Department of Industrial and Management Systems Engineering

Degrees Offered

- Master of science in industrial engineering
- Master of science in engineering with a major in industrial engineering
- Master of science in industrial hygiene
- Master of science in safety management
- Doctor of philosophy with a major in industrial engineering
- Doctor of philosophy with a major in occupational safety and health

One of the defining attributes in the success of the department is the dedication and talent of its fifteen faculty and three staff members. The aggregate careers of our faculty and staff represent over 300 years of service to students at WVU. In these 300 years of service is embodied the wisdom and experience to successfully prepare industrial engineers and occupational health and safety professionals for the 21st century. The faculty and staff typically educate nearly 300 undergraduate, 100 to 120 M.S., and fifteen to twenty-five Ph.D. students. The department is in the unique position in the United States of having two complimentary graduate programs in industrial hygiene and safety accredited by the Applied Science Accreditation Commission (ASAC) of the Accreditation Board for Engineering and Technology (ABET). The combined resources and faculty talents of these two programs create synergies that provide our students with outstanding academic and research experiences in the field of occupational safety and health. Excellent academic and research opportunities are also available for students in the areas of operations research, decision sciences, manufacturing, and ergonomics.

Degree Programs

MASTERS OF SCIENCE IN INDUSTRIAL ENGINEERING AND MASTERS OF SCIENCE IN ENGINEERING WITH A MAJOR IN INDUSTRIAL ENGINEERING

A graduate of these master’s programs will be prepared to accomplish the following:

1. Practice industrial engineering and to initiate and develop leadership roles in business, industry and/or government
2. Continue professional development and life-long learning
3. Interact in society and business in a professional and ethical manner
4. Be proficient in written and oral communication and to utilize people-oriented skills in individual and team environments
5. Apply the skills from industrial engineering to be proficient in his/her chosen field or further advanced studies

In order to meet the educational objectives, students of these master’s programs must be able to meet the following educational outcomes at the time of their graduation. Students will have acquired:

1. The ability to use and master modern and classical industrial engineering methodologies in their area of concentration
2. The ability to apply knowledge of math, science, and engineering
3. The ability to do research, and to design and conduct experiments, analyze and interpret data, develop implementation strategies, and shape recommendations so that results will be achieved and findings will be communicated effectively
4. The ability to work individually, on teams, and/or on multi-disciplinary teams to identify, formulate, and solve problems using industrial engineering knowledge, skills, and tools
5. The ability to design and implement or improve integrated systems that include people, materials, information, equipment, and energy using appropriate analytical, computational, and experimental practices
6. An understanding of professional and ethical responsibility and the broad education and knowledge of contemporary issues necessary to understand the impact of solutions in a global and societal context
7. A recognition of the need for and an ability to engage in life-long learning
8. The professional characteristics expected of a successful industrial engineer

MASTERS OF SCIENCE IN INDUSTRIAL HYGIENE

A graduate of the Industrial Hygiene Masters program will be prepared to:

1. Practice Industrial Hygiene and to initiate and develop leadership roles in business, industry, and/or government.
2. Continue professional development and life-long learning.
3. Interact in society and business in a professional, ethical manner to promote occupational and environmental health.
4. Be proficient in written and oral communication and to utilize people-oriented skills in individual and team environments.
5. Apply the skills from Industrial Hygiene to be proficient in his or her chosen field or doctoral studies.

In order to meet the educational objectives of the Industrial Hygiene program, students must be able to meet the following educational outcomes at the time of their graduation:

1. An ability to use the techniques, skills, and modern scientific and technical tools necessary for professional practice such as:
   - Principles and methods of industrial hygiene
   - Principles and methods of ergonomics
   - Principles and methods of safety
   - Principles of environmental sciences (Environmental elective)
   - Principles of epidemiology and biostatistics
   - Principles and methods of control of physical and chemical hazards
2. The ability to apply knowledge of math, science, and Industrial Hygiene;
3. The ability to design and conduct experiments, analyze and interpret data, develop implementation strategies, and shape recommendations so that results will be achieved and findings will be communicated effectively;
4. The ability to work individually, in teams, and/or in multi-disciplinary teams to identify, formulate, and solve problems using Industrial Hygiene, safety, and ergonomics knowledge, skills, and tools;
5. An ability to formulate or design a system, process, or program to meet desired needs;
6. An understanding of professional and ethical responsibility and the broad education and a knowledge of contemporary issues necessary to understand the impact of solutions in a global and societal context;
7. A recognition of the need for and an ability to engage in life-long learning; and
8. The professional characteristics expected of a successful Industrial Hygienist.

MASTERS OF SCIENCE IN SAFETY MANAGEMENT

A graduate of the Safety Management Masters program will be able to:

1. Communicate effectively, orally and in writing, including the transmission of safety data to management and employees.
2. Demonstrate knowledge and skills in the area of safety management.
3. Demonstrate knowledge of ethical and professional responsibilities and knowledge of applicable legislation and regulations.
4. Demonstrate the ability to apply various research activities through the decision-making process used in safety management.

In order to meet the educational objectives of the Safety Management program, students must be able to meet the following educational outcomes at the time of their graduation:

1. Demonstrate knowledge and skills to build a comprehensive Safety and Health Program based on loss control and regulations.
2. Demonstrate knowledge and skills to use analytical techniques in the Safety and Health function.
3. Demonstrate knowledge and skills with federal, state, and non-governmental Safety and Health Program standards and best practices.
4. Demonstrate skills in communications, written and oral, at the level of professionals in safety and health positions.
5. Demonstrate knowledge and skills in writing and evaluating safety and health research proposals.
6. Demonstrate knowledge and skills in using management tools to implement and evaluate safety, hygiene, and environmental programs.

DOCTOR OF PHILOSOPHY WITH A MAJOR IN INDUSTRIAL ENGINEERING

A graduate of the Industrial Engineering doctoral program will be prepared to:

1. Practice/teach Industrial Engineering and to initiate and develop leadership roles in education, business, industry and/or government.
2. Continue professional development and life-long learning.
3. Interact in society and business in a professional and ethical manner.
4. Be proficient in written and oral communication and to utilize people-oriented skills in individual and team environments.
5. Apply the skills from Industrial Engineering to be proficient in his/her chosen field.

In order to meet the educational objectives, students of the Industrial Engineering Doctoral program must be able to meet the following educational outcomes at the time of their graduation. Students will have acquired:

1. The ability to use, master, and teach modern and classical Industrial Engineering methodologies in their area of concentration.
2. The ability to apply knowledge of math, science, and engineering.
3. The ability to do research, and to design and conduct experiments, analyze and interpret data, develop implementation strategies, and shape recommendations so that results will be achieved and findings will be communicated effectively.
4. The ability to work individually, on teams, and/or on multi-disciplinary teams to identify, formulate, and solve problems using industrial engineering knowledge, skills, and tools.
5. The ability to design and implement or improve integrated systems that include people, materials, information, equipment, and energy using appropriate analytical, computational, and experimental practices.
6. A thorough understanding of professional and ethical responsibility and the broad education and knowledge of contemporary issues necessary to fully evaluate the impact of solutions in a global and societal context.
7. A recognition of the need for and an ability to engage in life-long learning.
8. The professional characteristics expected of a successful Industrial Engineer.

DOCTOR OF PHILOSOPHY WITH A MAJOR IN OCCUPATIONAL SAFETY AND HEALTH

A graduate of the Occupational Safety and Health doctoral program will be prepared to:

1. Anticipate and recognize hazards and environmental cases requiring the application of safety and health methods in occupational settings.
2. Identify social and epidemiological trends in occupational safety and health issues at the national and international levels.
3. Identify methods of management in application of effective control techniques.
4. To demonstrate understanding of federal, state, and local regulatory agencies as they impact the practice of occupational safety and health.
5. Conduct, disseminate, and publish original research in occupational safety and health.
6. Be qualified to enter the profession as a professor, practitioner, or researcher in occupational safety and health.

In order to meet the educational objectives, students of the Occupational Safety and Health Doctoral program must be able to meet the following educational outcomes at the time of their graduation. Students will have acquired the ability:

1. To construct, manage, and evaluate a comprehensive safety and health program for large industry or government agencies.
2. To participate in the safety and health regulatory process as an individual or part of a corporation or university.
3. To critically evaluate research conducted by other individuals or corporations in occupational safety and health.
4. To provide excellent teaching at the University or corporate levels.
5. To participate in activities such as conferences or seminars for continued professional improvement.
6. To actively participate as a leader in the professional organizations that serve the occupational safety and health fields.
7. To demonstrate the highest possible ethical standards in the field of occupational safety and health.

Faculty Research

The department has quality research laboratories in manufacturing, robotics and vision systems, CAD/CAM, operations research, production planning and control, decision sciences, ergonomics, industrial hygiene, and safety. Graduate students are encouraged to utilize these resources to explore and develop their capabilities. Research initiatives and on-going funding opportunities are available to students in the areas of: ergonomics, operations research, production planning and control, decision sciences, manufacturing, occupational safety and health, artificial intelligence, and respirator research.

Required Courses

Required courses are determined by the student’s degree program and area of emphasis. Specific course information by program area is available at the following website: http://www.imse.cemr.wvu.edu/courses/.

FACULTY

CHAIR

• Wafik Iskander - Ph.D., P.E. (Texas Tech University)

PROFESSORS

• Rashpal Ahluwalia - Ph.D., P.E. (Western Ontario University)
  Manufacturing Systems, Quality and Reliability Engineering, Robotics and Automation

• Jack Byrd Jr. - Ph.D., P.E. (West Virginia University)

• Robert Creese - Ph.D., P.E. (Pennsylvania State University)
  Manufacturing Processes/Systems, Foundry Engineering, Cost Engineering

• Bhaskaran Gopalakrishnan - Ph.D., P.E., CEM. (Virginia Polytechnic Institute and State University)

- Steven Guffey - Ph.D., C.I.H. (North Carolina State University)
  Ventilation Systems Theory and Design, Noise Measurement and Control, Exposure Assessment
- Majid Jaridi - Ph.D. (University of Michigan)
  Statistics, Quality Control, Forecasting and Transportation Research
- Warren Myers - Ph.D., C.I.H. (West Virginia University)
  Associate Dean for Academic Affairs, Industrial Hygiene and Safety, Worker Exposure Assessment and Modeling, Aerosol Filtration, Occupational Respiratory Protection Design and Testing
- Gary Winn - Ph.D. (Ohio State University)
  Construction Safety, Transportation Safety and Program Evaluation, Total Quality Management, Theory of Paradigm Shifts

ASSOCIATE PROFESSOR
- Alan McKendall, Jr. - Ph.D. (University of Missouri, Columbia)
  Operations Research, Meta-heuristics, Facilities Layout and Materials Handling, Project Scheduling, Integrated Production Systems
- Feng Yang - Ph.D. (Northwestern University)
  Simulation, Applied Statistics, Stochastic Processes

ASSISTANT PROFESSORS
- Michael Klishis - Ph.D. (West Virginia University)
  Safe Behaviors and Loss Control, Training, Instructional Development, Mine Safety and Health
- Ashish Nimbarte - Ph.D. (Louisiana State University)
  Work Related Musculoskeletal Disorders, Occupational Biomechanics and Biomechanical Modeling
- Xiaopeng Ning - Ph.D. (Iowa State University)
  Safety Engineering, Biomechanics, Ergonomics, Human Factors Engineering

PROFESSOR EMERITUS
- Ralph Plummer - Ph.D., P.E. (West Virginia University)
  Systems Safety Engineering, Energy Conservation, Human Factors, Ergonomics

ASSOCIATE PROFESSOR EMERITUS
- Andrew J. Sorine - Ed.D. (West Virginia University)
  Benchmarking, Safety and Health Programs, Safety Management Information Systems

VISITING AND ADJUNCT PROFESSORS
- Lorenzo G. Cena - Ph.D. (University of Iowa)
  Occupational and Environmental Health, Aerosol Generation and Characterization, Exposure Assessment
- Christopher Coffey - Ph.D. (West Virginia University)
  Occupational Safety and Health, Assessment, Evaluation of Respiratory Protective Equipment
- Ren Dong - Ph.D. (Concordia University)
  Human Factors Engineering, Ergonomics, Safety Engineering
- John R. Etherton - Ph.D. (West Virginia University)
  Safety Engineering, Human Factors
- Martin Harper - Ph.D. (London School of Hygiene and Tropical Medicine)
  Industrial Hygiene, Exposure Assessment
- James R. Harris - Ph.D., P.E. (West Virginia University)
  Safety Research, Human Factors
- Hongwei Hsiao - Ph.D. (University of Michigan)
  Safety Engineering, Human Factors
- Kevin Michael - Ph.D. (Pennsylvania State University)
  Acoustics, Hearing Protection, Industrial Hygiene
- Christopher Pan - Ph.D. (University of Cincinnati)
  Industrial Hygiene, Exposure Assessment
- Ju-Hyeong Park - Sc.D. M.P.H., C.I.H. (Harvard University)
  Industrial Hygiene, Exposure Assessment
- M. Abbas Virgi - Sc.D., C.I.H. (University of Massachusetts)
  Exposure Assessment, Epidemiology, Biostatistics
Admission

To qualify as a regular graduate student, applicants must have as a minimum the equivalent of a 3.0 GPA. Applicants with a minimum 2.75 GPA (or the equivalent) may be admitted on a provisional basis. Applicants with GPA below 2.75 would need approval of the dean or his designee. International students must demonstrate proficiency in communicating in English (a minimum TOFEL Score of 550, or IBT Score of 79, or IELTS Score of 6.5). Students must comply with the rules and regulations as outlined in this catalog for graduate work in the College of Engineering and Mineral Resources.

- For admission into the M.S.I.E. and M.S.E. programs, applicants must have a bachelor of science degree from an engineering department, or from physics, chemistry, computer sciences, mathematics, or a similar technical or science program. In general, a degree in one of the "hard" science programs is required with at least two years of calculus or equivalent mathematics.

- For admission into the M.S. Industrial Hygiene Program, applicants must meet ABET/ASAC prerequisite course requirements which are currently a minimum of sixty-three credit hours of approved science, mathematics, and other technical courses. Of these, at least fifteen credit hours must be junior or senior level. Specific pre/corequisite course requirements include two semesters of general/inorganic chemistry and two semesters of physics. On an individual basis, the faculty may identify additional pre/corequisite coursework, often including organic chemistry and biology. Applicants will be advised about their specific requirements at the time of admission. Applicants not meeting all of the listed requirements may be considered for admission as provisional students.

- For admission into the M.S. Safety Management Program, applicants must meet ABET/ASAC prerequisite course requirements, which are currently a minimum of sixty-three credit hours of approved science, mathematics, and other technical courses. Of these, at least fifteen credit hours must be junior or senior level. In addition, students must have a minimum of twenty-one hours of social sciences, humanities, and/or communications. On an individual basis, the faculty may identify additional prerequisite coursework. Applicants will be advised about their specific requirements at the time of admission. Applicants not meeting all of the listed requirements may be considered for admission as provisional students.

- For admission into the Ph.D. program, applicants should have, at a minimum, a 3.4 GPA (or equivalent) in their graduate work. They must also meet all the entrance requirements stated above for the Master’s programs. Typically, a Master’s degree is required for admission into the Ph.D. program.

Applicants to graduate programs in the IMSE department are required to provide the following.

- A completed application submitted to the WVU Admissions Office
- Official transcripts of all previous college course work
- TOEFL scores for international students as stated above
- GRE General Test scores (not required for the M.S. in Safety Management Program)
- Three letters of recommendation (required for the Ph.D. programs only).

Specific programs may have additional requirements.

Masters Degree Programs

Graduate programs in industrial and management systems engineering are designed to give students experience in developing innovative solutions to real problems by implementing creative ideas. Students can expect to develop their creative abilities in order to be effective in innovative environments while improving their abilities to communicate and implement new ideas.

Four degrees are offered at the master’s level: M.S.I.E., M.S.E., M.S. in industrial hygiene, and M.S. in safety management. See our graduate webpage at http://www.imse.cemr.wvu.edu/grad/degrees.php.

- The M.S. industrial engineering degree program is appropriate for students with a B.S. in industrial engineering or other engineering disciplines.
- The M.S. engineering degree program is designed for students having a baccalaureate degree in a technical field other than industrial engineering who wish to pursue a broader, more interdisciplinary program of graduate studies. An undergraduate degree in either another engineering field or the basic sciences is required for admission to the M.S.E.
- The M.S. in industrial hygiene is accredited by the Applied Science Accreditation Committee (ASAC) of the Accreditation Board of Engineering and Technology (ABET). Suitable undergraduate degrees include engineering, chemistry, biology, medical sciences, animal sciences, and the physical sciences. The three disciplines that form the basis of hygiene are industrial hygiene, industrial safety, and ergonomics.
- The M.S. in safety management degree program is accredited by the Applied Science Accreditation Committee (ASAC) of the Accreditation Board of Engineering and Technology (ABET). It is designed for students trained in the areas of animal sciences, chemical and biological sciences, engineering and technology sciences, medical sciences, the physical sciences, and business and economic sciences who have an interest in safety management.
Thesis

When a student elects the thesis or problem report option, the thesis or problem must conform to the general requirements of the university and to the written requirements of the Department of Industrial and Management Systems Engineering.

Graduation Requirements

The M.S.I.E. or M.S.E. degree requirements for the thesis option include completion of a minimum of twenty-four credit hours, plus a six-hour thesis; or candidates may take thirty-three credit hours and complete a three-hour problem report. The M.S.I.H. degree requires a total of a minimum forty-one hours, not including credits for a thesis or a problem report. A candidate for the M.S.I.E., M.S.E., or M.S.I.H. degrees must pass an oral examination on coursework and the thesis or problem report. M.S. in safety management degree candidates may opt to complete a minimum of thirty credit hours, plus a six-hour thesis, or they may opt to complete a minimum of thirty-three credit hours and a problem report, or a thirty-six-credit-hour all coursework program. Candidates who take the thirty-six-hour option are also required to pass a final comprehensive written examination. All graduate students must have a final grade point average of at least 3.0.

Doctor of Philosophy

The Doctor of Philosophy degree is administered through the college's interdisciplinary program; industrial engineering or occupational safety and health may be the major. A candidate for the degree of doctor of philosophy must comply with the rules and regulations outlined in the general requirements of the Statler College of Engineering and Mineral Resources. The research work for the doctoral dissertation must show a high degree of originality on the part of the student and must constitute an original contribution to the art and science of industrial engineering or occupational safety and health.

To be accepted in the Ph.D. program, applicants should have, at a minimum (or equivalent), a 3.4 GPA in their graduate work. They must also meet all the entrance requirements stated earlier for the master’s programs. Each student will develop a program with a major in industrial engineering or occupational safety and health designed to meet his/her needs and objectives in consultation with an advisor and the advisory and examining committee (AEC).

Required core courses for the Ph.D. program are determined by the student’s area of emphasis. In general, Ph.D. students take approximately fifty-four hours of coursework beyond their baccalaureate degree, with a minimum of thirty hours in industrial engineering or occupational safety and health. The research work for the doctoral dissertation may entail a fundamental investigation or a broad and comprehensive investigation into an area of specialization.

Early in the doctoral program, the student must pass an examination to demonstrate master's-level proficiency in industrial engineering or occupational safety and health subject matter. Upon completion of the coursework, the student must pass a written examination in order to be admitted to candidacy. An acceptable dissertation must be written and defended.

INDUSTRIAL ENGINEERING COURSES

**IENG 502. Adv Manufacturing Processes. 3 Hours.**
PR: IENG 302 and IENG 303. Metal cutting economic models, solidification processes, bulk deformation, sheet metal and drawing, joining design, and economics. Overall view of manufacturing systems. Introduction to numerical control programming and projects on numerical control equipment.

**IENG 505. Computer Integrated Manufactrg. 3 Hours.**
PR: Graduate standing. Several aspects of computerized manufacturing systems will be covered. Emphasis will be placed on computer fundamentals, computer-aided design and manufacturing, numerically- controlled (NC) machine tools, part programming, system devices, and direct digital control. (2 hr. lec., 1 hr. lab.).

**IENG 506. Computr Aided Process Planning. 3 Hours.**
PR: Consent. Computer aided process planning for manufacturing applications; selection of processes and parameters; machining, casting, and forming; development of process plans from design data; and analysis of effect of changes in design on manufacturability in concurrent engineering.

**IENG 507. Robotics/Flexible Automation. 3 Hours.**
PR: Graduate standing. This course will provide an understanding of the principles, capabilities, and limitations of industrial robots and other flexible automation tools. Emphasis will be placed on kinematic analysis, trajectory planning, machine vision, and manufacturing automation. (2 hr. lec., 1 hr. lab.).

**IENG 508. Adv Prblms-Manufacturing Engr. 1-3 Hours.**
PR: IENG 593 or IENG 502; Graduate standing. Special problems relating to one of the areas of manufacturing engineering, such as manufacturing processes, robotics, CAD/CAM, group technology, and manufacturing systems engineering.

**IENG 514. Design-Industrial Experiments. 3 Hours.**
PR: IENG 314 or Consent. Continuation of IENG 314. More complex experimental design especially useful to engineering and industrial researchers, including factorial and optimum-seeking design. Emphasis on use of existing digital computer routines and interpretation of results.

**IENG 518. Technology Forecasting. 3 Hours.**
PR: IENG 213 or Consent. Various procedures used in forecasting technical developments.
IENG 542. Advanced Production Control. 3 Hours.
PR: IENG 350. Different mathematical models useful in the design of effective production control systems. The various models include: static production control models under risk and uncertainty, dynamic models under certainty, and under risk.

IENG 551. Quality/Reliability Engineering. 3 Hours.
PR: Graduate standing. Introduction to quality and reliability engineering. Special emphasis on Taguchi Design and Markov Models for determining system reliability and availability.

IENG 553. Applied Linear Programming. 3 Hours.
PR: IENG 350 or Consent. Application of the assignment, transportation, and simplex algorithms to typical industrial problems. The methods and computational efficiencies of the revised simplex and other algorithms are also studied.

IENG 554. Applied Integer/Heuristic Programming. 3 Hours.
PR: IENG 350 or IENG 553 and knowledge of a computer programming language. Applications of integer and heuristic programming techniques for solving combinatorial optimization problems. Topics include computational complexity, relaxations, branch and bound, cutting planes, simulated annealing, tabu search, and genetic algorithms.

IENG 555. Scheduling/Sequencing Methods. 3 Hours.
PR: IENG 350. Theory and applications of analytical models used in the scheduling models; flow shop models; job shop models; and assembly line balancing methods.

IENG 556. Supply Chain Management. 3 Hours.
PR: IENG 350 or IENG 553. Principles and methods for designing and managing supply chain systems. Topics include: forecasting demand, strategies, aggregate planning, inventory control, outsourcing, transportation networks, and locating facilities within the supply chain network.

IENG 557. Geometric Programming. 3 Hours.
PR: IENG 350 or instructor consent. Introduction to the primal and dual solution techniques for geometric programming problems. Focus on the development of design relationships for cost optimization problems.

IENG 561. Industrial Hygiene Engineering. 3 Hours.
Introductory course in industrial hygiene with laboratory. Topics include: recognition, evaluation, and control of occupational and environmental contaminants and physical agents; basic IH quantitative analysis; PPE selection and evaluation.

IENG 564. Industrial Ergonomics. 3 Hours.
PR: IENG 360 or Consent. Practical experience in the application of ergonomic principles to industrial problems. Safety and production implications of work physiology, industrial biomechanics, and circadian rhythms, as well as current interest topics.

IENG 577. Advanced Engineering Economy. 3 Hours.
PR: IENG 377 or Consent. Special emphasis on depreciation, engineering and economic aspects of selection and replacement of equipment; relationship of technical economy to income taxation; and effect of borrowed capital and project cost control.

IENG 578. Cost and Estimating. 3 Hours.
PR: IENG 377 or Consent. Analysis of overhead, cost indexes, cost capacity factors; improvement curves; costing for materials with design considerations, conceptual cost estimating; costing for machining, joining, casting and forming; and facility cost estimation.

IENG 593A-Z. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

IENG 660. Human Factors System Design. 3 Hours.
PR: IENG 360 or Consent. Theoretical aspects and practical applications of man/machine relationships as they influence future system design. The student will examine human limitations with respect to acceptance of information, decision making, and ability to transmit the result of such decisions to controlled equipment systems to obtain design optimization. (2 hr. lec., 3 hr. lab.).

IENG 662. Systems Safety Engineering. 2. 3 Hours.
PR: IENG 461 or Consent. Analysis of manufacturing methods, processes, and properties of materials from a system safety engineering viewpoint. Emphasis will be on hazard analysis techniques (fault tree, MORT, failure modes, and effects) and machine guarding methods.

IENG 668. Advanced Problems-Human Factors. 1-3 Hours.
PR: IENG 360 or IENG 660 and graduate standing. Special problems relating to one of the areas of human factors, such as ventilation, ergonomics, controls, vigilance, safety, and occupational health.

IENG 691A-Z. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

IENG 693A-Z. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

IENG 695. Independent Study. 1-6 Hours.
Faculty supervised study of topics not available through regular course offerings.

IENG 697. Research. 1-15 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading may be S/U).
IENG 698. Thesis. 1-6 Hours.
PR: Consent. This is an optional course for programs that wish to provide formal supervision during the writing of student reports (698), or dissertations (798). Grading is normal.

IENG 754. Inventory Theory. 3 Hours.
PR: IENG 213 and IENG 350 or Consent. Techniques used in optimization of inventory systems. Elements of static, deterministic inventory models, and static, stochastic inventory models. Selected inventory models. Selected topics related to inventory analysis.

IENG 756. Applied Stochastic Processes. 3 Hours.
PR: Consent. Stochastic systems with emphasis on application to inventory and queueing theory. Conditional probability, Poisson processes, renewal processes, Markov chains with discrete and continuous parameters.

IENG 790. Teaching Practicum. 1-3 Hours.
PR: Consent. Supervised practice in college teaching of industrial and management systems engineering. Note: This course is intended to insure that graduate assistants are adequately prepared and supervised when they are given college teaching responsibility. It will also present a mechanism for students not on assistantships to gain teaching experience. (Grading will be S/U.).

IENG 791A-Z. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

IENG 792A-Z. Directed Study. 1-6 Hours.
Directed study, reading, and/or research.

IENG 793A-Z. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

IENG 794A-Z. Seminar. 1-6 Hours.
Special seminars arranged for advanced graduate students.

IENG 795. Independent Study. 1-9 Hours.
Faculty supervised study of topics not available through regular course offerings.

IENG 796. Graduate Seminar. 1 Hour.
PR: Consent. Each graduate student will present at least one seminar to the assembled faculty and graduate student body of his or her program.

IENG 797. Research. 1-15 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading may be S/U.)

IENG 798. Dissertation. 1-6 Hours.
PR: Consent. This is an optional course for programs that wish to provide formal supervision during the writing of student reports (698), or dissertations (798). Grading is normal.

IENG 799. Graduate Colloquium. 1-6 Hours.
PR: Consent. Graduate students not seeking coursework credit but who wish to meet residency requirements, use the University’s facilities, and participate in its academic and cultural programs. Note: Graduate students who are not actively involved in coursework or research are entitled, through enrollment in their department’s 699/799 Graduate Colloquium to consult with graduate faculty, participate in both formal and informal academic activities sponsored by their program, and retain all of the rights and privileges of duly enrolled students. Grading is S/U; colloquium credit may not be counted against credit requirements for masters programs. Registration for one credit of 699/799 graduate colloquium satisfies the University requirement of registration in the semester in which graduation occurs.

INDUSTRIAL HYGIENE SAFETY COURSES

IH&S 527. Noise Measurement and Control. 3 Hours.
PR: Senior or graduate standing. Includes noise physics, effects of noise on hearing and well-being, noise exposure regulations, and engineering of noise control. Practical experience with noise dosimeters and sound level meters is provided by a field trip.

IH&S 528. Industrial Ventilation Design. 3 Hours.
PR: Senior or graduate standing. Design of industrial exhaust ventilation for contaminant control. Includes dilution ventilation, hood design, duct system design, selection of fans and air-cleaning devices, and measurement of flows and pressures.

IH&S 627. Indstrl Hygn-Noise Assesment. 3 Hours.
PR: Consent. Industrial hygiene aspects of assessing and controlling noise induced hearing loss. Practical experience with noise dosimeters, sound-level meters and instrumentation used to access human noise exposure is provided by field trips and case studies.

IH&S 628. Ventilation Control Technology. 3 Hours.
PR: IMSE 561 or consent. The course will demonstrate techniques for the recognition, evaluation, and control of noise and ventilation problems. Students will use monitoring equipment to evaluate situations and perform several design projects.

IH&S 685. Internship. 3-6 Hours.
PR: Consent. (May be repeated) Professional internship providing on-the-job training under supervision of a previously approved environmentalist in settings appropriate to professional objectives.
IH&S 691A-Z. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

IH&S 692A-Z. Directed Study. 1-6 Hours.
Directed study, reading, and/or research.

IH&S 693A-Z. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

IH&S 694A-Z. Seminar. 1-6 Hours.
Special seminars arranged for advanced graduate students.

IH&S 695. Independent Study. 1-6 Hours.
Faculty supervised study of topics not available through regular course offerings.

IH&S 696. Graduate Seminar. 1 Hour.
PR: Consent. Each graduate student will present at least one seminar to the assembled faculty and graduate student body of his or her program.

PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading may be S/U.)

IH&S 698. Thesis. 1-6 Hours.
PR: Consent. This is an optional course for programs that wish to provide formal supervision during the writing of student reports (698), or dissertations (798). Grading is normal.

IH&S 699. Graduate Colloquium. 1-6 Hours.
PR: Consent. For graduate students not seeking coursework credit but who wish to meet residency requirements, use the University’s facilities, and participate in its academic and cultural programs. Note: Graduate students who are not actively involved in coursework or research are entitled, through enrollment in their department’s 699/799 Graduate Colloquium to consult with graduate faculty, participate in both formal and informal academic activities sponsored by their program, and retain all of the rights and privileges of duly enrolled students. Grading is S/U; colloquium credit may not be counted against credit requirements for masters programs. Registration for one credit of 699/799 graduate colloquium satisfies the University requirement of registration in the semester in which graduation occurs.

IH&S 725. Indstrl Hygiene Sampling/Analys. 4 Hours.
PR: IENG 561 and Consent. Calibration and use of sampling and analytical equipment used by industrial hygienists to evaluate the work environment. Advantages and disadvantages of different equipment under various conditions. Biological monitoring as an evaluation tool.

SAFETY MANAGEMENT COURSES

SAFM 501. Safety Management Integration. 3 Hours.
Consideration of integrated arrangements, staff roles, management theory, staff liaison, project improvement, effectiveness, audits, and collaboration needed to assure success of the safety function.

SAFM 502. Control Envrnmntl/Persnl Hazard. 3 Hours.
Investigation of hazard control principles relating to environmental facilities and equipment including control procedures recommended by authorities from the fields of engineering, medicine, and public health as well as from the field of safety.

SAFM 505. Safety Legislation/Compliance. 3 Hours.
Comprehensive study and analysis of federal and state legislation which mandates compliance with certain safety conditions and practices related to work performed in occupational and comparable settings.

SAFM 528. Economic Aspects of Safety. 3 Hours.
PR: Graduate standing. An overview of economic factors that must be considered when justifying the development and implementation of safety initiatives, including examining published research, cost estimating, ROI, risk assessment, benefit-cost analysis, and project planning.

SAFM 533. Disaster Preparedness. 3 Hours.
Major elements involved in disasters and emergencies, preparedness planning, systems utilization, and attention to essential human services, with emphasis on community action.

SAFM 534. Fire Safety Management. 3 Hours.
Analysis of fire services usually provided under safety manager jurisdiction, with special attention to legal bases, organizational structure, services rendered, training needs, and management techniques.

SAFM 539. Security Management. 3 Hours.
Safety manager responsibilities for security of persons and property including organizational patterns, personnel competencies expected, surveillance and monitoring methods, and occupational problems among security personnel.
SAFM 550. Loss Control and Recovery. 3 Hours.
Identifying and elimination areas of loss or recovering from losses of people, property, and efficacy via management practices, insurance and worker’s compensation, and other management techniques and resources effective in controlling those losses.

SAFM 552. Safety & Health Training. 3 Hours.
Analysis of safety and health performance discrepancies, developing and conducting training programs to eliminate those discrepancies and the evaluation of program effectiveness in terms of cost effectiveness and organizational impact.

SAFM 578. Substance Abuse in Workplace. 3 Hours.
The problem, nature, and effects of alcohol and drug use in the workplace; approaches for treatment and avoidance such as EAP’s, community programs, and testing; development of management approaches and programs.

SAFM 580. Fundamentals-Environmental Mang. 3 Hours.
An introductory but comprehensive overview of topics related to environmental technology as it applies to safety management. Focuses on regulation and technology relative to environmental management. Includes field trip.

SAFM 640. Instrumentation-Safety Managers. 3 Hours.
Anticipation, recognition, and evaluation of industrial hygiene topics encountered by safety managers. Fundamental instrumentation techniques are presented in laboratory and lecture formats. Management-oriented control and remediation programs are developed.

SAFM 642. Biomechanics Safety Management. 3 Hours.
Applying the laws of physics to describe the abilities and limitations of the human body biomechanically and physiologically in order to maintain safety, quality, and productivity objectives; based on safety management principles.

SAFM 689. Professional Field Experience. 1-18 Hours.
PR: Must have completed 12 hours in SAFM and consent. Prearranged experiential learning program, to be planned, supervised, and evaluated for credit by faculty and field supervisors. Involves temporary placement with public or private enterprise for professional competence development.

SAFM 691A-Z. Advanced Topics. 1-6 Hours.
Investigation of advanced topics not covered in regularly scheduled courses.

SAFM 692A-Z. Directed Study. 1-6 Hours.
Directed study, reading, and/or research.

SAFM 693A-Z. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

SAFM 695. Independent Study. 1-6 Hours.
Faculty supervised study of topics not available through regular course offerings.

SAFM 697. Research. 1-6 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper or equivalent scholarly project, or a dissertation. (Grading will be S/U.)

SAFM 699. Graduate Colloquium. 1-6 Hours.
PR: Consent. For graduate students not seeking coursework credit but who wish to meet residency requirements, use the University’s facilities, and participate in its academic and cultural programs. Note: Graduate students who are not actively involved in coursework or research are entitled, through enrollment in their department’s 699/799 Graduate Colloquium to consult with graduate faculty, participate in both formal and informal academic activities sponsored by their program, and retain all of the rights and privileges of duly enrolled students. Grading is S/U; colloquium credit may not be counted against credit requirements for masters programs. Registration for one credit of 699/799 graduate colloquium satisfies the University requirement of registration in the semester in which graduation occurs.

SAFM 790. Teaching Practicum. 1-3 Hours.
PR: Consent. Supervised practice in college teaching of safety and environmental management. Note: This course is intended to insure that graduate assistants are adequately prepared and supervised when they are given college teaching responsibility. It will also present a mechanism for students not on assistantships to gain teaching experience. (Grading will be S/U.)

SAFM 791A-Z. Advanced Topics. 1-6 Hours.
PR: Consent. Investigation of advanced topics not covered in regularly scheduled courses.

SAFM 792A-Z. Directed Study. 1-6 Hours.
Directed study, reading, and/or research.

SAFM 793A-Z. Special Topics. 1-6 Hours.
A study of contemporary topics selected from recent developments in the field.

SAFM 794A-Z. Seminar. 1-6 Hours.
Special seminars arranged for advanced graduate students.

SAFM 795. Independent Study. 1-9 Hours.
Faculty supervised study of topics not available through regular course offerings.
SAFM 796. Graduate Seminar. 1 Hour.
PR: Consent. Each graduate student will present at least one seminar to the assembled faculty and graduate student body of his or her program.

SAFM 797. Research. 1-15 Hours.
PR: Consent. Research activities leading to thesis, problem report, research paper, equivalent scholarly project, or dissertation. (Grading may be S/U.).

SAFM 798. Dissertation. 1-6 Hours.
PR: Consent. This is an optional course for programs that wish to provide formal supervision during the writing of students reports (698), or dissertations (798). Grading is normal.