# Industrial Engineering

## Ph.D. Graduate Handbook

## 2013 - 2014

ARIZONA STATE UNIVERSITY

# MANUAL OF THE PH.D. DEGREE IN INDUSTRIAL ENGINEERING

## ARIZONA STATE UNIVERSITY

**2013 - 2014**

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## I. Introduction to the Industrial Engineering Program

The Industrial Engineering (IE) program of the Ira A. Fulton School of Engineering at Arizona State University (ASU) offers an advanced academic program leading to the Doctor of Philosophy (Ph.D.) degree. The program requires core and elective coursework, Qualifying and Comprehensive Exams, a written dissertation, and an oral defense of the dissertation. The Ph.D. degree is offered to exceptional students who have completed, with distinction, a Bachelor's or Master's degree in engineering, or a closely related field.

## II. Objective of the handbook

The purpose of this handbook is to provide guidance and information related to admission, degree requirements, and general policies and procedures. Please note that in some cases you will find differences between the Graduate Catalog and the Industrial Engineering program requirements. In these cases, IE has established higher standards. Students must satisfy both sets of requirements. Please note that policies and procedures are occasionally amended to improve the program. Changes will be communicated to students through e-mail, and posting on the paper and online bulletin boards.

## III. Student responsibility

All students are expected to become familiar with university and program policies and procedures and abide by the terms set forth. Information is available both online and by hardcopy upon request. Most importantly you should visit the following websites:

- The Office of Graduate Education – http://graduate.asu.edu .
- The Graduate Catalog – www.asu.edu/catalog visit the section on policies and procedures.
- The Industrial Engineering Program – http://cidse.engineering.asu.edu/forstudent/graduate/industrial-engineering/
- The International Student Office – https://international.asu.edu/ , if applicable.
- The Ira A. Fulton School of Engineering – http://engineering.asu.edu

## IV. Faculty responsibility

The members of the faculty of Industrial Engineering have diverse backgrounds and knowledge. They are available to assist you in your plan of study and your educational and career goals. We encourage you to take the opportunity to make individual appointments with faculty members with whom you have common interests. Please refer to a list of the faculty names, areas of expertise, and research interest at the end of this handbook.

## V. Admission and eligibility to the doctoral degree program

The Industrial Engineering doctoral degree requires a background in engineering, math, statistics, physical science, or a closely related field. However, in some cases, students with non-traditional educational backgrounds will be considered for admission. These students may be required to take fundamental courses to better prepare them for the program coursework. A student is encouraged to contact the Office of Graduate Programs in IE to obtain advice on their educational pursuits.

**Eligibility -** Prior to applying to the IE doctoral program, students are required to have completed three semesters or 12 credit hours of Calculus including Multivariate Calculus.

**Application -** All students are required to submit an application with the Office of Graduate Education and pay the required fee in order to have their application properly processed.

**Application deadlines - December 15 for Fall and September 15 for Spring:**
To receive full consideration, we ask that you have all the required documents submitted by the deadline.

**GRE scores -** All students are required to submit official **general** Graduate Record Examination (GRE) scores directly to the Office of Graduate Education. Minimum guidelines for admission are 500 Verbal, 790 Quantitative, and 4.0 Analytical; however, admission decisions are made on the basis of the entire application packet. We do not require specific subject GRE scores. The ASU Institution code is 4007. If department code is required use 000 for GRE

**TOEFL -** The University requires all international applicants from a country whose native language is not English to provide the Test of English as a Foreign Languages (TOEFL) or the International English Language Testing System (IETLS) scores. IE uses 575 (paper-based) or 90 (internet-based) as minimum expectations for admission. **Please note that your application will not be processed until the university receives official TOEFL scores, which are valid two years from the start date of the degree program.** There are some exceptions for students who have been living in the United States and would like to have the TOEFL waived, should consult the Graduate Catalog under "English Language Requirement" and the Office of Graduate Education for details. Please address all TOEFL questions to the Office of Graduate Education. The ASU Institution code is 4007. If department code is required use 99 for TOEFL

**Personal statement** - The application must include a personal statement. The statement should: 1) explain professional goals and reasons for desiring to enroll in the doctorate program; 2) describe any research experiences; 3) indicate personal research interests; and 4) identify two or three ASU IE faculty with matching research interests.

**Letters of recommendation -** IE requires three (3) letters of recommendation, at least one of which must come from former faculty. There is no standard form for letters of recommendation. We encourage letters from people who know you well, such as teachers, professional associates and supervisors. Ask people who can comment on your academic, emotional, intellectual and professional development.

**GPA requirement -** Students applying directly from an undergraduate program must have a minimum cumulative GPA of 3.5 in the last 60 credit hours of the undergraduate degree and have been involved in some form of research at the undergraduate level. Students who are applying following a master's degree must have a minimum GPA of 3.5 for the last degree awarded.

**Application evaluation -** Several factors are taken into consideration when evaluating a student's application: the student's cumulative GPA, major, institution, personal

statement, letters of recommendation, standardized test scores, and performance in individual courses.

**Deficiencies -** Depending on prior academic preparation and accomplishments of an applicant, deficiency courses may be specified to ensure adequate background preparation. During advising, a student may have their course syllabi examined as evidence that deficiencies have been satisfied or may choose to take the deficiency test-out examination. Please note that deficiencies are not intended solely as prerequisites for graduate coursework; they also satisfy the breadth requirement for all graduates of IE.

**Deficiency test-out exam** - On the day before orientation in Fall and Spring semesters, a classroom will be set aside to allow students entering with deficiencies (listed in the admissions letter) to take a brief test to establish whether they possess basic knowledge of the course sufficient to have an assigned deficiency waived. There are no exams available for CSE 110 and CSE 205. The deficiency test-out exam is open-book and the allotted time for each test is 50 minutes. Students may take up to 3 test-out exams. This scheduled testing period is the only opportunity for deficiency test-outs. No other arrangements will be made for students to test-out of assigned deficiencies.

Below is a list of pre-requisites along with the associated ASU course numbers:

- CSE 110 – Java Language Programming
- CSE 205 – Concepts in Computer Science
- MAT 242 – Linear Algebra
- IEE 380 – Probability and Statistics for Engineering Problem Solving
- IEE 376 – Deterministic Operations Research
- IEE 470 – Introduction to Engineering Probability Models

Deficiency coursework completed with a grade of "C" or better at the undergraduate level will satisfy the requirements. A grade of "B" or better is required for all assigned deficiency coursework at the post-baccalaureate level.

**Notice of Admission** - IE submits its recommendation of admission to the Office of Graduate Education and the final notice of admission decision is notified in writing by the Office of Graduate Education. You may check your application status on MyASU.

## VI. Doctoral degree requirements

Degree requirements for the Ph.D. include a minimum of 85 semester hours beyond the bachelor's degree and deficiency courses. A maximum of 30 credit hours taken during the Master's degree can be applied to a Ph.D. degree, provided that coursework is approved as applicable to the doctoral degree. The Ph.D. is comprised of five major milestones which all students are required to pass successfully prior to graduation:

a. Completion of the core coursework
b. Passing the Qualifying Examination on the core coursework
c. Filing an approved Plan of Study
d. Passing the Comprehensive Examination and approval of the dissertation prospectus to advance to candidacy

e. Successful oral defense of an approved written dissertation.

**a. Core courses:** All incoming students are required to complete the five core courses of which at least 4 have to be completed in their first year for full-time students or within two years for part-time students.

The core courses are:

- IEE 605 - Information Systems Engineering
- IEE 620 - Optimization I
- IEE 621 - Optimization II
- IEE 640 - Stochastic Processes
- IEE 670 - Mathematical Statistics

**b. Qualifying Examination:** After completion of the core courses, each student must take the qualifying exam on 4 of the 5 core courses prior to progressing in their academic degree. Students who fail are allowed only one reexamination, which should be taken at the next scheduled examination date. More details will be provided by the end of the Fall semester.

**c. Formulation of the Plan of Study**: After successfully completing the core courses and passing the Qualifying Examination, students will be required to develop and submit a Plan of Study (POS) through MyASU. A minimum of 85 credit hours are required in the Plan of Study. A maximum of six credit hours of 400 level coursework may be used on an approved POS (400 level courses taken for a grade of Pass/Fail cannot be included on a POS). Courses with grades of "D" (1.00) and "E" (0.00) cannot be included on a POS. The degree is comprised of one major area (minimum of 18 credit hours) and two minors (minimum of 9 credit hours each). The Plan of Study must have the following <u>required</u> minimum components:

1. Five core courses (15 credit hours) (see previous *Core courses* for details)
2. Area & minor emphases coursework
   - Coursework of 42 credit hours beyond the core, of which <u>at most</u> 30 credit hours (subject to approval) from the Master's degree are applied. The core courses can be applied towards the major area and the two minors. Similarly, the approved 30 credit hours from the Master's degree can be applied towards the major area and the two minors.
3. Academic preparation
   - IEE 594 Seminar and Conference (1 credit hour)
   - IEE 700 Research Methods (1 credit hour)
   - IEE 790 Independent Study or IEE 584 Internship or additional 1 hour of IEE 594 (1 credit hour).
   - IEE 784 Teaching Internship (1 credit hour)
4. Research & dissertation
   - IEE 792 Research or graduate coursework (12 credit hours)
   - IEE 799 Dissertation (12 credit hours)

**d. Dissertation Supervisory Committee:** The role of the supervisory committee is to provide guidance and direction for the student's educational and research plan. As such,

the committee must have the necessary expertise to guide and evaluate research in the proposed dissertation area. A minimum of four committee members is required, including the committee chair or two co-chairs. Typical committees are made up of two committee members from the IE faculty in the student's major area; one member from the IE faculty outside of the area of the major; and one member from outside IE Program. The supervisory committee must be approved by the IE Program Chair and by the dean of the Office of Graduate Education prior to taking the Comprehensive Examination.

**e. Comprehensive Examination:** The Comprehensive Examination can be scheduled as early as one calendar year into the Ph.D. program but must follow passage of the qualifying exam. The comprehensive exam must be taken no later than the semester following the semester in which the 57th POS coursework credit hours are completed. The comprehensive examination and the dissertation prospectus are separate processes, both of which culminate with the oral comprehensive examination. Your committee chair will advise you of the expectations of the exam.

The student first makes arrangements with the advisory committee chair to schedule a five-week time period for the examination. Care must be taken to ensure that the entire examination will fall into one of the two regular semesters. The exam consists of two parts: a) a written exam; b) an oral defense on both the Comprehensive Exam and the Dissertation Prospectus. While separate, the two oral portions of the exam may be held at the same time. **The student is required to bring a Report of Doctoral Comprehensive Examination and Approval of the Ph.D. Dissertation Prospectus forms available on the CIDSE website to the oral examination, and after completion of the examination, the Chairperson should submit the form to the Graduate Academic Advisor.**

The five-week period will be spent as follows:

1. The student will submit a research proposal to the advisory committee. Guidelines for proposals are presented in Dissertation Prospectus below.
2. The members of the committee will submit written question(s) to the Dissertation Chair of the committee one week after submission of the research proposal. These questions should relate to the research area suggested by the student or to the coursework taken by the student.
3. The student will have 17 consecutive calendar days to develop written responses to the questions. The candidate should submit one complete, bound set of answers to all questions to each committee member.
4. The general knowledge oral portion of the examination will be held within two weeks of submission of the written responses. This examination normally lasts about two hours and will be primarily related to the research area, the student's written responses, and the dissertation prospectus. Appropriate related fundamental concepts may also be covered.
5. The final Pass/Fail is determined based on the combined responses to written and oral examination questions. A majority vote by the committee and a pass vote by the committee chair are required to pass.

6. Passing the examination makes the student a candidate for the Ph.D. degree. The Office of Graduate Education will inform the student and IE Office when candidacy is granted.

Should a student fail the examination, the advisory committee will decide if and when a retake of the examination is possible. A reexamination may be administered as early as three months and no later than one year from the date of the original examination. Only one retake is allowed.

The **Dissertation Prospectus** is a research proposal that precedes the dissertation. It is a document that introduces the doctoral student's proposed original contribution to the field of industrial engineering that will be created through the doctoral research and writing of the dissertation. The prospectus should raise an important issue in the field and discuss the issue's contribution to the discipline. The doctoral student should work with their advisor or co-advisors to prepare the prospectus. Upon completion, the student will deliver a hard copy of the prospectus to his/her supervisory committee. The committee will gather to discuss the prospectus. Following that, an oral delivery and review of the Dissertation Prospectus should be scheduled. This oral prospectus defense is considered part of the Comprehensive Exam and may be held in conjunction with the general knowledge defense.

While the format of the proposal is up to the committee chair, the written proposal typically contains:

1. A title page with author's name, committee members' names, institution, and date.
2. A table of contents.
3. An introduction explaining the nature of the research.
4. A clear statement of the research problem.
5. A thorough review of all relevant literature.
6. An argument that the problem is of sufficient relevance and importance to study.
7. A description of the proposed methodology and argument for its acceptability.
8. A statement of the expected contributions of the research.
9. A plan/schedule for completion of the research.
10. A complete bibliography following an accepted style.

The final version of the proposal is a binding agreement between the student and the Committee and will be enforced by the IE Program. Satisfactory completion of the research as outlined in the proposal will result in an approved dissertation. Following approval of the written dissertation, the student must schedule and pass a final oral defense.

**f. Dissertation Defense and 10-Day Rule**: Defense of a dissertation comprises submission of an approved dissertation followed by its successful oral defense. Students are required to submit a paper based on the dissertation research to an IE-related refereed journal before the final examination. They are strongly encouraged to present a conference paper(s) on their work during the course of the research. These publications are normally jointly written with the advisor and other appropriate faculty. Successful oral defense of the dissertation fulfills the IEE 799 requirement.

**Steps to Preparing for Your Defense**

Prior to defense:

1. Obtain a consensus of approval from the committee chair and the members to proceed with the oral defense.
2. Schedule a date and time with your committee for the oral defense.
3. Important: Ensure that a minimum of 50% of the official committee be physically present at the defense. If at least 50% of the committee cannot be physically present, the defense must be rescheduled.
4. Visit the Office of Graduate Education website to become familiar with the dates and deadlines on format approval and oral defense.

10 days prior to the defense:

These steps are required to be completed prior to 10 working days from the date of oral defense.

1. Reserve a room with the CIDSE front desk (Brickyard 5th floor).
2. Submit an electronic version of your abstract with title, full names of your committee members, defense date/time/place, and your name as you want it to appear on the defense announcement to the CIDSE front desk.
3. Schedule your defense on MyASU with the Office of Graduate Education.

On the day of the defense:

1. Set-up all your equipment at least one half-hour prior to your presentation to make sure they work.

After the defense:

1. Your committee will discuss the results of the exam with you and may have additional comments for you. At the end, the committee will make a recommendation: Pass, Pass with minor revisions, Pass with major revisions, or Fail.
2. Revisions are normal and are expected to be completed within one year period. This includes remaining registered until the finished document has been uploaded through MyASU on ProQuest.
3. Hand-deliver a signed copy of the Doctoral Defense Report to the CIDSE Advising Office BYENG 208.
4. Hand-deliver the signed Doctoral Defense Report form to the Office of Graduate Education.
5. Follow the steps on MyASU on uploading your final dissertation through Office of Graduate Education and ProQuest.

## VI. General Information

### a. Master's in Passing

After completion of 30 credit hours in the Ph.D. program and successfully passing the Qualifying Exam, students have the opportunity to request a Master's in Passing. In order for students to be awarded the Masters in Passing, the 30 completed credit hours must include 12 credit-hours of core coursework. The Graduate Academic Advisor will help eligible students file a Master's in Passing Plan of Study (MIP/POS). Students must then file for graduation, which includes a fee.

### b. Research standards for publication of dissertation

Graduate research is the study of an issue that is of sufficient breadth and depth to be publishable in an IE-related journal. The effort should reflect a minimum of 1,500 hours of thoughtful work for a dissertation (Ph.D.). The research should follow the 'scientific method' and thus be both objective and reproducible. The dissertation should demonstrate independent, original, and creative inquiry. There should be predefined hypotheses or developmental goals and objectives that are measurable and can be tested. The document should demonstrate proficiency with written English and should conform to the Office of Graduate Education format guidelines.

**c. Financial assistance and/or fellowships**

The Industrial Engineering Program's goal is to provide support to all incoming Ph.D. students. According to the student's academic performance and past academic research, funding offers will be extended to individual students with the highest academic achievements. We encourage students to highlight their past academic achievements in their personal statement and in their resume.

**d. Continuous Enrollment and Leave of Absence Policies**

Once admitted to a graduate degree program, doctoral students must be registered for a minimum of one credit hour (not audit) during all phases of their graduate education. This includes periods when they are engaged in research, working on or defending theses or dissertations, taking comprehensive exams, taking Graduate Foreign Language exams or in any other way using university facilities or faculty time including the term in which they graduate. This credit must appear on the Plan of Study or must be an appropriate graduate-level course (e.g. 695, or 795, Continuing Registration). Courses with grades of Withdrawal "W" and Audit "X" are not considered valid registration for continuous enrollment purposes.

Students planning to discontinue enrollment for a semester or more must request approval for a leave of absence. Student may petition the Office of Graduate Education for a leave of absence for a maximum of two semesters during their entire program. A petition for a leave of absence, endorsed by the members of the student's supervisory committee and the head of the academic unit, must be approved by the Office of Graduate Education dean. This request must be filed and approved before the anticipated absence.

An approved leave of absence will enable students to re-enter their program without re-applying to the university. Students who do not enroll for a fall or spring semester without an approved leave of absence by the Office of Graduate Education are considered withdrawn from the university under the assumption that they have decided to discontinue their program. Student removed for this reason may reapply for admission to resume their degree program; the application will be considered along with all other new applications to the degree program.

A student on leave is not required to pay fees, but in turn is not permitted to place any demands on university faculty or use any university resources.

**e. Maximum Time Limit**

Doctoral students must complete all program requirements within a ten-year period. The ten-year period starts with the semester and year of admission to the doctoral program. Graduate courses taken prior to admission that are included on the Plan of Study must have been completed within three years of the semester and year of admission to the program (previously awarded master's degrees used on the Plan of Study are exempt).

In addition, the student must defend the dissertation within five years after passing the Comprehensive Examinations. Therefore, the maximum time limit is the shortest of the following:

1. Time period since initial enrollment (10 year time limit).
2. Time after passing the comprehensive exams (5 year time limit).

Any exceptions must be approved by the supervisory committee and the Office of Graduate Education dean and ordinarily involves repeating the comprehensive examinations. The Office of Graduate Education may withdraw students who are unable to complete all degree requirements and graduate within the allowed maximum time limits.

**f. Registration requirements for research assistants (RA) and teaching assistants (TA)**

Students awarded an assistantship within the Ira A. Fulton School of Engineering are required to be registered for 12 credit hours. Audit credit hours do not count towards the 12 credit hours.

Students who obtain an assistantship outside the Ira A. Fulton School of Engineering are required to be enrolled a minimum of 6 credit hours. Audit credit does not count towards the 6 credit hours. Enrollment in continuing registration (IEE 795) does not count towards the 6 hour requirement.

TAs and RAs are treated as residents for tuition purposes. To be eligible for tuition remission, TAs and RAs must be employed a minimum of 10 hours per week (25 percent Full Time Equivalency {FTE}). TAs/RAs working 10-19 hours per week (25-49 percent FTE) receive a 50 percent remission of tuition for the semester or summer session of their employment. TAs/RAs working 20 hours per week (50 percent FTE) do not pay tuition during the semester or summer session of their employment. In addition, the university pays the individual health insurance premium for those TAs and RAs working 20 hours per week (50 percent FTE).

**g. Satisfactory Progress, Academic Probation, Progress probation, and Withdrawal from the IE Program**

Each semester, the Industrial Engineering Program reviews students' files for satisfactory progress towards completion of the degree. All students who do not meet on one of the four categories are placed on probation or withdrawn from the program:

1) Satisfactory progress;
2) Academic Probation;
3) Progress probation;
4) Withdrawal from the IE Program.

1. **Satisfactory progress** means that a student does not have any academic and progress probationary issues. In addition to the probationary rules, satisfactory progress includes each semester communication with the student's Committee Chair regarding his/her progress.
2. **Academic Probation** pertains to grades that might affect Program and University policies including graduation. The following are notices/letters you will receive if one of these pertains to your academics*:*
   - GPA below 3.0 in approved POS courses.
   - Overall post baccalaureate GPA below 3.0.
   - Received a "D" or "E" in a required deficiency course or in a course at the 400 level or above.
   - Deficiency GPA below 3.0.
3. **Progress probation** pertains to issues dealing with making progress towards a degree. The following are notices/letters you will receive if one of these pertains to your academics:
   - Lack of Progress toward removing deficiencies as listed on your admission letter.
   - Lack of Progress toward completing the five Core courses within the first 18 hours of POS courses.
   - Failure to pass the Ph.D. Comprehensive Examination.
   - Failure to take the Ph.D. Comprehensive Examination after completion of the 57th POS coursework credit hour.
   - Failure to pass the Ph.D. Qualifying Examination.

4. A student is recommended for **withdrawal from the IE Program** if she or he fails to meet the probationary standards placed upon in the semester mentioned in the probationary letter. The student will receive a letter from the Industrial Engineering Program explaining the reasons for the withdrawal. The student will have 5 calendar days from the date of the letter to appeal the decision. The IE Graduate Program Committee (GPC) will review the case and will make the necessary recommendation. The Graduate Program Chair, on behalf of the GPC, will provide a written explanation of the outcome. If the outcome is favorable, the student will have to meet all the outlined requirements at the end of the specified period. The student will be required to sign an agreement acknowledging the recommendations and the consequences if the agreements are not met. If the GPC recommends that the appeal is not granted in favor of the student, the Graduate Program Chair, on behalf of the GPC, will recommend to the Dean's Academic Affairs to withdraw the student from the IE Program. The student will then have the opportunity to appeal to the Ira A. Fulton Schools Standards Committee which reviews the student's case and makes the final ruling to Associate Dean and the IE Program. If the appeal is not granted in favor of the student, the Dean's Academic and Student Affairs will recommend to the Office of Graduate Education to withdraw the student from the IE Program. Please

refer the Office of Graduate Education catalog on policies and procedures or contact the graduate advisor in the CIDSE Advising Center.

**h. Academic Integrity**

The highest standards of academic integrity are expected of all graduate students, both in the academic coursework and in their related research activities. The failure of any graduate student to meet these standards may result in serious consequences including suspension or expulsion from the university and/or other sanctions as specified in the academic integrity policies of individual colleges as well as the university.

Violations of academic integrity include, but are not limited to: cheating, fabrication, tampering, plagiarism, or aiding and/or facilitating such activities. At the graduate level, it is expected that students are familiar with these issues and each student must take personal responsibility in their work. In addition, graduate students are expected to follow university guidelines related to the Student Code of Conduct. University policies related to academic integrity and code of conduct are available in the Office of Student Life, or at http://graduate.asu.edu/beintheknow .

**i. Academic Commendation**

In any semester in which a student achieves a 3.75 or higher GPA overall on six or more credit hours of Plan of Study courses while in good standing, the IE Program Administration Office will send a letter notifying the student of being placed on that semester's list of students receiving Academic Commendation. The list of students receiving Program Academic Commendation is forwarded to the Dean's Office of the Ira A. Fulton School of Engineering and is also posted on the Fulton School of Engineering website.

**j. IEE 584 Internship**

Graduate Internship is intended as a unique, new learning experience, apart from a regular engineering employment position. Therefore, it is not available to full or part-time workers regularly employed by the company where the internship is proposed. An internship cannot be done if all other class work has been completed, as the Internship Program is designed so that the practical experience gained will enhance the classroom learning experience.

IEE 584 Internship is for one (1 hour) credit hour per semester and typically limited to one semester. In special cases, internship is available for multiple semesters. A student may work full-time (40 hours) in a summer session and part-time (20 hours) in a Fall or Spring semester. Students are advised to consult with their academic advisor when formulating a Plan of Study.

An approved proposal is required before commencing the internship. The request will include a statement from the employer that indicates they understand that the work is to satisfy a degree requirement. A sample letter and other required forms are available from the Graduate Advisor. Students must receive approval from their

faculty advisor and from the Graduate Program Director before registering for IEE 584. In order to register for IEE 584, a student must have a GPA of 3.20. A final Plan of Study must be filed with the Office of Graduate Education showing the Internship course before registering for IEE 584. All application materials for an Internship must be completed by the last day of regular registration for any semester. The student must take classes appearing on the Plan of Study the semester following the internship.

**Renege: (verb) to fail to carry out a promise or commitment**
Never accept a job with the intention of turning it down if "something better" comes along. Not only is it inconsiderate and unprofessional, it also reflects badly on Arizona State University and might negatively impact another ASU student's opportunities with that employer. Also, employers communicate with each other and you don't want to get a bad reputation.

After you have given your decision careful consideration and accepted an offer, stop looking. Inform other employers who have extended offers that you have accepted another position. Don't accept further interview invitations or search further. Please refer to NACE's Playing Fair…Your Rights and Responsibilities as a Job Seeker http://www.naceweb.org/playing_fair/ to become familiar with Principles for Professional Practice.

**A five-page final report is required** before a grade and credit is given. The final report must be submitted to the reporting supervisor for comments and then to the faculty advisor for grade assignment.

**k. IEE 790 Independent Study**

Independent study is available for Ph.D. students. The student cannot combine IEE 790, 584, and 581 as part of the Plan of Study. The student must get written approval from the supervising faculty outlining the coverage of the content. The Independent Study form must be approved by the Associate Chair will be placed in the student's file.

**l. Student chapters of professional societies**

Our graduate students are involved in many professional societies. Most branches of Industrial Engineering have professional societies associated with them. Participation in professional societies is an excellent road to career and interest group connections. Student membership typically costs less than $30 and includes many benefits including a monthly magazine. Professors will be happy to sign a membership form that will entitle a student to reduced rates. The professional society for all areas of Industrial Engineering is the Institute of Industrial Engineers (IIE). The ASU student chapter of IIE was the first student chapter formed in the Industrial Engineering Program and has a long history including many chapter awards. In 1999, a new student chapter of INFORMS, an operations research and management science professional society, was formed at ASU.

**Concentration Areas of IE Graduate Courses**

| COURSE | TITLE | OR | PSL | IMS | IS |
|---|---|---|---|---|---|
| IEE 505 | Information Systems Engineering (3) | | | X | |
| IEE 511 | Analysis of Decision Processes (3) | X | X | X | X |
| IEE 512 | Introduction to Financial Engineering (3) | X | X | X | |
| IEE 520 | Statistical Learning for Data Mining (3) | | | X | X |
| IEE 521 | Urban Operations Research | X | X | | |
| IEE 526 | Operations Research in Healthcare | X | X | | |
| IEE 530 | Enterprise Modeling (3) | | | X | |
| IEE 532 | Management of Technology (3) | | | X | |
| IEE 533 | Scheduling (3) | X | X | | |
| IEE 534 | Supply Chain Modeling and Analysis (3) | X | X | | |
| IEE 535 | Introduction to International Logistics Systems (3) | | X | | |
| IEE 541 | Engineering Administration (3) | | | X | |
| IEE 545 | Simulating Stochastic Systems (3) | X | X | | |
| IEE 552 | Strategic Technological Planning (3) | | | X | |
| IEE 556 | Introduction to Systems Engineering | | | X | |
| IEE 561 | Production Systems (3) | | X | | |
| IEE 563 | Distributed Information Systems (3)* | | | X | |
| IEE 564 | Planning for Computer-Integrated Manufacturing (3)* | | | X | |
| IEE 565 | Computer-Integrated Manufacturing Research (3)* | | | X | |
| IEE 566 | Simulation in Manufacturing (3)* | | X | | |
| IEE 567 | Simulation system Analysis (3)* | | X | | |
| IEE 570 | Advanced Quality Control (3) | | | X | X |
| IEE 571 | Quality Management (3) | | | | X |
| IEE 572 | Design of Engineering Experiments (3) | | | | X |
| IEE 573 | Reliability Engineering (3) | | | | X |
| IEE 574 | Applied Deterministic Operations research Models (3) | X | X | | |
| IEE 575 | Applied Stochastic Operations Research Models (3) | X | X | | |
| IEE 576 | Analysis of Semiconductor Manuf. Operations (3)* | | X | | |
| IEE 577 | Advanced Information System Operations (3)* | | | X | |
| IEE 578 | Regression Analysis (3) | | | | X |
| IEE 579 | Time Series Analysis and Forecasting (3) | | | | X |
| IEE 581 | Six Sigma Methodology (3) | | | | X |
| IEE 582 | Response Surfaces and Process Optimization (3) | X | | X | X |
| IEE 605 | Foundations of Information Systems Engineering (3) | | | X | |
| IEE 620 | Optimization I (3) | X | | | |
| IEE 622 | Optimization II (3) | X | | | |
| IEE 640 | Probability & Stochastic Model (3) | X | | | |
| IEE 670 | Mathematical Statistics (3) | | | | X |
| IEE 672 | Advanced Topics in Experimental Design (3) | | | | X |
| IEE 677 | Regression and Generalized Linear Models (3) | | | | X |
| IEE 679 | Time Series Analy/Control (3) | | | | X |
| IEE 598 | Design of Computational Systems | | | X | |
| IEE 598 | Network Flows | X | X | | |
| BMI 501 | Intro to Biomedical Informatics | | | | X |
| BMI 502 | Foundations of BMI Methods I | | | | X |
| CSE 520 | Computer Architecture II (3) | | | X | |
| CSE 534 | Advanced Computer Networks (3) | | | X | |

| COURSE | TITLE | OR | PSL | IMS | IS |
|---|---|---|---|---|---|
| CSE 536 | Advanced Operating Systems (3) | | | X | |
| CSE 550 | Combinatorial Algorithms and Intractability (3) | X | | X | |
| STP 427 | Mathematical Statistics (3) | X | | | X |
| STP 526 | Theory of Statistical Linear Models (3) | | | | X |
| STP 532 | Applied Nonparametric Statistics (3) | | | | X |
| STP 533 | Applied Multivariate Analysis (3) | | | | X |
| STP 534 | Applied Discrete Data Analysis (3) | | | | X |
| MAT523 | Numerical Optimization (3) | X | | | |

OR = Operations and Research
PSL = Production Systems
IMS = Information & Management Systems
IS = Industrial Statistics

## COURSE DESCRIPTION

**IEE 505 Information Systems Engr**
Studies information systems application engineering.
Topics include information technology, data modeling, data organization, process mapping, application and database engineering, and user interface development. Pre-requisite: CSE 205

**IEE 511 Analysis of Decision Processes**
Methods of making decisions in complex environments and statistical decision theory; effects of risk, uncertainty, and strategy on engineering and managerial decisions. Pre-requisite: IEE 380

**IEE 512 Introduction to Financial Engineering**
Introductory course on financial engineering covering traditional portfolio theory, forwards, futures, financial stochastic models, option pricing, and risk management. Pre-requisite: Graduate Standing

**IEE 520 Statistical Learning for Data Mining**
Surveys data analysis methods for massive data sets and provides experience in analysis with computer software. Pre-requisite: IEE 470

**IEE 521 Urban Operations Research**
Probabilistic modeling and analysis of transportation systems (car, bus, train) and emergency service systems (fire, police, ambulance) using functions of random variables, geometric probability, queuing theory, location theory, network analysis and graph applications. Engineering Graduate student; Credit is allowed for only IEE 421. 498 (Urban Operations Research), 521 or 598 (Urban Operations Research)

**IEE 526 Operations Research in Healthcare**
Quantitative methods for modeling and analysis of healthcare systems to address operational and tactical decision-making problems. Topics include forecasting, scheduling, decision making, facility location and layout, staffing, quality control and supply chain management in hospitals and healthcare delivery facilities. Pre-requisites: Graduate Engineering student; Credit is allowed for only IEE 426, 498 (OR in Hospitals), 526 or 598 (OR in Hospitals)

**IEE 530 Enterprise Modeling**
Focuses on social, economic, and technical models of the enterprise with emphasis on the management of technological resources. Includes organization, econometric, financial, and large-scale mathematical models. Pre-requisite: Graduate Standing.

**IEE 533 Scheduling**
Provides the basic theory of scheduling and introduction to the applications domain. Pre-requisites: IEE 376 and 470

**IEE 534 Supply Chain Modeling/Analysis**
Techniques for modeling and analysis of supply chains. Inventory management, transportation/location models, value of information, channel alignment, risk pooling, contracts. Pre-requisites: CSE 100 or 110, IEE 376, and 470.

**IEE 535 Intro Intl Logistics Systems**
Exploratory project-oriented course that addresses domestic and international logistics practices from a high-level descriptive perspective and an analytical model-based perspective. Pre-requisite: IEE 376

**IEE 541 Engineering Administration**
Introduces quantitative and qualitative approaches to management functions, engineering administration, organizational analysis, decision making, and communication. Credit is allowed for only IEE 541 or 431. Pre-requisite: Graduate Standing

**IEE 545 Simulating Stochastic Systems**
Analyzes stochastic systems using basic queuing networks and discrete event simulation. Basic network modeling, shared resources, routing, assembly logic. Credit is allowed for only IEE 545 or 475. Pre-requisites: CSE 205 and IEE376; Co-requisites: IEE 470

**IEE 547 Human Factors Engineering**
Study of people at work; designing for human performance effectiveness and productivity. Considerations of human physiological and psychological factors. Credit is allowed for only IEE 547 or 437. Pre-requisite: Graduate Standing

**IEE 552 Strategic Technological Plng**
Studies concepts of strategy, strategy formulation process, and strategic planning methodologies with emphasis on engineering design and manufacturing strategy, complemented with case studies. Presents and uses an analytical executive planning decision support system throughout course. Pre-requisite: Engineering graduate student.

**IEE 556 Introduction to Systems Engineering**
Foundation course addressing the concepts needed for successful system planning, design and build process. Topics include successfully bringing large-scale systems to completion on schedule and on budget, modeling and cost estimating techniques, risk and variability. Graduate students are expected to have a background in and understanding of large-scale systems. Engineering graduate student; Credit is allowed for only IEE 456, 556 or 598 (Intro to Systems Engineering).

**IEE 561 Production Systems**
Understanding how factories operate, how performance is measured, and how operational changes impact performance metrics. Operational philosophies, increasing production efficiency through quantitative methods. Pre-requisites: IEE 376 and 470

**IEE 563 Distributed Info Systems**

Introduces concepts and technologies that form the core of distributed enterprise information systems. Topics include client-server architectures, distributed objects and paradigms, Internet, World Wide Web, distributed information sharing, network programming, and e-commerce and enterprise applications. Must be an Engineering MS/MSE/PHD student AND have completed IEE 505 with a grade C or better or be currently enrolled.

**IEE 564 Planning Cmptr-Integrated Mfg**
Theory and use of IDEF methodology in planning for flexible manufacturing, robotics, and real-time control. Simulation concepts applied to computer-integrated manufacturing planning. Must be an Engineering graduate student.

**IEE 566 Simulation in Manufacturing**
Uses simulation in computer-integrated manufacturing with an emphasis on modeling material handling systems. Programming, declarative, and intelligence-based simulation environments. Must be an Engineering graduate student and complete with a C or better IEE 475 or 545 or be currently enrolled.

**IEE 567 Simulation System Analysis**
Simulation modeling of processes involving discrete and continuous system components. Topics include random number generators, output analysis, variance reduction, and statistical issues related to simulation. Enroll requirements: Pre-requisites: Must be an Engineering graduate student and have completed with a C or better IEE 475 or 545 or be currently enrolled.

**IEE 570 Advanced Quality Control**
Process monitoring with control charts (Shewhart, cusum, EWMA), feedback adjustment and engineering process control, process capability, autocorrelation, selected topics from current literature. Pre-requisite: IEE 470.

**IEE 571 Quality Management**
Total quality concepts, quality strategies, quality and competitive position, quality costs, vendor relations, the quality manual, and quality in the services. Pre-requisite: Graduate Standing

**IEE 572 Design Engineering Experiments**
Analysis of variance and experimental design. Topics include strategy of experimentation, factorials, blocking and confounding, fractional factorials, response surfaces, nested and split-plot designs. Pre-requisite: IEE 380.

**IEE 573 Reliability Engineering**
Nature of reliability, time to failure densities, series/parallel/standby systems, complex system reliability, Bayesian reliability, and sequential reliability tests. Pre-requisite: IEE 380.

**IEE 574 Appl Deterministic Oper Rsch**
Develops advanced techniques in operations research for the solution of complex industrial systems problems. Goal programming, integer programming, heuristic methods, dynamic and nonlinear programming. Must be an Industrial Engineering MS/MSE/PhD student. Pre-requisite: IEE 376 or 470

**IEE 575 Appl Stochastic Oper Rsch Mdls**
Formulate and solve industrial systems problems with stochastic components using analytical techniques. Convolution, continuous-time Markov chains, queues with batching, priorities, balking, open/closed queuing networks. Enroll requirements: Pre-requisites: IEE 376 and 470

**IEE 576 Analy Semiconductor Mfg Oper**
Applies operations research and statistical methods to solve problems that involve semiconductor manufacturing operations. Pre-requisites: IEE 376 and 470.

**IEE 577 Adv. Information System Oper**
Industrial engineering knowledge and skills for information system operations, including aspects (security, quality of service, user interface, information modeling), problems, and solutions. Must be an Engineering graduate student and complete with a C or better IEE 505 or be currently enrolled.

**IEE 578 Regression Analysis**
Regression model building oriented toward engineers and physical scientists. Topics include linear regression, diagnostics, biased and robust fitting, nonlinear regression. Pre-requisites: IEE 470

**IEE 579 Time Series Analy/forecasting**
Forecasting time series by regression-based, exponential smoothing, and ARIMA model techniques; uses digital computer programs to augment the theory. Pre-requisites: IEE 470.

**IEE 580 Practicum**
Structured practical experience in a professional program, supervised by a practitioner and/or faculty member with whom the student works closely. Must be an MS/MSE/PHD Industrial Engineering student.

**IEE 581 Six Sigma Methodology**
The six sigma process improvement strategy of define, measure, analyze, improve, and control (DMAIC). Integrates and deploys statistical methods and other six sigma problem solving via the DMAIC framework. Pre-requisites: IEE 570, 572, 578. At least two of the courses must be completed before registering for this course and the third course must be taken concurrently.

**IEE 582 Response Surfaces/Process Opt**
Classical response surface analysis and designs including steepest ascent, canonical analysis, and multiple responses. Other topics include process robustness studies, robust design, and mixture experiments. Must be an Engineering MS/MSE/PHD student and have completed IEE 572 with a grade of C or better or be currently enrolled.

**IEE 584 Internship**
Structured practical experience following a contract or plan, supervised by faculty and practitioners. Must be an Engineering MS/MSE/PHD student.

**IEE 585 Six Sigma Capstone**.
The DMAIC (define, measure, analyze, improve, control) improvement strategy is applied in the formulation and execution of a six sigma project. Pre-requisites: IEE 581.

**IEE 590 Reading and Conference**
Independent study in which a student meets regularly with a faculty member to discuss assignments. Course may include such assignments as intensive reading in a specialized area, writing a synthesis of literature on a specified topic, or writing a literature review of a topic.

**IEE 591 Seminar**
A small class emphasizing discussion, presentations by students, and written research papers.

**IEE 592 Research**
Independent study in which a student, under the supervision of a faculty member, conducts research that is expected to lead to a specific project such as a thesis or dissertation, report, or publication. Assignments might include data collection, experimental work, data analysis, or preparation of a manuscript.

**IEE 593 Applied Project**
Preparation of a supervised applied project that is a graduation requirement in some professional majors.

**IEE 594 Conference and Workshop**
Topical instruction, usually in compressed format, leading to academic credit. Often offered off campus to groups of professionals. Must be an Industrial Engineering MS/MSE/PHD student.

**IEE 595 Continuing Registration**
Used in situations where registration is necessary but where credit is not needed. Replaces arbitrary enrollment in reading and conference, research, thesis, dissertation, etc. Used by students when taking comprehensive examinations, defending theses or dissertations, or fulfilling the continuous enrollment requirement in doctoral programs. Credit is not awarded, and no grade is assigned.

**IEE 598 Special Topics**
Topical courses not offered in regular course rotation--e.g., new courses not in the catalog, courses by visiting faculty, courses on timely topics, highly specialized courses responding to unique student demand. Check with the instructor for pre-requisites and/or co-requisites.

**IEE 599 Thesis**
Supervised research focused on preparation of thesis, including literature review, research, data collection and analysis, and writing.

**IEE 605 Foundations of Information Systems Engineering**
Introduces science and engineering technologies of information systems design and analysis with focus on industrial engineering applications. Topics include: design and analysis of computational algorithms; and data mining techniques for classification, clustering, feature extraction and data reduction problems. Pre-requisite: Industrial Engineering Graduate student; Credit is allowed for only IEE 598 (Found Info Syst Engr) or 605.

**IEE 620 Optimization I**
First course of the Ph.D. level deterministic course series. This course covers foundations of optimization and linear programming. Pre-requisites: MAT 272, 242, and IEE 376.

**IEE 622 Optimization II**
The course is a second graduate course of optimization. In this course, we introduce computational methods to solve optimization problem with integer variables efficiently as well as the mathematical theory. Pre-requisite: MAT 242 and IEE 376

**IEE 640 Probability and Stochastic Processes**
Presents fundamentals of probability and stochastic processes from a non-measure theoretic point-of-view to develop (a) basic model building and probabilistic reasoning skills, and (b) an understanding of important qualitative characteristics of some basic stochastic processes used to model dynamical systems with noise. Topics include a review of probability theory with particular attention to conditional probability and expectation; Markov chains; Renewal theory and the Poisson process. Considers applications in reliability, inventory theory, queuing. Pre-requisite: MAT 242, IEE 376 & 470

**IEE 670 Mathematical Statistics**
This course is an introduction to the field of mathematical statistics at a level intended for first-year Ph.D. students in Industrial Engineering. It builds a solid background in the principles, concepts and techniques of mathematical statistics. The class prepares students for advanced study and research in statistics, and is useful for understanding statistical data analysis techniques and developing statistical thinking. Pre-requisites: IEE 470

**IEE 672 Adv Topics-Experimental Design**
Multilevel and mixed-level factorials and fractions, design optimality, incomplete blocks, unbalanced designs, random effects and variance components, analysis of covariance. Must be an Engineering MS/MSE/PHD student AND have completed with a C or better IEE 572 or be currently enrolled.

**IEE 677 Regression/Genrlzd Linear Mod**
Theory of linear models including least squares, maximum likelihood, likelihood-based inference. Generalized linear models including Poisson and logistic regression, generalized estimating equations. Must be an Engineering MS/MSE/PHD student and have completed with a C or better IEE 578 or be currently enrolled.

**IEE 679 Time Series Analy/Control**
Identification, estimation, diagnostic checking techniques for ARIMA models, transfer functions, multiple time series models for feedback and feed forward control schemes. Must be an Engineering MS/MSE/PHD student and have completed with a C or better IEE 579 or be currently enrolled.

**IEE 684 Internship**
Structured practical experience following a contract or plan, supervised by faculty and practitioners.

**IEE 691 Seminar**
A small class emphasizing discussion, presentations by students, and written research papers.

**IEE 700 Research Methods**
Course on research methods in a specific discipline. Must be an Engineering MS/MSE/PHD student.

**IEE 784 Internship**
Structured practical experience following a contract or plan, supervised by faculty and practitioners.

**IEE 790 Reading and Conference**
Independent study in which a student meets regularly with a faculty member to discuss assignments. Course may include such assignments as intensive reading in a specialized area, writing a synthesis of literature on a specified topic, or writing a literature review of a topic.

**IEE 792 Research**
Independent study in which a student, under the supervision of a faculty member, conducts research that is expected to lead to a specific project such as a dissertation, report, or publication. Assignments might include data collection, experimental work, data analysis, or preparation of a manuscript.

**IEE 795 Continuing Registration**
Used in situations where registration is necessary but where credit is not needed. Replaces arbitrary enrollment in reading and conference, research, thesis, dissertation, etc. Used by students when taking comprehensive examinations, defending theses or dissertations, or fulfilling the continuous enrollment requirement in doctoral programs. Credit is not awarded, and no grade is assigned.

**IEE 799 Dissertation**
Supervised research focused on preparation of dissertation, including literature review, research, data collection and analysis, and writing. Grading method: Pass/Fail with Z Option

## Industrial Engineering Faculty

**Mary R. Anderson-Rowland, Ph.D.**
University of Iowa (IS)
Statistics and probability for quality control, academic scholarship programs for all engineering students with an emphasis on women and underrepresented minority students.

**Ronald G. Askin, Ph.D.**
Georgia Institute of Technology (OR, PSL, IS)
Design and operation of discrete manufacturing systems, decision analysis, applied operations research, facilities planning, industrial statistics and applied optimization.

**Linda Chattin, Ph.D.**
State University of New York, Buffalo (IS, OR)
Discrete optimization, stochastic processes and probabilistic modeling, and emergency service location.

**John W. Fowler, Ph.D.**
Texas A & M University (OR, PSL)
Deterministic scheduling, discrete event simulation methodology, semiconductor manufacturing systems analysis and applied operations research.

**Esma S. Gel, Ph.D.**
Northwestern University (OR, PSL)
Applied probability, stochastic processes, queuing theory, stochastic modeling and control of manufacturing systems.

**Jing Li, Ph.D.**
University of Michigan (IS, PSL)
Applied statistics, process control, data mining, causal modeling and inference.

**Pitu B. Mirchandani, Sc. D.**
Massachusetts Institute of Technology (OR, PSL)
Stochastic dynamic networks, location theory, real-time decision making under uncertainty and competition, and intelligent transportation systems.

**Douglas C. Montgomery, Ph.D.**
Virginia Polytechnic Institute and State University (IS, PSL)
Statistical design of experiments, optimization and response surface methodology, empirical stochastic modeling and industrial statistics.

**Rong Pan, Ph.D.**
Pennsylvania State University (IS, PSL)
Industrial statistics, reliability analysis and time series modeling.

**George C. Runger, Ph.D.**
University of Minnesota (IS, IMS)
Statistical learning, process control, and data mining for massive, multivariate data sets with applications in numerous disciplines.

**Soroush Saghafian, Ph.D.**
University of Michigan (OR, PSL)
Healthcare operations, control of flexible queuing systems, and supply chain and operations management.

**Dan L. Shunk, Ph.D.**
Purdue University (IMS, PSL)
Agile, enterprise and CIM systems, group technology, planning systems, economics of computer-integrated manufacturing (CIM), strategy and strategic role of technology.

**Daniel McCarville, Ph.D.**
Arizona State University (IMS, IS)
Quality engineering, industrial statistics, engineering management

**Wandaliz Torrez-Garcia, Ph.D.**
Arizona State University (IS)
Bioinformatics, Industrial statistics.

**J. René Villalobos, Ph.D.**
Texas A & M University (OR, PSL, IS)
Logistics, automated quality systems, manufacturing systems and applied operations research.

**Teresa Wu, Ph.D.**
University of Iowa (IMS, PSL)
Information systems, supply chain management, multi-agent systems, data mining, Petri nets, Kalman filtering.

**Nong Ye, Ph.D.**
Purdue University (IMS)
Information and systems assurance, data mining and modeling, quality optimization and control systems operations.

**Muhong Zhang, Ph.D.**
University of California, Berkeley (OR)
Integer programming, robust optimization, computational, optimization and network optimization