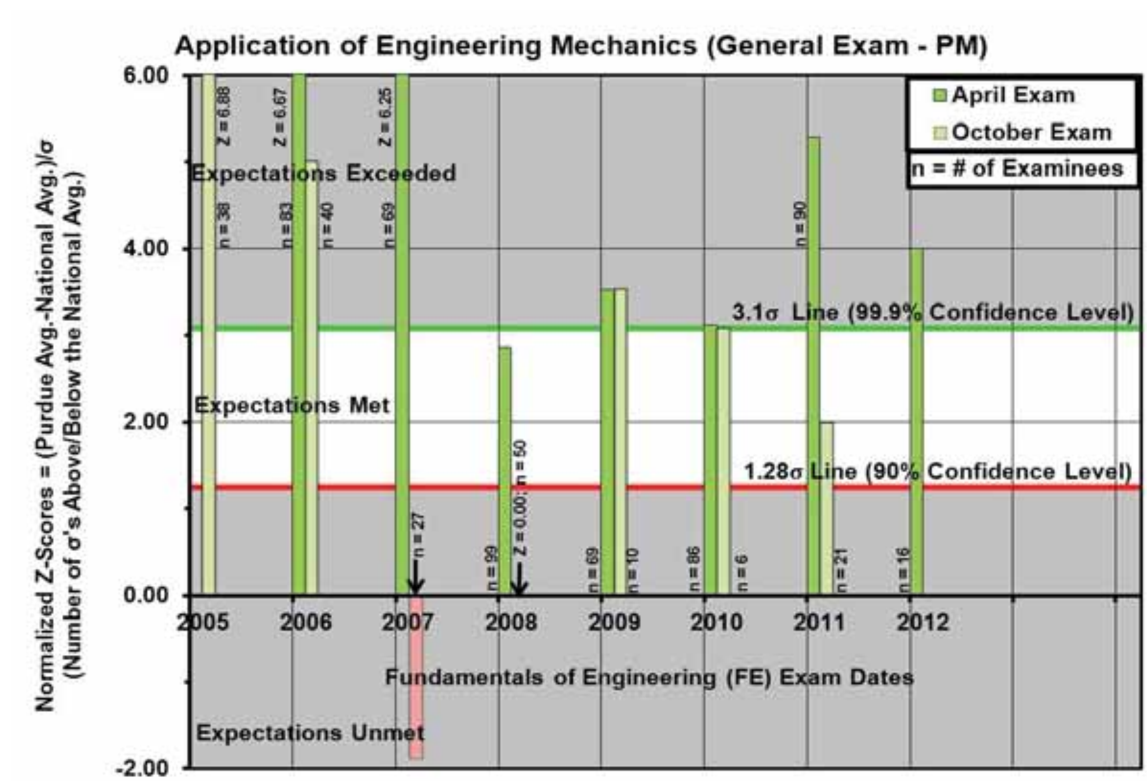


Figure E.10 Longitudinal Normalized Z-Scores for the FE Exam for the Application of Engineering Mechanics Topic.

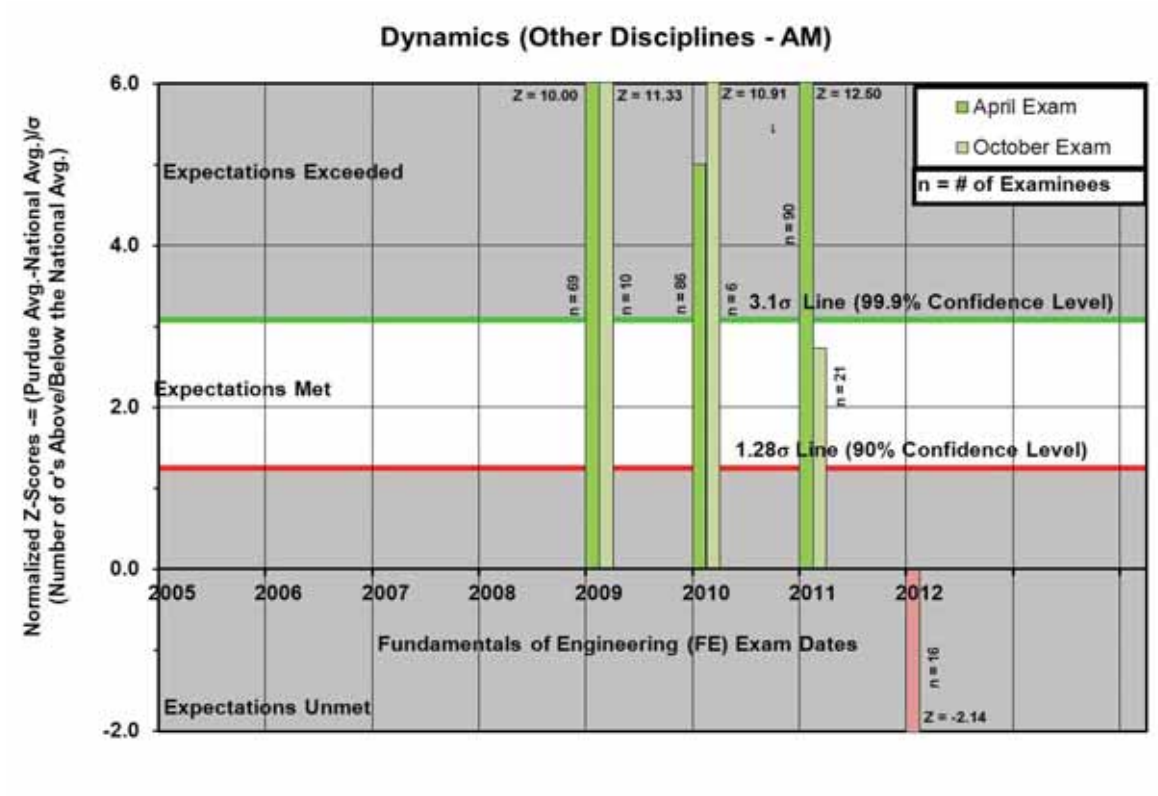


Figure E.11 Longitudinal Normalized Z-Scores for the FE Exam for the Dynamics Topic.

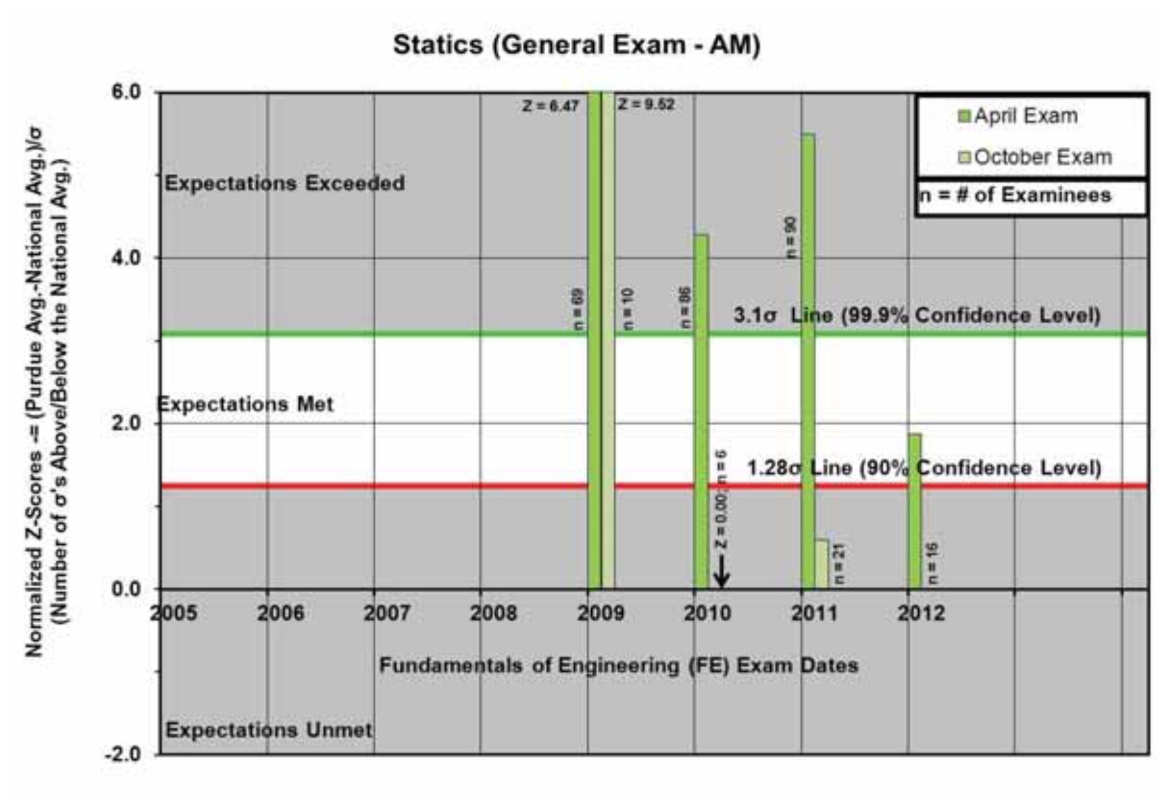


Figure E.12 Longitudinal Normalized Z-Scores for the FE Exam for the Statics Topic.

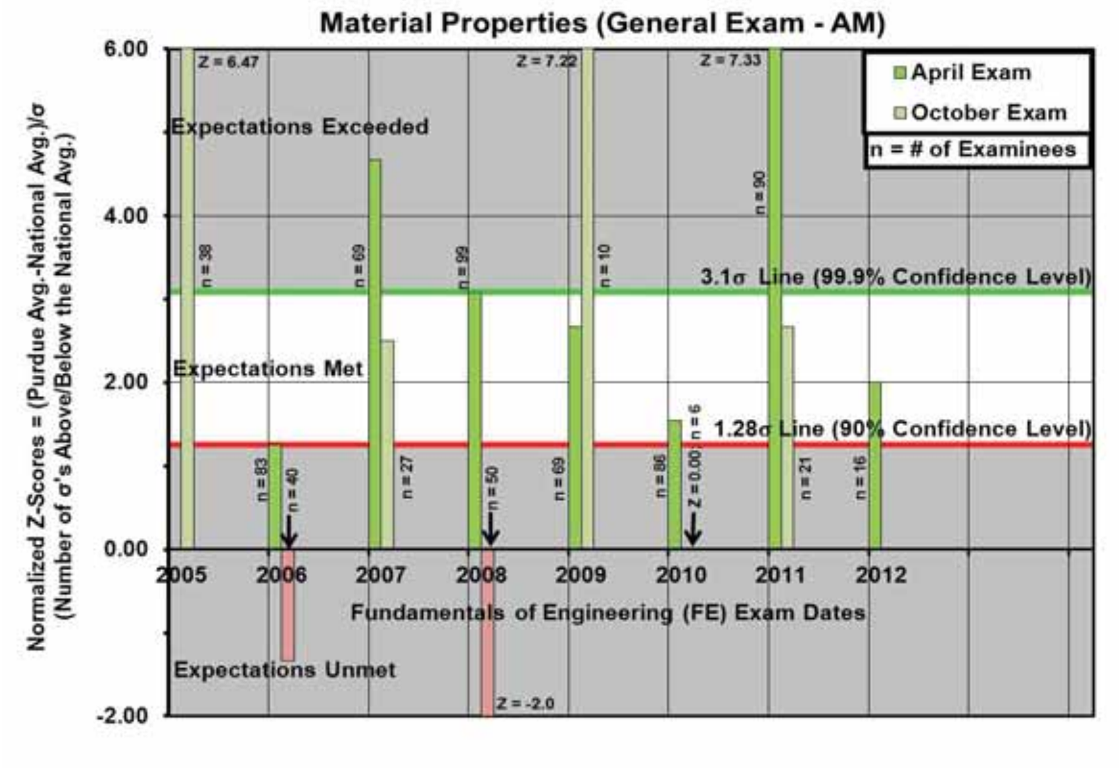


Figure E.13 Longitudinal Normalized Z-Scores for the FE Exam for the Material Properties Topic.

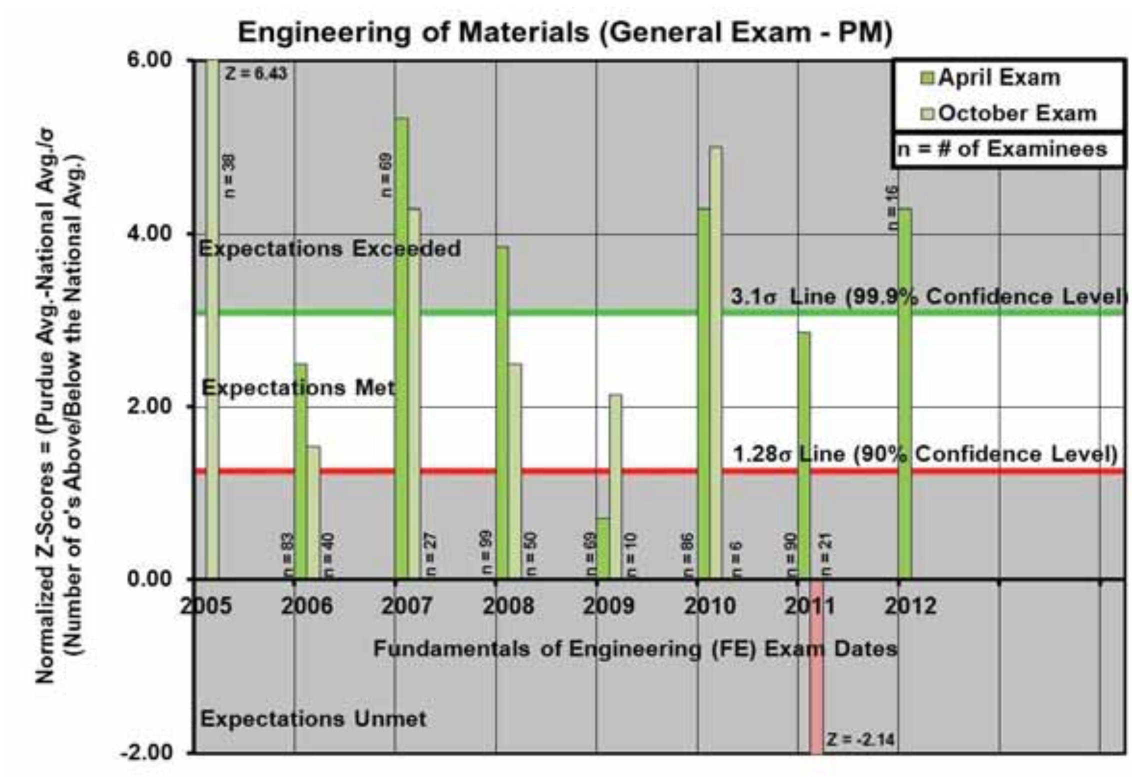


Figure E.14 Longitudinal Normalized Z-Scores for the FE Exam for the Engineering of Materials Topic.

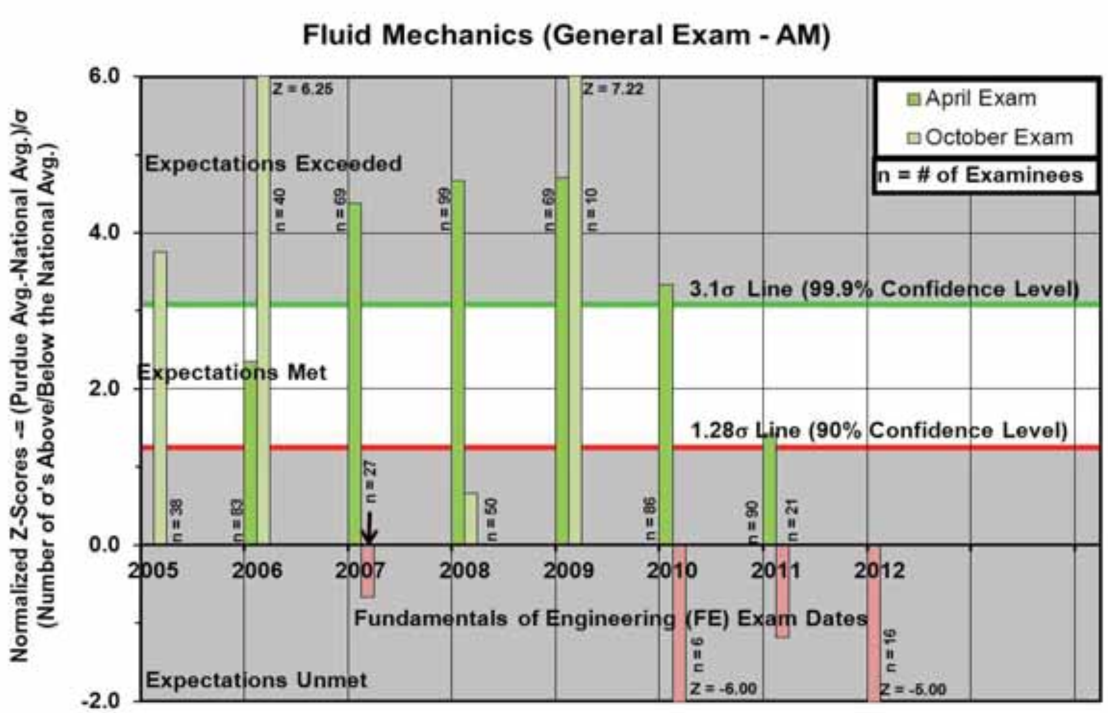


Figure E.15 Longitudinal Normalized Z-Scores for the FE Exam for the Fluid Mechanics Topic.

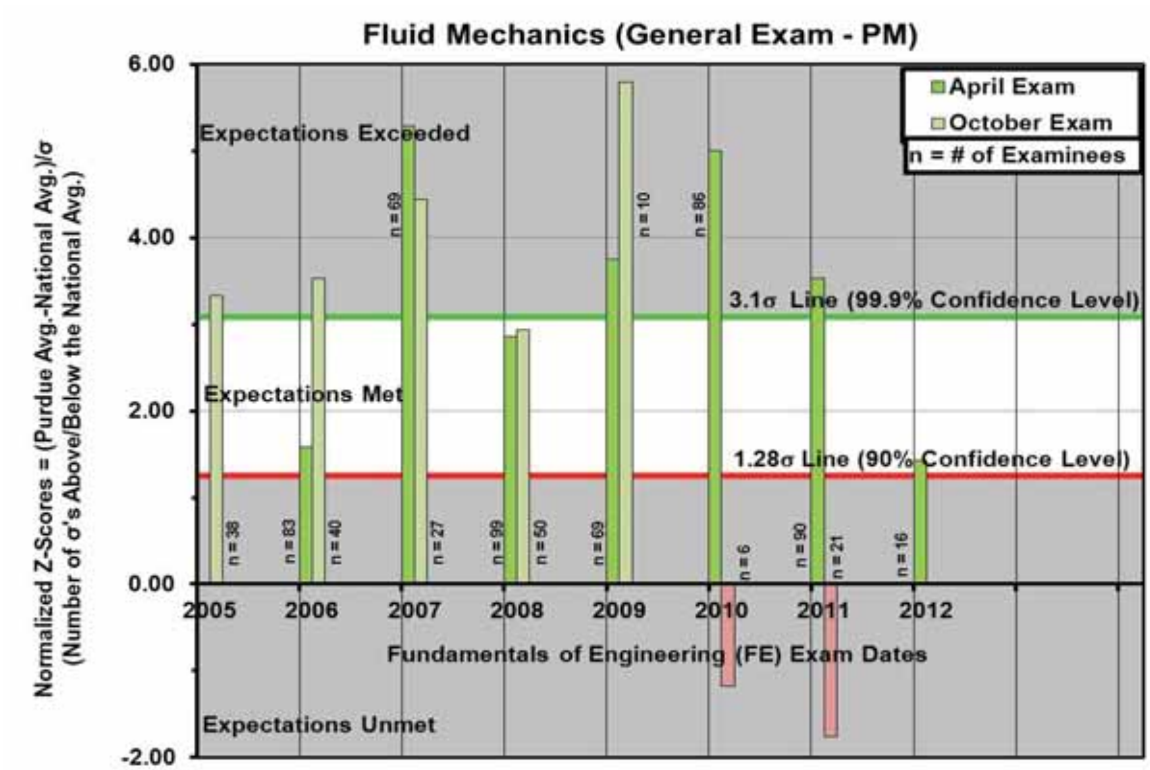


Figure E.15 Longitudinal Normalized Z-Scores for the FE Exam for the Fluids Topic.

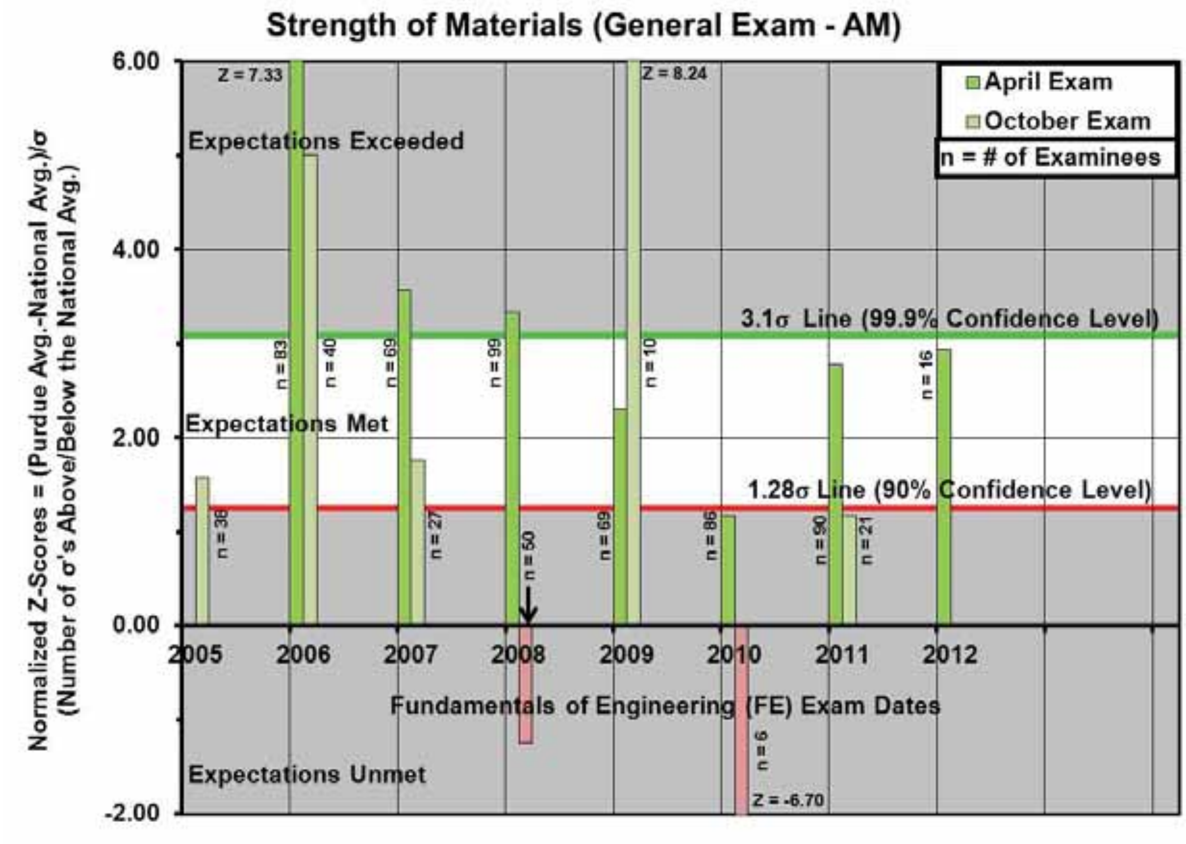


Figure E.17 Longitudinal Normalized Z-Scores for the FE Exam for the Strength of Materials Topic.

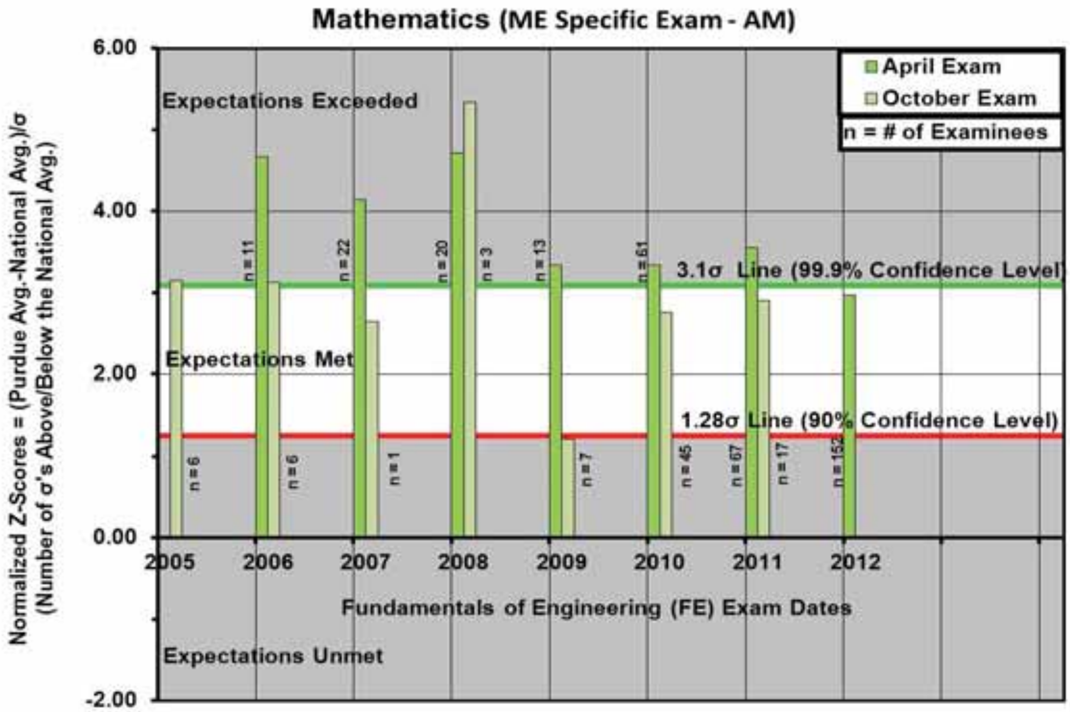


Figure E.18 Longitudinal Normalized Z-Scores for the FE Exam for the Mathematics Topic.

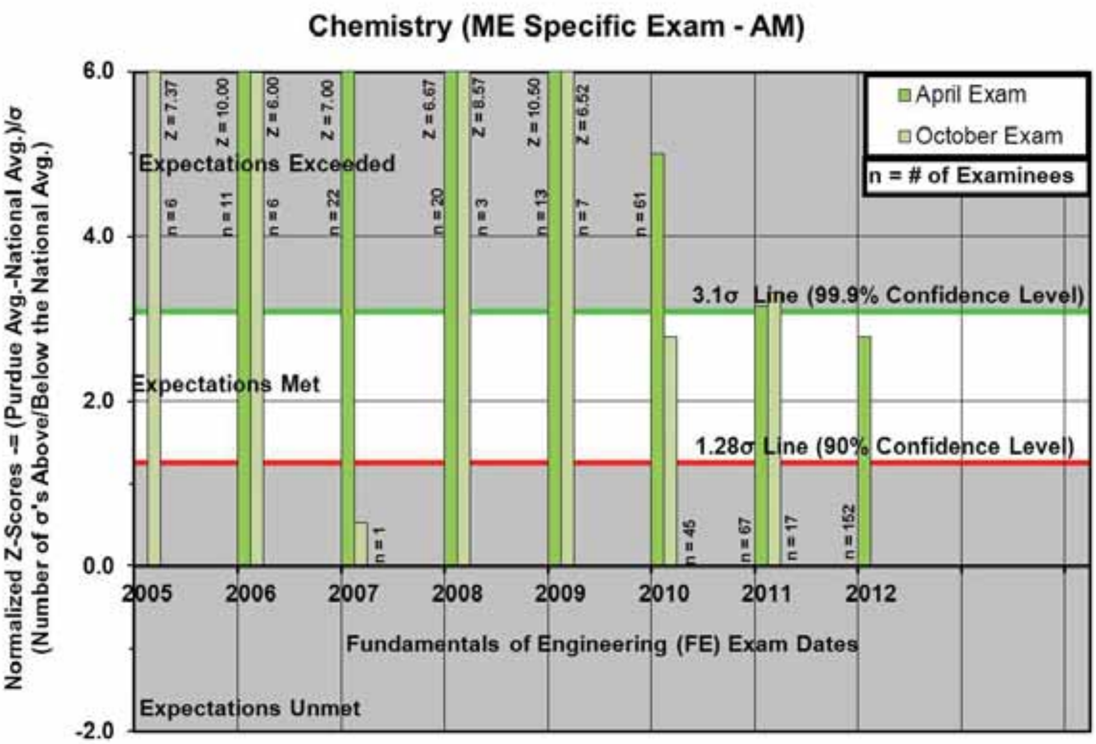


Figure E.19 Longitudinal Normalized Z-Scores for the FE Exam for the Chemistry Topic.

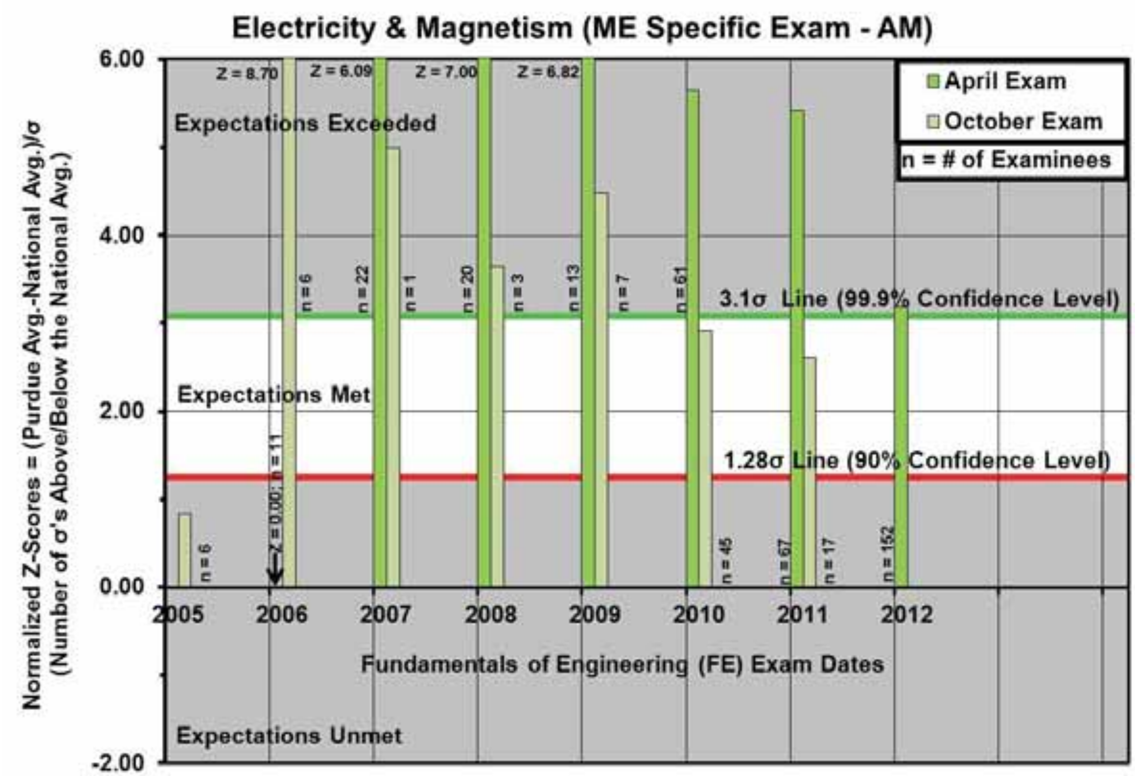


Figure E.20 Longitudinal Normalized Z-Scores for the FE Exam for the Electricity and Magnetism Topic.

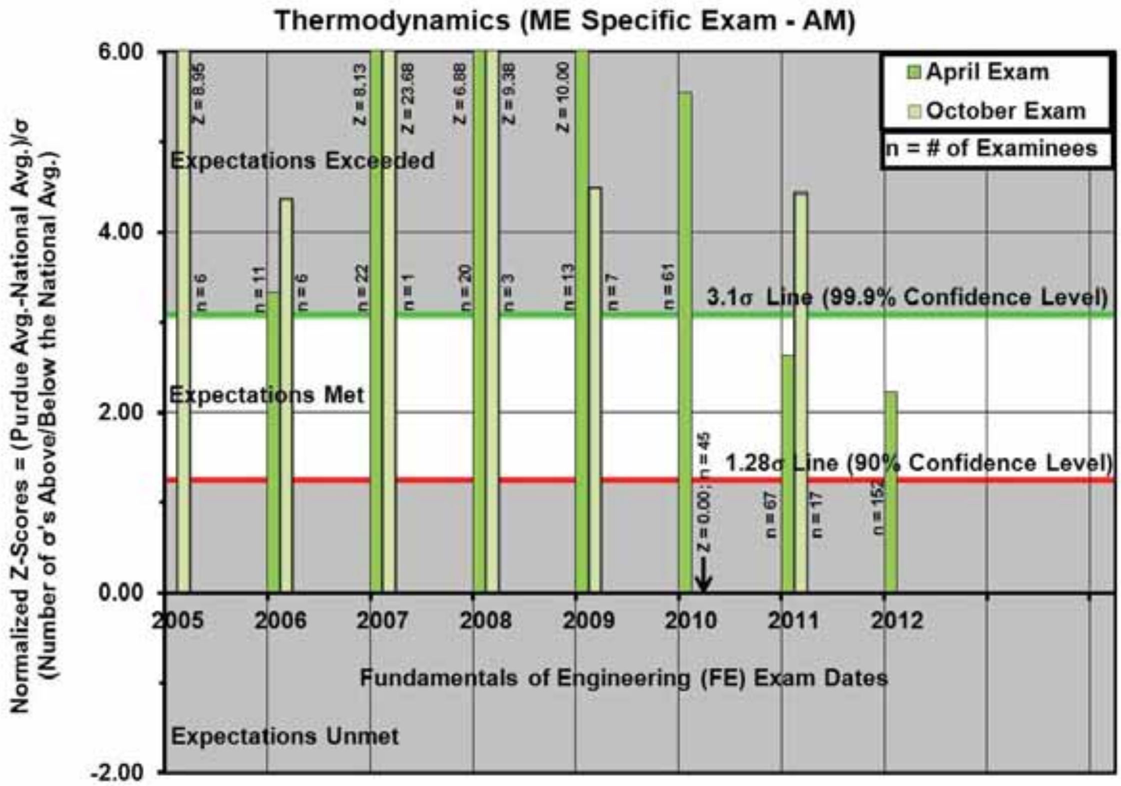


Figure E.21 Longitudinal Normalized Z-Scores for the FE Exam for the Thermodynamics Topic.

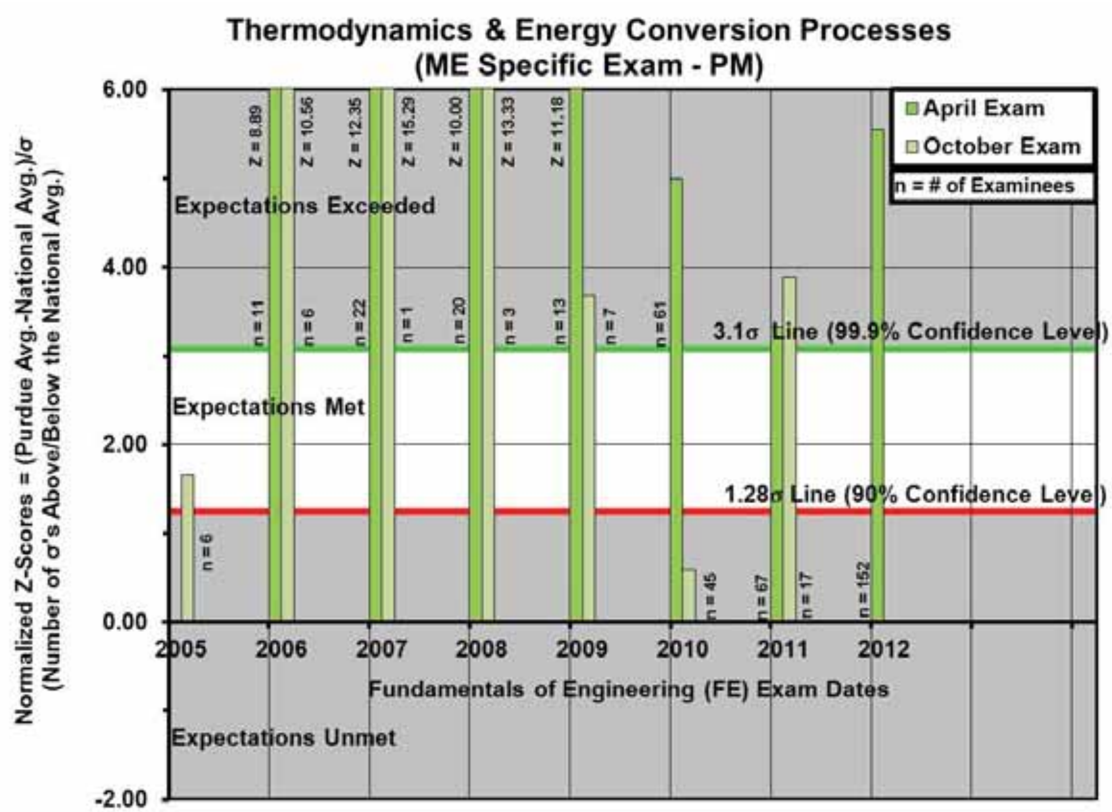


Figure E.22 Longitudinal Normalized Z-Scores for the FE Exam for the Thermodynamics and Energy Conversion Processes Topic.

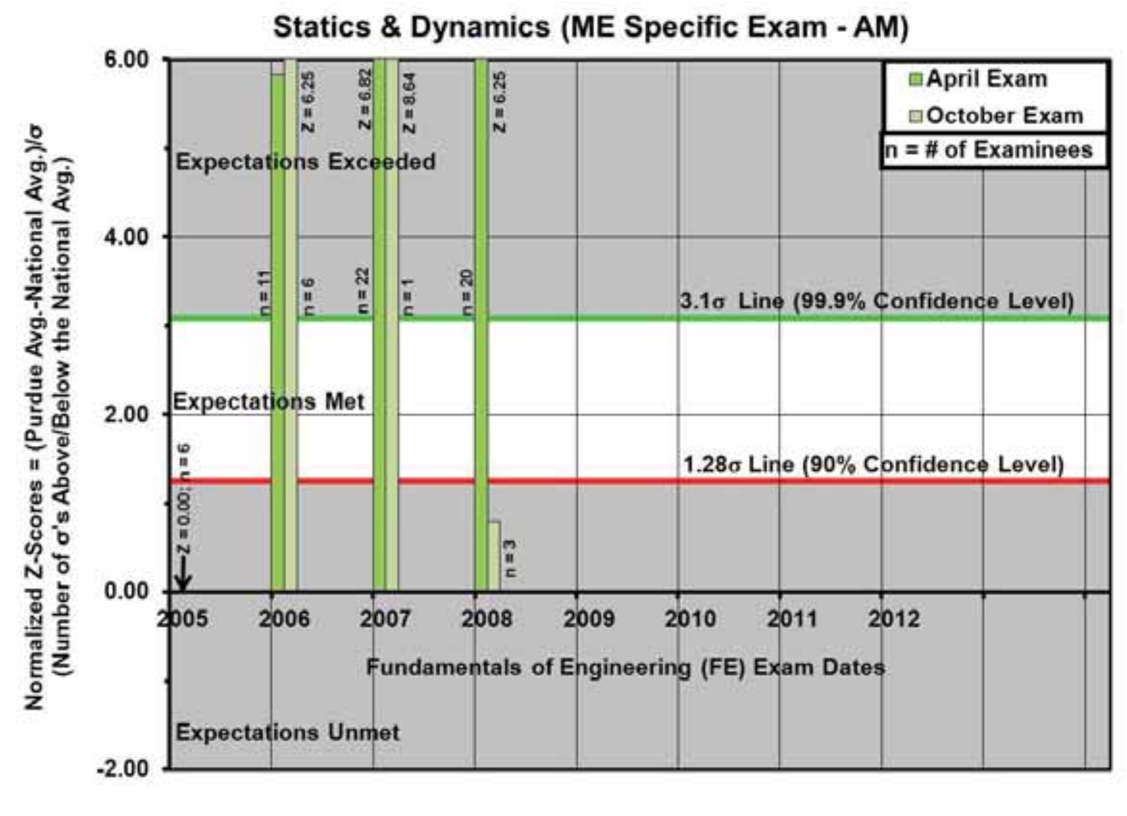


Figure E.23 Longitudinal Normalized Z-Scores for the FE Exam for the Engineering Mechanics (Statics and Dynamics) Topic.

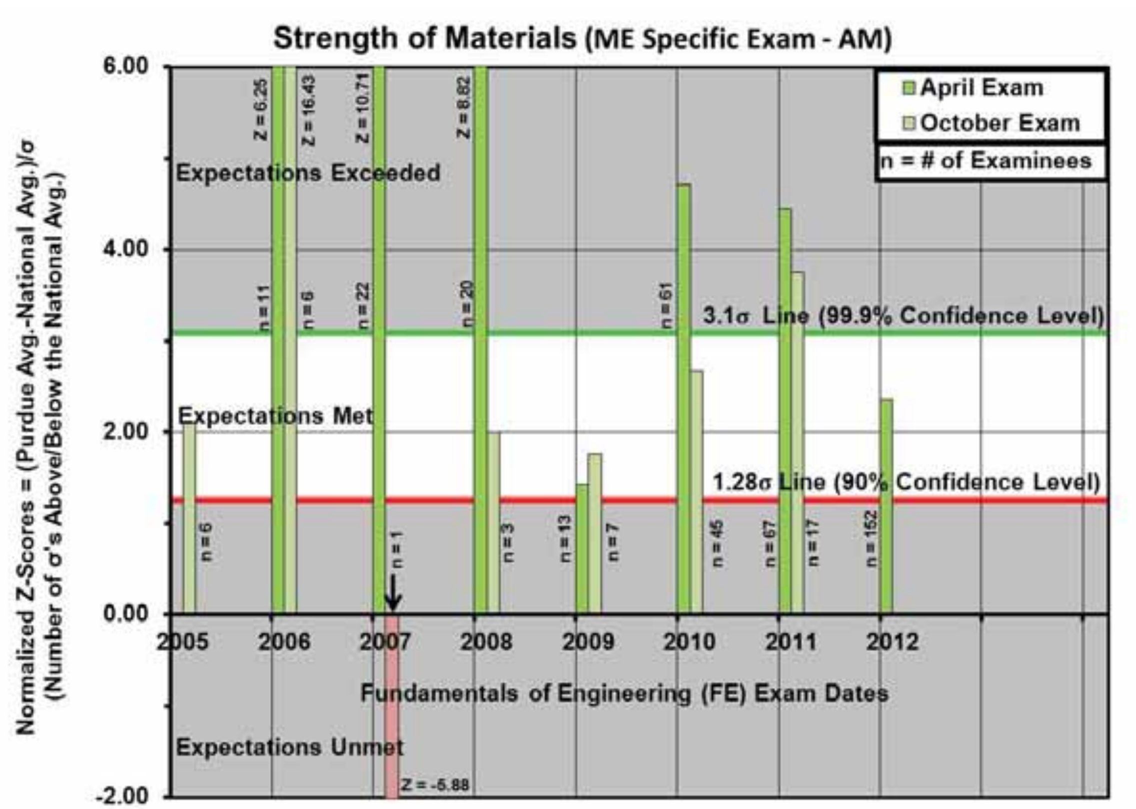


Figure E.24 Longitudinal Normalized Z-Scores for the FE Exam for the Strength of Materials Topic.

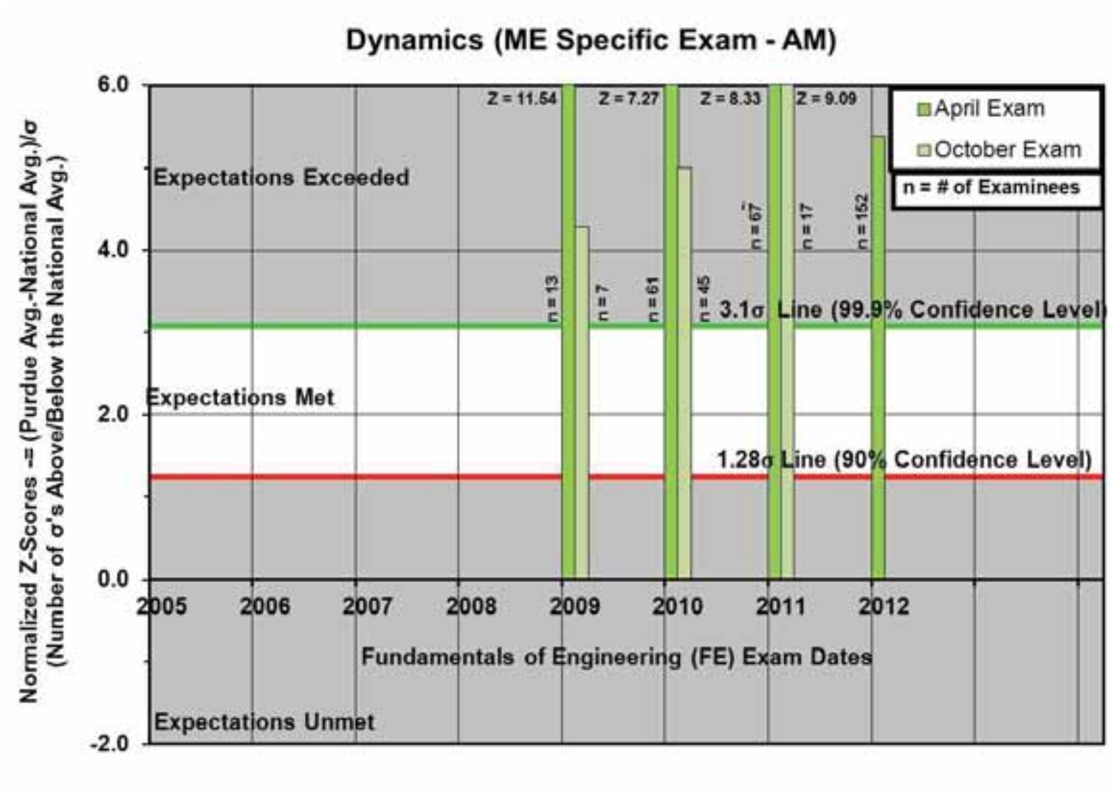


Figure E.25 Longitudinal Normalized Z-Scores for the FE Exam for the Dynamics Topic.

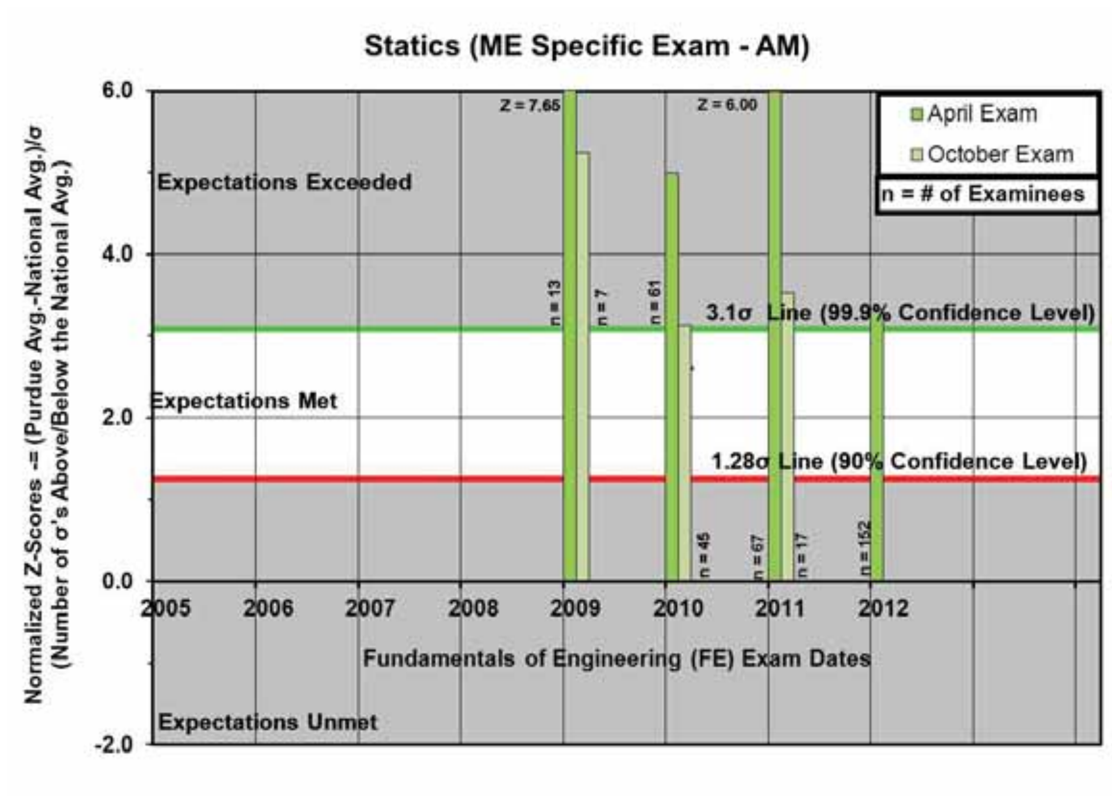


Figure E.26 Longitudinal Normalized Z-Scores for the FE Exam for the Statics Topic.

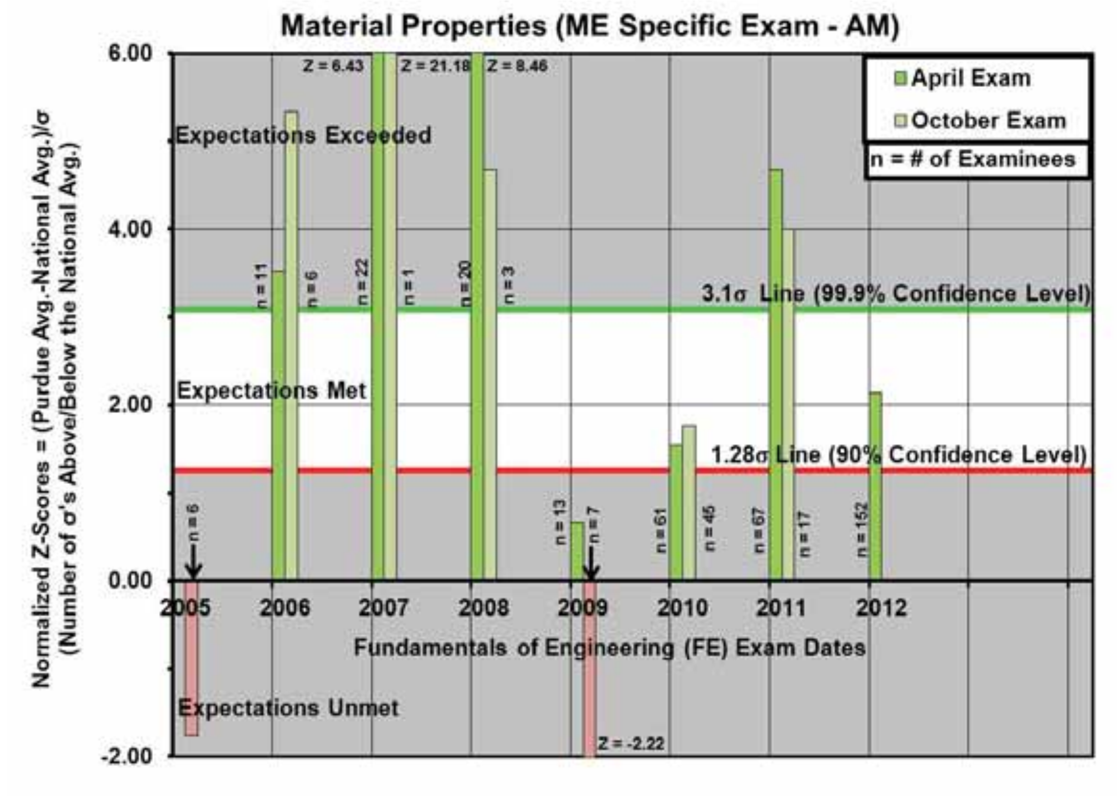


Figure E.27 Longitudinal Normalized Z-Scores for the FE Exam for the Materials Properties Topic.

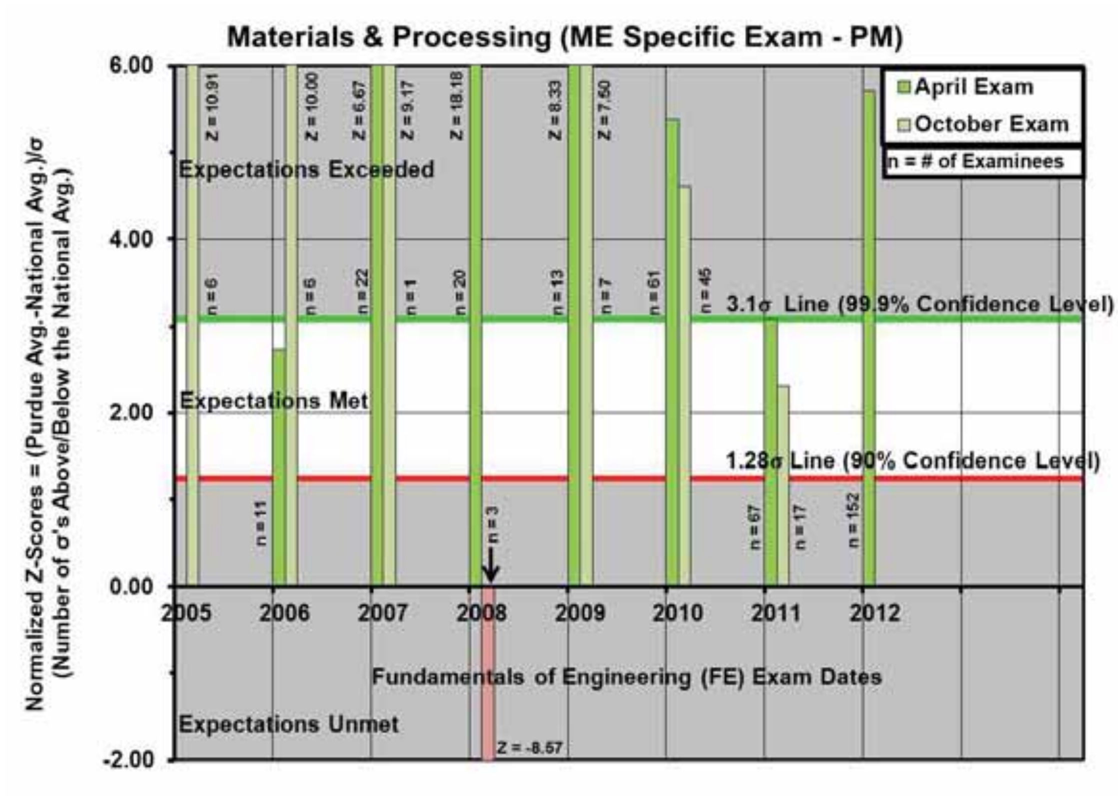


Figure E.28 Longitudinal Normalized Z-Scores for the FE Exam for the Materials and Processing Topic.

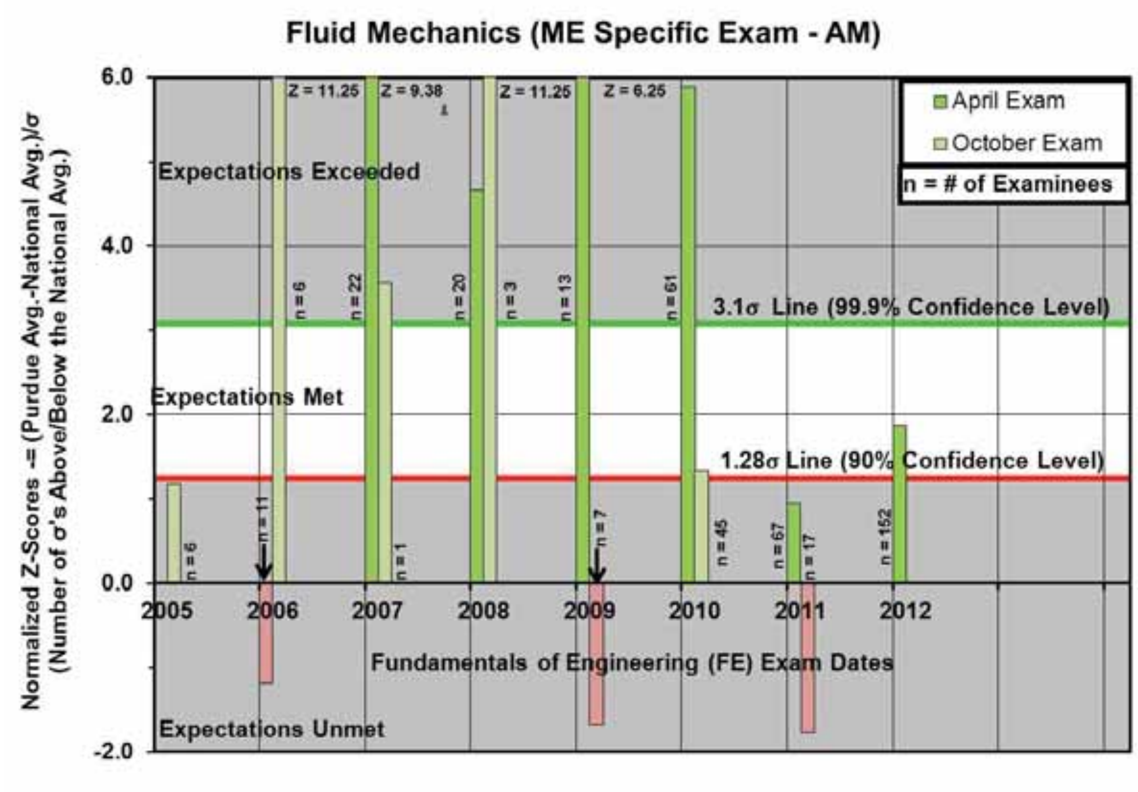


Figure E.29 Longitudinal Normalized Z-Scores for the FE Exam for the Fluid Mechanics Topic.

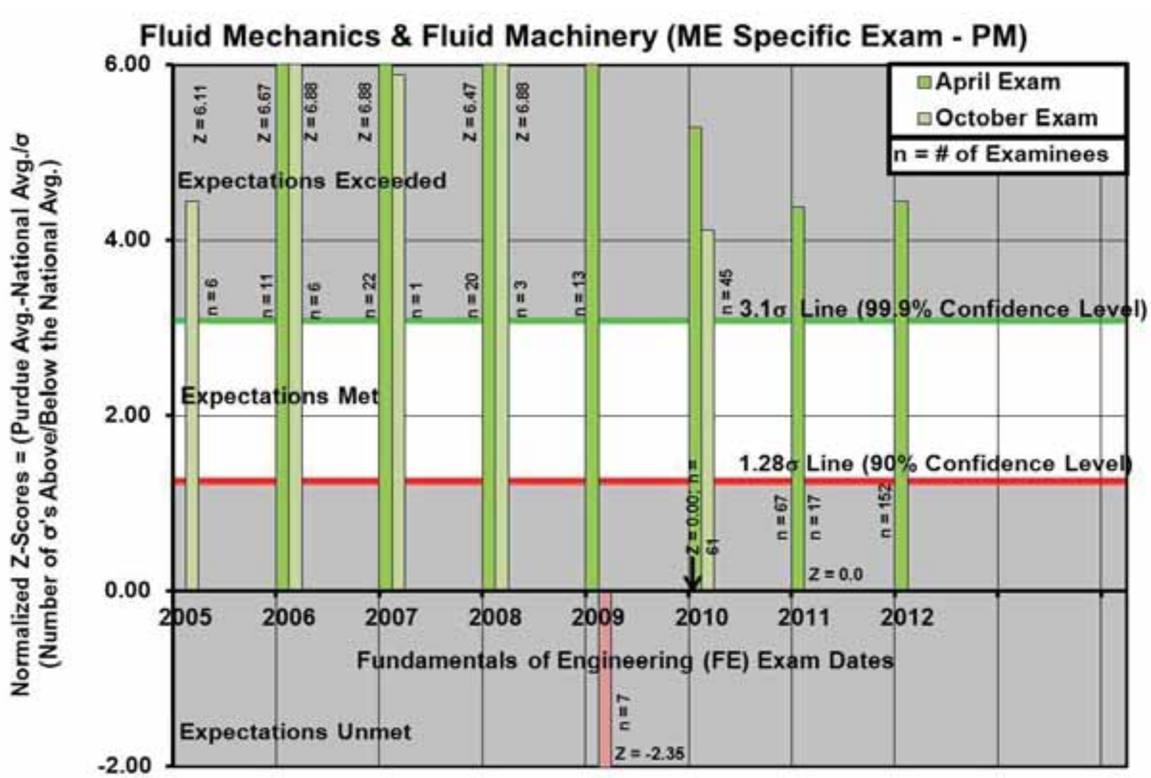


Figure E.30 Longitudinal Normalized Z-Scores for the FE Exam for the Fluid Mechanics and Fluid Machinery Topic.

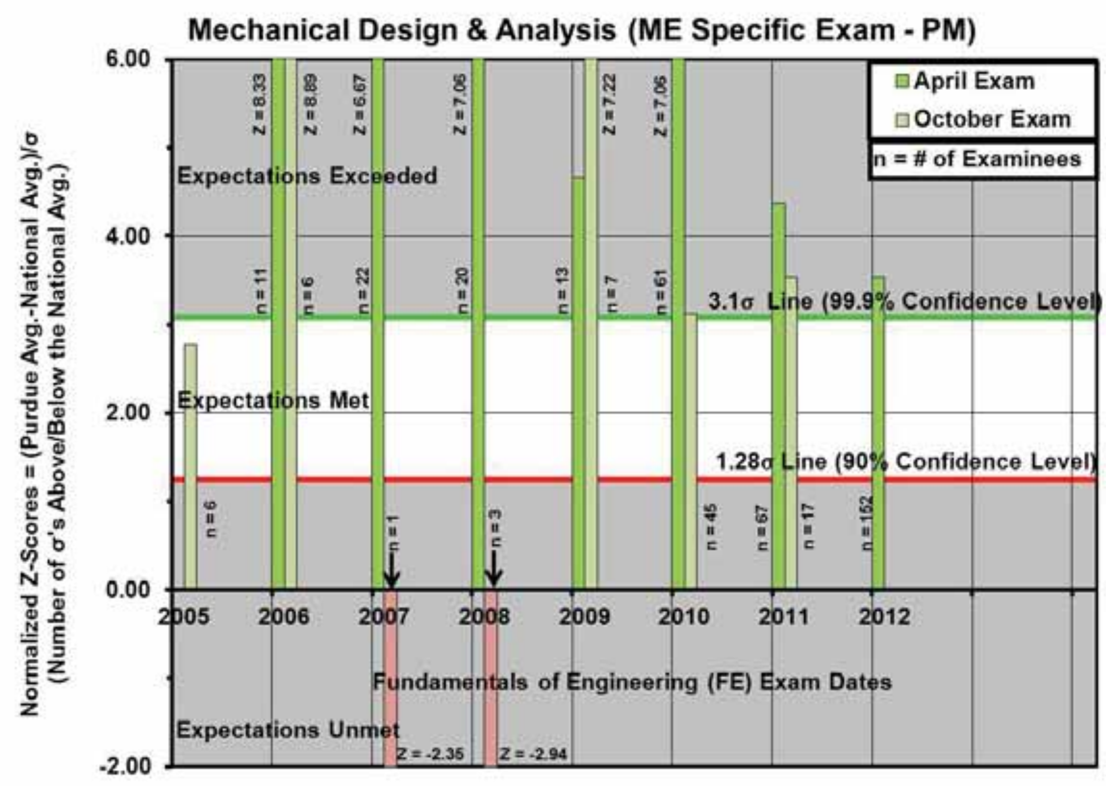


Figure E.31 Longitudinal Normalized Z-Scores for the FE Exam for the Mechanical Design and Analysis Topic.

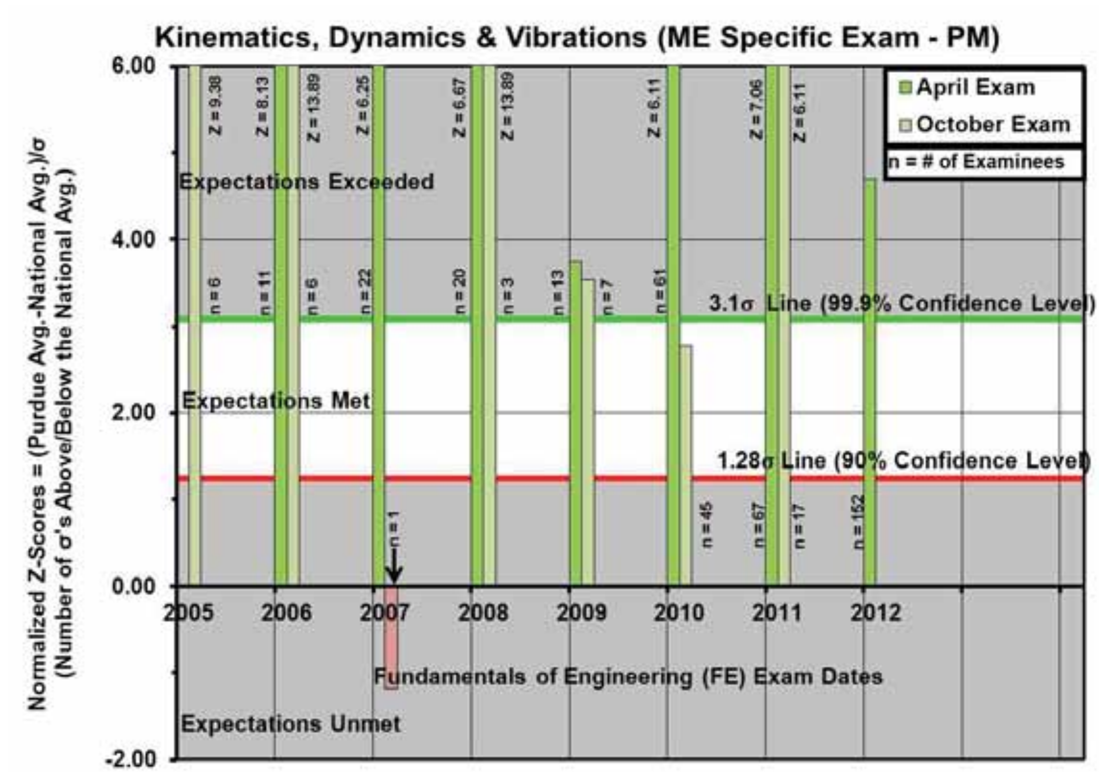


Figure E.32 Longitudinal Normalized Z-Scores for the FE Exam for the Kinematics, Dynamics, and Vibrations Topic.

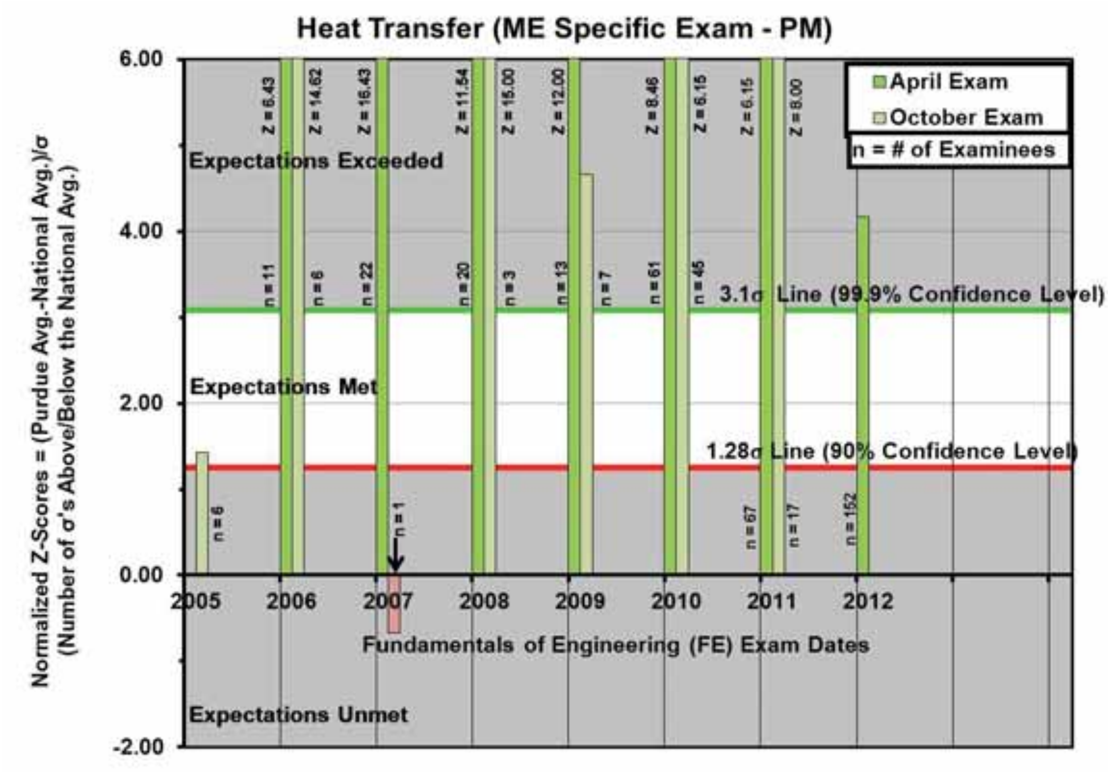


Figure E.33 Longitudinal Normalized Z-Scores for the FE Exam for the Heat Transfer Topic.

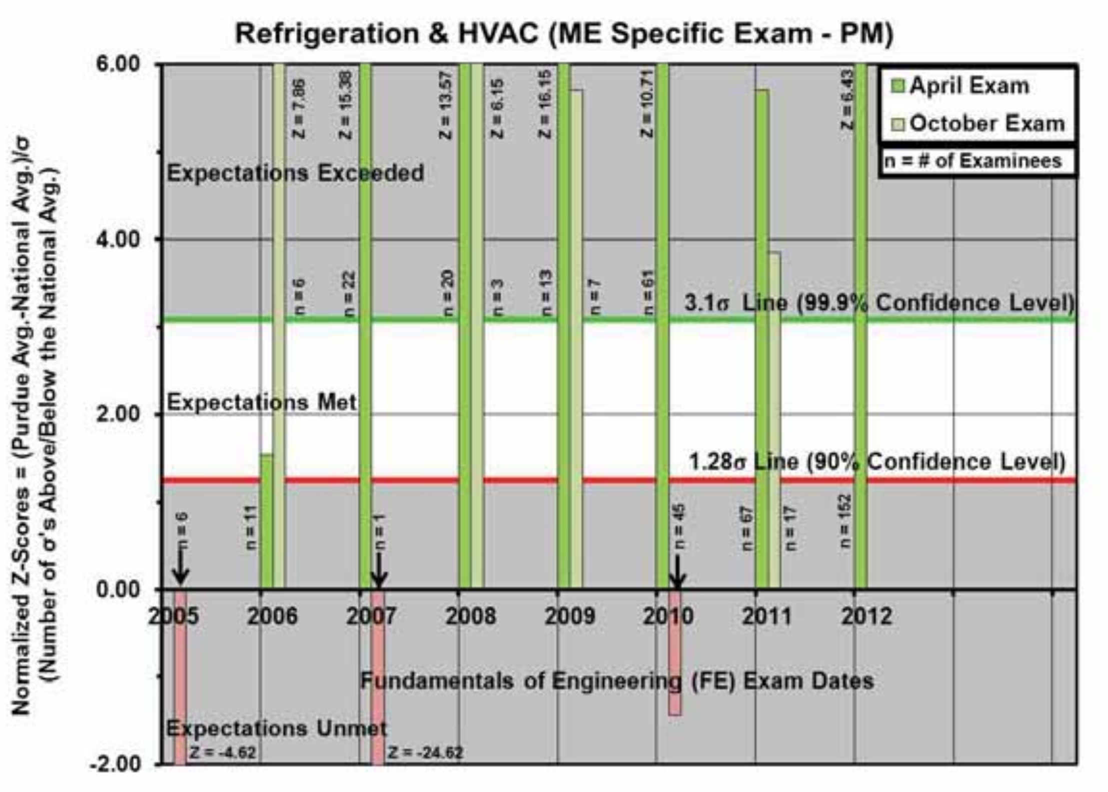


Figure E.34 Longitudinal Normalized Z-Scores for the FE Exam for the Refrigeration and HVAC Topic.

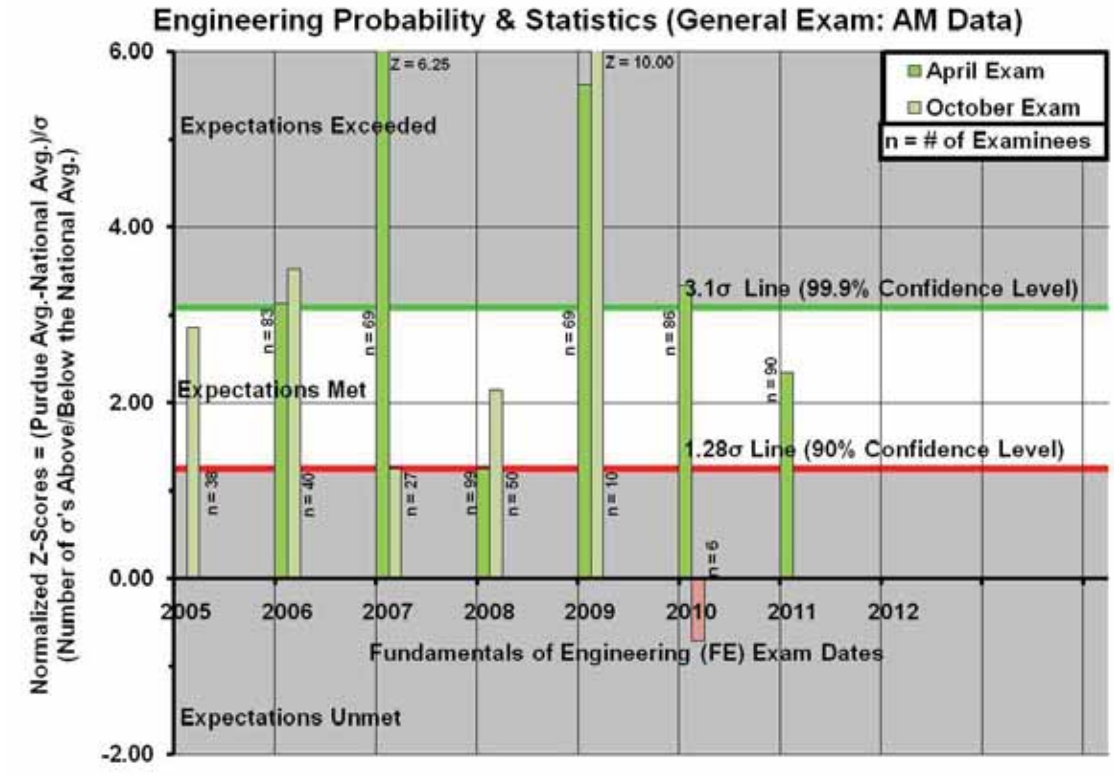


Figure E.35 Longitudinal Normalized Z-Scores of the FE Exam for the Engineering Probability and Statistics Topic.

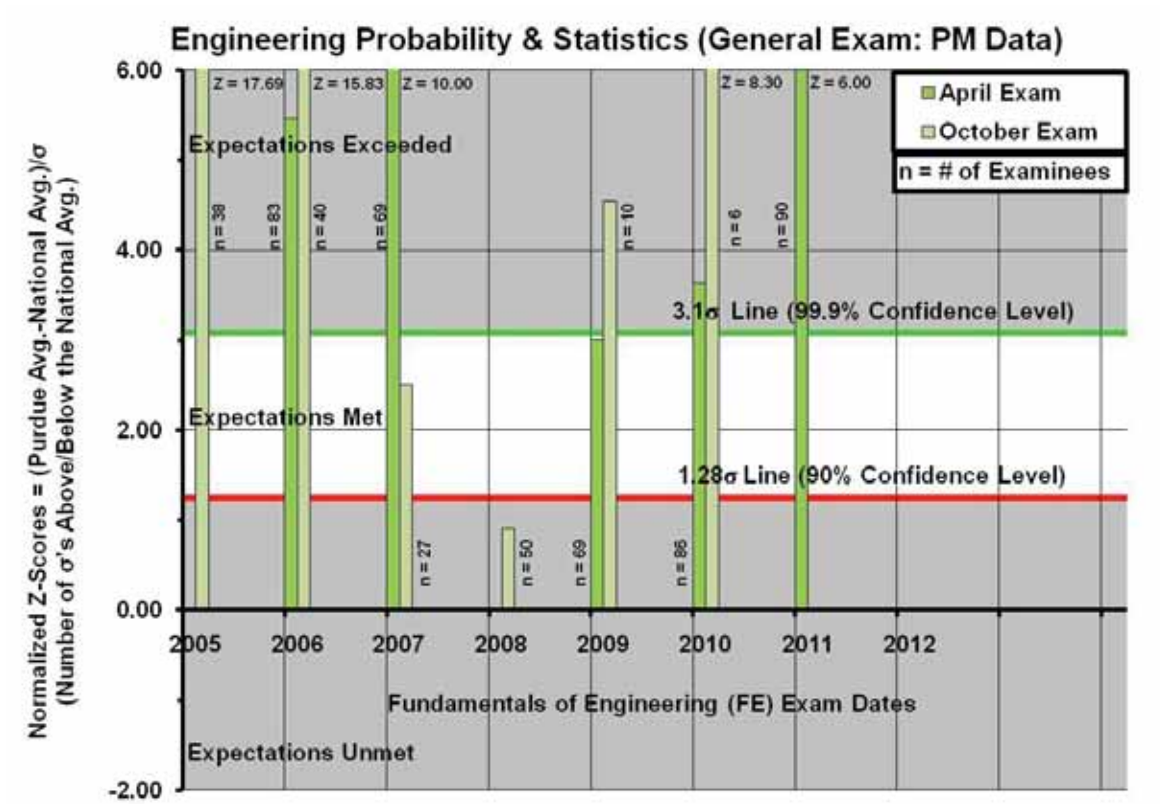


Figure E.36 Longitudinal Normalized Z-Scores of the FE Exam for the Engineering Probability and Statistics Topic.

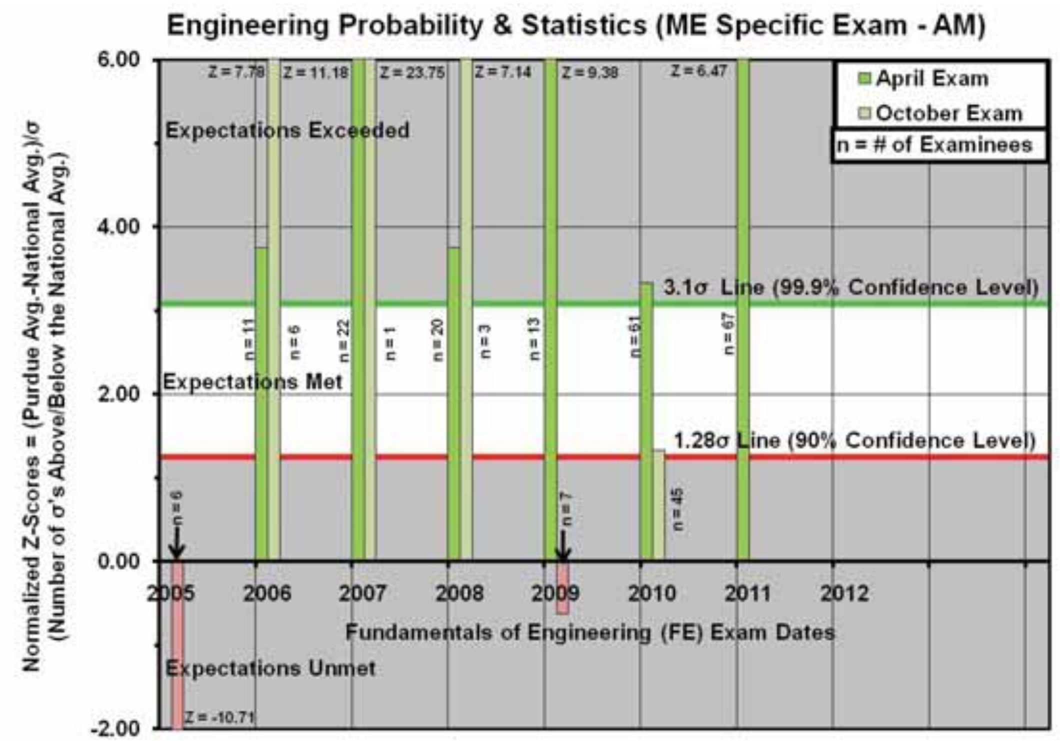


Figure E.37 Longitudinal Normalized Z-Scores of the FE Exam for the Engineering Probability and Statistics Topic.

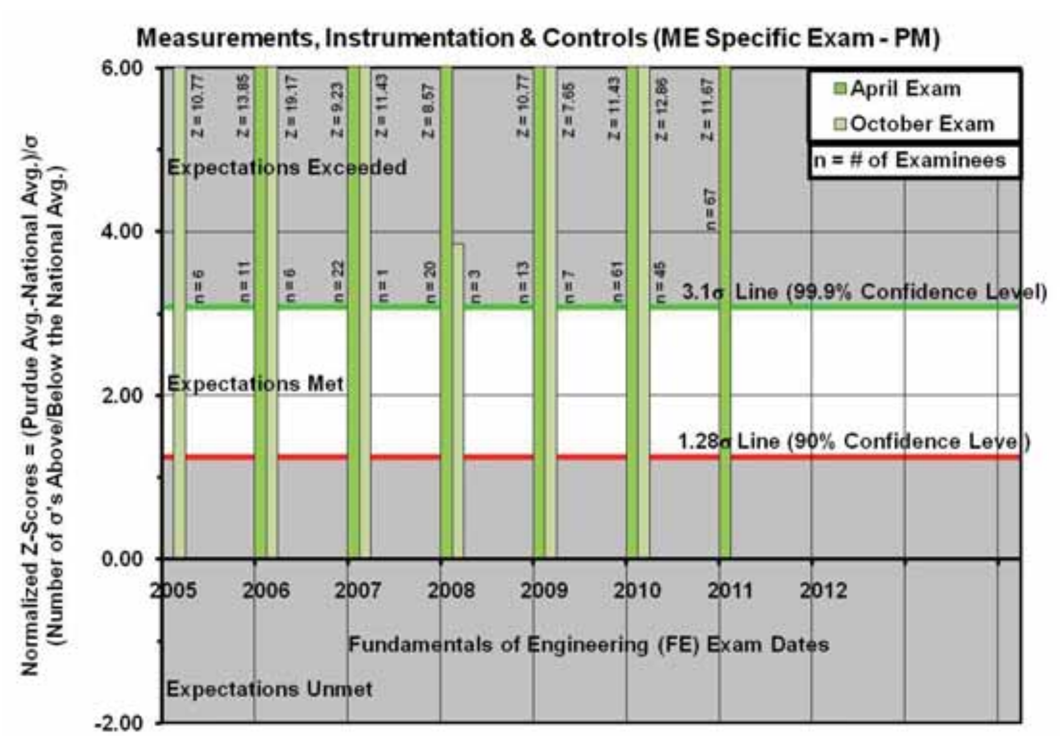


Figure E.38 Longitudinal Normalized Z-Scores of the FE Exam for the Measurements, Instrumentation and Controls Topic.