

Oregon State University
School of Mechanical, Industrial, and Manufacturing
Engineering

Industrial and Manufacturing Engineering Graduate Programs, Policies, and Procedures Manual

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Industrial and Manufacturing Engineering

Combining two major branches of engineering, Industrial and Manufacturing Engineering (IME) uses knowledge from the physical, information, and human sciences and applies engineering methods to design, implement, operate, and improve systems that produce and deliver high quality goods and services. Such systems include

- manufacturing systems;
- land, sea, and air transportation systems;
- communication systems;
- information acquisition, storage, retrieval, and distribution systems;
- power generation and distribution systems;
- health care systems;
- financial systems;
- government systems;
- military systems; and
- other complex technological systems.

IME uses engineering methods and in particular *systems engineering* methods to develop, implement and operate production and delivery systems. Systems engineering involves

- **definition** of system requirements through system and function analysis;
- **design** of the system to develop one or more alternative designs;
- **implementation** of the system in simulated, prototype, or operational form;
- **operation** of the system at the highest possible levels of performance;
- **evaluation** of the system to identify and quantify its strengths and weaknesses; and
- **improvement** of the system, through systematic, iterative refinement.

The Oregon State University (OSU) School of Mechanical, Industrial, and Manufacturing Engineering (MIME) offers graduate programs in IME that can prepare you for a variety of challenging and rewarding positions, including the following.

- Industrial Engineer
- Manufacturing Engineer
- Quality Engineer
- Plant Manager
- Systems Analyst
- Systems Engineer
- Engineering Program Manager
- Human Factors Engineer
- Ergonomist
- Chief Financial Officer
- Chief Information Officer
- Chief Executive Officer
- Professor
- Chief Scientist

Graduates of our M.S. and Ph.D. programs have gone on to work for the following organizations.

- American Airlines
- BankAmerica Corporation
- Boeing
- Deloitte Touche
- Freightliner
- Hewlett-Packard
- Household Credit Services
- IBM
- Intel
- Lockheed-Martin
- LSI Logic
- Naval Sea Systems Command, US Navy
- Petroleum Industry Division, Thailand
- Precision Interconnect
- Sabre Consulting SEH America
- Sun Microsystems
- Tektronix
- Wacker Siltronic
- Wafertech
- California Polytechnic Institute
- Dankook University, Korea
- Kasetsart University, Thailand
- King Fahd University of Petroleum & Minerals
- Sharif University of Technology, Iran
- and many others

Graduate Programs

The Oregon State University School of Mechanical, Industrial, and Manufacturing Engineering offers Master of Engineering (M.Eng), Master of Science (M.S.), and Doctor of Philosophy (Ph.D.) studies in IME in four Areas of Concentration, described in the following sections.

- **Manufacturing Systems Engineering**
- **Nano/Micro Fabrication**
- **Information Systems Engineering**
- **Human Systems Engineering**

Manufacturing Systems Engineering

Manufacturing Systems Engineering (MSE) focuses on the use of design, analysis, and technology to create efficient systems capable of producing highly reliable and economically competitive products by employing resources such as material, labor, machine tools, and computing equipment. Graduate studies in MSE cover Operations Research, Computer Integrated Manufacturing, Simulation, and Statistical Quality Engineering.

- **Operations Research (OR)** emphasizes the development of quantitative models and appropriate solution techniques for solving complex decision problems in manufacturing systems. OR may be applied to a variety of problems, including those in planning, design, scheduling, and layout.
- **Computer Integrated Manufacturing (CIM)** incorporates the computer as an integral means to improve the efficiency of the manufacturing system. Among the possible CIM applications are: the capture and analysis of process information; the design and control of processing systems; and the application of computer intelligence to improve various manufacturing processes.
- **Electronics Manufacturing (EMfg)** is focused on the application of engineering and manufacturing tools and methods to the development of electronic processes and products. EMfg covers processes and products associated with wafer manufacturing, semiconductor processing technologies, integrated circuit design, printed wiring board manufacturing, and surface mount technologies. In the context of electronics manufacturing, manufacturing topics such as statistical process control, environmental stewardship, design for manufacturability, supply chain management, production scheduling, and economic analysis are covered.
- **Environmentally Responsible Manufacturing (ERM)** is focused on the development of manufacturing processes and systems that do not have a deleterious effect on materials and energy reserves, reduce wastes, effluents, and pollutants, and protect human health and safety. ERM is supported by the development of modeling and analysis methodologies and tools, such as life cycle analysis, process input/output modeling, and design for environment methods.
- **Simulation** in MSE is the use of the computer to imitate the operation of manufacturing systems driven by discrete events. Simulation is used to understand and predict the behavior of systems whose interdependencies and complexity of operation precludes analytical analysis. It is frequently used to evaluate designs and re-engineer systems before implementation.
- **Statistical Quality Engineering (SQE)** is the development and implementation of statistical tools to design or improve the performance of processes and products.

Our MSE graduate faculty are

- **Toni Doolen** (EMfg),
- **Karl Haapala** (ERM)
- **David Kim** (OR, Simulation),
- **R. Logen Logendran** (OR, EMfg), and
- **David Porter**

Nano/Micro Fabrication

Nano/Micro Fabrication (NMF) comprises the integration of nanomaterial synthesis and microfabrication techniques with more conventional macro-scale manufacturing technologies for improving system performance in terms of yield, time, energy, and costs. In a broader sense, NMF involves the development of the materials, processes, and metrology necessary to economically produce systems with nano-scale and micro-scale dimensions. Research in NMF supports the interdisciplinary Microproducts Breakthrough Institute (MBI – see <http://www.pnl.gov/microproducts/>) and the Oregon Nanoscience and Microtechnologies Institute (ONAMI – see <http://www.onami.us/>) at OSU. The NMF concentration area is based in IME, but is interdisciplinary. NMF students utilize courses and laboratories from across the College of Engineering.

Graduate studies in NMF cover Nano/Micro Systems Development (NMSD) and Fabrication Science (FabS).

- **Nano/Micro Systems Development (NMSD).** Micro Energy and Chemical Systems (MECS) are systems of microchannel arrays which rely on embedded microchannel features to enhance heat and mass transfer for miniaturizing and improving control within energy, chemical, and biomedical systems. Many times in the development of these systems, novel processing methods must be innovated. MECS devices are generally developed using laminate (patterning, registration and bonding of thin sheets of material) and particulate (powder) processing platforms. Examples of process development efforts include powder injection molding, microlamination based on surface mount technology, and large-substrate thermal bonding based on differential thermal expansion. Examples of devices developed include microchannel heat pumps, cytosensors, fuel processors, biodiesel microreactors, and nanomaterial reactors.
- **Fabrication Science (FabS).** Effective process development requires an understanding of the physical and chemical phenomena influencing fabrication processes (e.g., thermal stress, solid state diffusion, crystal growth, etc.). As more is understood about fabrication processes, manufacturability rules can be established and computer-aided manufacturing engineering tools can be developed. Examples of analysis and modeling studies include effects of powder/binder systems on flow and compaction behavior in injection molds, effects of micromixer design on nanomaterial synthesis, and effects of bonding methods on microchannel pressure drop.

Our NMF graduate faculty are

- **Sundar Atre**, IME (NMSD, FabS)
- **Chih-hung “Alex” Chang**, Chemical Engineering (NMSD, FabS)
- **Karl Haapala**, IME (NMSD, FabS)
- **Brian Paul**, IME (NMSD, FabS)
- **Vince Remcho**, Chemistry (NMSD)
- **Bill Warnes**, Mechanical Engineering (FabS)

Information Systems Engineering

Information Systems Engineering (ISE) uses information to combine the technologies, people, processes, and organizational mechanisms for the purpose of improving organizational performance. Typical ISE technologies include database management systems, networks, wireless communications, automatic identification and data collection (e.g., bar codes, RFID, EDI), and web-enabled technologies. For the Industrial Engineer, the ISE option enables the student to apply these technologies to such applications as Supply Chain Engineering, Cost Management, Warehouse Management, Health Services Management, and Production Scheduling.

Our ISE graduate faculty are

- **Kenneth Funk**, and
- **David Porter**

Human Systems Engineering

Human Systems Engineering (HSE) uses engineering methods and knowledge from the physical, biological, information, social, and management sciences to develop, implement, operate, evaluate, and improve human-machine, human-human, and human-organization systems. Graduate studies in HSE cover Human Factors and Ergonomics, and Management Systems Engineering.

- **Human Factors and Ergonomics (HF&E)** apply scientific principles to develop systems in which people play significant roles as users, operators, and maintainers. To achieve high levels of system performance and human productivity, health, safety, and satisfaction, HF&E explicitly consider human sensory, perceptual, cognitive, and physical characteristics in the design of tools, equipment, workstations, and tasks for manufacturing, aerospace, health care, and other complex systems.
- **Management Systems Engineering (MgtSE)** focuses on the design of organizational and group systems, structures, and processes, utilizing an engineering design perspective. Organizational and group systems are composed of people, decision tools, and work processes, and MSE emphasizes the interactions among these components. MSE is a multi-disciplinary field and draws on the following areas: management and organizational behavior, macro ergonomics, organizational development, quality management, engineering management, and information systems.

Our HSE research faculty are

- **Toni Doolen** (MgtSE, HF&E), and
- **Kenneth Funk** (HF&E)

General Graduate Program Requirements

All of the requirements for the IME graduate program are *in addition to* requirements established by the OSU Graduate School. Consult the current OSU *Graduate Catalog* (available on the web at <http://osu.orst.edu/dept/gradcat/>) for Graduate School requirements.

Admission Requirements

The minimum admission requirements for the IME graduate program are as follows.

Prior Degree

To be admitted to the IME graduate program, a student must have earned an undergraduate or graduate degree in engineering, science, mathematics, or computer science.

Graduate Record Examination (GRE)

All Ph.D. applicants and any M.S. applicants who have not received an engineering degree from an ABET-accredited program should have earned scores on the Graduate Record Examination (GRE) of at least 720 (about 74th percentile) on the Quantitative section.

Grade Point Average (GPA)

To be admitted, a student must have earned a combined GPA of 3.00 on the last 90 quarter credit hours of graded course work including baccalaureate and post-baccalaureate course work.

Test of English as a Foreign Language (TOEFL)

For applicants whose native language is not English, a TOEFL score is required. A score of 550 (paper-based test, 213 on the computer-based test, or 80 on the internet-based test) and minimums of 55 (paper, about 22 computer,

about 18 internet) on each of the subscores are necessary for acceptance into the program. The English language proficiency requirement is waived for international students who have completed a degree at a U.S. university.

Course Preparation

A background in probability and statistics, linear algebra, computer programming, and engineering economics is required. However, an applicant who does not have adequate course preparation in one or more of these areas may be accepted to the program with the provision that he/she pass the courses specified below with a grade of B or better before completion of the second term of graduate study. Courses numbered 1xx, 2xx, 3xx, and 4xx do not carry graduate credit and may not be used on a graduate student's program of study.

Deficiency Area	Equivalent Courses at OSU
Probability and Statistics	ST 521 <i>and</i> ST 522 or ST 314
Linear Algebra	MTH 341
Computer Programming	CS 151
Engineering Economy	ENGR 390

A student's graduate committee (see below) may also require other remedial coursework.

Other Considerations

Please note that these criteria are the minimum requirements. Admission is on a competitive basis, and meeting the minimum requirements does not assure admission. We consider past academic performance, work experience, letters of recommendation, available faculty and facilities, and other pertinent factors in determining whether an applicant can be accommodated and is likely to be successful in the program.

Advising, Committees, and Meeting

Advising is provided by the student's graduate committee, and primarily by the major professor. The IME Graduate Committee Chair will act as initial advisor for all incoming graduate students until their permanent major professor is selected. It is the student's responsibility to select a permanent major professor and assemble a committee as soon as possible. MS students must assemble a committee and file a program of study (see below) before completing 18 credit hours at OSU. PhD students must file a program of study, approved by the graduate committee at a *formal meeting*, no later than the fifth term of enrollment in the PhD program. All students must begin discussions with prospective major and minor professors during their first term of enrollment.

An M.S. thesis committee consists of a major professor, another representative from the major field, a minor professor, and a Graduate Council representative assigned by the OSU Graduate School. An M.S. non-thesis committee consists of a major professor, another representative from the major field, and a minor professor. An M.Eng. committee consists of a major professor, another representative from the major field, and a minor professor. A Ph.D. committee consists of a major professor, a second graduate faculty member from the major area, one or more minor professors, and a Graduate Council representative assigned by the OSU Graduate School.

Programs of Study

A graduate program of study is a set of courses approved by the student's graduate committee and filed with the OSU Graduate School. It consists of a major area of study and one or more minor areas of study. The major area of study must be in one of the four IME areas of concentration described above. Each minor may be in one of the other areas of concentration or in an area of concentration outside IME (see the OSU *Graduate Catalog* for a complete list of concentration areas). In addition to the courses listed for the various programs (see below), the graduate committee and the School Director may require students to take courses deemed necessary to provide desirable academic skills upon graduation.

- IE 522 Industrial Optimization II
- IE 545 Human Factors Engineering
- or
- IE 570 Management Systems Engineering
- IE 552 Design of Industrial Experiments
- IE 563 Advanced Production Planning and Control¹
- IE 594 Research Methodology
- IE 603 Thesis (Dissertation)

4 credits

3 credits

3 credits

3 credits

36 or more credits

The major may include up to 12 credit hours of M.S. thesis.

- one or more minors of at least 18 credits each in other IME areas of concentration or in areas of concentration listed in the OSU *Graduate Catalog*.

Credits from the student's master's degree (including up to a maximum of 12 credits for the master's thesis) may be included in the major or a minor at the discretion of the student's graduate committee.

IME Majors and Minors

An IME graduate major must include the required courses listed above, plus the courses of one of the four areas of concentration listed below. An IME graduate minor must include the courses of one of the areas of concentration.

Manufacturing Systems Engineering Majors and Minors

A Manufacturing Systems Engineering major or minor must include

- all of the following courses:
 - IE 521 Industrial Systems Optimization I
 - or
 - IE 522 Industrial Systems Optimization II
 - IE 563 Advanced Production Planning and Control
- and enough courses from the following list to complete the credit requirements for the major or minor:
 - IE 512 Information Systems Engineering
 - IE 515 Simulation and Decision Support Systems
 - IE 536 Lean Manufacturing Systems Engineering
 - IE 537 Virtual and Automated Manufacturing Systems
 - IE 545 Human Factors Engineering
 - IE 564 Design and Scheduling of Cellular Manufacturing Systems
 - ME 515 Risk and Reliability Based Design (originally offered as ME 519)
 - ME 516 Complex System Design (originally offered as ME 519)
 - ME 517 Optimization in Design
 - any other graduate-level course related to MSE and approved by the MSE major or minor professor

3 credits

3 credits

3 credits

4 credits

4 credits

4 credits

4 credits

3 credits

3 credits

3 credits

4 credits

3 credits

Nano/Micro Fabrication Majors and Minors

A Nano/Micro Fabrication (NMF) major or minor must include²

- three of the following four core courses:
 - IE 531 Meso-scale Manufacturing
 - IE 532³ Microfabrication Technology

3 credits

3 credits

² A background in solid modeling is required (ENGR 248 available for no graduate credit).

³ ECE 511 (3 credits) may be substituted for this course if IE 532 is not offered. Also, ECE 518 (3 credits) may be substituted with ECE 518 instructor approval.

- IE 534 Ceramic Processing 3 credits
- IE 591 Polymer Processing 3 credits
- as many of the following background courses as needed:
 - ME 570 Structure-Property Relationships in Materials 3 credits
 - ME 580 Materials Selection 3 credits
 - ME 581 Thermodynamics 3 credits
 - ME 582 Kinetics 3 credits
 - ME 589 Introduction to Materials Science 3 credits
- Metals*
 - ME 587 Dislocations, Deformation, and Creep 3 credits
- Polymers*
 - ChE 545 Polymer Engineering and Science 4 credits
 - WSE 535 Polymer Synthesis and Structure 3 credits
- Semiconductors and Thin Films*
 - ME 571 Electronic Properties of Materials 3 credits
 - ECE 513⁴ Electronic Materials and Characterization 3 credits
- All nanomanufacturing students are strongly encouraged to consider the following:
 - ChE 540 Chemical Reactors I 4 credits
 - Chem 535 Structure Determination by Spectroscopic Methods 3 credits
 - Chem 548 Surface Chemistry 3 credits
 - BI 566 Electron Microscopy 3 credits
- All fabrication science students are strongly encouraged to consider the following:
 - ME 520 Applied Stress Analysis 3 credits
 - ME 523 Advanced Stress Analysis 3 credits
 - ME 524 Finite Element Modeling of Mechanical Engineering Systems 3 credits
 - ChE 514⁵ Fluid Flow 3 credits
 - ME 567 Engineering Applications of Computational Fluid Dynamics 3 credits
- and enough courses from the following list to complete the credit requirements for the major or minor:
 - IE 536 Lean Manufacturing Systems Engineering 4 credits
 - IE 537 Virtual and Automated Manufacturing Systems 4 credits
 - ChE 540 Chemical Reactors I 4 credits
 - ChE 544 Thin Film Materials Processing 3 credits
 - ChE 571 Electronic Materials Processing 3 credits
 - ECE 512 Process Integration 3 credits
 - ECE 582 Optical Electronic Systems 4 credits
 - ECE 599 Nanotechnology 3 credits
 - ME 544 Advanced Power Generation Systems 3 credits
 - ME 549 Micro-scale Energy Conversion (ENGR 332 prereq) 3 credits
 - ME 555 Experimental Techniques in Material Science 4 credits
 - ME 569 Micro-scale Fluid Dynamics (ENGR 331 prereq) 3 credits
 - ME 578 Thin Film Materials Characterization and Properties 3 credits
 - ME 584 Adv Fracture and Fatigue 4 credits
 - OC 528 Microprobe Analysis 3 credits
 - WSE 542 Composites Manufacturing 4 credits
 - WSE 530 Polymer Composites 3 credits
 - any other graduate-level course related to NMF and approved by the NMF major or minor professor

(ME 549 and 569 are selected topics courses that do not yet have permanent numbers. Please check the mechanical engineering offering each term to determine if it is appropriate.)

⁴ ECE 517 (3 credits) may be substituted for this course with ECE 517 instructor approval if ECE 513 is not offered.

⁵ ME 565 (3 credits) may be substituted for this course if ChE 514 is not offered.

Information Systems Engineering Majors and Minors

An Information Systems Engineering major or minor must include

- all of the following courses:
 - IE 511 Visual Programming for Industrial Applications 4 credits
 - IE 512 Information Systems Engineering 4 credits
 - IE 518 Telecommunication Concepts 3 credits
 - IE 519 Wireless Networks 3 credits
- and enough courses from the following list to complete the credit requirements for the major or minor:
 - IE 515 Simulation and Decision Support Systems 4 credits
 - IE 536 Lean Manufacturing Systems Engineering 4 credits
 - IE 537 Virtual and Automated Manufacturing Systems 4 credits
 - IE 545 Human Factors Engineering 3 credits
 - IE 563 Advanced Production Planning and Control 3 credits
 - IE 564 Design and Scheduling of Cellular Manufacturing Systems 3 credits
 - ME 516 Complex System Design (originally offered as ME 519) 4 credits
 - IE 571 Project Management in Engineering 3 credits
 - CS 552 User Interface Design 4 credits
 - CS 582 Object-Oriented Analysis and Programming 4 credits
 - any other graduate-level course related to ISE and approved by the ISE major or minor professor

Human Systems Engineering Majors and Minors

A Human Systems Engineering major or minor must include

- both of the following courses:
 - IE 545 Human Factors Engineering 4 credits
 - IE 570 Management Systems Engineering 4 credits
- at least one course from the following list:
 - IE 515 Simulation and Decision Support Systems 4 credits
 - IE 521 Industrial Optimization I 3 credits
 - IE 522 Industrial Optimization II 3 credits
- and enough courses from the following list to complete the credit requirements for the major or minor:
 - IE 546 Human-Machine Systems Engineering 3 credits
 - IE 548 Cognitive Engineering 3 credits
 - IE 571 Engineering Project Management 3 credits
 - IE 572 Communication and Team Building for Engineers 3 credits
 - BA 550 Organizational Theory and Behavior 4 credits
 - BA 565 Systems Thinking and Practice 4 credits
 - EXSS 512 Applied Motor Learning 3 credits
 - EXSS 525 Biomechanics of the Skeletal System 3 credits
 - EXSS 526 Biomechanical Analysis Techniques 3 credits
 - H 545 Occupational Health 3 credits
 - H 582 Problems and Research in Safety 3 credits
 - H 593 Transportation and Motor Fleet Safety 3 credits
 - H 596 The Process of Hazard Control 3 credits
 - ME 516 Complex System Design (originally offered as ME 519) 4 credits
 - PSY 340 Cognition (take as PSY 505) 3 credits
 - PSY 537 Motivation 3 credits
 - PSY 540 Cognition Research Methods 4 credits
 - PSY 542 Perception 3 credits
 - PSY 544 Learning and Memory 3 credits
 - PSY 596 Industrial and Organizational Psychology 3 credits
 - SOC 518 Qualitative Research Methods 3 credits
 - SOC 524 Social Psychology 3 credits
 - ST 531 Sampling Methods 3 credits

- any other graduate-level course related to HSE and approved by the HSE major or minor professor

Academic Performance

Grade Point Average

A graduate student is expected to maintain a GPA of 3.00 or above in all of the following:

- Each registered quarter.
- Each major or minor field in the program.
- Overall cumulative grade at Oregon State University.

Failing to meet these standards is considered grounds for termination of the student's program.

Satisfactory Progress

Satisfaction of the above grade point average requirements does not in itself constitute satisfactory progress toward a graduate degree. Besides maintaining a satisfactory GPA and satisfying the other requirements set forth in this document, every student must file a program of study with the OSU Graduate School in a timely manner and must satisfactorily complete all course and thesis work on that program of study in a reasonable period of time, nominally two years for the M.S. degree and five years for the Ph.D.

Review of Performance and Progress; Disciplinary Action

Each term the IME Graduate Faculty will review the performance and progress of each IME graduate student. If a student should fail to meet grade point or satisfactory performance standards, the Faculty will send the student a letter of notification. The student will then have two terms to meet grade point and satisfactory performance standards or be dismissed from the IME graduate program. If grade point average or progress falls below standards again, the student will be dismissed from the program.

Course Load

The maximum course load for a graduate student is sixteen credits per quarter. A student using any resource of the University must be registered for a least three credit hours for the term. A student should be enrolled for a reasonable number of credits sufficient to represent the use of University or School space, facilities, or faculty time. At the very least, this is three credits in any quarter the student uses University or School space, facilities, or faculty time.

Project Reports, Theses, and Dissertations

M.S. Research-in-lieu-of-thesis Report

Each M.S. non-thesis student must complete a project in fulfillment of the Graduate School's research-in-lieu-of-thesis requirement. This project must involve the application of industrial and manufacturing engineering knowledge and methods to a practical problem and must be documented with a final report. The project must be approved in advanced and supervised and graded by the major professor.

M.S. Thesis

A Master's thesis documents an original research contribution of the student or the novel application of existing industrial and manufacturing engineering knowledge to a practical problem. The research topic must be approved by the major professor and the research title must be registered with the Graduate School. In addition to the thesis, the candidate must prepare an article based on their research that is suitable for publication in a refereed journal or conference proceedings. The School Director may withhold signature from the final copy of the thesis until a draft

of the paper is presented. The paper should be co-authored with the major professor (and others that significantly contributed to the research).

Ph.D. Dissertation

A Ph.D. dissertation (also called a Ph.D. thesis) demonstrates the student's competence as a researcher and author. Though students are encouraged to talk with the faculty concerning the faculty's research interests, it is the responsibility of the student to identify a viable dissertation topic, and to prepare a proposal for review by the supervisory committee.

The research must result in a written dissertation that represents a significant, original contribution by the candidate to knowledge in the field of industrial and manufacturing engineering. In addition to the dissertation, the candidate must prepare an article based on their research, which is suitable for publication in a refereed journal. The target journal for the paper must be a peer-reviewed journal. The School Director may withhold signature from the final copy of the dissertation until a draft of the paper is presented. The paper should be co-authored with the major professor (and others that significantly contributed to the research).

Thesis and Dissertation Instructions

A title should be formulated as early as feasible and submitted on the Thesis Title Approval form, which is available from the Graduate School. This should be filed with the Graduate School at least one term before the final examination.

The final draft of the thesis must be typed and include the title page, approval page, abstract, all text, table of contents, lists of figures and tables, bibliography, and appendices. In addition, the text must include all figures, tables, and page numbers. The student must furnish copies of the thesis draft to all members of their committee including the Graduate Council Representative and one copy to the Graduate School at least two weeks prior to the exam.

Two final approved copies must be submitted to the School of MIME (one for the major professor and one for the school records) bound in accordance with the Graduate School requirements within six weeks of successfully completing the oral defense. Either the major professor or the School Director can withhold signature until such time as this requirement is met.

Meetings and Examinations

M.Eng. Final Examination

The final examination for M.Eng. is an oral examination administered by an examination committee composed of the major professor as its chairperson, another representative from the major field, and the minor professor. The objective of this examination is to ensure that student has an excellent understanding of industrial and manufacturing program concepts and practice.

M.S. Non-Thesis Final Examination

Each M.S. student selecting the non-thesis option must complete an oral final examination administered by an examination committee composed of the major professor as its chairperson, another representative from the major field, and the minor professor. The objective of this examination is to ensure that student has a solid understanding of industrial and manufacturing engineering concepts and practice. The research-in-lieu-of-thesis project (approved and supervised by the major professor) must be completed prior to the examination and a final project report must be written and copies distributed to all examination committee member at least one week prior to the examination. Up to one-half of the examination may be devoted to presentation of and examination over the project.

M.S. Thesis Final Examination

The final examination for the M.S. thesis option is an oral examination administered by an examination committee composed of the major professor as its chairperson, another representative from the major field, the minor professor, and a Graduate Council representative. This examination must be scheduled by the student through the Graduate School at least one week in advance. See the OSU *Graduate Catalog* for details. The exam must be announced at least one week in advance and scheduled to minimize conflict with the graduate courses offered by the school. All currently enrolled IME graduate students are strongly encouraged to attend the presentation phase of the final oral examination. A student may repeat the exam once with the approval of the student's committee.

Ph.D. Meetings and Examinations

Pursuing a Ph.D. in IME requires the completion of three milestones: 1) a preliminary examination, 2) a research proposal meeting, and 3) a dissertation defense. Each of these milestones is discussed in the sections below. The student is responsible for scheduling these meetings and examinations. Most must be scheduled through the Graduate School at least one week in advance (two weeks for the oral defense of the dissertation. See the OSU *Graduate Catalog* for details.

Ph.D. Preliminary Examination

In order to advance to the state of candidacy, each Ph.D. student must satisfactorily complete a preliminary examination conducted by the student's Ph.D. committee members. The purpose of the examination is to determine whether the student has the intelligence, motivation, and creativity necessary to complete the Ph.D. successfully. The examination will include a written portion, consisting of a set of questions from the student's committee members, and an associated oral examination during which the committee will question the student on the written responses and any other academic topic that they feel is appropriate. The preliminary examination shall be scheduled at the convenience of both the student and the committee and should occur after the majority of the course work on the student's Ph.D. program of study has been completed.

The student must make arrangements with their committee chairperson to schedule a five-week time period for the examination. The five-week period will be spent as follows:

- a) The period starts when the student submits a short research pre-proposal to their committee. This pre-proposal should be no more than five typed pages, and should include an area of interest and a suggested research topic, pertinent literature review, and a tentative plan for research completion. The student should realize that changes can be made to this topic and research plan at a later date. The pre-proposal must be approved by the candidate's advisor prior to submission to the committee.
- b) The committee will prepare written questions and submit them to the committee chairperson for collection by the student two weeks after submission of the research pre-proposal. The document provided by the student should be used to provide a context for the committee's questions. However, committee members have the discretion to ask questions related to the student's program of study, but unrelated to the student's pre-proposal. A committee member may decline to submit written questions.
- c) The student will have two weeks to develop written responses to the questions. The student shall submit their typed responses in the form of one complete bound document for each committee member to the IME office (COVL 118) by 5:00 p.m. exactly two weeks after receiving the questions. The IME office will expeditiously distribute the copies to the committee members.
- d) The committee will have at least one week to review the written responses to the examination and will then conduct an oral examination in accordance with Graduate School policy. It is the student's responsibility to schedule this exam through the Graduate School. The exam will be nominally two hours in length and should thoroughly cover the written responses and any other academic topic that the committee deems appropriate.
- e) The answers to the written examination will be evaluated as part of the oral examination. There will not be an evaluation of the written questions separate from the oral exam. The result of the Ph.D. Preliminary Examination will be either a pass, fail with permission to retake, or fail without permission to retake.

A student who passes the examination will be considered to be a candidate for the Ph.D. degree in Industrial Engineering. Should a student fail the examination, the committee will decide if and when a retake of the examination is possible. If the student fails the oral examination, then they will be required to repeat the written questions as well.

Ph.D. Research Proposal Meeting

After completing the Ph.D. preliminary examination, the Ph.D. candidate should work closely with their major professor (and committee members, as appropriate) to define a problem area and complete a final research proposal. At a minimum, this proposal should include an introduction, problem statement, literature review, and methodology.

After both the student and major professor agree that the research proposal is ready for distribution, the student must provide each committee member with a bound copy of the research proposal, and schedule a research proposal meeting (typically two hours in length) to defend the proposal. Committee members should have at least two weeks to read and review the proposal prior to the meeting.

A research proposal must be approved by the student's committee before the student may proceed with their research. Therefore, the possible results of this meeting are pass, request for minor revisions, and request for major revisions that would require a second research proposal meeting.

Ph.D. Dissertation Final Examination

The successful defense of the dissertation at a final oral examination represents the culmination of the research program and completion of the requirements for the degree of Doctor of Philosophy. The examination must be scheduled to minimize conflict with the graduate courses offered by the school, and must be scheduled by the student through the Graduate School and announced at least two weeks in advance. All currently enrolled graduate students are strongly encouraged to attend the presentation phase of the final oral examination.

Graduate Teaching Assistant and Graduate Research Assistant Appointments

The School of MIME offers a limited number of Graduate Teaching Assistant (GTA) and Graduate Research Assistant (GRA) appointments to qualified students. A graduate assistant appointment provides a tuition waiver and a monthly stipend that varies depending on job responsibilities and level of the appointment – typically 0.20 to 0.49 Full Time Equivalent (FTE). Students applying for the M.Eng. program are ineligible for any assistantships.

GTAs assist faculty in lectures, laboratories, grading, and other tasks associated with conducting a course. Qualifications for GTAs include a strong background in the topics of the courses that are the subject of the appointment and excellent English communication skills. A minimum TOEFL score of 570 is required to serve as a GTA. The graduate committee chairperson makes GTA appointment decisions and offers are usually made in January for positions starting in fall term. The maximum duration for GTA appointments is three terms. GTAs wishing to be funded more than three terms should make every effort to secure a GRA position.

GRAs assist graduate faculty in sponsored research projects, performing a wide variety of tasks ranging from data analysis and computer programming to co-authoring papers and planning research programs. Qualifications for GRAs vary widely depending on need but usually include strong analytical, design, and communication skills. Since GRA salaries are paid by sponsored research projects that do not necessarily follow the academic calendar, GRA opportunities may appear at any time. Individual graduate faculty members recruit and hire GRAs.

Masters graduate students accepting GTA or GRA appointments are required to complete a thesis. A GTA or GRA must take fifteen credits per term if appointed on a 0.20-0.29 FTE basis and twelve credits per term if the appointment is over 0.29 FTE. These credits may be composed of a combination of course work and/or non-graded thesis hours.

IME Graduate Faculty

	Research Interests	Contact Information
Sundar Atre	Advanced materials and manufacturing techniques for multiscale architectures, with applications in transport, energy, medical, communications and consumer sectors	324 Rogers Sundar.Atre@oregonstate.edu (541)-737-8272 http://mime.oregonstate.edu/people/faculty/ime/atre.html
Belinda Batten	Computational methods for control and optimization of distributed parameter systems, mathematical modeling, numerical analysis, dynamics and control of autonomous vehicles, bioinspired systems	208 Rogers bbatten@engr.orst.edu (541)737-9492 http://mime.oregonstate.edu/people/faculty/dynamics/bbatten.html
Toni Doolen	Manufacturing systems design, work group effectiveness, error management and error reduction, survey design and methodology, functional modeling, and non-experimental research design methodologies.	410 Rogers toni.doolen@oregonstate.edu (541) 737-5641 http://mime.oregonstate.edu/people/faculty/ime/doolen.html
Kenneth Funk	Human factors engineering, aviation human factors, human factors in health care, human-machine systems engineering, engineering psychology, philosophy of technology	212 Rogers ken.funk@oregonstate.edu (541) 737-2365 http://mime.oregonstate.edu/people/faculty/ime/funk.html
Karl Haapala	Sustainable design and manufacturing, life cycle engineering, manufacturing process modeling and analysis, nanomanufacturing.	312 Rogers Karl.Haapala@oregonstate.edu (541) 737-3122 http://mime.oregonstate.edu/people/faculty/ime/haapala.html
David Kim	Production system design and optimization, performance evaluation of production systems, alternative road pricing systems, discrete event dynamic systems, facility layout, applied operations research	424 Rogers david.kim@oregonstate.edu (541) 737-8858 http://mime.oregonstate.edu/people/faculty/ime/kim.html
R. Logen Logendran	Production planning and control, cellular manufacturing, group scheduling, routing and scheduling, facility layout, flexible manufacturing systems, integration of design and manufacturing, applied operations research	416 Rogers Logen.Logendran@oregonstate.edu (541) 737-5239 http://mime.oregonstate.edu/people/faculty/ime/logendran.html
Brian Paul	Process development for nano/micro fabrication (e.g microlamination, nanomaterials deposition), Development of highly-parallel microfluidic systems, Microreactor-assisted nanomaterial synthesis.	322 Rogers brian.paul@oregonstate.edu (541) 737-7320 (OSU) (541) 713-1332 (HP B11) http://mime.oregonstate.edu/people/faculty/ime/paul.html

	Research Interests	Contact Information
David Porter	Information systems engineering, wireless communications (http://ie.oregonstate.edu/mts/), intelligent transportation systems, automatic data collection, manufacturing systems, radio frequency identification (RFID) in the supply chain, supply chain management	420 Rogers david.porter@oregonstate.edu (541) 737-2446 http://mime.oregonstate.edu/people/faculty/ime/porter.html
John Shea	Process and quality improvement, economic analysis, engineering curriculum	113 Dearborn john.shea@oregonstate.edu (541) 737-2873 http://mime.oregonstate.edu/people/faculty/ime/sheah.html

Affiliated Research Faculty

	Research Interests	Contact Information
Chih-hung “Alex” Chang Chemical Engineering	Electronic materials (growth and characterization); Microfabrication (deposition); Chemical microreactor design; and Nanotechnology	301 Gleeson changch@che.orst.edu (541) 737-8548 http://cbee.oregonstate.edu/people/faculty/chang.html
Vince Remcho Chemistry College of Science	Mechanics of chemical separations, molecular recognition processes (aptamers, imprinted polymers); Porous monolithic sorbents; Microfluidic devices for analytical chemistry	249 Gilbert vincent.remcho@oregonstate.edu (541) 737-8181 http://chemistry.oregonstate.edu/remcho.html
Bill Warnes Mechanical Engineering	Intermetallics, Superconductors: microstructure/properties relationship; property measurement; and composite superconductors	303E Dearborn warnesw@engr.orst.edu (541) 737-7016 http://mime.oregonstate.edu/people/faculty/materials/warnes.html