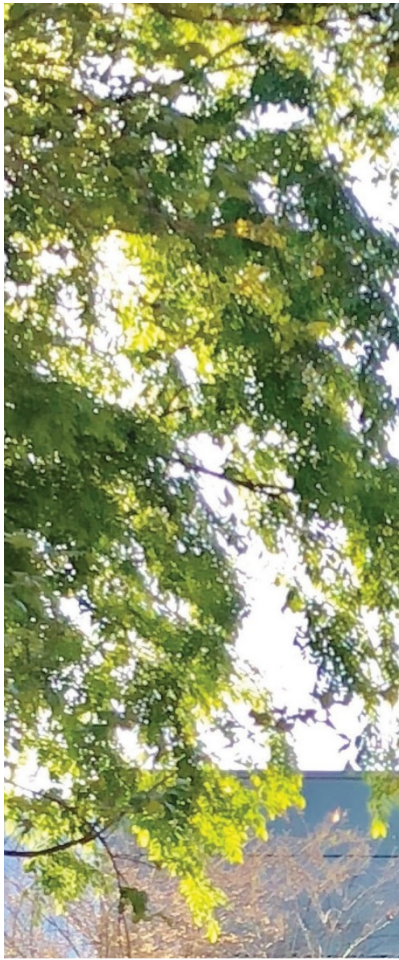




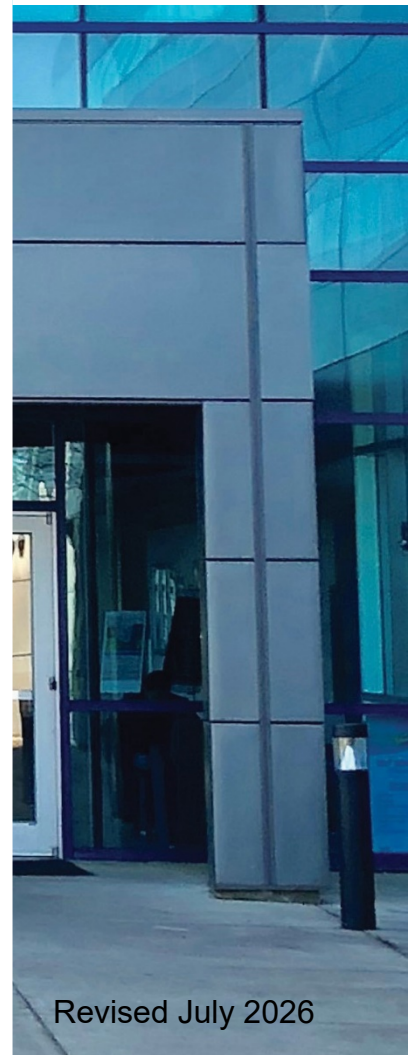
Department of Industrial &
Manufacturing Engineering

Graduate Student Handbook

2026-2027



FAMU-FSU
Engineering



Revised July 2026



Graduate Program Advising Manual

**Department of Industrial and Manufacturing Engineering
Florida A&M University – Florida State University
College of Engineering**

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1. Background

Industrial Engineering is a broad discipline that encompasses education and basic/applied research concerning the design, improvement, and installation of integrated systems of people, material, information, equipment and energy. Graduate instruction and research are broadly grouped into three categories: manufacturing engineering, quality engineering, and industrial systems. Current research interests include, manufacturing processes and systems; statistical quality control; failure and life-cycle analysis; mathematical optimization of complex production systems; condition monitoring; reliability engineering; statistical machine learning; distributed sensor networks; manufacturing process monitoring and diagnosis; set-covering theory; simulation environments; polymeric materials; nanomaterials processing and applications; additive thin-film manufacturing; printed electronics; carbon nanotube based functional materials; advanced composites and multi-scale materials; simulation for material processing; composite material processing.

1.1. Program Objectives

The objectives of the graduate program are to provide students with the knowledge, skills, tools and qualifications needed to successfully practice industrial engineering or to continue their education at the doctoral level. To accomplish these objectives, the program provides educational opportunities for students to become professionally responsible, creative problem-solvers and decision-makers in a world undergoing rapid change, both technologically and socially.

Specifically, the programs emphasize: (i) Acquisition of knowledge and understanding of appropriate fundamentals to ensure a solid foundation for the development of professional, technical and business competence (ii) Development of skills necessary for integrating knowledge in order to produce efficient and economic solutions (iii) Development of team work and written/oral communication skills (iv) Development of, and practice in, computer-assisted problem solving (v) Cultivation of an understanding and awareness of the human role in all stages of professional activities (vi) Commitment to continuing professional growth for all parties associated with the Industrial and Manufacturing Engineering Department.

1.2. Prerequisite Course Work Requirements

Candidates for admission to graduate study in industrial engineering must meet university and departmental criteria. In some cases, students may be admitted on a provisional basis pending successful completion of prerequisite work. In all matters concerning admission, decisions made by the departmental graduate committee are final. Students who do not have a bachelor's degree in industrial engineering are required to complete the following prerequisite courses before undertaking graduate study:

- EGN 3443 Statistical Topics in Industrial Engineering,
- MAC 2313 Calculus with Analytic Geometry III or MAS 3105 Applied Linear Algebra or an equivalent course as determined by the graduate committee.
- ESI 3312C Operations Research I: Deterministic or ESI 4313 Operations Research II: Nondeterministic or an equivalent course as determined by the graduate committee.
- a class in FORTRAN, PASCAL, C, Matlab (required as evidence of proficiency in programming) or equivalent course in programming as determined by the graduate committee.

These prerequisites are intended to ensure an adequate background in mathematics, computing and engineering prior to graduate studies in Industrial Engineering. Although graduate courses may be taken before all prerequisite requirements have been satisfied, students must make significant progress each semester towards satisfying their prerequisites. Degree plans cannot be filed until after the prerequisites have been satisfied.

Students must earn a grade of "B" or better in prerequisite courses for those courses to satisfy degree requirements. A student may petition the department to have one prerequisite course with a grade of "C" count toward the applicable course requirements, subject to departmental approval. Course grades of "D" or below do not satisfy degree requirements. Prerequisite courses may not be taken on a pass/fail basis. Students who have less than a 3.0 cumulative GPA in prerequisite coursework will be placed on probation. If a student earns less than a 3.0 GPA in prerequisite coursework while on probation, the student will be removed from the program.

In some cases, students may be required to complete additional prerequisite courses before beginning graduate study. Any additional prerequisite courses required as a condition of admission will be specifically identified in the student's letter of admission.

The assignment of prerequisite courses is made on the basis of the transcripts and other evidence presented with the application. Because transcripts and records often do not clearly indicate course content, some prerequisite course assignments may be inappropriate. Students who wish to waive prerequisites must present proper documentation of previous course content and ask the Director of Graduate Studies to waive the prerequisite.

1.3.Degrees Offered

The Department of Industrial and Manufacturing Engineering offers two graduate degree programs: Master of Science (MS) and Doctor of Philosophy (PhD). The department offers a variety of Master of Science in Industrial Engineering (MSIE) program and Master of Science Systems Engineering (MSSE) options to accommodate students' needs and specializations. Students may pursue a traditional MS, a non-thesis MS program with specialization in Engineering Management, or an MS Systems Engineering. The traditional MS program is research based, requiring the students to write and defend a thesis in their chosen area. MS with specialization in Engineering Management and MS Systems Engineering do not require a thesis. The Ph.D. program is a dissertation-based degree program requiring the successful completion of prescribed academic coursework and original research. Degree completion requires demonstrated mastery of the academic discipline and successful completion, defense, and approval of a doctoral dissertation that provides evidence of the student's independent research and scholarly contribution to the field.

The department also offers a BS-MS Pathway, which combines undergraduate-graduate program designed for five years of full-time study. The graduate degree is an MS in Engineering Management to be completed in a timeframe after the BS. It provides students with a unique opportunity to increase competitiveness of the students in the job market by combining advanced undergraduate and graduate studies in industrial engineering with practical, real-world experiences and at the same time increase graduate enrollment by attracting motivated and qualified undergraduate students.

1.4.Certifications Offered

The Department of Industrial and Manufacturing Engineering offers two certificates integrated into its course curriculum: (1) Systems Engineering Leadership and (2) Engineering Data Analytics. The Systems Engineering Leadership Certificate consists of four courses (12 credit hours) in systems engineering. The Engineering Data Analytics Certificate consists of 12 credit hours of coursework in data analytics and machine learning for engineering systems.

Applications to these certificate programs should follow the guidelines linked below:

Links: <https://eng.famu.fsu.edu/ime/systems-engineering-leadership-graduate-certificate>

Links: <https://eng.famu.fsu.edu/ime/engineering-data-analytics-certificate-program>

2. Admission Requirements

2.1. Master of Science in Industrial Engineering (MSIE) Program

The admissions requirements for the Master of Science in Industrial Engineering (MSIE) degree program are:

- Complete your BS Degree in Industrial Engineering, or a related area in science or mathematics as determined by the Director of Graduate Studies, with GPA at least 3.0/4.0 in all work attempted while registered as an upper-division undergraduate student working toward a baccalaureate degree.
- Good academic standing in the previous institution last attended
- A minimum graduate record examination (GRE) score of at least 155 in the Quantitative section and at least 146 Verbal Reasoning section.
- For international applicants, TOEFL score at least 80 or IELTS score at least 6.5
- Three letters of recommendation obtained from academics or professionals who can comment on the academic and research potential of the applicant. A letterhead is required for all submitted letters of recommendation. Applicants should notify individuals of this compliance criteria before submitting letters to the university admission portal.
- Statement of purpose describing reasons for pursuing a Master of Science degree and a career in Industrial and Manufacturing Engineering.

2.2.Master of Science in Industrial Engineering (MSIE) in Engineering Management

Requirements for admission to this program are identical to the MSIE admission requirements, except that (i) GRE minimum score requirements are 151 in quantitative and 146 in verbal and (ii) applicants' BS degree can be in engineering, computer science, mathematics, physics, or a related area as determined by the Director of Graduate Studies.

Admission Requirement for Combined Pathway

Well-qualified students, who are expected to have a GPA of 3.5 or better in the undergraduate studies, are eligible to apply for the combined BS-MS pathway during the spring semester of their third year in the College. Qualified undergraduate students interested in the program should meet with the undergraduate academic advisor and the department graduate program director in the

spring semester of their third year to determine whether they are eligible to apply and to plan their study in the senior year. Application to the undergraduate portion of the program will be reviewed by the department graduate committee and admission will be decided by the graduate program director with recommendation from the graduate committee and undergraduate academic advisor. Once admitted, students can proceed with taking 3 graduate level industrial engineering courses in their senior year to replace 8 credit hours in the existing undergraduate program. Admitted student should carry a course load of no more than fifteen (15) semester hours, and need to receive the approval of the dean, the department chair, and the undergraduate advisor prior to registration. Students will register the course at the graduate level and be graded the same as graduate students. Student will have the option to graduate with BS degree with the 3 graduate level courses.

For admission to the graduate portion of the program the students must make a formal graduate application in their senior year. Students who are interested in enrolling in the graduate program should meet with the director of graduate studies in the senior year to determine admission requirements and whether they are eligible to apply. Application, evaluation, and admission will follow the stand IME department requirements for MS in Engineering Management.

2.3. Master of Science (MS) Systems Engineering

Requirements for admission to this program are identical to the MSIE admission requirements, except that (i) GRE minimum score requirements are 151 in quantitative and 146 in verbal and (ii) applicants' BS degree can be in engineering, computer science, mathematics, physics, or a related area as determined by the Director of Graduate Studies.

2.4. Ph.D. Program

The PhD program can be undertaken from a Bachelor's or a Master's degree. The BS - PhD route provides a fast track for well-rounded students to bypass the MSIE degree and receive their doctorate in Industrial and Manufacturing Engineering in a relatively short time. The MS - PhD program is designed for students who have previously received an MS degree in engineering or a related discipline.

The admissions requirements for the PhD in Industrial Engineering degree program are:

- Complete your BS Degree in Industrial Engineering, or a related area with GPA at least 3.0/4.0 or MS Degree in Industrial Engineering or a related area with GPA of at least 3.4/4.0.
- Good academic standing in the latter institution last attended.
- A minimum graduate record examination (GRE) score of at least 155 in the Quantitative section and at least 146 Verbal Reasoning section.
- For international applicants, TOEFL score at least 80 or IELTS score at least 6.5
- Three letters of recommendation obtained from academics or professionals who can comment on the academic and research potential of the applicant.
- Statement of purpose describing reasons for pursuing a Master of Science degree and a career in Industrial and Manufacturing Engineering.
- GRE acceptance will follow the most recent guidance from the university.

3. Degree Requirements

3.1.Master of Science in Industrial Engineering (MSIE) program

Each MSIE student who intends to complete a thesis is required to take a minimum of thirty (30) semester hours (twenty-four semester hours of course work and six semester hours of thesis). At least eighteen (18) semester hours of the course work hours must be taken in the Industrial and Manufacturing Engineering Department. If a student is transferring from a previous institution, IME will only account for transfer credits as allowed by the State of Florida. A maximum of 6 credit hours of graduate courses not counted toward a previous degree from another regionally accredited graduate school may be transferred from another academic institution(s) to the student's current doctoral degree program, with the approval the IME Departmental Graduate Director. A grade of "B" or better is required on all transfer credits. Direct Independent Study (DIS) courses are not counted toward the required course work hours unless they meet the following: (1) the courses are offered on a regular basis with a permanent course number (or EIN 5930 before receiving a permanent course number) and have all requirement course components; and (2) the courses are offered temporarily as DIS course only because they cannot be offered as a regular course due to enrollment does not meet the university minimum requirement. A copy of the course for consideration should be submitted to the Department. Students must maintain an **overall GPA of 3.0** or above at all times while enrolled in the program in order to graduate. The MS students who are being funded by the department must maintain an **overall GPA of 3.4** or above at all times.

When submitting a **degree plan**, students must specify one of the department's areas of concentration as their major: manufacturing systems and engineering, or quality engineering and industrial systems. If the desired area of concentration differs from the initial area assigned (based on the student's graduate application), a petition to the Director of Graduate Studies must be submitted requesting the change.

There are two sets of courses under the traditional MSIE program: core courses and specialization & elective courses:

a. Core Courses (9 credits):

Every student choosing the thesis option must take the following courses and receive a **grade of B or better** in each:

- ESI 5408, Applied Optimization (**IEC1**)
- ESI 5247, Engineering Experiments (**IEC2**)
- ESI 5525, Modeling and Analysis of Manufacturing and Industrial Systems (**IEC3**)
- EIN 5936, Graduate Seminar (0 credits) (**IEC4**).

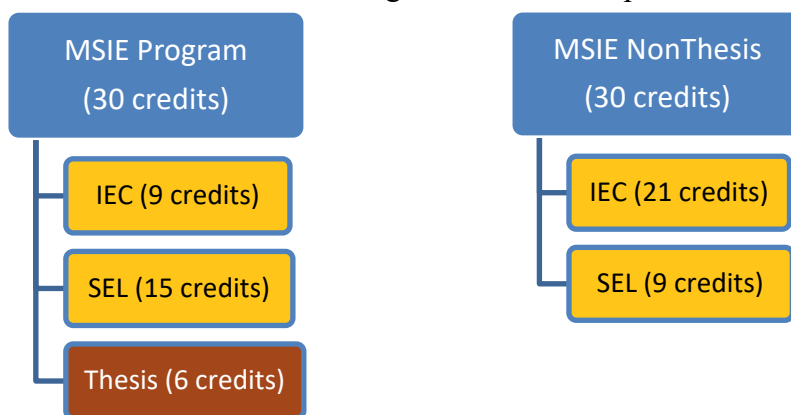
b. Specialty Electives (15 Credits):

The IME department has different specialty areas that include Manufacturing Engineering and Quality Engineering & Optimization. These courses are used to define minimum requirements for each interest area. The student is required to take at least 9 credit hours from those courses listed in his or her chosen area of specialization from the IME department (the remaining 6 credits can be taken from any department on campus). Substitutions may be made with the approval of the student's advisory committee and the Director of Graduate Studies. With the consent of the advisory committee, IME course offerings, Directed Individual Study credits, courses from other engineering departments, and other academic schools or colleges of the two universities can be counted towards Technical Elective courses.

The 5 specialty elective courses are labeled **SEL1**, **SEL2**, ... , **SEL5** (specialty electives). Some courses that may be taken as elective courses are as follows:

- EMA 5182 Composite Materials Engineering
- EIN 5930 Advanced Composite Engineering Seminar
- EIN 5930 Polymer Materials Manufacturing & Processing
- EMA 5015C Nanomaterials and Nanotechnology
- EIN 5524 System Modeling and Simulation
- EIN 5930 Data Mining
- EIN 5930 Response Surfaces and Process Optimization
- ESI 5228 Introduction to ISO 9000
- ESI 5243 Engineering Data Analysis
- ESI 5451 Project Analysis and Design
- EIN 5930 Special Topics in Industrial Engineering

MSIE Program Course Groups



Suggested timeline for the MSIE Program

- Before first semester: Meet with the Director of Graduate Studies or your temporary graduate advisor to plan a course of study for your first semester and to confirm any prerequisite needs.
- During the first semester: Begin the process of identifying faculty research interests compatible with your career goals.
- Before the end of the second semester: Establish a supervisory committee. Submit a **degree plan** to the IME CANVAS Student portal.
- At least one semester before the final semester: Develop and present a **thesis proposal**. Schedule proposal defense through committee chair.
- During final semester: Apply for graduation. At least 6 weeks prior to the final thesis defense make a **thesis research progress presentation**. Pay the diploma fee. Schedule the **final oral examination** and defend the thesis. Arrange for cap and gown at FAMU or FSU bookstore.

MSIE with Non-Thesis Option

Under exceptional circumstances, students may be allowed administratively to complete an MSIE non-theses option. In such cases, students are required to complete a minimum of 30 semester hours of course work at the graduate level, at least 24 of which must be taken in the Department of Industrial Engineering, without writing a thesis. Direct Independent Study (DIS) courses (EIN 5905) are not counted toward the required course work hours unless they meet the following: (1) the courses are offered on a regular basis with a permanent course number (or EIN 5930 before receiving a permanent course number) and have all requirement course components; and (2) the courses are offered temporarily as DIS course only because they cannot be offered as a regular course due to enrollment does not meet the university minimum requirement. Each student must obtain **an overall GPA of 3.0** or above in order to graduate.

There are two sets of courses under the non-thesis MSIE option. Core courses and elective courses.

a. Core courses (21 credits)

- ESI 5408 Applied Optimization (3hrs)
- ESI 5247 Design and Analysis of Engineering Experiments (3hrs)
- ESI 5525 Modeling and Analysis of Manufacturing and Industrial Systems (3hrs)
- ESI 5243 Engineering Data Analysis (3hrs)
- ESI5154 Statistical Process Control or ESI 5228 Introduction to ISO 9000 (3hrs)
- EIN 5412 Computer-Aided Manufacturing (3hrs)

- ESI 5451 Project Analysis and Design (3hrs)
- EIN 5936 Graduate Seminar (0 credits)

b. Specialty Elective courses (9 credits)

- See Specialty Electives for MSIE Thesis Option

3.2.MSIE in Engineering Management

Students are expected to complete 30 semester hours of course work, (21 credits core and 9 credits elective) and will not complete a thesis. Students must maintain a **minimum GPA of 3.0** at all times while enrolled in the program.

There are 3 sets of courses under this program: IE Core, Management Core, Electives. IE Core courses constitute 18 credits, Management core constitute 3 credits and the Elective courses constitute 12 credits. At least 6 credits of the Electives must be taken from the College of Engineering.

The courses will be labeled **IEC1** to **IEC7** for IE Core, **MC** for Management Core, **EEL1** and **EEL 2** for electives taken from College of Engineering and **MEL 1** and **MEL 2** for electives taken from College of Business. Only 1 College of Business course may be selected. Any other consideration for course registration is determined by the College of Business through a formal request via the IME Department (this is not a guarantee).

a. IE Core Courses (15 credit hours)

- ESI 5243 Engineering Data Analysis (**IEC1 - Spring**)
- EIN 5182 Engineering Management (**IEC2 - Fall**)
- ESI 5451 Project Analysis and Design (**IEC3**)
- EIN 5931 Leadership and Communications (**IEC4 - Spring**)
- EIN 5353 Engineering Economics and Financial Analysis (**IEC5 - Spring**)
- EIN 5936 Graduate Seminar (0 credits) (**IEC7 - Fall**)

b. Management Core Options (3 credit hours) – (MC1)

- MAR 5465 Purchasing and Supply Chain Management
- MAN 5935 Entrepreneurial Management
- MAR 5905 Business-to-Business Sales and Marketing
- MAR 5125 Marketing Strategy
- MAN 5245 Organizational Behavior
- FIN 5840 Applied Econometrics in Finance

c. Elective Options (12 credit hours, at least 6 credits must be from the COE) – Management Electives (MEL) and Engineering Electives (EEL)

- ESI-5510 Fundamentals of Systems Engineering
- ESI 5536 Model Based Systems Engineering and Simulation
- ESI 5556 Digital Transformation for Systems Engineering
- ESI 5247 Engineering Experiments (**IEC6 - Spring**)
- MAR 5625 Market Research and Analytics
- MAR 5861 Customer Relationship Management
- MAN5501 Production and Operations Management
- FIN 5515 Investment Management and Analysis
- FIN 5425 Problems in Financial Management
- FIN 5317 Financial Institutions and Risk Management

- FIN 5605 Multinational Financial Management
- ISM 5021 Information and Technology Management
- ISM 5046 Social and Organization Issues in MIS
- ISM 5315 Project Management
- BUL 5810 The Legal & Ethical Environment of Business
- ESI 5412 Computer-Aided Manufacturing
- EIN 5413 Computer-Aided Process Planning
- ESI 5154 Statistical Process Control
- ESI 5408 Applied Optimization
- EIN 5399 Concurrent Engineering
- ESI 5525 Modeling and Analysis of Industrial Systems
- ESI 5248 Environment Conscious Design and Manufacturing
- EIN 5226 Total Quality Management
- EMA5182 Composite Material Engineering
- EIN 5445C Technology Entrepreneurship and Commercialization
- EIN 5930 Learning from Data – Planning, Inference & Prediction

A sample course sequence for the Engineering Management program is as follows.

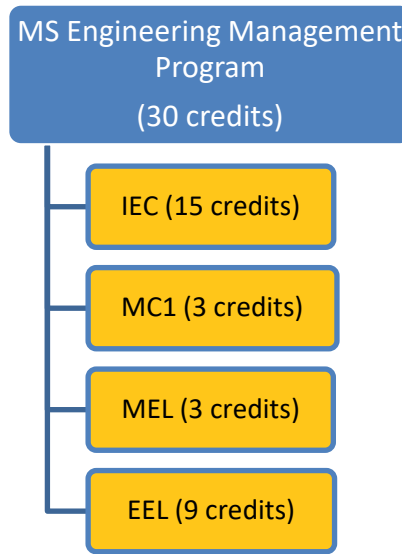
Year 1:

Fall	Spring	Summer
EIN5322 Engineering Management EIN 5930 Technology Entrepreneurship and Commercialization EIN 5936 Graduate Seminar	ESI 5408 Applied Optimization ESI 5247 Engineering Experiments EIN 5353 Engineering Economics	MAR 5125 Market strategy ESI-5510 Fundamentals of Systems Engineering

Year 2:

Fall	Spring
MAR 5465 Purchasing and Supply Chain Management ESI 5451 Project Analysis and Design	EIN 5931 Leadership and Communications

MS Engineering Management Program Course Groups



Combined Pathway

The undergraduate portion of the program will be referred to as *BS-MS with Specialization in Data Science*. The graduate portion of the program is identical to our existing *MSIE with Specialization in Engineering Management* program.

All BS-MS students must take the following distribution of courses for a total of thirty (30) credit hours to receive the combined BS-MS degree. Nine (9) of the thirty (30) credit hours must be taken during the senior year of the student's BS degree program as the shared credits. The remaining twenty-one (21) credit hours are taken as part of the MS degree program. Students have the option to graduate with only the BS degree at the completion of the Nine (9) credit hours of the graduate courses.

The undergraduate portion of the program of study requires the following courses be taken in the senior year:

Fall Semester

- ESI 4234 - Quality Control (3)
- EIN 4243 - Human Factors (3)
- EIN 4621 - Mfg. Systems (3)
- EIN 4890 - Senior Design I (3)
- ESI 3628 - Computing Topics (3)

Spring Semester

- ESI 4523 - Simulation (3)
- EIN 4892 - Senior Design II (3)
- IE Elective or Graduate Course (3)
- Technical Elective or Graduate Course (3)
- IME Practicum (2) or Graduate Course (3)

List of approved graduate courses to be taken in senior undergraduate year (all offered in the Spring Semester):

- ESI 5408- Applied Optimization (3)
- EIN 5353- Engineering Economics (3)
- ESI 5247- Engineering Experiments (3)

Registering for Graduate Courses: To register for a graduate course students must complete a Request to Take Graduate Courses form available from the Registrar's Office. The form must be submitted to the university no later than the third day of classes.

Once the student is admitted to the graduate program, the student can begin undertaking the remaining graduate coursework which consists of 21 credit hours. This program is course-based (no thesis credits need to be taken) and follows the MS track in Industrial Engineering with Specialization in Engineering Management. The 21 credit hours will consist of 3 sets of courses: IE core, Management Core and Elective courses. Direct Independent Study (DIS) courses (EIN 5905) are not counted toward the required course work hours unless they meet the following: (1) the courses are offered on a regular basis with a permanent course number (or EIN 5930 before receiving a permanent course number) and have all requirement course components; and (2) the courses are offered temporarily as DIS course only because they cannot be offered as a regular course due to enrollment does not meet the university minimum requirement.

IE Core Courses (12 credit hours)

- ESI 5243 Engineering Data Analysis
- EIN 5182 Engineering Management
- ESI 5451 Project Analysis and Design
- EIN 5931 Leadership and Communications
- EIN 5936 Graduate Seminar (0 credits)

Management Core Courses (3 credit hours)

- MAR 5465 Purchasing and Supply Chain Management
- MAN 5935 Entrepreneurial Management
- MAR 5905 Business-to-Business Sales and Marketing
- MAR 5125 Marketing Strategy
- MAN 5245 Organizational Behavior
- FIN 5840 Applied Econometrics in Finance

Elective Courses (6 credit hours)

- MAR 5625 Market Research and Analytics
- MAR 5861 Customer Relationship Management
- MAN5501 Production and Operations Management
- FIN 5515 Investment Management and Analysis
- FIN 5425 Problems in Financial Management
- FIN 5317 Financial Institutions and Risk Management
- FIN 5605 Multinational Financial Management
- ISM 5021 Information and Technology Management

- ISM 5046 Social and Organization Issues in MIS
- ISM 5315 Project Management
- BUL 5810 The Legal & Ethical Environment of Business
- ESI 5525 Modeling and Analysis of Industrial Systems
- EMA5182 Composite Material Engineering
- EIN 5930 Technology Entrepreneurship and Commercialization
- EIN 5930 Learning from Data – Planning, Inference & Prediction

It is possible to complete the graduate coursework in 2 semesters. The student can pursue either of the following two combinations: a) takes 4 courses (12 credits) in the Fall and 3 courses (9 credits) in the Spring semester; or b) takes 3 courses (9 credits) in the Fall and 4 courses (12 credits) in the Spring semester, of the graduate year. If no more than 9 credits per semester are to be taken, then it is possible to complete the graduate coursework in 3 semesters. A possible course layout for this case is as follows:

Fall semester

- EIN 5322 - Engineering Management (3)
- ESI 5525 - Modeling and Analysis of Industrial Systems (3)
- EIN5930-Learning From Data (3)
- EIN5936 Graduate Seminar (0)

Spring semester

- EIN 5931 - Leadership and Communications (3)
- EIN 5930 - Technology Entrepreneurship & Commercialization (3)
- MAN5245-Organizational Behavior (3)

Summer semester

- MAR 5125 - Marketing strategy in the Global Environment (3)
- MAN 5501-Operations Management (3)

Students must earn a 'B' grade or better in each graduate level core course taken. GPA should not fall below 3.5 in the undergraduate study and GPA should not fall below 3.0 in the graduate study. Once the thirty-three credits of the graduate courses are completed successfully, the student is eligible to graduate with a MS degree in Industrial Engineering with Specialization in Engineering Management.

3.3. Master of Science Systems Engineering (MSSE)

The MS Systems Engineering curriculum consists of thirty-three (30) credit hours. The curriculum has seven 3-hour core courses and three 3-hour technical electives in Systems Engineering or other related engineering disciplines, subjected to the approval by the IME department.

. Students must maintain a **minimum GPA of 3.0** at all times while enrolled in the program. The following table shows the overview of the curriculum:

Core Courses for MSSE Students:

- ESI 5510 - Fundamentals of Systems Engineering
- EIN 5356C - Cost Estimating for Engineering Economic Analysis
- ESI 5353 - Engineering Risk Analysis and Decision Making with Uncertainty
- ESI 5512 - System Requirements Analysis and Knowledge Management
- ESI 5001 - Systems Test and Evaluation

- ESI 5000 - Design Considerations for Systems Engineering
- ESI 5536 - Model Based Systems Engineering and Simulation

Tech elective areas include (but aren't limited to):

- Advanced model-based systems engineering
- Simulation, human factors, human systems integration
- Data analytics, operations research and optimization
- Autonomous systems
- Maritime systems
- Aerospace systems
- Electrical and power systems
- Transportation systems
- Engineering management, project management

Direct Independent Study (DIS) courses (EIN 5905) are not counted toward the required course work hours unless they meet the following: (1) the courses are offered on a regular basis with a permanent course number (or EIN 5930 before receiving a permanent course number) and have all requirement course components; and (2) the courses are offered temporarily as DIS course only because they cannot be offered as a regular course due to enrollment does not meet the university minimum requirement.

3.4. Ph.D. Program

The PhD in industrial engineering is designed for students and professionals who wish to pursue academic careers or to achieve advanced standing in the field. The PhD program can be started from a Bachelor's or a Master's degree. The general requirement is a minimum of 45 credit hours of work beyond the baccalaureate degree. Twelve semester hours are the Industrial Engineering core courses and they will have been satisfied by a student who has earned a master's degree in industrial engineering. Of the remaining required hours, 9 to 15 credits must be letter-graded course work combined with a minimum of twenty-four additional hours of dissertation research.

The course work consists of:

- 1) Twelve semester hours of industrial engineering core courses (IE core courses)
- 2) six semester hours of breadth-requirement core courses (PhD core courses),
- 3) up to six semester hours of depth-requirement courses (Additional courses), as determined by the student's doctoral supervisory committee.
- 4) three semester hours of review paper based directed independent study (RPD), only required for BS to PhD students who have not previously written an MS Thesis.

Residency and time-for-completion requirements are determined by the student's university of enrollment. The PhD students who are being funded by the department must maintain an **overall GPA of 3.5** or above at all times. Doctoral candidates must meet the department **publication requirements** before the viva voce of their dissertation.

Students will be eligible for doctoral candidacy after completing 24 credit hours of course work. Direct Independent Study (DIS) courses (EIN 5905) are not counted toward the required course work hours unless they meet the following: (1) the courses are offered on a regular basis with a

permanent course number (or EIN 5930 before receiving a permanent course number) and have all requirement course components; and (2) the courses are offered temporarily as DIS course only because they cannot be offered as a regular course due to enrollment does not meet the university minimum requirement. The students who entered the program with a BS degree or an MS degree with no thesis are required to take a 3 credit hour Review Paper Directed Independent Study (RPD), which is intended to allow students to demonstrate their ability to conduct a literature review and display their understanding of the theoretical framework as directed by the doctoral committee. This is the only EIN 5905 course that counts toward the required course hour on a regular basis (also see part c, Core Courses for PhD Students section) Throughout the duration of study, the student must maintain a grade of 'B' or higher in every course.

Suggested Timeline of PhD Study

The PhD program consists of three different phases; below is a recommended timeline:

Phase 1

- Before first semester registration: Meet with the Director of Graduate Studies or your temporary graduate advisor to plan a course of study for your first semester. This includes submission of a **degree plan** to the IME CANVAS portal.
- During the first and second semesters: Start taking courses required from the IE Core, Mathematical Core Course and Computational Core Course Groups (see below).
- Before the end of the second semester: Begin the process of identifying faculty research interests compatible with your academic or career goals. Establish a doctoral supervisory committee.
- During the third semester: Finish taking the core courses.

Phase 2

- By the end of the fourth semester: Schedule the doctoral **Preliminary Examination**. Defend the Preliminary Exam. Doctoral Forms can be found on Canvas Modules: <https://famu-fsu-eng.instructure.com/courses/13503/modules>.
- Deliver an **Annual Progress Presentation** to the committee once every year

Phase 3

- Submit the **Dissertation Proposal** and deliver an oral presentation of the proposal to the committee (about one year after passing the prelim exam, and at least six months before the dissertation defense presentation)
- During final semester: Deliver the **Final Progress Presentation** (at least 6 weeks prior to Defense). Apply for the degree. Pay the diploma fee. Schedule the final oral **Dissertation Defense Presentation** through your committee chair and defend the dissertation.

According to this timeline students are expected complete their IE and PhD core courses by the third semester. (Note: Summer term is not considered in this semester count). At a predetermined point in the third or fourth semester, the student must successfully complete the preliminary exam. The student will be allowed to attempt the prelim exam only two times. In the third semester or beyond, the student will take any additional course requirements set by their committee. However, this cannot extend beyond the student's fourth semester in the program. After you passed prelim exam you must continuously register for dissertation credits. Post candidacy, student must satisfy residency requirement of 24 dissertation credit hours in a given period of 12 consecutive months.

Core Courses for PhD Students

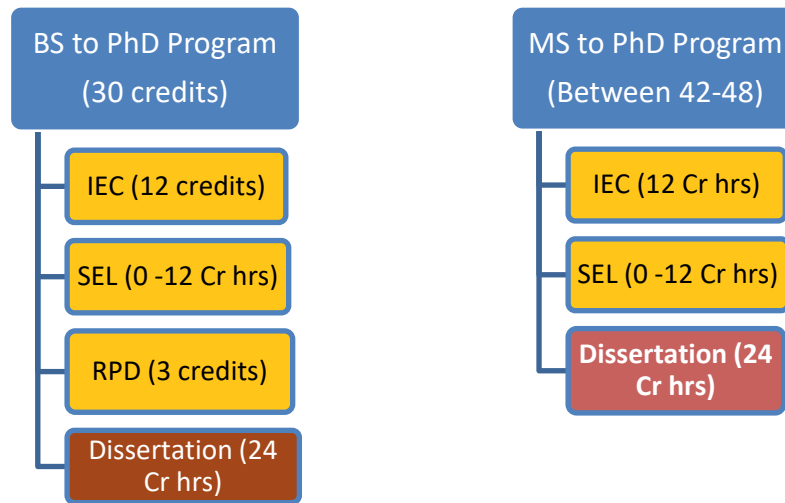
All PhD students are required to take the following courses as soon as possible after their admission to the PhD program. These courses provide students with a common, solid background in mathematics, statistics, and industrial engineering. Students must earn a grade of "B" or higher in the core courses. Students who do not satisfy this requirement may be dismissed from the program.

- a. **IE Core courses (IEC group) -12 credits:** The following courses are required if the student did not take them to fulfill requirements for the master's degree.
 - ESI 5247, Engineering Experiments (IEC1)
 - ESI 5408 Applied Optimization (IEC2)
 - ESI 5525, Modeling and Analysis of Manufacturing; and Industrial Systems (IEC3)
 - EIN 5020, Research Methodology (IEC4)
 - EIN 5936, Graduate Seminar (IEC5)
- b. **Review Paper Directed Independent Study (RPD) – 3 credits:** This course is required only for students who have not written an MS Thesis in their prior study. The following directed independent study course must be completed before undertaking the preliminary exam. Students should consult the direct advisor before enrolling in this course.
 - EIN 5905 (3) Review Paper Directed Independent Study (3).
- c. **Additional courses - minimum 12 credits:** The student may be required to fulfill additional course requirements, depending on the goals of the doctoral committee, with a minimum of twelve credit hours. The make-up of these courses is at the discretion of the doctoral committee with advisor consent and is intended to enhance the student's fundamental knowledge in the chosen research area. With the consent of the advisory committee, Directed Individual Study credits, courses from other engineering departments, and other academic schools or colleges of the two universities can be counted towards Additional courses.
- d. **Other courses**
 - MAA 5306 Advanced Calculus I (3).
 - MAD 5345 Elementary Partial Differential Equations I (3).
 - STA 5323 Introduction to Mathematical Statistics (3)
 - EIN 5930 Specialized Topics in Industrial Engineering (1-6).
 - MAD 5403 Foundations of Computational Methods I (3).
 - MAP 5395 Finite Element Methods (3).
 - STA 5106 Computational Methods in Statistics I (3)
 - ISC 5315 - Applied Computational Science I
 - ISC 5228 - Monte Carlo Methods

Substitute courses on math or statistics of 5xxx and higher may be allowed at the discretion and approval of the graduate director. These are suggested additional course.

The following flow chart summarizes the course and dissertation credit requirements for the BS-PhD and the MS-PhD routes. Once the necessary course work is complete, the student must successfully attempt the preliminary exam, and then take a minimum of 24 dissertation hours to be eligible for graduation. Once the preliminary exam is passed, will a student be considered a PhD candidate.

PhD Program Course Groups



Preliminary Examination

Following completion of the coursework as defined in the degree plan, and upon certification of the doctoral supervisory committee that the student has 1) maintained a minimum 3.4 GPA and 2) progressed sufficiently in the study of industrial engineering and its research tools to begin independent research in the area of the proposed dissertation, the student is ready to take the preliminary examination. Students are admitted to candidacy after passing the preliminary examination.

The purpose of the preliminary examination is to test the adequacy of a student's background related to the student's area of concentration, and to determine if the student is adequately prepared to formulate and undertake acceptable dissertation research. The procedures are available from the department. It must be successfully completed by the student's third semester (MS - PhD route), or fourth semester (BS - PhD route). In the semester the student intends to complete the prelim exam, student needs to register for the 0-credit hour prelim exam course. This registration must only be done once, during the semester in which student completes the attempt.

If a student fails the preliminary examination before being admitted to candidacy, a re-examination may be offered by the student's supervisory committee. The College of Engineering Dean's office should be notified of the outcome of any preliminary exam attempt.

Students can take the preliminary examination for admission to candidacy only two times. A second failure on the preliminary exam makes the student ineligible to continue in the degree program. The second attempt at the preliminary exam shall occur no sooner than six full class weeks after the results of the first attempt are shared with the student. For the purpose of this policy, a "full class week" is defined as a week with five days during which classes are held at FSU. Students must be registered separately for their first and second attempt, if necessary within the same semester, and must receive either a "pass" or a "fail" grade for each attempt.

An exception request regarding the timing of the re-examination can be submitted for consideration to College of Engineering Dean's Office by either the student or the supervisory committee. Students who allege that academic regulations and/or procedures were improperly applied for the re-examination of their preliminary exam may have their grievances addressed

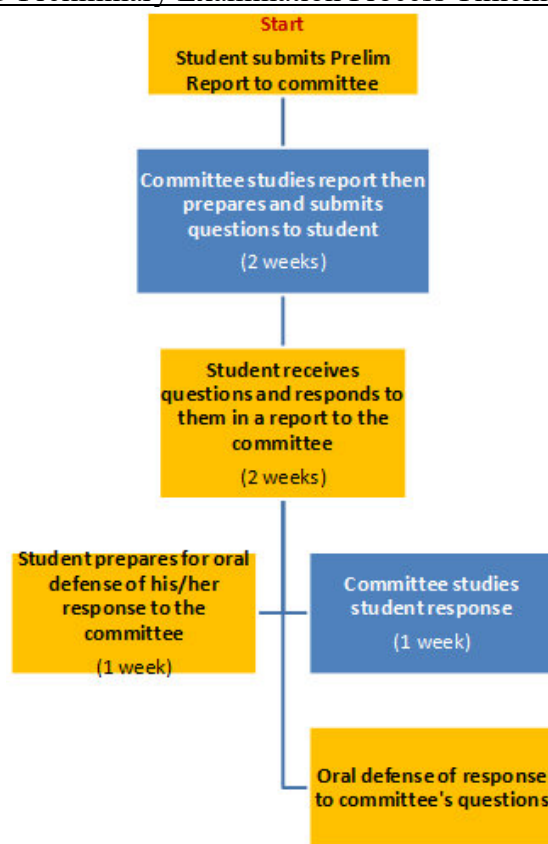
through the general academic appeals process. The full preliminary exam policy as listed here must be added to all doctoral student handbooks.

In preparing for the prelim exam, the student shall present to the doctoral committee a research review report demonstrating an understanding of the theoretical framework in the area of research based on an in-depth literature review. In demonstrating an understanding of the literature, the student must include a discussion that identifies the knowledge gaps in their research area. The student shall end the prelim report by indicating what kind of research is necessary to close the identified knowledge gaps, and a schedule for an initial assessment, which leads to a research proposal. Upon submission of the prelim report, the committee will respond to the student with questions based on the literature review and research area.

The student must make arrangements with the major professor to schedule a **five-week time period** for the examination. The student is required to bring an Application for Preliminary Examination (available from the Department) to the oral examination. After completion of the examination, the supervisory committee chair should submit the signed form to the Director of Graduate Studies. The five-week time period will be spent as follows:

- With the consultation of the major professor, the student will submit a research review report to the supervisory committee. This document should be approximately 20 typed double-spaced pages.
- The committee will submit written questions to the major professor for collection by the student two weeks after submission of the research review report. These questions will relate to the research review report.
- The student will have two weeks to develop written responses to the questions in preparation of the oral exam. These responses will be submitted to the major professor, who will then distribute the responses to the committee members. The student should submit a complete bound set of answers to each committee member.
- The oral examination will be held within one week of submission of the written responses. This examination will be primarily related to the research area and the student's written responses. Appropriate related fundamental concepts may also be covered.
- Pass/fail is determined on the combined written and oral responses to committee questions. A majority of committee votes and a pass vote by the committee chair is required to pass.
- A student who passes the examination will be recognized as a candidate for the PhD Degree. The Preliminary Examination Report Form should be filled after the examination is completed.

PhD Preliminary Examination Process Timeline



Annual Progress Presentation

Upon completion of the preliminary exam the PhD candidate is required to deliver a progress presentation to the committee members once every year. The purpose of the presentation is to demonstrate that the student has made measurable progress during the academic year towards his/her study and for the committee members to provide input for the student. The format of the progress report is to be determined by the committee members. The PhD Annual Progress Review Form should be filled after the progress presentation.

Research Proposal

The research proposal is a description of the research which the student intends to undertake and which will be reported in a detailed, comprehensive fashion in the completed dissertation. It offers the student an opportunity to convince the supervisory committee of the appropriateness of the research topic, as well as of his/her capability to pursue the projected topic to a successful conclusion.

The research proposal must be submitted to the supervisory committee after the student passes the preliminary exam (usually 1 year after the prelim exam) and before beginning dissertation research. The student must provide an oral presentation at least one week after submitting the proposal. A revised proposal (with approval signatures from all thesis supervisory committee members must be submitted to the Director of Graduate Studies within two weeks after the presentation. Use the **PhD Research Proposal Form** for the proposal presentation. Research proposal must be completed at least six months before dissertation defense.

The research proposal narrative must include:

1. Problem Statement. The definition of the problem to be investigated, including its scope.
2. Objectives. Objectives of the project, clearly stated in terms that lend themselves to observation and/or measurement.
3. Present Status of the Problem. Summary of pertinent previous research in the field, documented with citations from the literature. Must demonstrate the relation of the material cited to the present problem.
4. Procedure. Approach and steps to be taken to achieve objectives. Must include nature of data and the procedure(s) to be employed in the analysis of the data, and state clearly how the research will be done.
5. Expected Results and Schedule. Expected results from the research work, including an outline and plan to accomplish the research work in the time remaining prior to defense.

Progress Report and Presentation

Upon completion of the preliminary exam the PhD candidate is required to deliver an Annual Progress report to the committee members once every year. The format of the progress report is to be determined by the committee members. The PhD Annual Progress Review Form should be filled after the progress presentation.

Upon completion of the dissertation proposal examination, the PhD candidate is required to deliver a Final Progress presentation to the committee members. The final progress presentation should be held at least 6 weeks prior to the dissertation defense presentation. All committee members should attend the presentation in person or via distant technology. The PhD Final Progress Review Form should be filled after the final progress presentation.

Publication Requirement

Before proceeding to defend their dissertation research, all Ph.D. students are required to have accepted at least two (2) refereed journal papers for which the candidate is the first author and submitted at least two (2) refereed journal papers from their dissertation. The submitted papers should be under consideration at the time of the defense

Dissertation Defense Requirements

Subject to approval of the doctoral candidate's committee confirming the candidate's readiness to defend his/her dissertation and upon satisfaction of the publication requirements the candidate may proceed to defend their dissertation research.

All committee members and the student must be physically present during the entire defense. In cases where this is not possible, the department allows no more than one member to attend the defense in real time by participating via distance technology. The distance technology must allow two way audio and visual links. That is, the committee member who is away can be seen and heard by all other members and the student and vice versa. Communication link that allow only audio (i.e. teleconferencing) is not acceptable in a defense. Link to DOC template.

Dissertation

After completion of the preliminary examination, the student is admitted to formal candidacy for the PhD. After a period of preliminary research as determined by the doctoral committee, a research proposal must be successfully presented to the committee by the doctoral candidate. A doctoral dissertation then must be completed on a topic approved by the candidate's doctoral supervisory committee. To be acceptable, it must be an achievement in original research constituting a significant contribution to knowledge and represent a substantial scholarly effort on

the part of the student. The doctoral supervisory committee, department chairperson, and such other members of the faculty as appointed by the academic dean or specified by university regulations will conduct the examination. Publication of the dissertation shall conform to the regulations of the university in which the student is registered.

4. University Requirements and Policies

University requirements and policies are provided by the FAMU Office Graduate Studies and Research (<http://www.famu.edu/index.cfm?a=graduatestudies>) and by The Graduate School at FSU (<http://www.gradstudies.fsu.edu/>). In addition for more complete information on policies see the FAMU General Catalog at <http://catalog.famu.edu/> and the FSU Graduate Student Handbook <http://registrar.fsu.edu/bulletin/grad/>.

4.1.Scholarly Engagement

The purpose of the Scholarly Engagement requirement is to ensure that doctoral students are active participants in the scholarly community. To meet the Scholarly Engagement requirement, doctoral students should interact with faculty and peers in ways that may include enrolling in courses; attending seminars, symposia, and conferences; engaging in collaborative study and research beyond the university campus; and utilizing the library, laboratories, and other facilities provided by the university. The goal is to prepare students to be scholars who can independently acquire, evaluate, and extend knowledge, as well as develop themselves as effective communicators and disseminators of knowledge.

Effective fall 2016, Ph.D. students enrolled at FSU will no longer be required to conform to the residency requirement. They are no longer required to complete 24 graduate credit hours in a 12 month period following completion of 30 hours or a master's degree. Beginning in the fall 2016 the Registrar will no longer check for compliance with this requirement. This applies to all students (new and returning). Students must still comply with the continuous enrollment policy. There is no change in the total number of hours required for the degree.

The IME Program assesses the scholarly engagement of PhD students through the Annual Progress Review Presentation. The intent of the annual review is to assure that each student has the opportunity for scholarly engagement and continues to make timely progression toward completion of the degree program.

4.2.Continuous Enrollment

Continuous enrollment is defined as enrollment without an interruption of two or more consecutive semesters (including Summer term). Students who are not enrolled at the University for two or more consecutive semesters (or consecutive semester and Summer term) must apply for readmission before resuming their studies.

4.3.University-wide Standards for Teaching Assistants

Students who assume any teaching assistant (TA) role (e.g., grader, lab TA, course TA) must satisfy the minimum requirements for the specific teaching role(s). Requirements include graduate coursework or a master's in the discipline, participation in the Program in Instructional Excellence (PIE) fall conference and the PIE workshop on Sexual Harassment (<http://pie.fsu.edu/>), certification of spoken English for those whose native language is not English, supervision by a faculty member, and periodic evaluations. For specific requirements, see the document "University-wide Standards for Graduate Teaching Assistants," which may be found at http://registrar.fsu.edu/bulletin/grad/info/teach_assist.htm.

International graduate students should have a score of 26 or higher in the speaking section of TOEFL or a 50 or higher on the SPEAK test administered by FSU upon arrival. New students who do not meet the requirement will enroll in the remedial English courses offered by the Center for Intensive English Studies at FSU.

The annual Fall Program for Instructional Excellence (PIE) TA Orientation/Teaching Conference is held Wednesday-Thursday the week prior to the first week of classes each fall. This conference includes sessions that provide graduate students with teaching policy training requirements as stated in the University-wide TA Standards along with best practices in grading, communicating with students, encouraging critical thinking in the classroom, and Blackboard and technology usage. All graduate students must attend this training.

4.4. Time Limit for Completion of Degree Requirements

All requirements for the doctoral degree must be completed within five calendar years from the time the student passes the preliminary examination, or the student's supervisory committee will require that a new preliminary examination be passed. The work for the master's degree must be completed within seven years from the time the student first registers for graduate credit.

5. Forms

All departmental graduate student forms can be found at the IME Graduate Studies web page <http://eng.fsu.edu/ime/graduate/resources.html>. FAMU forms may be found at <http://www.famu.edu/index.cfm?graduatestudies>. FSU forms may be found in the Grad Space organization site in Canvas <http://campus.fsu.edu>

6. Department Graduate Courses

Definition of Prefixes

EGN—Engineering: General

EIN—Industrial Engineering

EMA—Materials Engineering

ESI—Industrial/Systems Engineering

EIN 5182. Engineering Management (3). Prerequisite: EIN 5353. Course in modeling existing and future organizations, with emphasis on organizations for the 21st century. Special consideration is given to flat matrix models.

EIN 5353. Engineering Economic Analysis (3). Prerequisites: EGN 3443 and MAP 3305. This course includes feasibility science, mathematics and engineering focused on the engineering economic analysis of design and system alternatives for high technology operations.

EIN 5392. Manufacturing Processes and Systems (3). Prerequisite: EGN 4000. Material forming, material removal, and material joining processes. Shop floor layout topics. Material flow topics. Information system topics. System integration topics. Manufacturing system evaluation topics. Case studies and design exercises.

EIN 5398. Manufacturing Materials Processing (3). Prerequisite: EIN 5392. Review of basic concepts and fundamental results of materials science. Fundamentals of casting processes and applications. Nontraditional methods in materials processing. Microscale material processing, with applications to microelectronics and similar structures. Industrial byproduct processing. Automation issues. Case studies and design exercises.

EIN 5459. Concurrent Engineering (3). Prerequisite: Graduate or senior standing with instructor permission. Concurrent product and process design. Product life cycle attributes. Design for manufacturing. Quality function deployment. Concurrent engineering project management topics. Case studies and design exercises.

EIN 5524. System Modeling and Simulation (3). Prerequisites: CGS 3460, EGN 3443, and ESI 3443. Discrete event, continuous, and process simulation. Combined discrete/continuous simulation. Manufacturing systems modeling. Event graphs. Simulation languages and systems. Experimentation with models. Introduction to simulation-specific statistical problems. Model validation and verification issues. Design exercises.

EIN 5622. Computer-Aided Manufacturing (3). Prerequisite: EIN 3390C. CAD/CAM. Numerical Control (NC) and Computer Numerical Control (CNC). Programmable automation. Computer-aided process planning.

EIN 5623. Computer-Aided Process Planning (3). Prerequisites: CGS 3408, EGN 2123, EIN 3390C, and EIN 4312. Course covers the role of process planning and computer-aided process planning (CAPP), development of CAPP, configuration of CAPP systems, input approaches of CAPP systems, process routing planning, machining operations design, variant CAPP systems, generative CAPP systems and artificial intelligence in CAPP.

EIN 5905r. Directed Individual Study (1–3). (S/U grade only.) Prerequisite: Instructor permission. May be repeated to a maximum of six semester hours.

EIN 5930r. Special Topics in Industrial Engineering (1–6). Prerequisite: Instructor permission. Topics in industrial engineering with particular emphasis on recent developments. May be repeated to a maximum of six (6) semester hours.

EIN 5931. Leadership and Communications (3). Prerequisites: Graduate standing and EGN 3613. Course topics include leadership theories, motivation, goal setting, planning, proposal writing and technical presentations. Presentations given by business leaders are planned.

EIN 5936r. Graduate Seminar (0). (S/U grade only.) Research presentations by faculty, students, and guests from industry.

EIN 6901r. Master's Thesis (1–6). (S/U grade only.) Prerequisite: Approval by department. Each master's thesis shall be supervised by a master's degree supervisory committee. Completed master's thesis shall be presented to the department in the form of a written report and a seminar. May be repeated to a maximum of nine semester hours.

EIN 8976r. Master's Thesis Defense (0). (P/F grade only.)

EMA 5182. Composite Materials Engineering (3). Prerequisite: Instructor permission. Course provides basic understanding of composite materials. Topics include introduction to composite materials, properties and forms of constituent materials, consideration of composite behavior and failure modes, characterization of material performance and testing, introduction to available manufacturing techniques, laboratory demonstrations, and case studies.

ESI 5223. Statistical Process Control (3). Prerequisite: ESI 4234. Advanced methods of statistical process control for univariate and multivariate processes, methods for change point detection and estimation, control chart performance comparisons, process capability studies.

ESI 5228. Introduction to ISO 9000 (3). Prerequisite: Instructor permission. Introduction to the ISO 9000 quality system standards. Quality auditing. Audit report writing. Documenting the requirements. Case studies and demonstrations.

ESI 5243. Engineering Data Analysis (3). Prerequisite: EGN 3443 or equivalent. Analysis of experimental and observational data from engineering systems. Course focuses on empirical model building using observational data for characterization, estimation, inference and prediction.

ESI 5247. Engineering Experiments (3). Prerequisites: EGN 3443 Course provides an introduction to designing experiments and analyzing the results. It is intended for engineers and scientists who perform experiments or serve as advisers to experimentation in industrial settings. Students must have an understanding of basic statistical concepts. A statistical approach to designing and analyzing experiments is provided as a means to efficiently study and comprehend the underlying process being evaluated. Insight is gained that leads to improved performance and quality.

ESI 5249. Response Surfaces and Process Optimization (3). Prerequisite: ESI 5247. This course explores combined statistical experiment designs, empirical model building, and optimization methods. Topics include restrictions on randomization, mixture experiments, and robust design. Emphasis is placed on software tools to build designs and perform appropriate analyses.

ESI 5328. Environmentally Conscious Design and Manufacturing (3). Prerequisite: Graduate standing. This course offers a review of basic concepts and fundamentals of environmentally conscious design and manufacturing. The topics include ecology and environment; review of environmental laws and regulations pertaining to design and manufacturing; the global picture of environmental concerns; integration of environmentally conscious design and manufacturing within a company; and life-cycle analysis for product and process design.

ESI 5408. Applied Optimization (3). Prerequisite: ESI 3312C. Optimization topics relevant to industrial operations and systems. Emphasis on basic modeling assumptions and procedure implementation. Topics shall include linear programming, nonlinear programming, discrete optimization and large-scale optimization software. Design exercises.

ESI 5451. Project Analysis and Design (3). Prerequisites: EGN 3613 and ESI 3312C. Project analysis and evaluation, utilizing networks and graph theory, advanced engineering economy, simulation procedures and other evaluation software. Project implementation topics, including resource shortfalls and expediting. Case studies and design exercises.

ESI 5458. Optimization on Networks (3). Prerequisite: ESI 3312C. Review of basic combinatorics. Basic concepts of graph theory. Matching and covering, and applications. Traversability and path problems on networks and applications. Tree problems. Network flows and applications. Eulerian paths, Hamiltonian paths, and applications. Location problems on networks. Design exercises.

ESI 5524. Advanced Simulation Applications (3). Prerequisite: ESI 4523 or EIN 5524. Application of simulation to complex systems, including material handling systems, real time scheduling, high speed/high volume production, modern manufacturing techniques, health-care delivery and logistics. Concurrent use of simulation and other analysis techniques. Use of experimental design, output analysis and validation techniques. Case studies.

ESI 5525. Modeling and Analysis of Manufacturing and Industrial Systems (3). Prerequisites: EIN 4333, ESI 3312C, ESI 4523, ESI 5408, and ESI 5524. Modeling and analysis of material flow systems, flow-shop and job-shop scheduling, material handling system analysis, mathematical and simulation modeling for general manufacturing and industrial systems.

EIN 6629. Tolerancing and Metrology for Precision Manufacturing (3). Prerequisites: EIN 5398, 5408. Theory and applications of tolerancing techniques in precision machining. Topics include tolerance representation, tolerance stack-up, tolerance analysis and synthesis, statistical tolerancing, coordinate measuring machines, form error evaluation algorithms, and advanced topics in form error assessment. Case studies and design exercises.

EIN 6980r. Dissertation (3–24). (S/U grade only.) Prerequisite: Doctoral candidate standing. Mandatory class for all PhD seeking students. May be repeated to a maximum of forty-eight semester hours.

EIN 8964. Preliminary Doctoral Examination (0). (P/F grade only.) Prerequisite: Doctoral candidate standing.

EIN 8985r. Dissertation Defense (0). (P/F grade only.) Prerequisite: Doctoral candidate standing.