INDUSTRIAL AND SYSTEMS ENGINEERING

The Master's program in Industrial & Systems Engineering (ISE) is a 30 credit hour degree program designed for engineers and other professionals who have responsibility for designing, installing, improving and evaluating large integrated systems. Specializations/courses are available in the areas of:

- Human Factors/Ergonomics
- Operations Research & Management Science
- Quality Systems Design
- Advanced Manufacturing & Automation
- Information Systems Management
- Program Management & Product Development

The program may be completed entirely on campus, entirely online, or through a combination of on-campus and online courses.

The ISE Ph.D. program provides educational opportunities to talented students to acquire the advanced knowledge needed to become creative researchers as well as technical leaders and technology innovators in industrial and systems engineering. The program is a full-time, research-based degree designed to address the growing needs of society for scientific and engineering professionals with advanced knowledge, technical skills, and abilities to conduct original and high-quality translational research in industrial and systems engineering. Students are admitted for full-time study and all admission offers are for the Fall term only.

Specific requirements of the program are described below.

The program may be completed entirely on campus, entirely online, or through a combination of on-campus and online courses.

Admission

Undergraduate Degree Requirement

Admission to this degree program requires a bachelor's degree in engineering, physical science, computer science, or applied mathematics.

Students who do not meet BS degree requirements of the program should speak to the program advisor regarding the additional requirements to be met.

Course Prerequisites

- Calculus based course in probability and statistics (IMSE 510, Probability and Statistical Models or equivalent)
- A course in operations research (IMSE 500, Models of Operations Research or equivalent)

The IMSE 510 and IMSE 500 course requirements can be completed after admission into the program. Both IMSE 500 and IMSE 510 will count toward the 30-credit degree requirement. IMSE 500 will count towards the program concentration requirements and IMSE 510 will count as a program elective.

Degree Requirements

The degree MSE in ISE requires a minimum of 30 credit hours.

Minimum Grade Requirement in addition to maintaining a minimum cumulative GPA of 3.0 or higher every semester:

- Courses in which grades of C- or below are earned cannot be used to fulfill degree requirements.
- A minimum of a 3.0 cumulative GPA or higher is required at the time of graduation.

Advanced Standing Provision

Up to six graduate credit hours (grade of *B* or better) may be transferred from another accredited institution. Students may transfer up to one-half (1/2) of the minimum number of credit hours required for their master's or professional degree from another University of Michigan program.

Graduate Academic Policies can be found below:

http://catalog.umd.umich.edu/academic-policies-graduate/

Specific Course Requirements

The program of study must satisfy the following distribution and course requirements:

Code	Title	Credit Hours
Core		
IMSE 511	Design and Analysis of Exp	3
IMSE 501	Human Factors & Ergonomics	3
IMSE 580	Prod & Oper Engineering I	3
Concentration		
A minimum of 12 credit hours from the three concentration areas. All four courses can be taken from one concentration area or any combination of the three concentration areas below.		12
Total Credit Hours		**21**

Concentrations

Code	Title	Credit Hours
Industrial Systems Engineering Concentration		
Human Factors and Ergonomics:		
IMSE 543	Industrial Ergonomics	3
IMSE 545	Vehicle Ergonomics I	3
IMSE 546	Safety Engineering	3
IMSE 548	Res.Meth.Human Fctrs/Ergonomic	3
IMSE 577	Human-Computer Interaction	3
IMSE 593	Vehicle Package Engineering	3
AENG 546	Vehicle Ergonomics II	3
Operations Research & Management Science:		
IMSE 500	Models of Oper Research	3
IMSE 505	Optimization	3
IMSE 514	Multivariate Statistics	3
IMSE 5205	Eng Risk-Benefit Analysis	3
IMSE 5215	Program Budget, Cost Est & Con	3
IMSE 559	System Simulation	3

IMSE 586	Big Data Aanal & Visuliztn	3
IMSE 605	Advanced Optimization	3
IMSE 606	Advanced Stochastic Processes	3
Integrated Design and Manufacturing Engineering Concentration		
Quality Systems Design:		
IMSE 513	Robust Design	3
IMSE 519	Quan Meth in Quality Engin	3
IMSE 561	Tot Qual Mgmt and Six Sigma	3
IMSE 567	Reliability Analysis	3
Advanced Manufacturing & Automation:		
IMSE 504	Metal Forming Processes	3
IMSE 538	Intelligent Manufacturing	3
IMSE 5655	Supply Chain Management	3
IMSE 581	Prod & Oper Engineering II	3
IMSE 5825	Industrial Controls	3
Information Systems Concentration		
Information Systems Management:		
CIS 527	Computer Networks	3
IMSE 553	Software Engineering	3
IMSE 556	Database Systems	3
Enterprise Information Systems:		
IMSE 555	Decision Support/Expert Sys	3
IMSE 564	Applied Data Analytics and Modeling for Enterprise Systems	3
IMSE 570	Enterprise Information Systems	3
IMSE 5715	Modeling of Int Info Syst	3
IMSE 5725	Object Oriented System Design	3
IMSE 5755	Bus Proc Int using Entrpr Tech	3
Program Management & Product Development		
EMGT 580	Mgt of Prod and Proc Design	3
IMSE 515	Fundamentals of Program Mgt	3
IMSE 516	Project Management and Control	3
IMSE 517	Managing Global Programs	3

Cognate Requirements (6 credits):

At least two graduate-level cognate courses for a minimum of six (6) credit hours total in departments other than IMSE must be elected.

Electives (3 credits):

The remaining 3 credit hours may be selected from the approved electives list of courses.

Code	Title	Credit Hours
Approved MSE-ISE Electives		
Select one of the following:		
Any 500-level IMSE, HCDE (except HCDE 501), EMGT (except EMGT 520), AENG, CIS, ECE, ESE, ME class.		
ACC 505	Devel & Interp Financial Info	3
FIN 531	Fin Fundament & Value Creation	3
MKT 515	Marketing Management	3
OB 510	Organization Behavior	3
OM 660	Supply Chain Analytics	3
OM 661	Supply Chain Logis Mgmt	3
OM 664	Strategic Sourcing	3
STAT 530	Applied Regression Analysis	3
STAT 550	Multivariate Stat Analysis	3
STAT 560	Time Series Analysis	3

Thesis Option:

With the approval of the graduate advisor, students may substitute a master's thesis for no more than six **(6)** credit hours of graduate coursework. **Six** master's thesis credits will replace **3** credits of concentration requirements and **3** credits of elective requirements in the program.

Dual Degree, MBA/MSE-Industrial Systems Engineering

The MBA/MSE-Industrial Systems Engineering has been carefully developed to meet the increasing need for professionals who have expertise in both engineering and management. It is open to students who have completed a Bachelor of Science degree in engineering, a physical science, computer science, or applied mathematics.

The program is offered jointly by the College of Business and the College of Engineering and Computer Science. It allows students to receive both the MBA and MSE-ISE simultaneously upon completion of the required 57-66 credit hours.

You may complete the program on campus, on-line, or any combination of the two, and you may enroll on a full- or part-time basis.

Admission is rolling, and you may begin the program in September, January, or May. Students must apply and be admitted to the MBA and the MSE-ISE programs separately. University of Michigan-Dearborn students who have been admitted to the program may take up to 6 graduate business credits during the final semester of their undergraduate program.

Program Goals and Objectives

Master of Business Administration

Goal 1: Students will have an understanding of the core business disciplines and be able to apply this knowledge to global business situations.
Objectives: MBA students will:

1. Demonstrate knowledge of disciplinary concepts, terminology, models, and perspectives.
2. Identify business problems and apply appropriate solutions (problem-finding/problem-solving).
3. Integrate knowledge across disciplinary areas (integrative thinking).
4. Apply knowledge in a global environment.

Goal 2: Students will be effective communicators.

Objectives: MBA students will:

1. Demonstrate an ability to effectively communicate in a manner that is typically required of a business professional.

Goal 3: Students will appreciate the importance of ethical/corporate social responsibility principles.

Objectives: MBA students will:

1. Identify and explain alternative approaches to ethical/corporate social responsibility issues.

Admission Prerequisites

Master of Business Administration

- Mathematics admission prerequisite

MSE in Industrial and Systems Engineering

- Completion of a bachelor of science degree in engineering, a physical science, computer science, or applied mathematics
- A course in Probability and Statistics equivalent to IMSE 510
- A course in Operations Research equivalent to IMSE 500

Ph.D. in Industrial and Systems Engineering

About the Program

The Ph.D. Industrial and Systems Engineering (I&SE) program provides educational opportunities for talented students to acquire the advanced knowledge needed to become creative researchers as well as technical leaders and technology innovators in industrial and systems engineering.

This Ph.D. (I&SE) program of the Rackham Graduate School of the University of Michigan-Ann Arbor is located, administered, and offered by UM-Dearborn. The program observes the standards for admissions, registration, degree requirements, awarding of degrees, and other administrative policies and regulations established by the Executive Board of the Rackham Graduate School.

Program Description:

The Ph.D. (I&SE) program offers concentrations in integrated design and manufacturing, decision science and operations research, and human factors and ergonomics.

The program requires the core, concentration, and cognate coursework; qualifying and dissertation proposal examinations; a written dissertation; and an oral defense of the dissertation. The Ph.D. (I&SE) degree is offered for exceptional students who have completed, with distinction, **a bachelor's or master's degree** in engineering, applied mathematics, computer science, physical sciences, or closely related fields.

Specific **coursework requirements** for students depending on their admission options are as follows:

1. Students admitted with a **relevant bachelor's degree** must complete no fewer than **36** credit hours of coursework, of which a minimum of **18** credits must satisfy the core (breadth) and concentration (depth) coursework requirements of the Ph.D. (I&SE) curriculum. The remaining **18** credits must be from the existing MSE (I&SE) curriculum.
2. Students admitted with **relevant prior MS degrees earned in a Rackham program or at UM-Dearborn**, must complete no fewer than **6** credit hours of coursework from the approved Ph.D. (I&SE) curriculum.
3. Students admitted with a **relevant master's degree** acquired outside the University of Michigan system must complete no fewer than **18** credit hours of coursework from the approved Ph.D. (I&SE) curriculum.
4. All students must complete a minimum of **24** credit hours of a Ph.D. dissertation.

The completed coursework for all students must satisfy the core (breadth), concentration (depth), and cognate requirements of the Ph.D. (I&SE) program. This may require greater than the minimum number of credit hours.

The Ph.D. (I&SE) is composed of five major milestones, which all students are required to pass successfully before graduation:

- Filing an approved plan of study
- Completion of the required coursework with a minimum GPA of 3.3
- Passing the qualifying examination on the core coursework
- Advancement to candidacy
- Passing the dissertation proposal examination
- Completion of required dissertation research credit hours
- Successful oral defense of an approved written dissertation

Students Admitted with a Bachelor's

Students in this group must complete no fewer than **36** credit hours of coursework, of which a minimum of **18** credits must satisfy the core (breadth) and concentration (depth) coursework requirements of the approved Ph.D. (I&SE) curriculum. Students of this group are expected to become candidates in the **third** year and are strongly encouraged to complete the degree within **five** years. These students ordinarily complete the requirements for the MSE (I&SE) degree along the way and may receive this degree in addition to the Ph.D. A master's thesis is optional. MSE (I&SE) degree is the only master's degree that students of this group may receive in addition to the Ph.D. (I&SE).

Advancement to Candidacy and Time Limits

Students of this group should achieve candidacy within **three** years from the time of initial enrollment in the program. To achieve candidacy, a student is required to:

- Complete the required coursework
- Pass the qualifying examination by the end of the **fourth** semester in the program
- Complete ENGR 700 including RCRS training workshops
- Submit the candidacy application form
- Post a minimum cumulative GPA of 3.3 out of 4 at the time of applying for the candidacy

A student should apply for candidacy as soon as they meet all the candidacy requirements. If it has been more than **three** years since the student started the program, a Petition for Modification or Waiver of Regulation asking for an extension for time to candidacy approved by the Ph.D. (I&SE) program committee is required.

Students Admitted with a Master's earned from Rackham Program or at UM-Dearborn

Students in this group must complete no fewer than **6** credit hours of coursework from the approved Ph.D. (I&SE) curriculum. The completed coursework must satisfy the core (breadth), concentration (depth), and cognate requirements of the Ph.D. (I&SE) program.

Students Admitted with a Master's earned from Outside of the University of Michigan System

Students in this group must complete no fewer than **18** credit hours of coursework from the approved Ph.D. (I&SE) curriculum. The completed

coursework must satisfy the core (breadth), concentration (depth), and cognate requirements of the Ph.D. (I&SE) program.

Advancement to Candidacy and Time Limits

Students admitted with a relevant Master's should achieve candidacy within **two** years from the time of initial enrollment in the program and are strongly encouraged to complete the degree within four years. To achieve candidacy, a student is required to:

- Complete the required coursework
- Pass the qualifying examination by the end of the **third** semester in the program
- Complete ENGR 700 including RCRS training workshops
- Submit the candidacy application form
- Post a minimum cumulative GPA of 3.3 out of 4 at the time of applying for the candidacy

A student should apply for candidacy as soon as they meet all the candidacy requirements. If it has been more than **two** years since the student started the program, a Petition for Modification or Waiver of Regulation asking for an extension for time to candidacy approved by the Ph.D. (I&SE) program committee is required.

Post Candidacy Registration Requirements

Candidates must register for the IMSE 990 Dissertation course each fall and winter until completion of all degree requirements.

Curriculum

Satisfactory Progress Requirements

Only letter-graded courses at the 500+ level count toward the degree. Courses completed with a grade lower than B or a "U" grade are not accepted.

To advance to candidacy, the cumulative coursework GPA (Grade Point Average) must be 3.3 or above on the 4.0-scale.

Coursework Requirement

Breadth Requirement

The breadth requirement is satisfied by a student taking three core courses (9 credit hours) in the program. The minimum grade for breadth requirement courses is B.

Depth Requirement

Students must select at least three courses (9 credit hours) from the same concentration area. The minimum grade for depth requirement courses is B.

Approved Program Courses

Code	Title	Credit Hours
A. Core Courses (select three courses, 9 credit hours)		
IMSE 505	Optimization	3
IMSE 514	Multivariate Statistics	3
IMSE 548	Res.Meth.Human Fctrs/Ergonomic	3
IMSE 581	Prod & Oper Engineering II	3

Code	Title	Credit Hours
B. Concentration Areas and Courses (Select 9 credit hours from one Concentration Area 1, 2 or 3. 0:9 credits of concentration area courses are required depending on the student's individual background. Students should consult with their advisor.)		
Area 1. Integrated Design and Manufacturing (Select 3 courses)		
IMSE 511	Design and Analysis of Exp	3
IMSE 519	Quan Meth in Quality Engin	3
IMSE 559	System Simulation	3
IMSE 561	Tot Qual Mgmt and Six Sigma	3
IMSE 567	Reliability Analysis	3
IMSE 538	Intelligent Manufacturing	3
IMSE 5655	Supply Chain Management	3
IMSE 586	Big Data Aanal & Visuliztn	3
IMSE 580	Prod & Oper Engineering I	3
EMGT 580	Mgt of Prod and Proc Design	3
AENG 589	Auto Assembly Systems	3
IMSE 605	Advanced Optimization	3
IMSE 606	Advanced Stochastic Processes	3

Code	Title	Credit Hours
Area 2. Operations Research and Decision Science (Select 3 courses)		
IMSE 5205	Eng Risk-Benefit Analysis	3
IMSE 5215	Program Budget, Cost Est & Con	3
IMSE 5655	Supply Chain Management	3
IMSE 559	System Simulation	3
IMSE 581	Prod & Oper Engineering II	3
IMSE 586	Big Data Aanal & Visuliztn	3
IMSE 605	Advanced Optimization	3
IMSE 606	Advanced Stochastic Processes	3

Code	Title	Credit Hours
Area 3. Human Factors and Ergonomics (Select 3 courses)		
HCDE 510	Foundation of HCDE	3
IMSE 501	Human Factors & Ergonomics	3
IMSE 511	Design and Analysis of Exp	3
IMSE 543	Industrial Ergonomics	3
IMSE 545	Vehicle Ergonomics I	3
IMSE 546	Safety Engineering	3
IMSE 577	Human-Computer Interaction	3
IMSE 586	Big Data Aanal & Visuliztn	3
IMSE 593	Vehicle Package Engineering	3

Cognate Requirement

At least 4 credit hours of coursework must be outside the industrial and systems engineering area. See the Cognate section below for ways to satisfy this requirement. A list of cognate course is provided in the approved program courses section.

Cognate Courses

Code	Title	Credit Hours
Computer and Information Science		
CIS 505	Algorithm Analysis and Design	3
CIS 536	Text Mining and Information Retrieval	3
CIS 550	Object-Oriented Programming and Its Applications	3
CIS 556	Database Systems	3
CIS 571	Web Services	3
CIS 579	Artificial Intelligence	3
CIS 652	Advanced Information Visualization and Virtualization	3
Electrical and Computer Engineering		
ECE 531	Intelligent Vehicle Systems	3
ECE 533	Active Automotive Safety Sys	3
ECE 537	Data Mining	3
ECE 542	Intr to Pwr Mgmt & Reliability	3
ECE 552	Fuzzy Systems	3
ECE 579	Intelligent Systems	3
ECE 5831	Pat Rec & Neural Netwks	3
ECE 644	Advanced Robotics	3
ECE 679	Adv Intelligent Sys	3
Mechanical Engineering		
ME 552	Sustainable Energy Systems	3
ME 565	Mechatronics	3
ME 567	Reliability Consid in Design	3
ME 580	Advanced Engineering Materials	3
ME 584	Mechanical Behavior of Polymer	3
Mathematics and Statistics		
MATH 520	Stochastic Processes	3
MATH 525	Statistical Inference	3
MATH 562	Mathematical Modeling	3
MATH 583	Discrete Optimization	3
MATH 584	Applied&Algorithmic Graph Thy	3
MATH 592	Introduction to Topology	3
STAT 535	Data Analysis and Modeling	3
STAT 530	Applied Regression Analysis	3
Psychology		
PSYC 530	Psychology in the Workplace	3
PSYC 548	Psychological Assessment I	4
PSYC 563	Sensation and Perception	3
PSYC 561	Learning and Memory	3
PSYC 565	Ind&Grp Tech in Cln Hlth Psyc	3

Required Seminar Courses

ENGR 700 Ph.D. Research Methodology Seminar

This course provides doctoral students with the fundamental training for conducting high-level scholarly research used in the various fields of engineering. Topics include evaluation of information resources, intellectual property, writing for journals and dissertation, effective work with scientific literature, literature review, plagiarism, publication, bibliographic management, and library resources. Students also complete the Responsible Conduct of Research (RCR) and Scholarship Training workshops. Additionally, students appointed as GSIs are required to attend the approved GSI training workshop.

The course is required for all doctoral students in the first year of enrollment and prior to taking the qualifying exam. Students must register for two semesters of ENGR 700 (one Fall semester and one Winter semester). Passing is based on participation and attendance. The seminars will carry no credit hours.

Cognate Requirement

The IMSE department recognizes the value of intellectual breadth in graduate education and the importance of formal graduate study in areas beyond the student's field of specialization. The student can satisfy the Ph.D. (I&SE) program cognate requirement in one of the following ways:

- Completion of at least four hours of approved cognate credits, which must be from outside the IMSE department. The minimum acceptable grade for a cognate course is a B. The list of approved cognate courses can be found in the Approved Program courses section.
- Completion of a University of Michigan master's degree that included a cognate component. This coursework must be completed no more than five (5) years before admission to the Ph.D. (I&SE) program.
- Completion of a relevant master's degree from another university that had coursework that meets the expectation of the program cognate requirement. This coursework must be completed no more than five (5) years before admission to the Ph.D. (I&SE) program. These courses do not apply toward the minimum 18 credit hours in residence at UM-Dearborn required for the degree and do not appear on the university transcript.

Qualifying Exam

The purpose of the qualifying examination is to assist both the department and the student in determining whether a student can be expected to perform at a sufficiently high level in advanced coursework and research to complete the requirements for the degree. To appear in the qualifying exam the student must (1) complete related Core area coursework and (2) post a minimum cumulative GPA of 3.3 out of 4 at the time of applying for the exam

The examinations are given twice a year, once in the fall and once in the winter. The qualifying examination is composed of the following.

- A student must take one three-hour written qualifying examination covering the material in three core courses taken in the program.
- Each one-hour portion of the examination covers material from one of three core courses taken in the program: (1) Optimization (coverage of IMSE 505), (2) Applied Probability and Statistics (coverage of IMSE 514), (3) Production (coverage of IMSE 581), and (4) Ergonomics (coverage of IMSE 548).

Dissertation Proposal Requirements: The dissertation proposal examination requires

- Achieving Candidacy
- Identify a research advisor and agree on an appropriate topic
- Submit and defend a proposal for the doctoral research content

The examination must be completed within a year of passing the qualifying examination.

Dissertation and Oral Defense: The dissertation examination requires the following:

- Passing the dissertation proposal examination
- Completion of required dissertation research credit hours
- Conduction an original research
- Submission of a written dissertation
- A Pre-Defense meeting
- An Oral Defense of an approved written dissertation

The dissertation defense may not be scheduled in the same academic term as the dissertation proposal examination.

The Ph.D. (I&SE) program has a limit of 7 years. Students are expected to complete the degree within five years of achieving candidacy, but no more than seven years from the date of the first enrollment in the Ph.D. I&SE program.

Forming the Dissertation Committee

The composition of a dissertation committee adheres to the Rackham guidelines (see the Rackham dissertation handbook).

- The dissertation committee will consist of four members, including at least three tenure-track members (appointment as Professor, Associate Professor, or Assistant Professor) of the instructional faculty affiliated with a Rackham doctoral program.
- The student's dissertation advisor, who must be a member of the graduate faculty of the department, will serve as chair or co-chair.
- Of the additional members, two must hold at least 50% appointment as tenured or tenure-track faculty of the Department of Industrial and Manufacturing Systems Engineering, with at least one being a member of the IMSE graduate faculty.
- The third committee member (cognate member) must be from outside the department: a faculty member with at least 50% appointment from a Rackham Doctoral program other than Ph.D. (I&SE).
- The composition of the dissertation committee must be approved by the Ph.D. program committee and requires Rackham approval.
- A committee may have a sole chair or two co-chairs. By special arrangement, retired faculty members who were affiliated with a Rackham doctoral program or research professors may serve as sole chairs. Persons who may serve as co-chair, but not the sole chair, include:
  - tenure or tenure-track members of the University's instructional faculty who are not affiliated with a Rackham doctoral program;
  - research faculty;
  - instructors and lecturers;
  - similarly qualified University faculty or staff, or person from outside the University; and
  - former University faculty members who have moved to a faculty position at another university.

In the cases when it is justified by the nature of the student's research and by approval of the program committee, the dissertation work can be co-supervised by two co-chairs. Both co-chairs must hold at least 50 percent appointments as tenured or tenure-track faculty. One of them must be a member of the graduate faculty of the IMSE department. The other can be from the IMSE department or a department other than IMSE.

Dissertation Proposal and Dissertation Research

Please refer to the Path to Degree (https://umdearborn.edu/cecs/graduate-programs/path-degree/) **for the policies, procedures, and forms for the dissertation committee, dissertation proposal, dissertation, and final oral defense.**

Dissertation Proposal Examination

The main objective of the dissertation proposal examination is to ensure sufficient strength and feasibility of the proposed research topic, as well as the suitability of the student's background and skills regarding the topic.

The examination consists of a written dissertation proposal and its open-to-the-public presentation by the student. The examination is conducted by the dissertation committee. As a rule, the dissertation committee continues overseeing the student's work to the stage of the final dissertation defense.

Dissertation

After passing the dissertation proposal examination, the student may proceed with the dissertation research and the writing of the dissertation. The dissertation should document the original contributions made by the candidate as a result of independent research. This research work should be of archival quality. In advance of graduation, all members of the student's dissertation committee must approve the dissertation. To obtain this approval a student must submit a written copy of the dissertation to the dissertation committee and defend the research work at a final oral examination open to other faculty, students, and the interested public. Students must be registered for IMSE 990 the full spring/summer term if defending the dissertation after May during the spring/summer term.

The dissertation must strictly follow the Rackham Graduate School Dissertation guidelines as described in the Dissertation Handbook Guidelines for copyrighting, publishing and distributing, dissertation embargo and distribution limitations.

Students are expected to complete the degree within two years of passing the dissertation proposal exam, but no more than seven years from the date of the first enrollment in the Ph.D. I&SE program. The Ph.D. I&SE committee conducts annual reviews to evaluate progress toward degree completion. Students defending the dissertation must be registered in the 990 Dissertation Research course.

Dissertation Research Requirement

- At least 24 credit hours of doctoral research credit must be completed before graduation.
  - Students who have completed the coursework requirements but have not reached the candidacy status should register for IMSE 980 (Pre-Candidacy Dissertation Research). A maximum of 12 credits may be completed in IMSE 980 Pre-Candidacy course.
  - Students who have **achieved candidacy** should register for **8 credits in IMSE 990** (Doctoral Dissertation Research).

Note that the actual completion of the dissertation project is likely to take several years at full-time enrollment and, thus, require more than the minimum number of credit hours.

Final Oral Defense

Upon completion of the dissertation work, the student initiates the last step toward the degree—the dissertation defense process. The process follows the official guidelines and consists of the following main stages:

1. Preparation of a written dissertation formatted in accordance with the guidelines,
2. Pre-Defense meetings with the members of the program committee,
3. Written evaluations of the dissertation by the dissertation committee members presented to the Ph.D. program committee,
4. The Oral Defense of the dissertation consisting of two parts:
   - Public seminar and open question session held by the student
   - Private deliberations by the committee,
5. Final oral examination report and certificate of approval prepared by the dissertation committee and submitted to the Ph.D. program committee.
6. Post-Defense meeting with the CECS Graduate Education Office

Learning Goals

Industrial & Systems Engineering MSE Goals

1. Provide students with the requisite knowledge and skills that enable them to design, install and manage large integrated engineering and service systems.
2. Provide students with analytical skills that allow them to evaluate and improve large integrated engineering and service systems.
3. Provide students access to modern engineering tools that enable them to solve complex industrial and systems engineering problems.

IMSE 500 Models of Oper Research 3 Credit Hours
The method of mathematical modeling and its application to decision-making problems in organizations. Some widely used models and techniques: linear programming, queuing, inventory, and simulation.
Restriction(s):
Can enroll if Class is Graduate

IMSE 501 Human Factors & Ergonomics 3 Credit Hours
The analysis and prediction of human performance in industrial and other man-machine systems using work sampling, time-motion analysis, synthetic and standard time study, and learning curves, in the design of such systems. Lecture and laboratory. Cannot receive credit for both IMSE 442, and IMSE 501. This class may be scheduled at the same time as the undergraduate course IMSE 442. Graduate students will be required to do additional research paper and/or project.
Prerequisite(s): IMSE 317* or IMSE 510*
Restriction(s):
Can enroll if Class is Post-baccalaureate NCFD or Graduate

IMSE 5010 Fundamentals of Program Mgt 3 Credit Hours
An overview of the project/program management framework and knowledge areas including plan development and execution; management of scope, time, cost, quality, human resource, communications, risk, and procurement. Typical program phases and life cycles observed in defense, construction, automobile, and software industries. Program organizational structures, program management processes, international project management, role of software tools for program management, product development, applications of Lean Product Development techniques, cutting waste and lead time in program management.
Prerequisite(s): IMSE 510
Restriction(s):
Can enroll if Class is Post-baccalaureate NCFD or Graduate
Can enroll if College is Business

IMSE 502 Computer-Integrated Mfg 3 Credit Hours
This course provides basic knowledge of elements in Computer-Integrated Manufacturing Systems, with particular emphasis on Computer-Aided Design (CAD), Computer-Aided Manufacturing (CAM), Computer-Aided Process Planning (CAPP), materials handling, and information flow in manufacturing systems. Hands-on experiments and course projects are required. Two lecture hours and three laboratory hours. Credit cannot be given for both IMSE 483 and IMSE 502. This class may be scheduled at the same time as the undergraduate course IMSE 483. Graduate students will be required to do additional research paper and/or project.
Restriction(s):
Can enroll if Class is Post-baccalaureate NCFD or Graduate

IMSE 503 Computer-Aided M/C & Tool Desg 3 Credit Hours
Study of the fundamentals of machine tool design, cutting tools, metal forming dies, and jig fixtures for practical applications in machining and assembly. Principles of design for manufacture and assembly as applied to tool and machine design. Laboratory exercise and projects are required using computer-aided design software. Two lecture hours and three laboratory hours. Credit cannot be given for both IMSE 484 and IMSE 503. This class may be scheduled at the same time as the undergraduate course IMSE 484. Graduate students will be required to do additional research paper and/or project.
Prerequisite(s): IMSE 382 or ME 381
Restriction(s):
Can enroll if Class is Post-baccalaureate NCFD or Graduate

IMSE 504 Metal Forming Processes 3 Credit Hours
This course focus is on fundamentals of metal forming processes; mechanics of metal forming; formability of manufacture; and economic aspect of the process. Emphasis is placed on analysis of bulk and sheet metal forming processes as applied to practical cases such as automobile manufacturing. Laboratory and course project are required. Credit cannot be given for both IMSE 488 and IMSE 504. This class may be scheduled at the same time as the undergraduate course IMSE 488. Graduate students will be required to do additional research paper and/or project.
Prerequisite(s): IMSE 382 or IMSE 381
Restriction(s):
Can enroll if Class is Post-baccalaureate NCFD or Graduate

IMSE 505 Optimization 3 Credit Hours
Theory of linear and nonlinear programming. Language multipliers and Kuhn-Tucker conditions. Convex programming. Combinatorial and integer programming. Dynamics programming. Heuristic and search optimization techniques. Theory and emphasis on applications using various computer codes.
Prerequisite(s): IMSE 300 or IMSE 500

IMSE 507 Industrial Robots 3 Credit Hours
The course introduces the fundamentals of robotics technology, programming and their applications in industrial environment. The emphasis will be on robotics anatomy and configurations, robotics kinematics, end effectors, use of sensors in robotics, robotics programming, design of robot workcell, robotics applications to production problems, cost justifications and robotics safety, rather than on the extensive theory of robotics. A term project is required. (F).

IMSE 510 Probability & Statistical Mod 3 Credit Hours
Review of basic concepts in probability and statistics. Multivariate distributions. Estimation and order statistics. General hypothesis testing, and non-parametric tests. Linear, multiple-linear, and nonlinear regression models. Analysis of variance.Introduction to the design of experiments.
Prerequisite(s): IMSE 317

IMSE 511 Design and Analysis of Exp 3 Credit Hours
One factor, two factor, and multifactor experiments. Fixed random and mixed models. Blocked confounding, incomplete blocks, factorial experiments, fractional factorial experiments. Introduction to response surface analysis.
Prerequisite(s): IMSE 510

IMSE 512 Taguchi Method of Quality Eng 3 Credit Hours
Quality engineering methodology developed by Genichi Taguchi. Design and analysis of experiments using orthogonal arrays and linear graphs. Accumulation analysis for categorized data. Signal-to-noise ratio as a measure of quality characteristics. Simulation using orthogonal arrays. Parameter design for reducing variability around the target without cost increase. Tolerance design for reducing variability with minimum cost increase. Evaluation and improvement of measurement.
Prerequisite(s): IMSE 510

IMSE 513 Robust Design 3 Credit Hours
Students will learn models and methods in the context of overall strategies to empirically study the design of products and manufacturing processes to reduce variability and to reduce sensitivity to parameter variation. Topics include: process capability studies and measures, basic DOE concepts, factorial experiments, evaluating sources of variation, evolutionary operation and adaptive statistical process control.
Prerequisite(s): IMSE 510

IMSE 514 Multivariate Statistics 3 Credit Hours
Linear statistical models used in simple and multiple regression, and analysis of variation. Principles and techniques of principle component analysis are studied and applied to business and engineering problems using statistical computer software. (YR)
Prerequisite(s): IMSE 510

IMSE 515 Fundamentals of Program Mgt 3 Credit Hours
An overview of the project/program management framework and knowledge areas including plan development and execution, scope management, time management, cost management, quality management, human resource management, communications management, risk management, and procurement management. Typical Program Phases and Life Cycles observed in Defense, Construction, Automobile, and Software Industries. Program Organizational Structures, Program Management Processes, and International Project Management are covered. Role of software tools for Program Management and Product Development are discussed. Applications of Lean Product Development Techniques are considered. Cutting waste and lead time in program management are covered. Case studies are used extensively throughout the course.
Prerequisite(s): IMSE 510
Restriction(s):
Can enroll if Level is Rackham or Professional Development or Graduate

IMSE 516 Project Management and Control 3 Credit Hours
Project Planning, Scheduling, and Controlling functions are discussed in detail including work breakdown structure, CPM and PERT methods, resource allocation and leveling techniques, cost control and minimization, trade-off analysis, learning curves overlapping relationships and concurrent engineering, multiple project execution and optimization. Applications of Lean Techniques in program management are discussed as well as the role of IT in accelerating the product development and reducing the program time. The importance of integrating the Supply Chain in the Product Development is also considered. Case studies and project management software are used throughout the course.
Prerequisite(s): IMSE 510
Restriction(s):
Can enroll if Level is Rackham or Professional Development or Graduate

IMSE 517 Managing Global Programs 3 Credit Hours
This course focuses on some of the central strategic and organizational problems that arise in managing global programs, including cultural conflicts, developing and managing international managers, global and local brands, and organizing to resolve global-local conflicts. The course uses a combination of case studies, problems, lectures and discussion, over a wide variety of companies and countries.
Prerequisite(s): IMSE 515
Restriction(s):
Can enroll if Level is Rackham or Professional Development or Graduate

IMSE 519 Quan Meth in Quality Engin 3 Credit Hours
This course introduces the advanced quantitative and analytical methods used in quality measurement, prediction, control and improvement. The topics include sampling design and plan, control charts, statistical quality control, time series, process capability analysis and quality cost analysis. Quality related topics in robust and tolerance design are also included.
Prerequisite(s): IMSE 510
Restriction(s):
Can enroll if Level is Doctorate or Rackham or Graduate or

IMSE 520 Managerial Decision Analysis 3 Credit Hours
Normative decision analysis, decisions, structures, and trees. Utility theory, game theory, and statistical decision theory are introduced. Applications of the theories to management studies in capital investment, bidding, purchasing, and risk analysis are discussed.
Prerequisite(s): IMSE 510

IMSE 5205 Eng Risk-Benefit Analysis 3 Credit Hours
Analysis risk assessment, decision and cost-benefit analysis, and fault-tree methods for describing and making decisions about societal risks associated with large engineering projects. Balancing risks and benefits in situations involving human safety, environmental risks, and financial uncertainties. Presentations of major risk assessment and the public decision processed associated with them.
Prerequisite(s): IMSE 510
Restriction(s):
Can enroll if Class is Post-baccalaureate NCFD or Graduate
Can enroll if College is Business

IMSE 521 Mfg Cost Estimation & Control 3 Credit Hours
In this course, concepts of strategic costing in product development and manufacturing are introduced. Engineering economy techniques are used in the study of life cycle cost elements. Equipment acquisition and replacement justification methods under risk and uncertainty are presented.
Restriction(s):
Can enroll if Class is Graduate

IMSE 5215 Program Budget, Cost Est & Con 3 Credit Hours
This course focuses on cost estimation and control for program managers and engineers. The course introduces a systematic approach for applying engineering economy techniques in cost estimating, resource planning, cost planning, cost management and control, and the study of life cycle cost elements. An introduction to decisions under risk and uncertainty as well as an introduction to project crashing are also presented.
Prerequisite(s): IMSE 510
Restriction(s):
Can enroll if Class is Post-baccalaureate NCFD or Graduate
Can enroll if Level is Doctorate or Rackham or Graduate or Professional Development
Can enroll if College is Engineering and Computer Science or Business

IMSE 533 Manufacturing Systems 3 Credit Hours
This course introduces methodologies and tools for modeling, design and operations planning of manufacturing systems. Topics include introduction to integrated manufacturing systems, manufacturing system and data modeling methodologies, process planning, group technology, manufacturing system layout, scheduling, push and pull production systems. Industrial case studies are presented and discussed.
Restriction(s):
Can enroll if Class is Graduate

IMSE 536 Machinery Diagnostics 3 Credit Hours
Introduction to diagnostic system design. Fundamentals of mechanical vibration and noise. Vibration-generating sources in machinery. Sensing and data acquisition methods. Data interpretation by statistical and spectral analysis methods. Fault classifications methods. Computer implementation.
Prerequisite(s): IMSE 510
Restriction(s):
Can enroll if Class is Graduate

IMSE 537 Metal Machining Processes 3 Credit Hours
Detailed study of the principles of conventional and non-traditional metal removing processes, machine tools accuracy, cutting fluids, and cutting tools. The course emphasis will be on the mechanics of metal cutting, machining processes, cutting tool materials and tool geometry, selection of cutting conditions, planning for machining and optimization of manufacturing process. Role of numerical control in improving machining process and productivity of manufacturing system.
Prerequisite(s): ME 381 or IMSE 382 or AENG 587

IMSE 538 Intelligent Manufacturing 3 Credit Hours
A comprehensive and integrated approach to topics associated with the science of artificial intelligence and their role in today's manufacturing environments. Design and management issues including information systems in an automated and integrated manufacturing environment.
Prerequisite(s): IMSE 317
Restriction(s):
Can enroll if Class is Graduate

IMSE 543 Industrial Ergonomics 3 Credit Hours
Effective ergonomic interventions in industrial environment enhance productivity, safety and job satisfaction. This course introduces engineers and engineering students how to apply ergonomic principles in designing industrial and manufacturing operations in which people play a significant role, so that human capabilities are maximized, physical fatigue is minimized, and performance is optimized. Case studies and topics emphasize industrial applications. (OC).
Prerequisite(s): IMSE 4425
Restriction(s):
Can enroll if Class is Graduate

IMSE 544 Industrial Biomechanics 3 Credit Hours
This course introduces the mechanical behavior of the musculoskeletal systems as related to physical work activities. Fundamentals of human body mechanics (Kinetic and Kinematic aspects of locomotion, body link systems, muscle strength and performance), muscle fatigue and musculoskeletal injury mechanism are covered with application to design of physical work activities and equipment. (OC).
Prerequisite(s): IMSE 4425
Restriction(s):
Can enroll if Class is Post-baccalaureate NCFD or Graduate

IMSE 545 Vehicle Ergonomics I 3 Credit Hours
Overview of drive characteristics, capabilities, and limitations. Human variability and driver demographics, driver performance measurements. Driver information processing models, driver errors and response time. Driver sensory capabilities: vision, audition, and other inputs. Vehicle controls and displays. Driver anthropometry, biomechanical considerations.
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate
Can enroll if College is Engineering and Computer Science

IMSE 546 Safety Engineering 3 Credit Hours
Safety requirements for production processes, equipment, and plants; organization and administration of safety programs, current safety laws, current occupational safety research.
Restriction(s):
Can enroll if Level is Graduate

IMSE 548 Res.Meth.Human Fctrs/Ergonomic 3 Credit Hours
Full Course Titile: Research Methods in Human Factors and Erogonomics -This course covers principals and guidelines of Human Factors and Ergonomics (HFE) practices applied to complex human machine systems. The emphasis is on understanding advanced HFE assessment and surveillance methods in describing and quantifying human-machine-environment interaction. Key topics include, human modeling and simulation, information processing and related motor behavior, and egronomics design and evaluation tools. (W).
Prerequisite(s): IMSE 4425 or IMSE 501

IMSE 549 Product Design and Evaluation 3 Credit Hours
Design approaches and processes used in developing customer/user-oriented products. Study of widely used product evaluation techniques: methods of observation, communication and experimentation; subjective (e.g., psychological scaling) and objective measurement methods. Review of product design and evaluation case studies. Laboratory projects to evaluate several products. (OC).
Restriction(s):
Can enroll if Level is Graduate

IMSE 550 Data Management 3 Credit Hours
Topics in computer organization; principle data structures (stacks, trees, linked lists) and their use; searching and sorting; algorithm specification, and recursion. Programming assignments will deal with applications of these subjects.

IMSE 551 Compiler Construction 3 Credit Hours
The design and construction of compilers and programming systems. Lexical scan; parsing techniques; code generation and optimization; storage allocation. Applications of formal language theory in compiler design. Translator writing systems; XPL.
Prerequisite(s): IMSE 550

IMSE 552 Design/Analysis of Algorithms 3 Credit Hours
Design, evaluation, and communication of algorithms for solving problems using a digital computer. Topics include problem-solving approaches, algorithm notation, determination of algorithm correctness, measures of efficiency, improvement of algorithms. Examples and homework in designing algorithms for data processing, scheduling, combinatorial optimization, and elementary computer graphics, and numerical analysis.
Prerequisite(s): IMSE 550

IMSE 553 Software Engineering 3 Credit Hours
Program design methodologies; control flow and data flow in programs; program measurement. Software life cycle; large program design, development, testing, and maintenance. Software reliability and fault tolerance. Evolution dynamics of software.
Restriction(s):
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if College is Engineering and Computer Science
Can enroll if Major is Software Engineering, Computer & Information Science, Info Systems and Technology,

IMSE 555 Decision Support/Expert Sys 3 Credit Hours
Decision support process and decision support systems, development tools, executive support systems, expert systems and their development processes, expert shells, integration of decision support and expert systems.
Prerequisite(s): IMSE 350

IMSE 556 Database Systems 3 Credit Hours
Introduction to database system concepts and techniques. Topics covered include: database environment, ER model, relational data model, object-oriented databases, object-relational databases, database design theory and methodology, database languages, query processing and optimization, concurrency control, database recovery, and database security. No credit given to both CIS 421 and CIS 556.
Restriction(s):
Cannot enroll if Class is
Can enroll if Level is Rackham or Graduate or Doctorate or
Can enroll if Major is Software Engineering, Data Science, Info Systems and Technology, , Computer & Information Science

IMSE 5585 Electronic Commerce 3 Credit Hours
This course examines how new information technologies and networks affect the exchange of goods and services between buyers and sellers in firms. What are economics of different electronic commerce models for firms? The course combines critical evaluation of business strategies with hands-on experience in building supporting electronic commerce systems utilizing electronic data interchange (EDI) software. (YR).
Restriction(s):
Can enroll if Class is Post-baccalaureate Cert only or Post-baccalaureate NCFD or Graduate

IMSE 559 System Simulation 3 Credit Hours
The modeling and simulation of discrete-change, continuous-change and combined-change stochastic systems. Conducting simulation studies using contemporary software such as SLAM II or random number generation, distribution sampling, and output analysis. Comparisons with analytical queuing models.
Prerequisite(s): IMSE 510

IMSE 561 Tot Qual Mgmt and Six Sigma 3 Credit Hours
This course covers implementing Total Quality Management (TQM), undertaking Six Sigma Projects, and applying Baldrige National Quality Award criteria and ISO 9000 principles to improve quality performances in an organization. Topics include Definitions and Importance of Quality, Quality Costs, Quality Function Deployment (QFD), Product Specification and Critical-to-quality Measures (CQM), Statistical Quality Control (SQC), Robustness Concepts, Quality System Design and Evaluation. Six Sigma and DMAIC Methodologies, Design for Six Sigma (DFSS) process, IDOV (Identity requirements, Design alternatives, Optimize the design and Verify process capability) Methodology, and several other concepts and tools related to quality are also covered.
Prerequisite(s): IMSE 510
Restriction(s):
Can enroll if Class is Graduate

IMSE 564 Applied Data Analytics and Modeling for Enterprise Systems 3 Credit Hours
This course explores the theory, practice and application of data analytics to consolidate, arrange, analyze and model vast amount of data for organizations which supports forecasting and prediction of future events. In-depth studies and hands on exercises will be covered in Data Warehousing, Business Intelligence for ERP systems, Data Mining, Predictive Analysis, Provisioning and Modeling of In-memory Analytics system. Various software tools, such as SAP HANA Cloud Analytics, Lumira and Modeling Software, will be introduced and used in this class. (W).
Restriction(s):
Can enroll if Class is Post-baccalaureate Cert only or Post-baccalaureate NCFD or Graduate

IMSE 5655 Supply Chain Management 3 Credit Hours
This course will address theories, concepts, models, methodologies and techniques for managing a supply chain. Topics include supply chain strategy, drivers and metrics of performance, designing global and regional supply chain networks using optimization models, planning demand and supply in a supply chain using forecasting, aggregate planning, and inventory optimization models, designing the transportation systems, pricing, and employing IT systems effectively in supply chains.
Restriction(s):
Can enroll if Class is Post-baccalaureate Cert only or Post-baccalaureate NCFD or Graduate

IMSE 567 Reliability Analysis 3 Credit Hours
Statistics of reliability and life testing. Application of stochastic models for failure based on Poisson and related processes. Use of exponential and extreme value distribution in reliability. Use of Markov process in the areas of equipment reliability, maintenance and availability.
Prerequisite(s): IMSE 510

IMSE 569 Sys Simulation in Auto Engin 3 Credit Hours
The modeling and simulation of discrete, continuous and combined change stochastic systems. Conducting simulation studies using contemporary software such as ARENA and WITNESS. Topics in simulation methodology include random number generation, distribution sampling, input and output analysis. Integration techniques for continuous simulation, application to design of manufacturing and automotive systems.
Prerequisite(s): IMSE 510

IMSE 570 Enterprise Information Systems 3 Credit Hours
The purpose of this course is to provide a foundation for the analysis, design and implementation of enterprise information systems. Topics include systems and organization theories, and information systems planning and evaluation. Students will be also introduced to various systems development life cycle phases of an enterprise information system. Students will acquire an understanding of the flow of information (forecasts, financial, accounting and operational data) within an enterprise and the factors that should be considered in designing an integrated enterprise information system. This includes all systems in the business cycle from revenue forecasts, production planning, inventory management, logistics, manufacturing, accounts payable, sales, accounts receivable, payroll, general ledger and report generation. Specifications for some of these systems will be developed utilizing ERP software such as SAP R/3 application development software suite. (F, W).
Restriction(s):
Cannot enroll if Class is

IMSE 5715 Modeling of Int Info Syst 3 Credit Hours
A review of approaches for modeling of integrated information systems. ARIS architecture. Data, control, function, and organization views of an information system.Requirements definition, design specification, and implementation definition of the different views. Process chain diagrams. Management of ERP projects. (YR).
Restriction(s):
Can enroll if Class is Post-baccalaureate Cert only or Post-baccalaureate NCFD or Graduate

IMSE 5725 Object Oriented System Design 3 Credit Hours
Students will be introduced to fundamental concepts and methods of object oriented design and development. Topics that will be covered include object oriented database concepts, data models, schema design (conceptual schemas and physical schemas), query languages, physical storage of objects and indexes on objects, version management, schema evolution and systems issues such as concurrent control and recovery from failure. For application programming, a programming language such as C++ will be used for database design and query language. (YR).
Restriction(s):
Can enroll if Class is Post-baccalaureate Cert only or Post-baccalaureate NCFD or Graduate

IMSE 5755 Bus Proc Int using Entrpr Tech 3 Credit Hours
Full Title: Business Process Integration using Enterprise Technology
This course introduces the concept of integration, optimization and configuration of strategic business processes across the enterprise using ERP software technology. Use cases and specifications for some of these systems are introduced in different functional areas, such as Finance, Human Capital Management, Logistics, and Project Systems utilizing ERP software. (F)
Restriction(s):
Can enroll if Level is Rackham or Graduate

IMSE 577 Human-Computer Interaction 3 Credit Hours
Full Course Title: Human-Computer Interaction for UI and UX Design -This course introduces current theory and design techniques concerning how user interfaces (UI) and user experience (UX) should be designed and assessed to be easy to learn and use. Course includes flowing general modules introduction of HCI & UX; Interface/Interaction design strategy; Advanced Issues in HCI; and Evaluation methods. (W).
Restriction(s):
Can enroll if Class is Graduate
Can enroll if Level is Doctorate or Rackham or Graduate or

IMSE 580 Prod & Oper Engineering I 3 Credit Hours
Production and operations management techniques including forecasting, inventory control, MRP, detailed scheduling, aggregate planning, process variability and its effects on throughput and inventory, factory physics principles, and lean methods.
Prerequisite(s): EMGT 505
Restriction(s):
Can enroll if Level is Rackham or Graduate

IMSE 581 Prod & Oper Engineering II 3 Credit Hours
This course addresses the advanced theory and techniques of production and inventory systems. Topics include advanced forecasting methods, production scheduling and lot-sizing, stochastic single-and multi-item inventory systems, and service operations. This course also includes discussions of research articles on production and inventory systems.
Prerequisite(s): IMSE 580 or EMGT 520

IMSE 5825 Industrial Controls 3 Credit Hours
This course introduces the principle aspects of computers and their applications in systems control, principles of automation, with emphasis on manufacturing industries. Discussion on the hardware and software associated with this task and other topics such as integrated systems modeling, sensor technologies, digital and analog signal processing and control, and information communication are also included. Laboratory exercises and projects are required. Credit cannot be given for both IMSE 482 and IMSE 5825. This class may be scheduled at the same time as the undergraduate course IMSE 482. Graduate students will be required to do additional research paper and/or project.
Prerequisite(s): ECE 305
Restriction(s):
Can enroll if Class is Post-baccalaureate NCFD or Graduate

IMSE 584 Logistical Systems 3 Credit Hours
Introduction to concepts of physical distribution and logistics management. Quantitative treatment of topics in materials management, transportation, forecasting, warehouse location. Logistical system design techniques which synthesize the above topics in order to design a fundamental system.
Prerequisite(s): IMSE 580

IMSE 585 Material Handling Systems 3 Credit Hours
Studies of material handling methods and equipment, study of techniques used in the analysis and design of material handling systems, study of storage and warehousing systems.
Prerequisite(s): IMSE 500

IMSE 586 Big Data Aanal & Visuliztn 3 Credit Hours
Introduction to big data analytics and visualization. This course provides students with hands-on experience of using analytical and predictive modeling techniques and software for practical applications. Topics include data visualization principles and techniques, data processing and manipulation, and statistical learning methods such as linear regression, classification, model selection, clustering, principal components analysis, and time-series analysis. (F).
Prerequisite(s): IMSE 510
Corequisite(s): IMSE 510

IMSE 587 Facilities Planning 3 Credit Hours
Analysis, planning and design of physical facilities utilizing operations research, engineering and economic principles. Synthesis of physical plant equipment and man into an integrated system for either service or manufacturing activities. Design of material handling systems. Students are required to select problems of interest and present design project reports. Credit may not be given for both IMSE 474 and IMSE 587. This class may be scheduled at the same time as the undergraduate course IMSE 474. Graduate students will be required to do additional research paper and/or project.
Prerequisite(s): IMSE 500

IMSE 588 Bldg High Perf Learning Org 3 Credit Hours
The purpose of this course is to develop students' knowledge and skills to explore and experience how the disciplines of systems thinking, personal mastery, mental models, team learning and shared vision impact on organizational learning and influence management practices for building highly performing organizations.

IMSE 590 Grad Study in Sel Topics I 1 to 3 Credit Hours
Individual or group of selected topics in industrial and systems engineering.
Restriction(s):
Can enroll if Class is Graduate

IMSE 591 Grad Study in Sel Topics II 1 to 3 Credit Hours
Continuation of IMSE 590.
Restriction(s):
Can enroll if Class is Graduate

IMSE 593 Vehicle Package Engineering 3 Credit Hours
Vehicle package specifications related to exterior and interior design reference points, dimensions and curb loadings. Benchmarking package studies, ergonomic tools and design practices used in the automobile industry. Driver positioning considerations; seat height, heel points, hip points, steering wheel location, seat pan, and back angles. Pedal design issues, gear shift positioning. Visibility of instrument panel space. Armrest and console design considerations. Principles and considerations in selecting and location types and characteristics of controls and displays on instrument panels, doors, consoles, and headers. Engine compartment packaging issues. Perception of interior spaciousness and visibility of the road over cowl and hood. (F).
Restriction(s):
Can enroll if Class is Graduate

IMSE 600 Research in IMSE 1 to 3 Credit Hours
Individual or group study or research in a field of interest to the student. Topics may be chosen from any of the areas of industrial and systems engineering. The student will submit a project report and give an oral presentation at the close of the term.
Restriction(s):
Can enroll if Class is Graduate

IMSE 605 Advanced Optimization 3 Credit Hours
This course will cover selected advanced optimization methods for engineering disciplines and information systems. Topics include nonlinear programming, network optimization, dynamic programming and optimal control. Theories related to optimality and convergence, population-based optimization, etc. will be covered. Students will be expected to write computer program code to implement optimization methodologies.
Prerequisite(s): IMSE 500
Restriction(s):
Can enroll if Class is Graduate
Can enroll if Level is Doctorate or Rackham or Graduate or

IMSE 606 Advanced Stochastic Processes 3 Credit Hours
This course introduces the theory and applications of discrete and continuous stochastic processes and models. The topics include Poisson process, renewal theory, discrete-time and continuous-time Markov chains, martingales, random walks, and Brownian motion. Other Markov processes with applications to queuing, simulation, and operations research in manufacturing and service systems will also be covered.
Prerequisite(s): IMSE 510
Restriction(s):
Can enroll if Level is Doctorate or Rackham or Graduate or
Can enroll if College is Engineering and Computer Science

IMSE 610 Adv Top Enterprise Info Sys 3 Credit Hours
This course introduces advanced topics in the development, management and improvement of information systems in the context of supporting large enterprises. It covers emerging issues and solutions in modeling, IT infrastructure and technologies, critical enterprise functions, knowledge engineering, security and governance of enterprise information systems. It focuses on the changing requirements posed by the dynamics of their residing environment and information technology.
Prerequisite(s): IMSE 5715
Restriction(s):
Can enroll if Class is Graduate
Can enroll if Level is Doctorate or Rackham or Graduate or

IMSE 699 Master's Thesis Project 1 to 6 Credit Hours
Graduate students electing this course, while working under the general supervision of a member of the department faculty, are expected to plan and conduct the work themselves, to submit a thesis for review and approval, and to present an oral defense of the thesis.
Restriction(s):
Can enroll if Class is Graduate

IMSE 791 Advanced Guided Study for Doctoral Students 1 to 6 Credit Hours
Independent study and research work on the material related to the doctoral research project under the guidance of the faculty advisor. The course is for doctoral students who have not completed the PhD program's coursework requirements. A report and an oral presentation are required. (F, W, S).

IMSE 980 Ph.D. diss research precand 1 to 9 Credit Hours
Full Title: Ph.D. dissertation research pre-candidate Dissertation research by a pre-candidate student of the Ph.D. in Industrial and Systems Engineering (I&SE) Program conducted under guidance of the faculty advisor. The credits earned in this dissertation research course count towards (fulfil) 24 credit hours of dissertation research requirements of the Ph.D. I&SE program. (F,W,S)
Restriction(s):
Can enroll if Level is Doctorate or
Can enroll if Major is Industrial & Systems Engin

IMSE 990 PHD Dis Research Cand 1 to 12 Credit Hours
Full Title: Ph.D. dissertation research candidate Dissertation research by a candidate student of the Ph.D. in Industrial and Systems Engineering Program conducted under guidance of the faculty advisor. (F,W,S)
Restriction(s):
Can enroll if Level is Doctorate or
Can enroll if Major is Industrial & Systems Engin

*An asterisk denotes that a course may be taken concurrently.

Frequency of Offering

The following abbreviations are used to denote the frequency of offering: (F) fall term; (W) winter term; (S) summer term; (F, W) fall and winter terms; (YR) once a year; (AY) alternating years; (OC) offered occasionally