

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

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

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School of Mechanical, Industrial, and Manufacturing
Engineering
204 Rogers Hall
Oregon State University
Corvallis, Oregon 97331-6001
USA

Phone: (541) 737-9191

Fax: (541) 737-2600

Website: <http://mime.oregonstate.edu/academics/grad/ie>

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

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

- | | |
|--------------------------------------|---|
| • American Airlines | • Sabre Consulting SEH America |
| • Bank of America | • Sandia National Laboratory |
| • Boeing | • Sun Microsystems |
| • Deloitte & Touche | • Tektronix |
| • Daimler Trucks North America | • Unilever |
| • General Electric | • Wacker Siltronic |
| • Hewlett-Packard | • Wafertech |
| • IBM | • California Polytechnic Institute |
| • Intel | • Dankook University, Korea |
| • Lockheed-Martin | • Kasetsart University, Thailand |
| • LSI Logic | • Sharif University of Technology, Iran |
| • Naval Sea Systems Command, US Navy | • and many others |
| • Precision Interconnect | |

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**
- **Advanced Manufacturing**
- **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.
- **Sustainable Manufacturing Systems (SMS)** is focused on the development of manufacturing systems that positively influence quality of life through foundational concepts, methods, and tools for the systemic and holistic assessment of economic, environmental, and social factors. SMS is supported by the development of modeling and analysis methodologies including systems thinking, life cycle assessment, life cycle costing, and other design for sustainable manufacturing 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.

Our MSE graduate faculty are

- **Javier Calvo** (SMS)
- **Toni Doolen** (EMfg)
- **Karl Haapala** (SMS)
- **David Kim** (OR, Simulation)
- **R. Logen Logendran** (OR, EMfg)
- **David Porter** (CIM), and
- **Hector Vergara** (OR)

Advanced Manufacturing

Advanced Manufacturing (AM) comprises the development of new materials and processing techniques and technologies for production of components, devices and systems over macro, meso and micro length-scales with

required operational performance in an economically, environmentally, and socially sustainable manner. Effective process development derives from an understanding of the physical and chemical phenomena influencing manufacturing processes. At the same time, bottom-up cost and material/energy flow estimating is required to evaluate the economics and environmental impacts of competing manufacturing routes. As more is understood about the needs for a particular product manufacturing process, associated manufacturing rules, tooling, and metrology are developed leading to positive process outcomes. Research in AM supports the interdisciplinary Microproducts Breakthrough Institute (MBI – see <http://mbi-online.org>) and the Oregon Nanoscience and Microtechnologies Institute (ONAMI – see <http://www.onami.us/>) at OSU. The AM concentration area is an interdisciplinary spread across IME and ME, and extends into Material Science, Chemical Engineering, and even Chemistry. AM students utilize courses and laboratories from across the College of Engineering. Graduate studies in AM include:

- **Nanomanufacturing** (Nano) differs from nanotechnology in that it controls matter at the scale of a nanometer *at high production rates*. Low cost routes to nanostructured surfaces and materials involve moving away from gas-phase processing to solution processing. Microchannel process technology (MPT) can enhance heat and mass transfer within solution processes leading to better process control. The utilization of the fundamentally different behavior of nanoparticles can lead to cheaper, faster and better manufacturing processes. Investigations include evaluating the effects of mixer design on nanoparticle size distribution during nanomaterial synthesis using computational fluid dynamics and examining low-temperature rapid printing of metallic and non-metallic nanoparticle inks.
- **Micromanufacturing** (Micro) processes are developed around microchannel lamination or powder processing platforms drawing on backgrounds in solid mechanics, fluid mechanics, heat transfer, thermodynamics and materials science. Examples of analysis and modeling studies include effects of powder/binder systems on flow and compaction behavior in injection molds, effects of device geometry and materials on the outcome of bonding processes, and length scaling effects in microforming.
- **Sustainable Manufacturing** (SM) is focused on the development of manufacturing processes that do not have a deleterious effect on materials and energy reserves, while reducing wastes, effluents, and pollutants, and protecting human health and safety. Advanced manufacturing comprises the development and application of novel processes for which economic, environmental, and social effects are often uncertain. Sustainable manufacturing research is supported by the development of process modeling and analysis methodologies and tools, such as life cycle assessment, process input/output modeling, and design for environment methods as well as the development of new energy-efficient manufacturing processes.
- **Process-Machine Interaction** (PMI) investigates the mechanics and physics of manufacturing processes, the performance, accuracy, and efficiency of manufacturing machines, and the interactions of the process mechanics and equipment performance. Research develops and applies computational methods for materials modeling, optimization of motion trajectories, and high performance motion control algorithms.

Our AM graduate faculty are

- **Roberto Albertani**, ME (Composites)
- **Sundar Atre**, IME (Nano/Micro)
- **Chih-hung “Alex” Chang**, Chemical Engineering (Nano)
- **Karl Haapala**, IME (SM/Nano/Micro)
- **Rajiv Malhotra**, ME (Nano/Micro)
- **Brian Paul**, IME (Nano/Micro)
- **Vince Remcho**, Chemistry (Nano)
- **Burak Sencer**, ME (PMI), and
- **Bill Warnes**, Materials Science

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**
- **David Porter, and**
- **Hector Vergara**

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

- **Javier Calvo** (MgtSE, HF&E)
- **Toni Doolen** (MgtSE, HF&E)
- **Chinweike Eseonu** (MgtSE) 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 740 (about

74th percentile) on the Quantitative section. Applicants with GRE test scores under the new system should have earned at least 158 (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. An applicant who does not have adequate course preparation in one or more of these areas, however, 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 or IE 212
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 (minimum of four members). An M.S. non-thesis committee consists of a major professor, another representative from the major field, and a minor professor (minimum of three members). An M.Eng. committee consists of a major professor, another representative from the major field, and a minor professor (minimum of three members). 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 (minimum of five members).

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 student's graduate committee and the IME Graduate Program Chair may require other courses deemed necessary to provide desirable academic skills upon graduation.

M.Eng. and M.S. Programs

M.Eng. Program

An M.Eng. program, based only on course work, consists of at least 45 graduate-level credits, as follows:

- a major of at least 30 credits in one of the IME areas of concentration. The major must also include the following courses:
 - IE 552 Design of Industrial Experiments 3 credits
 - IE 563 Advanced Production Planning and Control¹ 3 credits
- one minor of at least 15 credits in one of the other IME areas of concentration or another area of concentration listed in the OSU *Graduate Catalog*.

At least 30 credits must be IE courses.

M.S. Non-Thesis Program

An M.S. non-thesis program consists of at least 51 graduate-level credits, as follows:

- a major of at least 30 credits in one of the IME areas of concentration. The major must also include the following courses:
 - IE 552 Design of Industrial Experiments 3 credits
 - IE 563 Advanced Production Planning and Control¹ 3 credits
 - IE 506 Projects (research-in-lieu-of-thesis) 3 – 6 credits
- one minor of at least 15 credits in one of the other IME areas of concentration or another area of concentration listed in the OSU *Graduate Catalog*.

At least 30 credits must be IE courses.

M.S. Thesis Program

An M.S. thesis program consists of at least 45 graduate-level credits, as follows:

- a major of at least 30 credits in one of the IME areas of concentration. The major must also include the following courses:
 - IE 552 Design of Industrial Experiments 3 credits
 - IE 563 Advanced Production Planning and Control¹ 3 credits
 - IE 594 Research Methodology 3 credits
 - IE 503 Thesis 6 – 12 credits
- one minor of at least 15 credits in one of the other IME areas of concentration or another area of concentration listed in the OSU *Graduate Catalog*.

At least 30 credits must be IE courses.

¹ If your major or minor is NOT Manufacturing Systems Engineering (MSE) AND your BS degree is in IE, then you are not required to take IE 563. Everyone else must take IE 563.

Ph.D. Programs

A Ph.D. program consists of at least 108 credits *beyond the baccalaureate degree* and, as the IE Ph.D. is a multidisciplinary degree, a student's committee may require more than the minimum. Required coursework is as follows:

- a major of at least 75 credits in one of the IME areas of concentration. The major must also include the following courses:
 - IE 512 Information Systems Engineering 4 credits
 - IE 521 Industrial Optimization I 3 credits
 - or
 - IE 522 Industrial Optimization II 3 credits
 - IE 545 Human Factors Engineering 4 credits
 - or
 - IE 570 Management Systems Engineering 3 credits
 - IE 552 Design of Industrial Experiments 3 credits
 - IE 563 Advanced Production Planning and Control¹ 3 credits
 - IE 594 Research Methodology 3 credits
 - IE 603 Thesis (Dissertation) 36 or more creditsThe 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 3 credits
 - or
 - IE 522 Industrial Systems Optimization II 3 credits
 - IE 563 Advanced Production Planning and Control 3 credits
- enough courses from the following list to complete the credit requirements for the major or minor:
 - IE 512 Information Systems Engineering 4 credits
 - IE 515 Simulation and Decision Support Systems 4 credits
 - IE 536 Lean Manufacturing Systems Engineering 4 credits
 - IE 545 Human Factors Engineering 3 credits
 - IE 564 Design and Scheduling of Cellular Manufacturing Systems 3 credits
 - ME 515 Risk and Reliability Based Design (originally offered as ME 519) 3 credits
 - ME 516 Complex System Design (originally offered as ME 519) 4 credits
 - ME 517 Optimization in Design 3 credits
- and any other graduate-level course related to MSE and approved by the MSE major or minor professor

Advanced Manufacturing Majors and Minors

An Advanced Manufacturing (AM) major or minor must include²

- the following materials science course:
 - ME 570 Structure-Property Relationships in Materials 3 credits
- at least one of the following manufacturing process courses:
 - MFGE 531 Meso-scale Manufacturing 3 credits
 - MFGE 534 Ceramic Processing 3 credits
 - MFGE 538 Composites Manufacturing 4 credits
- at least one of the following manufacturing systems courses:
 - MFGE 535 Industrial Sustainability Analysis 3 credits
 - MFGE 536 Lean Manufacturing Systems Engineering 4 credits
- all nanomanufacturing students are strongly encouraged to consider the following:
 - ChE 514³ Fluid Flow 3 credits
 - ChE 517⁴ Instrumentation in Chemical, Bio and Env Engr 3 credits
 - ChE 581 Microreactor Engineering 3 credits
 - Ch 661 Separations 4 credits
- all micromanufacturing and PMI students are encouraged to consider the following:
 - ME 520 Applied Stress Analysis 4 credits
 - ME 524 Finite Element Modeling of Mechanical Engineering Systems 3 credits
 - ME 567 Engineering Applications of Computational Fluid Dynamics 3 credits
- enough courses from the following to complete the credit requirements for the major or minor:
 - Materials Processing*
 - ChE 544 Thin Film Materials Processing 3 credits
 - ECE 511⁵ Electronic Materials Processing 3 credits
 - ChE 571 Electronic Materials Processing 3 credits
 - ECE 582 Optical Electronic Systems 4 credits
 - ECE 599 Nanotechnology 3 credits
 - Materials Science*
 - ME 580 Materials Selection 3 credits
 - ME 581 Thermodynamics 3 credits
 - ME 582 Kinetics 3 credits
 - ME 555 Experimental Techniques in Material Science 4 credits
 - ME 578 Thin Film Materials Characterization and Properties 3 credits
 - ME 584 Advanced Fracture and Fatigue 4 credits
 - OC 528 Microprobe Analysis 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
 - Composites*
 - ME 583 Composite Materials 3 credits
 - WSE 530 Polymer Composites 3 credits
 - Semiconductors and Thin Films*
 - ME 571 Electronic Properties of Materials 3 credits

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

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

⁴ ME 555, BI 566, Ch 535, Ch 548 and Ch 660 all have elements of this course that could be used for substitution.

⁵ ECE 518 (3 credits) may be substituted with ECE 518 instructor approval.

- ECE 513⁶ Electronic Materials and Characterization 3 credits
- and any other graduate-level course related to AM and approved by the AM major or minor professor

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
- 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 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
 - CS 552 User Interface Design 4 credits
 - CS 582 Object-Oriented Analysis and Programming 4 credits
- and 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
- 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

⁶ ECE 517 (3 credits) may be substituted for this course with ECE 517 instructor approval if ECE 513 is not offered.

- 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
- and 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 advance 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 at least one article based on their research. The article should be suitable for publication in a refereed journal or conference proceedings. The School Head 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 student's graduate 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 at least one article based on their research, which is suitable for publication in a refereed (peer-reviewed) journal. The School Head 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

The final draft of the thesis must be typed according to the graduate school requirements. For a complete set of instructions, refer to the thesis guide at: <http://gradschool.oregonstate.edu/success/thesis-guide>. 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.

The final approved copy of the thesis must be submitted electronically to the Graduate School. In addition, 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 Head 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 (minimum of three members). The objective of this examination is to ensure that student has an excellent understanding of industrial and manufacturing engineering 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 (minimum of three members). This examination must be scheduled by the student through the Graduate School at least two weeks in advance. See the OSU Graduate School website (<http://gradschool.oregonstate.edu/success/exams-and-meetings>) for details. 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 members of the examination committee at least two weeks prior to the examination.

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 (minimum of four members). This examination must be scheduled by the student through the Graduate School at least two weeks in advance. See the OSU *Graduate School website* (<http://gradschool.oregonstate.edu/success/exams-and-meetings>) for details. The objective of this examination is to ensure that student has a solid understanding of industrial and manufacturing engineering concepts and practice. 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 public presentation phase of final oral examination. A student may repeat the exam once with the approval of the student's committee.

Ph.D. Meetings and Examinations

In addition to the Program of Study Meeting, 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. The oral preliminary examination and the dissertation defense must be scheduled through the Graduate School at least two weeks in advance See the OSU *Graduate School website* (<http://gradschool.oregonstate.edu/success/exams-and-meetings>) 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, creativity, and communication skills 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 single-spaced typed pages, excluding the list of references, 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 major professor 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 by 5:00 p.m. exactly two weeks after receiving the questions.
- 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. This meeting is not scheduled through the Graduate School,

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
Javier Calvo	Transition-phase management seen as a systemic process, applied systems thinking, engineering economic modeling, lean thinking, six sigma and biomass utilization.	410 Rogers Javier.Calvo@oregonstate.edu (541) 737-TBA http://mime.oregonstate.edu/people/faculty/ime/calvo.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.	229 Strand Agriculture toni.doolen@oregonstate.edu (541) 737-5974 http://mime.oregonstate.edu/people/faculty/ime/doolen.html
Chinweike Eseonu	Technical entrepreneurship, science and engineering policy (with focus on sustainability and entrepreneurship related policy), transportation system management, and process optimization.	406 Rogers chinweike.eseonu@oregonstate.edu (541) 737-0024 http://mime.oregonstate.edu/people/eseonu
Kenneth Funk	Human factors engineering applied to aviation, health care, and manufacturing, engineering psychology, engineering ethics, philosophy of technology	212 Rogers ken.funk@oregonstate.edu (541) 737-2357 http://mime.oregonstate.edu/people/faculty/ime/funk.html
Karl Haapala	Sustainable design and manufacturing, life cycle engineering, manufacturing process modeling, sustainable energy systems analysis, development and analysis of nano-assisted manufacturing processes.	312 Rogers Karl.Haapala@oregonstate.edu (541) 737-3122 http://mime.oregonstate.edu/people/faculty/ime/haapala.html
David Kim	Production system design, optimization, and performance evaluation, transportation system data collection, experimental design and data analysis, applied operations research, discrete event simulation.	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/logendran
Brian Paul	Process development for microchannel lamination, development of highly-parallel microfluidic systems for microreactor-assisted nanomaterial synthesis and deposition.	322 Rogers brian.paul@oregonstate.edu (541) 737-7320 (OSU) (541) 713-1332 (MBI) http://mime.oregonstate.edu/people/faculty/ime/paul.html

	Research Interests	Contact Information
David Porter	Information systems engineering, wireless communications (http://mime.oregonstate.edu/research/mtsl/), 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/she.html
Hector Vergara	Operations research applications in transportation, logistics and distribution, supply chain design and optimization, facility location, network design; manufacturing systems; data collection and decision support systems.	422 Rogers hector.vergara@oregonstate.edu (541) 737-0955 http://mime.oregonstate.edu/people/vergara

Affiliated Research Faculty

	Research Interests	Contact Information
Roberto Albertani Mechanical Engineering	Aerodynamics and stress analysis of flexible structures, environmental impact of wind energy, high-performance sailboats testing techniques, fiber composites technology, micro air vehicles, and biological flight mechanics.	412 Rogers Hall roberto.albertani@oregonstate.edu 541.737.7024 http://mime.oregonstate.edu/people/albertani
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
Rajiv Malhotra Mechanical Engineering	Micro-Macro process innovation; Multiphysics based manufacturing process modeling; Deformation based & Additive Manufacturing; Laser and Plasma based micro-manufacturing.	rajiv.malhotra@oregonstate.edu http://mime.oregonstate.edu/people/rajiv-malhotra
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
Burak Sencer Mechanical Engineering		
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