Industrial Engineering

Ph.D. Graduate Handbook

2017 - 2018

ARIZONA STATE UNIVERSITY

MANUAL OF THE PH.D. DEGREE IN INDUSTRIAL ENGINEERING

ARIZONA STATE UNIVERSITY

2017 - 2018

IE graduate degrees please contact:

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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 College and the Industrial Engineering program requirements. In most of the cases, the differences are due to the fact that the IE Program has established higher standards than those set forth by the Graduate College. Thus, 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 will be emailed and will be available online. Most importantly you should visit the following websites:

- The Graduate College – http://graduate.asu.edu .
- Graduate College Policies and Procedures – https://graduate.asu.edu/policies-procedures
- The Industrial Engineering Program – http://cidse.engineering.asu.edu/forstudent/graduate/industrial-engineering/
    - The International Student and Scholars Center– https://issc.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 School of Computing,

Informatics, and Decision Systems Engineering (CIDSE) 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 Admission 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 Admission. The average GRE scores for students admitted into the Ph.D. program have been 151 Verbal, 163 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/ English Proficiency - 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 (IELTS) scores, or Pearson (PTE). Industrial Engineering Program uses 575 (paper-based) or 90 (internet-based) as minimum expectations for admission for TOEFL, 7.0 for IELTS and 65 for PTE. **Please note that your application will not be processed until the university receives official 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 English Proficiency waived. Please address all English Proficiency questions to the Office of Graduate Admission https://students.asu.edu/graduate/proficiency . The ASU institution code is: 4007. If a 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. Our current application process allows students to submit the letter of recommendations electronically by indicating the names and the e-mails of the recommender. In turn, the Office of Graduate Admission sends an e-mail to the recommender alerting him or her to go online and submit a 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. Students wishing to have their course syllabi examined as evidence that deficiencies have been satisfied must submit a petition form together with the support documents to CIDSE.Advising@asu.edu. If after evaluation the petition is not approved, the student 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. More instructions will be sent, as the exam date gets closer to the semester. Students may take up to three 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. International coursework are evaluated differently.

Notice of Admission - IE submits its recommendation of admission to the Office of Graduate Admission and the final notice of admission decision is notified in writing by

the Office of Graduate Admission. You may check your application status on MyASU (my.asu.edu).

Pre-admission credits and Transfer credit – Please refer to the Graduate College policies and procedures.

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.

Assigned deficiency courses must be completed by the end of the 12th semester hour. A "B" or better average is required for deficiency courses, and a "B" must be achieved in each course. A grade of "B" or better in a course that follows a prerequisite class does not waive this requirement.

a. Core courses: All incoming students are required to complete the five core courses of which at least four 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 622 - Optimization II
- IEE 640 - Stochastic Processes*
- IEE 670 - Mathematical Statistics*

b. Qualifying Examination*: Students will be tested for the Qualifying Exam on IEE 620, IEE 640 and IEE 670. Each student must sit for the qualifying exam on the 3 core courses and pass them prior to progressing in his/her academic degree. Students who fail are allowed only one reexamination, which should be taken at the next scheduled examination date. A student must have a cumulative and graduate GPA of 3.0 or higher and have completed all assigned deficiency courses in order to sit for the exam.

Note: Students who are interested in obtaining a Master in Passing Degree through the Qualifying exam option are required to enroll in one graduate-level credit hour in the

semester that Qualifying Exam is being administered is taken. Please communicate your intent to pursue the Master in Passing to the Graduate Advising Team.

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 (iPOS) 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 iPOS (400 level courses taken for a grade of Pass/Fail cannot be included on an iPOS). Courses with grades of "D" (1.00) and "E" (0.00) cannot be included on an IPOS. 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 required 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 at most 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)

A maximum of six credit hours of 400 level coursework may be used on an approved iPOS (400 level courses taken for a grade of Pass/Fail cannot be included on an iPOS). Students must get an approval from the Program Chair prior to enrolling and completing a 400 level coursework, except for the course that is a deficiency requirement. Courses with grades of "D" (1.00) and "E" (0.00) cannot be included on an IPOS.

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. The Chair and Co-chairs must be selected from the approved list of graduate faculty approved for the program by the Graduate College. On case by case a onetime approval can be given for an individual to serve as the co-chair for a student's dissertation. Typical committee is 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 who is not a member of the IE Program Faculty. The

supervisory committee must be approved by the IE Program Chair and by the dean of the Graduate College prior to taking the Comprehensive Examination.

The first step in forming a Supervisory Committee is securing a Chair of the Committee. It is the responsibility of the student that an IPOS with Committee Chair be filed no later than the semester after completing 24th credit or Second Semester after taking the Qualifying Examination. It is also the joint responsibility of the student and his/her Committee Chair to file an iPOS identifying the overall Committee composition no later than the semester after completing the 40th credit of the preliminary iPOS.

e. Comprehensive Examination: The Comprehensive Examination can be scheduled after passing the qualifying exam. The comprehensive exam must be taken no later than the semester following the semester in which the 57th iPOS coursework credit hours are completed. The comprehensive examination and the dissertation prospectus are separate processes, both of which culminate with the oral comprehensive examination. The committee chair will advise the student 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; and 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 Graduate College 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. The committee members review the prospectus for originality and contribution. Following that, an oral delivery and a committee review of the Dissertation Prospectus should be scheduled. This oral prospectus defense is considered to be a 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 document 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 Graduate College 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 Graduate College.

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 Report for Doctoral Defense Form to the CIDSE Advising Office (Centerpoint, Suite 105).
4. Follow the steps on MyASU on uploading your final dissertation through the Graduate College 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 15 credit-hours of core coursework. The Graduate Academic Advisor will help eligible students file a Master's in Passing Plan of Study (MIP/IPOS). Students must then file for graduation, which includes a fee.

Note- Similarly to the regular I.E. M.S. Degree, the Master's in Passing has a **culminating event** requirement, which consists of a written examination. Due to university rules, the results of examinations taken during periods in which students are

not registered for credit are not eligible to be counted toward degree requirements. PhD students interested and eligible to obtain the Master's in Passing degree have three options to satisfy their culminating event requirements: (1) Register for one graduate-level credit hour during the semester that they take the Qualifying Examination and use the Qualifying Examination as the culminating event, or (2) Take the M.S. Comprehensive Exam offered in fall and spring semesters each academic year, or (3) Use the written portion of their Ph.D. Comprehensive Examination when scheduled in a spring or fall semester.
Please communicate your intent to the Graduate Advising Team

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 Graduate College 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 graduate 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, 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 Graduate College 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 Graduate College 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 Graduate College 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).

Any exceptions must be approved by the supervisory committee and the Graduate College dean and ordinarily involves repeating the comprehensive examinations. The Graduate College 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). The TA/RA offer does not cover additional fees beyond tuition.

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 iPOS 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 year for full-time students or two years for part-time students of iPOS courses.
   - Failure to pass the Ph.D. Comprehensive Examination.
   - Failure to take the Ph.D. Comprehensive Examination after completion of the 57th IPOS 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 Graduate College to withdraw the student from the IE Program. Please refer the Graduate College 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 schools 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

For Spring 2017 and earlier semesters:

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 Advising 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 Schools of Engineering.

For Fall 2017 and later semesters:

In any semester in which a student achieves a 3.85 or higher GPA overall on six or more credit hours of Plan of Study courses while in good standing, the IE Program Advising 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 Schools of Engineering.

j. IEE 584 Internship

Curricular Practical Training (CPT) is an academic experience usually obtained at off-campus work settings, allowing the student to apply knowledge and skills gained in various classes. It is intended as a unique, hands-on learning experience to provide

students with a number of valuable skills that they can use upon graduation from their graduate degree programs. Accordingly, it is not available to full-time or part-time workers regularly employed by the company where the internship is proposed.

The CPT is available to both domestic and international students. However, international students must work with the International Students and Scholars Center (ISSC) and submit additional documentation to obtain work authorization. Furthermore, international students must include the CPT course IEE 584 (1 credit hour) as an integral part of their Program of Study, reflected by their approved iPOS.

Addition of the CPT course(s) should be done at the initial submission of the student's iPOS. The Internship course cannot be added to an approved iPOS once all coursework has been completed. Exceptions may be made if the internship is relevant to dissertation research.

The IE Program Chair will determine the need for a CPT internship in such cases in consultation with the Graduate Academic Advisor. Note that approval of an iPOS with the IEE 584 course confirms that the internship is an integral part of the degree requirements as planned by the student. Additional internship that is not part of the 85 credit hours can be removed from the iPOS. Note: Only internship courses can be removed from the iPOS. Courses that are approved as part of the overall degree program in the iPOS can only be substituted with another approved coursework.

In order to be eligible for internship, a student must be in **good academic standing (cumulative, graduate and iPOS GPA of 3.00 or above) and not have an academic integrity violation** in a course for two full semesters (summer semesters not included) from the initial reporting of the incident. For example, a sanctioned academic integrity violation initially reported on April 15, 2017 will make the student ineligible for this approval until the end of Spring 18 semester.

International students need to be aware of immigration policies and regulations, which may jeopardize their academic status. Hence, it is strongly recommended for international students to consult with the International Students and Scholars Center (ISSC).

All students (domestic and international) may take part in an Out-Of-State internship in the summer semester. The eligibility requirements for CPT internships remain the same as mentioned.

During the regular fall and spring semesters, international graduate students in F-1 status must register for a minimum of nine (9) credit hours to maintain full-time status and be enrolled in a minimum six (6) credit hours of in-person, on-campus coursework at the ASU Tempe campus. A maximum of three (3) credit hours of online courses is permitted. The IEE 580 Practicum course will not count as satisfying the student's "physical presence" at ASU. Students will not be able to take part in internships outside the Phoenix metropolitan area. In some cases students may be approved to do an

internship in Tucson or other nearby locations to Phoenix, as long as the student is able to prove they can physically attend their courses on campus.

Required documents and forms for the internship proposal must be submitted to the CIDSE Advising Office at least two weeks prior to the beginning of the semester in which the internship is planned. Students will not be able to request late-add registration of the IEE 584 Internship credit to their class schedule after the drop/add deadline of each semester.

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 the IEE 584 - Internship, a student must have a **cumulative, graduate and iPOS GPA of 3.00 or above** and not have an academic integrity violation in a course for two full semesters (summer semesters not included) from the initial reporting of the incident. A final Plan of Study must be filed with the Graduate College 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
It is unethical for students to continue to seek or consider other employment opportunities once an offer has been accepted. CIDSE expects students to honor an acceptance and withdraw from all employment seeking activities. Students who accept an offer from an organization and later renege/decline the offer will be prohibited from further requesting future CPT pending a meeting with the Assistant Director.

A five-page final report is required at the end of the internship 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. Refer to the CIDSE website for guidelines to prepare the final report.

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 506	Web-Enabled Decision Support Systems			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 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 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 578	Regression Analysis (3)				X
IEE 579	Time Series Analysis and Forecasting (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 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	
CSE 536	Advanced Operating Systems (3)			X	
CSE 550	Combinatorial Algorithms and Intractability (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
STP 598	Computational Statistics				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 506 Web-Enabled Decision Support Systems
Development and analysis of Web-enabled applications for decision support. Topics include: (1) Web application development using ASP.NET; (2) design for computing scalability, interface usability and cyber security; and (3) use of application development skills and design concepts to develop a decision support system consisting of database, analytical data processing, expert knowledge and reasoning, and user-friendly interface for enabling transitions from data to information, knowledge and decisions. Knowledge of database development is necessary to be successful in this course. Perquisite: 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: IEE 574 or 620

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 or 556.

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 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 380.

IEE 571 Quality Management
Total quality concepts, quality strategies, quality and competitive iPOSition, 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 IEE 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 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 380

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 380.

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. Prerequisites: IEE 570, 572, 578. At least two of the courses must be completed before registering for this course and the third 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 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

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.

Adolfo R. Escobedo, Ph.D.
Texas A&M University (OR)
Theory and application of optimization, mathematical programming error reduction and elimination.

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

Cheryl L. Jennings, Ph.D.
Arizona State University (IS)
Quality engineering, quality management, engineering statistics, business analytics

Feng Ju, Ph.D.
University of Wisconsin Madison (OR, PSL)
Stochastic processes, stochastic modeling and control of manufacturing and healthcare systems, battery management systems.

Joseph Juarez, Ph.D.
Arizona State University (IS)
Industrial statistics

Jing Li, Ph.D.
University of Michigan (IS, PSL)
Statistical learning, data mining, biomedical and health informatics, quality and reliability engineering

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

Pitu B. Mirchandani, Sc. D.
Massachusetts Institute of Technology (OR, PSL)
Optimization, decision-making under uncertainty, real-time control and logistics, application interests in urban service systems, transportation, and homeland security

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.

Theodore P. Pavlic, Ph.D.
The Ohio State University (OR, PSL, IMS, IS)
Distributed algorithms, autonomous systems, decentralized decision making, complex adaptive systems, self-organization, hybrid dynamical systems, sustainability in the built environment, behavioral ecology, behavioral economics, operations research, bio-mimicry and bio-inspiration, parallel computation, robotics, energy systems, intelligent control; optimization; game theory; resource allocation; collective behavior

Giulia Pedrielli, Ph.D.
Poltecnico di Milano (OR, PSL)
Simulation methodology, stochastics and learning statistics related to simulation improvement both for performance and evaluation as well as simulation-based optimization of complex systems.

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.

Jorge A. Sefair, Ph.D.
University of Florida (OR)
Network optimization, robust optimization, integer programming, and applications of optimization in environment, public policy, urban planning, and finance.

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.

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.

Hao Yan, PhD
Georgia Institute of Technology (IS, ISM)
Real time modeling and analysis with large scale high dimensional data, smart adaptive sampling strategy and data reconstruction, data fusion for modeling of complex systems,

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