decision support systems to management and engineering. **OTHER PREREQS:** Programming experience.

IE 416. ARTIFICIAL INTELLIGENCE SYSTEMS FOR ENGINEERING (3). Concepts of symbolic problem solving, knowledge representation, and inference applied to problems in engineering analysis and design. Artificial Intelligence programming. **OTHER PREREQS:** IE 411/IE 511 and senior or graduate standing in engineering.

IE 417. BAR CODES AND AUTOMATIC DATA CAPTURE (4). Bar code symbologies, two-dimensional bar code symbologies, bar code reading and printing, smart cards, automatic speech recognition, and wireless technologies. Lec/lab.

IE 418. TELECOMMUNICATION CONCEPTS (3). Telecommunication concepts for industrial applications. OSI reference model, local area networks, wide area networks, internet architecture. **OTHER PREREQS:** Previous programming experience.

IE 419. WIRELESS NETWORKS (3). RF fundamentals, ISO 802.11 standards, spread spectrum technology, narrow band technology, direct sequence and frequency hopping transmission schemes, electromagnetic interference, design of indoor wireless networks. **ENFORCED PREREQS:** IE 418

IE 425. INDUSTRIAL SYSTEMS OPTIMIZATION (4). Techniques of analysis and solution of problems in industrial and management systems. Emphasis on applications of linear programming, integer programming, and queuing analysis. **OTHER PREREQS:** ST 314 or equivalent statistical material and MTH 306 or MTH 341.

IE 436. LEAN MANUFACTURING SYSTEMS ENGINEERING (4). The planning, evaluation, deployment, and integration of lean manufacturing theory and methods. Examines manufacturing processes/equipment and systems, e.g. planning/control, product design, supply chain resource management. Lec/lab.

IE 437. VIRTUAL AND AUTOMATED MANUFACTURING SYSTEMS (4). Automated manufacturing system design and operations-sensors, actuators, programmable controls. Concepts for integrated design/verification of virtual system models, control and hardware implementation. **OTHER PREREQS:** IE 337 should be taken concurrently.

IE 447. INDUSTRIAL ERGONOMICS/ OCCUPATIONAL BIOMECHANICS (3). Topics in industrial ergonomics and occupational biomechanics. Physiological and biomechanical capabilities and limitations of workers. Applications are to the design work tasks and work environments. **OTHER PREREQS:** Senior standing in science or engineering.

IE 470. MANAGEMENT SYSTEMS ENGINEERING (4). Improvement of organizational performance through the design and implementation of systems that integrate personnel, technological, environmental, and organizational variables. Topics include performance assessment and measurement as well as improvement methodologies. **OTHER PREREQS:** Senior standing.

IE 471. PROJECT MANAGEMENT IN ENGINEERING (3). Critical issues in the management of engineering and high-technology projects are discussed. Time, cost, and performance parameters are analyzed from the organizational, people, and resource perspectives. Network optimization and simulation concepts are introduced. Resource-constrained project scheduling case discussions and a term project are included. **OTHER PREREQS:** ST 314 or equivalent and computer programming experience.

IE 475. ADVANCED MANUFACTURING COSTING TECHNIQUES (3). Costing techniques applicable in advanced manufacturing enterprises: activity-based costing, economic value added, Japanese cost management techniques, life cycle costing, throughput accounting, cost of quality, and financial versus operational performance measures. Emphasis on linkages to such advanced manufacturing systems as cellular manufacturing, flexible manufacturing, JIT, Lean, and ERP. **OTHER PREREQS:** BA 211, ENGR 390.

IE 491. SELECTED TOPICS IN SYSTEMS STUDIES (1-5). Recent advances in industrial engineering pertaining to the theory and application of system studies. Analysis and design of natural resource systems; evaluation; detection extraction; processing and marketing systems; advanced design of production systems with reference to social, economic, and regional planning; human engineering studies of man-machine systems; applications of operations research techniques. Nonsequence course. Not offered every term.

IE 492. SELECTED TOPICS IN SYSTEMS STUDIES (1-5). Recent advances in industrial engineering pertaining to the theory and application of system studies. Analysis and design of natural resource systems; evaluation; detection extraction; processing and marketing systems; advanced design of production systems with reference to social, economic, and regional planning; human engineering studies of man-machine systems; applications of operations research techniques. Nonsequence course. Not offered each term.

IE 493. SELECTED TOPICS IN SYSTEMS STUDIES (1-5). Recent advances in industrial engineering pertaining to the theory and application of system studies. Analysis and design of natural resource systems; evaluation; detection extraction; processing and marketing systems; advanced design of production systems with reference to social, economic, and regional planning; human engineering studies of man-machine systems; applications of operations research techniques. Nonsequence course. Not offered each term.

IE 497. INDUSTRIAL ENGINEERING ANALYSIS AND DESIGN (3). Product design; selection and replacement of major tools, processes, and equipment; paperwork controls; subsystem revision; system or plant revision; selection and training of personnel; long-run policies and strategy. **OTHER PREREQS:** Senior standing in industrial engineering or manufacturing engineering.

IE 498. INDUSTRIAL ENGINEERING ANALYSIS AND DESIGN (3). Product design; selection and replacement of major tools, processes, and equipment; paperwork controls; subsystem revision; system or plant revision; selection and training of personnel; long-run policies and strategy. **OTHER PREREQS:** Senior standing in industrial engineering or manufacturing engineering.

IE 499. SPECIAL TOPICS (1-16).

IE 503. THESIS (1-16). OTHER PREREQS: Departmental approval required.

IE 505. READING AND CONFERENCE (1-16). OTHER PREREQS: Departmental approval required.

IE 506. PROJECTS (1-16). OTHER PREREQS: Departmental approval required.

IE 507. SEMINAR (1-16).

IE 511. VISUAL PROGRAMMING FOR INDUSTRIAL APPLICATIONS (4). Object-oriented modeling, Unified Modeling Language, software development concepts, file and database connectivity, and visual programming skills (Microsoft Visual Basic) for use in developing industrial applications, such as process monitoring and supply chain management. **OTHER PREREQS:** CS 151 or equivalent.

IE 512. INFORMATION SYSTEMS ENGINEERING (4). Framework for enterprising information systems. Engineering and scientific systems. Requirements definition, enhanced entity relationship modeling, logical modeling, structured query language, relational model, referential integrity. Lec/lab.

IE 513. E-COMMERCE APPLICATIONS FOR ENGINEERS (3). Design of distributed information systems for industrial environments, e-commerce systems, supply chain systems. Application of Web software to develop components of industrial information systems. **OTHER PREREQS:** IE 411.

IE 514. MOBILE COMPUTING APPLICATIONS (3). Mobile application environments, PDAs and ubiquitous computing hardware, Windows CE Operating System, PDA GUI design and application development, infrared and wireless data communication. **OTHER PREREQS:** IE 411.

IE 515. SIMULATION AND DECISION SUPPORT SYSTEMS (4). Analysis and design of integrated manufacturing systems through the application of computer modeling techniques. Model validation and verification. Application of simulation and decision support systems to management and engineering. **OTHER PREREQS:** Programming experience.

IE 516. ARTIFICIAL INTELLIGENCE SYSTEMS FOR ENGINEERING (3). Concepts of symbolic problem solving, knowledge representation, and inference applied to problems in engineering analysis and design. Artificial Intelligence programming. **OTHER PREREQS:** IE 411/IE 511 and graduate standing in engineering.

IE 517. BAR CODES AND AUTOMATIC DATA CAPTURE (4). Bar code symbologies, two-dimensional bar code symbologies, bar code reading and printing, smart cards, automatic speech recognition, and wireless technologies. Lec/lab.

IE 518. TELECOMMUNICATION CONCEPTS (3). Telecommunication concepts for industrial applications. OSI reference model, local area networks, wide area networks, internet architecture. **OTHER PREREQS:** Previous programming experience.

IE 519. WIRELESS NETWORKS (3). RF fundamentals, ISO 802.11 standards, spread spectrum technology, narrow band technology, direct sequence and frequency hopping transmission schemes, electromagnetic interference, design of indoor wireless networks. **ENFORCED PREREQS:** IE 518

IE 521. INDUSTRIAL SYSTEMS OPTIMIZATION I (3). Techniques for analysis and solution of problems in industrial and management systems. Emphasis on application of linear and integer programming and extensions. **OTHER PREREQS:** MTH 341.

IE 522. INDUSTRIAL SYSTEMS OPTIMIZATION II (3). Techniques for analysis and solution of problems in industrial and management systems. Emphasis on applications of dynamic programming. Markovian processes, and questions as applied to industrial problems. **OTHER PREREQS:** ST 514.

IE 531. MESO-SCALE MANUFACTURING (3). Meso-scale processing techniques for fabricating microfluidic devices, especially microtechnology-based energy, chemical and biological systems. Introduction to microlamination and techniques for lamina patterning, registration and bonding. Lec/lab. **OTHER PREREQS:** Graduate standing in science or engineering.

IE 532. MICROFABRICATION TECHNOLOGY (3). Survey of microfabrication processing techniques, including bulk, surface, and mold micromachining and application of this technology to microelectromechanical systems (MEMS). Some review of semiconductor integrated circuit processing. **OTHER PREREQS:** Graduate standing in engineering science.

IE 534. CERAMICS PROCESSING (3). Introduction to materials, manufacturing methods, properties and applications of ceramics. The emphasis of the course is on understanding and exploring the inter-relationships between material characteristics, processing variables and component geometry in the context of ceramics. **OTHER PREREQS:** Graduate standing in engineering or science, or senior standing in manufacturing engineering.

IE 536. LEAN MANUFACTURING SYSTEMS ENGINEERING (4). The planning, evaluation, deployment, and integration of lean manufacturing theory and methods. Examines manufacturing processes/equipment and systems, e.g. planning/control, product design, supply chain resource management. Lec/lab.

IE 537. VIRTUAL AND AUTOMATED MANUFACTURING SYSTEMS (4). Automated manufacturing system design and operations-sensors, actuators, programmable controls. Concepts for integrated design/verification of virtual system models, control and hardware implementation. **OTHER PREREQS:** Graduate standing in engineering. Concurrent enrollment in IE 337 is recommended.

IE 545. HUMAN FACTORS ENGINEERING (4). Analysis and design of work systems considering human characteristics, capabilities and limitations. Analysis and design of displays, controls, tools, and workstations. Human performance analysis. Human factors research methods. **OTHER PREREQS:** Graduate standing.

IE 546. HUMAN-MACHINE SYSTEMS ENGINEERING (3). Development of safe, high performance human-machine systems. System/function/task analysis, function allocation, design, mockups and rapid prototyping, human factors test and evaluation. Critical examination of the human-factors and domain-specific literature to identify human factors problems, and knowledge and methods to address those problems. **OTHER PREREQS:** IE 545.

IE 547. INDUSTRIAL ERGONOMICS/ OCCUPATIONAL BIOMECHANICS (3). Topics in industrial ergonomics and occupational biomechanics. Physiological and biomechanical capabilities and limitations of workers. Applications are to the design of work tasks and work environments. **OTHER PREREQS:** Graduate standing in science or engineering.

IE 548. COGNITIVE ENGINEERING (3). Theories and models of human sensory, cognitive, and motor performance pertaining to the operation of complex systems. Applications to human-machine systems engineering. Research topics and methods related to cognitive engineering. **OTHER PREREQS:** Graduate standing in science or engineering, IE 545.

IE 551. STATISTICAL PROCESS CONTROL (3). Systematic analysis of industrial processes through the applications of statistical techniques. Analysis of product quality, design of quality improvement programs, and development of reliability models. **OTHER PREREQS:** ST 314.

IE 552. DESIGN OF INDUSTRIAL EXPERIMENTS (3). Techniques for the statistical analysis and design of industrial control systems. Emphasis on the use of advanced mathematical models and techniques for the control and enhancement of industrial productivity. Applications include, but are not limited to, the estimation and control of process fallout and rework. **OTHER PREREQS:** IE 351 or IE 551.

IE 563. ADVANCED PRODUCTION PLANNING AND CONTROL (3). Application of quantitative and heuristic methods to problems of production, material, and capacity planning. Mathematical models for inventory systems, sequencing, and scheduling. Assembly line balancing methods. Just-in-time manufacturing. **OTHER PREREQS:** IE 521, ST 514.

IE 564. DESIGN AND SCHEDULING OF CELLULAR MANUFACTURING SYSTEMS (3). Designing manufacturing cells. Impact of alternate process plan on cell design. Part-machine assignment to cells. Disaggregated manufacturing cells. Group scheduling. **OTHER PREREQS:** Graduate standing, computer experience.

IE 570. MANAGEMENT SYSTEMS ENGINEERING (4). Improvement of organizational performance through the design and implementation of systems that integrate personnel, technological, environmental, and organizational variables. Topics include performance assessment and measurement as well as improvement methodologies. **OTHER PREREQS:** Graduate standing.

IE 571. PROJECT MANAGEMENT IN ENGINEERING (3). Critical issues in the management of engineering and high-technology projects are discussed. Time, cost, and performance parameters are analyzed from the organizational, people, and resource perspectives. Network optimization and simulation concepts are introduced. Resource-constrained project scheduling case discussions and a term project are included. **OTHER PREREQS:** ST 314 or equivalent and computer programming experience.

IE 591. SELECTED TOPICS IN SYSTEM STUDIES (1-5). Recent advances in industrial engineering pertaining to the theory and application of system studies. Analysis and design of natural resource systems; evaluation; detection extraction; processing and marketing systems; advanced design of production systems with reference to social, economic, and regional planning; human engineering studies of man-machine systems; applications of operations research techniques. Nonsequence course. Not offered every term.

IE 592. SELECTED TOPICS IN SYSTEM STUDIES (1-5). Recent advances in industrial engineering pertaining to the theory and application of system studies. Analysis and design of natural resource systems; evaluation; detection extraction; processing and marketing systems; advanced design of production systems with reference to social, economic, and regional planning; human engineering studies of man-machine systems; applications of operations research techniques. Nonsequence course. Not offered each term.

IE 593. SELECTED TOPICS IN SYSTEM STUDIES (1-5). Recent advances in industrial engineering pertaining to the theory and application of system studies. Analysis and design of natural resource systems; evaluation; detection extraction; processing and marketing systems; advanced design of production systems with reference to social, economic, and regional planning; human engineering studies of man-machine systems; applications of operations research techniques. Nonsequence course. Not offered every term.

IE 594. RESEARCH METHODS IN ENGINEERING (3). Introduction to research methodologies including surveys, interviews, quasi-experimentation, and case studies. Methods for research design, and collection and analysis of data. **OTHER PREREQS:** Graduate standing or instructor approval.

IE 603. THESIS (1-16). OTHER PREREQS: Departmental approval required.

IE 605. READING AND CONFERENCE (1-16). OTHER PREREQS: Departmental approval required.

IE 606. PROJECTS (1-16). OTHER PREREQS: Departmental approval required.

IE 607. SEMINAR (1-16).

MECHANICAL ENGINEERING

EAC/ABET Accredited
Belinda A. Batten, *Head*
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FACULTY

Professors Batten, Kennedy, Liburdy
Associate Professors Bay, Busch, Drost, Paasch, Pence, Peterson, I. Tumer, K. Tumer, Warnes
Assistant Professors Apte, Ge, Gibbons, Kruzic, Narayanan, Schmitt, Walker, Zaworski

Undergraduate Major

Mechanical Engineering (BS)

Graduate Majors

Mechanical Engineering (MEng, MS, PhD)

Graduate Areas of Concentration
Applied Mechanics
Applied Thermodynamics
Biomechanics
Combustion
Design
Design and Analysis of Mechanical and Thermal Fluid Systems
Dynamics
Energy
Fluid Mechanics
Heat Transfer
Materials Science
Mechanical Engineering
Physical and Mechanical Metallurgy
Solid Mechanics
Stress Analysis
Systems and Control

Materials Science (MS, PhD)

Graduate Areas of Concentration
Chemistry
Chemical Engineering
Civil Engineering
Electrical and Computer Engineering
Forest Products
Mathematics
Mechanical Engineering
Nuclear Engineering
Physics

Graduate Minors

Mechanical Engineering

Mechanical engineers design and develop small devices, large equipment and processes for society. They play major roles in the design, testing and operation of mechanisms, machines, and systems, including processes for energy conversion and equipment used in households, businesses, transportation and manufacturing.

In addition to the university baccalaureate core, the mechanical engineering curriculum has its base in mathematics, science, engineering science, and design. Mathematics and science courses occur primarily in the first two years. Engineering science is a major component, which is treated from the sophomore year to graduation in a combination of required and technical elective sources.

OSU's Mechanical Engineering Program has all the attributes needed for the best learning environment: ABET accredited curriculum, excellent faculty, modern facilities, quality students, strong industrial interaction, and optimal size (large enough for good selections of courses and small enough for good interaction between students and faculty).

The department's mission is to provide a high quality engineering program that prepares students for successful careers, lifelong learning and service to their profession and society. The program shares goals common to the College of Engineering (see College statement on the first page of this section), as well as those of enabling graduates to be work-ready in both thermal and mechanical systems through an integrated design-based offering, hands-on experiences and actual work experiences.

Engineering design is an integral element of the program. The philosophy is to "plant the seed" for design at the freshman level and grow it throughout the program. Most of the skills are developed at the junior and senior levels, when students have achieved proficiency in the basic technical requirements. At the junior level, the design process is extensively developed in three courses. At the senior year, design experiences occur in several areas, culminating in the two-term senior project in which students in small teams carry out the design of some product or process under the supervision of a faculty advisor. Attention to hands-on activity add a very desirable "feel" for many aspects of the design process.

A good choice of senior electives enables students to achieve a degree of specialization and depth to match their interests. The areas include applied stress analysis; design and analysis of mechanical and thermal/fluid systems; concurrent engineering; dynamics of mechanical and aeronautical systems, control system design, robotics; heat transfer; fluid dynamics; and metallurgy and materials.

The faculty encourages a vibrant extracurricular program for professional and leadership experiences. Students are encouraged to obtain at least three months of work experience through an industrial or research internship or to participate in a foreign exchange program. The department's goal is to have more than 95 percent of its students graduate with such experience. In addition to students having general internships, many of the professional-level students participate in the industry-driven Multiple Engineering Cooperative Program (MECOP). This program provides two paid six-month internships at over 60 Pacific Northwest companies where interns work with a company mentor and improve their capabilities for the work environment.

Mechanical engineers can be found in a wide variety of industries including aerospace, electronics, biomedical, transportation, manufacturing, energy, automotive, and government labs. Because of the increasing complexity of mechanical systems, graduate study for the MS and PhD degrees is advisable for students who wish to specialize in depth in any of the above areas. The undergraduate curriculum provides an excellent foundation for graduate study.

MECHANICAL ENGINEERING (BS, CRED, HBS)

Pre-Mechanical Engineering

Freshman Year (47)
CH 201. Chemistry for Engineering Majors (3)[E]
CH 202. Chemistry for Engineering Majors (3)
CH 205. Laboratory for CH 202 (1)
COMM 111. *Public Speaking (3)[1,E]
HHS 231. *Lifetime Fitness for Health (2)[1]
HHS 241–HHS 248. *Lifetime Fitness: (various activities) (1)[1]
ENGR 248. Engineering Graphics and 3-D Modeling (3)
ME 101. Intro to Mechanical Engineering (3)
MTH 251. *Differential Calculus (4)[E]
MTH 252. Integral Calculus (4)[E]
MTH 254. Vector Calculus I (4)[E]
PH 211. *General Physics with Calculus (4)[E]
WR 121. *English Composition (3)[E]
*Perspectives Courses (9)[1]

Sophomore Year (47)
ENGR 201. Electrical Fundamentals I (3)[5]
ENGR 202. Electrical Fundamentals II (3)
ENGR 211. Statics (3)[E]
ENGR 212. Dynamics (3)[E]
ENGR 213. Strength of Materials (3)[5]
ME 102. Intro to Mechanical Engineering (3)[E]
MTH 256. Applied Differential Equations (4)[E]
MTH 306. Matrix and Power Series Methods (4)[E]
PH 212, PH 213. *General Physics with Calculus (4,4)[E]

ST 314. Intro to Statistics for Engineers (3)[5]
WR 327. *Technical Writing (3)
Biological Science Course (4)[1]
*Difference, Power, and Discrimination Elective (3)[1]

Professional Mechanical Engineering

Junior Year (44)
ENGR 321. Materials Science (3)
ENGR 322. Mechanical Properties of Materials (4)
ENGR 390. Engineering Economy (3)
ME 311. Intro to Thermal-Fluid Sciences (4)
ME 312. Thermodynamics (4)
ME 316. Mechanics of Materials (3)
ME 317. Dynamics (4)
ME 331. Introductory Fluid Mechanics (4)
ME 332. Heat Transfer (4)
ME 373. Mechanical Engineering Methods (3)
ME 382. Introduction to Design (4)
ME 383. Mechanical Component Design (4)

Senior Year (42)
ECON 201. *Intro to Microeconomics (4)[1] or ECON 202. *Intro to Macroeconomics (4)[1]
ME 418, ME 419. ^Senior Project (4,4)
ME 430. Systems Dynamics and Control (4)
ME 451. Introduction to Instrumentation and Measurement Systems (4)
Restricted ME Laboratory Course (4)
Restricted ME Analysis Elective (4)
Restricted ME Design Elective (4)
Restricted ME Analysis or Design Elective (3)
Free Electives (1)
*Synthesis Courses (6)[1]

Total=180

Footnotes:
* Baccalaureate Core Course
^ Writing Intensive Course
[E] Required for entry into the professional program.
[1] Must be selected to satisfy baccalaureate core requirements.
[5] Prerequisite for upper-division courses. Recommended for completion prior to entry into the professional program.

MATERIALS SCIENCE (MS, PhD)

Graduate Areas of Concentration
Chemistry, chemical engineering, civil engineering, electrical and computer engineering, forest products, mathematics, mechanical engineering, nuclear engineering, physics

Materials science is an interdisciplinary science with roots in many aspects of science and engineering. Reflecting this character, the materials science program at Oregon State University is spread over nine departments in three colleges and there is no department of materials science. Rather, there is a Center for Advanced Materials Research and also a Master of Science and Doctor of Philosophy degree in Materials Science. The Materials Science graduate program is offered by the Graduate School and administered by the program director for the university. The degree emphasizes a core competency in materials science followed by courses in either structural materials or in electronic and magnetic materials. A student should apply for the MSMS program by forwarding an application to the Program Director who will, on approval, forward the application to the resident department(s) within the Colleges of Engineering, Science or Forestry indicated by the applicant. Financial support and thesis guidance is normally provided by the participating department. All graduate faculty members participate in the Center for Advanced Materials Research.

Applications and other inquiries should be forwarded to: Prof. Bill Warnes, Materials Science Program Director, 204 Rogers Hall, Oregon State University, Corvallis, OR, 97331, USA. E-mail: william.warnes@oregonstate.edu.

For more information, visit the website at http://me.oregonstate.edu/students/graduates/matsci/.

MECHANICAL ENGINEERING (MEng, MS, PhD)

Graduate Areas of Concentration
Applied mechanics, applied thermodynamics, biomechanics, combustion, design, design and analysis of mechanical and thermal fluid systems, dynamics, energy, fluid mechanics, heat transfer, materials science, mechanical engineering, physical and mechanical metallurgy, solid mechanics, stress analysis, systems and control

The Department of Mechanical Engineering offers graduate programs leading to the Master of Engineering, Master of Science, and Doctor of Philosophy degrees. Master's degree candidates may pursue thesis or nonthesis options; students in the nonthesis option must complete additional course work where an individual project may be included.

The mechanical engineering field is diverse, therefore research activities in the department encompass a broad range of technical endeavors. Areas of research include applied mechanics, solid mechanics, biomechanics, dynamics, stress analysis, design, systems and control, energy, applied thermodynamics, heat transfer, fluid mechanics, metallurgy, and materials science.

In addition, research activities have been directed toward areas of current interest and need, including wind energy, microscale energy conversion, combustion, composite materials, superconductors, advanced materials, impact dynamics, mechatronics, microscale fluid mechanics, diagnostics in design, design for manufacture and computer-aided design and manufacturing, design and control of complex systems.

MATERIALS SCIENCE GRADUATE MINOR

For more details, see the departmental advisor.

MECHANICAL ENGINEERING GRADUATE MINOR

For more details, see the departmental advisor.

COURSES

ME 101. INTRODUCTION TO MECHANICAL ENGINEERING (3). Orientation to mechanical engineering: methods used in solving engineering problems; experience with typical mechanical engineering projects and problems; ethics, curricula and engineering careers. Lec/rec. **OTHER PREREQS:** Trigonometry.

ME 102. INTRODUCTION TO MECHANICAL ENGINEERING (3). Systematic approaches to engineering problem solving using computers. Flow charting, input/output design, computer programming in a high level language and use of engineering software. Lec/lab. **OTHER PREREQS:** Trigonometry.

ME 206. PROJECTS (1-16). OTHER PREREQS: Sophomore standing.

ME 306. PROJECTS (1-16). OTHER PREREQS: Junior standing.

ME 311. INTRODUCTION TO THERMAL-FLUID SCIENCES (4). Basic concepts of fluid mechanics, thermodynamics and heat transfer are introduced. Conservation of mass, energy, moment and the second law of thermodynamics are included. CROSSLISTED as NE 311. **ENFORCED PREREQS:** (ENGR 212 or ENGR 212H) and (MTH 256 or MTH 256H)

ME 311H. INTRODUCTION TO FLUID-THERMAL SCIENCES (4). Basic concepts of fluid mechanics, thermodynamics and heat transfer are introduced. Conservation of mass, energy, moment and the second law of thermodynamics are included. **ENFORCED PREREQS:** (ENGR 212 or ENGR 212H) and (MTH 256 or MTH 256H) **OTHER PREREQS:** Honors College approval required.

ME 312. THERMODYNAMICS (4). Exergy destruction, machine and cycle processes, law of corresponding states, non-reactive gas mixtures, reactive mixtures, thermodynamics of compressible fluid flow. CROSSLISTED as NE 312. **ENFORCED PREREQS:** (MTH 256 or MTH 256H) and (ENGR 311 or ENGR 311H or ME 311 or ME 311H)

ME 316. MECHANICS OF MATERIALS (3). Determination of stresses, deflections, and stability of deformable bodies with an introduction to finite element analysis. **ENFORCED PREREQS:** ENGR 213 and (MTH 256 or MTH 256H)

ME 317. INTERMEDIATE DYNAMICS (4). Continuation of the study of kinematics and kinetics of particles and rigid bodies, with applications to mechanical systems of current interest to engineers. **ENFORCED PREREQS:** (ENGR 212 or ENGR 212H) and (MTH 256 or MTH 256H) and ME 373*

ME 331. INTRODUCTORY FLUID MECHANICS (4). Introduces the concepts and applications of fluid mechanics and dimensional analysis with an emphasis on fluid behavior, internal and external flows, analysis of engineering applications of incompressible pipe systems, and external aerodynamics. CROSSLISTED as NE 331. **ENFORCED PREREQS:** (MTH 254 or MTH 254H) and (MTH 256 or MTH 256H) and (ENGR 212 or ENGR 212H) and (ENGR 311 or ENGR 311H or ME 311 or ME 311H)

ME 332. HEAT TRANSFER (4). A treatment of conductive, convective and radiative energy transfer using control volume and differential analysis and prediction of transport properties. CROSSLISTED as NE 332. **ENFORCED PREREQS:** (MTH 256 or MTH 256H) and (ENGR 212 or ENGR 212H) and (ENGR 311 or ENGR 311H or ME 311) and (ME 331 or ME 331H or ENGR 331)

ME 332H. HEAT TRANSFER (4). A treatment of conductive, convective and radiative energy transfer using control volume and differential analysis and prediction of transport properties. **ENFORCED PREREQS:** (MTH 256 or MTH 256H) and (ENGR 212 or ENGR 212H) and (ENGR 311 or ENGR 311H or ME 311) and (ME 331 or ME 331H or ENGR 331) **OTHER PREREQS:** Honors College approval required.

ME 373. MECHANICAL ENGINEERING METHODS (3). Analytical and numerical methods for solving representative mechanical engineering problems. Lec. **ENFORCED PREREQS:** MTH 256 or MTH 256H **OTHER PREREQS:** ME 102, or equivalent.

ME 382. INTRODUCTION TO DESIGN (4). Organization, planning, economics, and the use of creativity and optimization in solving mechanical design problems. Case studies and/or industrial design problems. Lec/lab. **ENFORCED PREREQS:** ENGR 248 and ME 316*

ME 383. MECHANICAL COMPONENT DESIGN (4). Failure analysis and design of machine components. Lec/lab. **ENFORCED PREREQS:** ME 382 **OTHER PREREQS:** ME 316.

ME 401. RESEARCH (1-16). May be repeated for a maximum of 9 credits.

ME 403. THESIS (1-16). OTHER PREREQS: Departmental approval required.

ME 405. READING AND CONFERENCE (1-16). May be repeated for a maximum of 9 credits.

ME 405H. READING AND CONFERENCE (1-16). May be repeated for a maximum of 9 credits. **OTHER PREREQS:** Honors College approval required.

ME 406. PROJECTS (1-16). May be repeated for a maximum of 15 credits.

ME 407. SEMINAR (1-16). Senior seminar; may be repeated two times for 2 credits.

ME 407H. SEMINAR (1-16). Senior seminar; may be repeated two times for 2 credits. **OTHER PREREQS:** Honors College approval required.

ME 410. INTERNSHIP (1-16). Credits may not apply toward BS degree in Mechanical Engineering. Graded P/N. **OTHER PREREQS:** Departmental approval required.

ME 413. COMPUTER-AIDED DESIGN (4). Computer-Aided Mechanical Design (CAMD) tools (hardware/software) and their applications to mechanical systems design. Design projects involving the application of CAD constitutes a major portion of the course. Lec/lab. **ENFORCED PREREQS:** ME 383

ME 414. MECHATRONICS (4). Digital control, integration of electronics and microprocessor technology with mechanical systems. Lec/lab. **ENFORCED PREREQS:** ME 373 and ME 430

ME 418. ^SENIOR PROJECT (4). Planning for senior project. (Writing Intensive Course) **ENFORCED PREREQS:** ME 317 and ME 383 and ENGR 322 and (ENGR 312 or ME 312) and (ENGR 332 or ME 332) and WR 327

ME 419. ^SENIOR PROJECT (4). An investigation carried out under the supervision of a faculty member. Project may contain experimental, analytical, or computer work but must be design. A formal written report is required. (Writing Intensive Course) **OTHER PREREQS:** ME 418.

ME 420. APPLIED STRESS ANALYSIS (4). Elasticity theory, failure theories, energy methods, finite element analysis. **ENFORCED PREREQS:** ME 316

ME 422. MECHANICAL VIBRATIONS (4). Dynamic response of single and multiple degree-of-freedom systems. **ENFORCED PREREQS:** ME 317

ME 424. FINITE ELEMENT MODELING OF MECHANICAL ENGINEERING SYSTEMS (3). Application of modern finite element code in the analysis of complex mechanical engineering systems. Extensive use of engineering workstations. Lec/lab. **ENFORCED PREREQS:** ME 422/ME 520.

ME 430. SYSTEMS DYNAMICS AND CONTROL (4). Modeling and analysis of linear continuous systems in time and frequency domains. Fundamentals of single-input-single output control system design. **ENFORCED PREREQS:** ME 317

ME 441. THERMAL/FLUID SYSTEM DESIGN (3). Fluid system components, including pumps, fans, turbines, compressors, heat exchangers, piping, and ducting systems. Students design systems integrating these components. Project work with written and oral reports. Lec/lab. **ENFORCED PREREQS:** (ENGR 312 or ME 312) and (ENGR 332 or ME 332) and ENGR 390 and ME 373 and ME 383

ME 442. THERMAL MANAGEMENT IN ELECTRONIC SYSTEMS (4). Intermediate heat transfer course focusing on the problem of cooling electronic components, microprocessors, printed circuit boards, and large electronic structures such as computers where a more integrated thermal management approach must be taken. A finite element heat transfer package is introduced as an analysis tool for the course. **ENFORCED PREREQS:** ENGR 332 or ME 332

ME 444. ADVANCED POWER GENERATION SYSTEMS (4). Thermal mechanical evaluation of modern power generation technologies, including fossil and nuclear Rankine cycle power plants, gas turbines, cogeneration power plants, distributed power generation and fuel cells. Lec/rec. **ENFORCED PREREQS:** (ENGR 312 or ME 312) and (ENGR 332 or ME 332)

ME 445. INTRODUCTION TO COMBUSTION (3). Study of combustion science based on the background of chemistry, thermodynamics, fluid mechanics and heat transfer. Stoichiometry, energetics of chemical reactions, flame temperature, equilibrium product analyses, chemical kinetics, and chain reactions. **ENFORCED PREREQS:** (ENGR 312 or ME 312) and (ENGR 332 or ME 332)

ME 450. HEAT TRANSFER IN MANUFACTURING PROCESSES (3). An intermediate heat transfer course seeking to lay a foundation for determining the heating and cooling patterns and loads associated with a variety of modern and classical manufacturing processes. Lec. **ENFORCED PREREQS:** (ENGR 312 or ME 312) and (ENGR 332 or ME 332) **OTHER PREREQS:** Or equivalent.

ME 451. INTRODUCTION TO INSTRUMENTATION AND MEASUREMENT SYSTEMS (4). Function, operation, and application of common mechanical engineering instruments, measurement principles, and statistical analysis. Major elements of measurement systems, including transduction, signal conditioning, and data recording. Function and operation of digital data acquisition systems. Lec/lab. **ENFORCED PREREQS:** (ENGR 311 or ENGR 311H or ME 311 or ME 311H) and ME 316 and ME 317 and ME 373

ME 452. THERMAL AND FLUIDS SCIENCES LABORATORY (4). Course emphasis is on experiments related to thermodynamics, heat transfer, and fluid mechanics. Proper experimental methods, data and uncertainty analysis related to thermal and fluids measurements are discussed. **ENFORCED PREREQS:** ME 451

ME 453. STRUCTURE AND MECHANICS LABORATORY (4). Techniques for measurement of structural response and material properties. Proper use of rosette strain gauges, load cells, and displacement transducers. Full-field strain measurement using photoelasticity and digital image correlation. Proper implementation of material testing standards. Characterization of anisotropic composite materials. **ENFORCED PREREQS:** ME 451

ME 454. DYNAMIC MECHANICAL SYSTEMS LABORATORY (4). Design, implementation, and use of portable digital data acquisition systems for characterization and control of dynamic mechanical systems. Emphasis on durable systems developed for harsh environments. **ENFORCED PREREQS:** ME 451

ME 460. INTERMEDIATE FLUID MECHANICS (4). Ideal fluid flow including potential flow theory. Introduction to compressible flow. Viscous flow and boundary layer theory. Introduction to turbulence. **ENFORCED PREREQS:** (ENGR 331 or ENGR 331H or ME 331) and ME 373 **OTHER PREREQS:** ME 331 or equivalent.

ME 461. GAS DYNAMICS (3). Dynamics and thermodynamics of compressible fluid flow. One-dimensional isentropic flow, nozzles, diffusers, normal and oblique shocks. Flow with friction and heating. Two-dimensional Prandtl-Meyer flow and method of characteristics. Computer solutions to general gas dynamic flow. **ENFORCED PREREQS:** ENGR 312 and (ENGR 331 or ENGR 331H or ME 331)

ME 477. SOLIDIFICATION (3). Thermodynamics, kinetics and structure of non-crystalline solids and liquids; glass transition and relaxation phenomena; mechanical properties and application of amorphous materials.

ME 478. THIN FILM MATERIALS CHARACTERIZATION AND PROPERTIES (3). Processing of thin films and characterization of the microstructure; diffusion and solid state reactions; mechanical, magnetic and electronic properties of thin films. **ENFORCED PREREQS:** (ENGR 311 or ENGR 311H) and ENGR 321 and ENGR 322

ME 479. AMORPHOUS MATERIALS (3). Thermodynamics, kinetics and structure of non-crystalline solids and liquids; glass transition and relaxation phenomena; mechanical properties and applications of amorphous materials. **ENFORCED PREREQS:** (ENGR 311 or ENGR 311H) and ENGR 321 and ENGR 322

ME 480. MATERIALS SELECTION (3). Selecting materials for engineering applications. The major families of materials, their properties, and how their properties are controlled; case studies and design projects emphasizing materials selection. **ENFORCED PREREQS:** ENGR 322

ME 481. THERMODYNAMICS OF SOLIDS (3). Thermodynamics of solutions and phase equilibrium. Phase diagrams and invariant reactions. Order and disorder in solutions. Applications to advanced materials development. **ENFORCED PREREQS:** ENGR 321

ME 482. RATE PROCESSES IN MATERIALS (3). Diffusion in solids, including vacancy and interstitial and short-circuit diffusion. Phase transformations including classic nucleation and growth theory. Applications to materials development. Laboratory will emphasize microstructural evaluation and quantitative metallography. **ENFORCED PREREQS:** ME 481

ME 483. COMPOSITE MATERIALS (3). Fibers and matrices, mechanics of composites, reinforcement and failure mechanisms, properties and applications. Lec/lab. **ENFORCED PREREQS:** ENGR 322

ME 484. FRACTURE OF MATERIALS (3). Fracture mechanics and fatigue mechanisms: mechanisms of ductile and brittle fracture. Environmentally induced fracture and fatigue. Considerations in design of engineering materials and structures will be discussed. **ENFORCED PREREQS:** ENGR 322

ME 487. DISLOCATIONS AND THE MECHANICAL BEHAVIOR OF MATERIALS (3). Imperfections in crystalline solids. Planar, line and point defects in solids. Emphasis will be placed on vacancies and dislocations. The static and dynamic features of dislocations will be discussed. Discussions on role of imperfections on materials behavior and development will be included. **ENFORCED PREREQS:** ENGR 322

ME 493. MECHANICAL COMPONENT ANALYSIS (3). Advanced techniques for the analysis of mechanical components. Lec/rec. **ENFORCED PREREQS:** ME 383

ME 501. RESEARCH (1-16). May be repeated many times.

ME 502. INDEPENDENT STUDIES (1-16).

ME 503. THESIS (1-16). May be repeated many times.

ME 505. READING AND CONFERENCE (1-16). May be repeated many times.

ME 506. PROJECTS (1-16). May be repeated many times.

ME 507. SEMINAR (1-16). May be repeated many times.

ME 508. THERMAL FLUID SCIENCE SEMINAR (1). Student participation seminar experience for 1 course credit. Students will present and listen to seminars concerning ongoing research within the thermal fluid sciences.

ME 511. CAD/CAM III (3). Tolerance analysis and application in design/manufacturing practice. Tolerance specification, analysis, ANSI and ISQ standards, computer-based metrology for qualification of parts, management of imperfect geometry through geometric dimensioning and tolerancing. **OTHER PREREQS:** Advanced engineering undergraduate or graduate standing.

ME 512. KINEMATIC DESIGN OF LINKAGES (4). Freedom and constraint in mechanical systems. Methods of planar linkage analysis and synthesis. Simulation of mechanism dynamics. Lec/lab. **OTHER PREREQS:** ME 317.

ME 514. MECHATRONICS (3). Digital control, integration of electronics and microprocessor technology with mechanical systems. Lec/lab. **OTHER PREREQS:** ME 373, ME 430.

ME 517. OPTIMIZATION IN DESIGN (3). Optimization methods as applied to engineering design, theory and application of nonlinear optimization techniques for multivariate unconstrained and constrained problems. Model boundedness and sensitivity. Not offered every year. **OTHER PREREQS:** ME 383, ME 413.

ME 518. THE CONCURRENT DESIGN OF PRODUCTS (3). Concurrent design requires the systematic communication of information across the entire product development and manufacturing enterprise. Focuses on the structure and methods to enable concurrent design. These methods include the management of design information, quality function deployment (QFS), functional modeling, design for assembly (DFA), parametric design, and others.

ME 519. SELECTED TOPICS IN DESIGN (3). Topics in mechanical design selected from the following: design processes, quality engineering, design for assembly, statistical machine design, the Taguchi method, and parametric design.

ME 520. APPLIED STRESS ANALYSIS (4). Elasticity theory, failure theories, energy methods, finite element analysis. **OTHER PREREQS:** ME 316.

ME 522. MECHANICAL VIBRATIONS (4). Dynamic response of single and multiple degree-of-freedom systems. **OTHER PREREQS:** ME 317.

ME 523. ADVANCED STRESS ANALYSIS (4). Analytical and finite element techniques applied to plate/shell structures and to nonlinear problems in stress analysis including plasticity effects, creep, large deflections, buckling and contact mechanics. **ENFORCED PREREQS:** ME 520

ME 524. FINITE ELEMENT MODELING OF MECHANICAL ENGINEERING SYSTEMS (3). Application of modern finite element code in the analysis of complex mechanical engineering systems. Extensive use of engineering workstations. Lec/lab. **ENFORCED PREREQS:** ME 422/ME 520.

ME 529. SELECTED TOPICS IN SOLID MECHANICS (3). Advanced topics in solid mechanics emphasizing research applications of current interest.

ME 531. LINEAR MULTIVARIABLE CONTROL SYSTEMS I (4). A graduate course focused on designing control systems where the device to be controlled by a set of linear multivariable differential equations. Lec.

ME 532. LINEAR MULTIVARIABLE CONTROL SYSTEMS II (4). Focuses on designing control systems where the device to be controlled is an uncertain system, yet can be described by a set of linear differential equations. Lec. **ENFORCED PREREQS:** ME 531 **OTHER PREREQS:** Or equivalent.

ME 533. NONLINEAR DYNAMIC ANALYSIS (4). Course focuses on understanding the behavior of nonlinear dynamic systems of interest to mechanical engineers. Lec. **OTHER PREREQS:** ME 317 or equivalent.

ME 534. NONLINEAR MULTIVARIABLE CONTROL SYSTEMS (4). Focuses on designing control systems when the device to be controlled is mathematically described by a nonlinear set of differential equations. Lec. **ENFORCED PREREQS:** ME 533 **OTHER PREREQS:** Or equivalent.

ME 535. ADVANCED DYNAMICS (4). A graduate course focused on dynamics of rigid bodies using Newtonian mechanics. Lec. **OTHER PREREQS:** ME 317 or equivalent.

ME 536. ADVANCED DYNAMICS (4). A graduate course focused on dynamics of rigid bodies using analytical mechanics. Lec. Offered alternate years. **ENFORCED PREREQS:** ME 535 **OTHER PREREQS:** Or equivalent.

ME 537. VIBRATION ANALYSIS (3). Analytical mechanics and the fundamental equations of vibrating mechanical systems; inertia, stiffness, and flexibility matrices and their relationships with kinetic and potential energies. Prediction of response of multi-degree-of-freedom and distributed-parameter systems using normal coordinates. Offered alternate years. **OTHER PREREQS:** ME 422/ME 522.

ME 539. SELECTED TOPICS IN DYNAMICS (3). Advanced topics in dynamics emphasizing research applications of current interest.

ME 542. THERMAL MANAGEMENT IN ELECTRONIC SYSTEMS (4). Intermediate heat transfer course focusing on the problem of cooling electronic components, microprocessors, printed circuit boards, and large electronic structures such as computers where a more integrated thermal management approach must be taken. A finite element heat transfer package is introduced as an analysis tool for the course. **OTHER PREREQS:** ENGR 332 or ME 332.

ME 544. ADVANCED POWER GENERATION SYSTEMS (4). Thermal mechanical evaluation of modern power generation technologies, including fossil and nuclear Rankine cycle power plants, gas turbines, cogeneration power plants, distributed power generation and fuel cells. Lec/rec. **OTHER PREREQS:** ENGR 312 and (ENGR 332 or ME 332).

ME 545. INTRODUCTION TO COMBUSTION (3). Study of combustion science based on the background of chemistry, thermodynamics, fluid mechanics and heat transfer. Stoichiometry, energetics of chemical reactions, flame temperature, equilibrium product analyses, chemical kinetics, and chain reactions. **OTHER PREREQS:** (ENGR 312 or ME 312) and (ENGR 332 or ME 332).

ME 546. CONVECTION HEAT TRANSFER (3). An advanced treatment of forced and natural convection heat transfer processes emphasizing underlying physical phenomena. Current topical literature will be considered; analytical and numerical problem solving is included. **OTHER PREREQS:** (ENGR 332 or ME 332) and ME 373.

ME 547. CONDUCTIVE HEAT TRANSFER (3). Analytical and numerical solutions to steady state and transient conduction problems. **OTHER PREREQS:** (ENGR 332 or ME 332) and ME 373.

ME 548. RADIATION HEAT TRANSFER (3). Analytical and numerical methods of solution of thermal radiation problems. **OTHER PREREQS:** (ENGR 332 or ME 332) and ME 373.

ME 549. SELECTED TOPICS IN HEAT TRANSFER (3). Topics in heat transfer including advanced problems in conduction, radiation, and convection. Additional examination of heat transfer in multiphase systems, inverse problems, combined modes, equipment design, solution techniques and other topics of current interest considered, including extensive use of current literature. Not all topics covered each year.

ME 550. HEAT TRANSFER IN MANUFACTURING PROCESSES (3). An intermediate heat transfer course seeking to lay a foundation for determining the heating and cooling patterns and loads associated with a variety of modern and classical manufacturing processes. Lec. **OTHER PREREQS:** (ENGR 312 or ME 312) and (ENGR 332 or ME 332) or equivalent.

ME 552. MEASUREMENTS IN FLUID MECHANICS AND HEAT TRANSFER (4). Course emphasis is on measurement techniques and data analysis methods related to fluid mechanics and heat transfer. Proper experimental methods, data and uncertainty analyses related to thermal and fluids measurements are discussed. Local and spatial mapping of fluid and thermal fields are highlighted. **OTHER PREREQS:** ENGR 331, ENGR 332, ME 451 or equivalent.

ME 553. STRUCTURE AND MECHANICS LABORATORY (4). Techniques for measurement of structural response and material properties. Proper use of rosette strain gauges, load cells, and displacement transducers. Full-field strain measurement using photoelasticity and digital image correlation. Proper implementation of material testing standards. Characterization of anisotropic composite materials. **OTHER PREREQS:** ME 451.

ME 560. INTERMEDIATE FLUID MECHANICS (4). Ideal fluid flow including potential flow theory. Introduction to compressible flow. Viscous flow and boundary layer theory. Introduction to turbulence. **OTHER PREREQS:** ME 331 or equivalent.

ME 561. GAS DYNAMICS (3). Dynamics and thermodynamics of compressible fluid flow. One-dimensional isentropic flow, nozzles, diffusers, normal and oblique shocks. Flow with friction and heating. Two-dimensional Prandtl-Meyer flow and method of characteristics. Computer solutions to general gas dynamic flow. **OTHER PREREQS:** ENGR 312 and (ENGR 331 or ME 331)

ME 565. INCOMPRESSIBLE FLUID MECHANICS (3). Generalized fluid mechanics; kinematics; methods of description, geometry of the vector field, dynamics of nonviscous fluids, potential motion, two-dimensional potential flow with vorticity.

ME 566. VISCOUS FLOW (3). Boundary layer, stability, transition prediction methods, computational methods in fluid mechanics, recent developments. **ENFORCED PREREQS:** ME 565

ME 567. ENGINEERING APPLICATIONS OF COMPUTATIONAL FLUID DYNAMICS (4). Basic concepts of computational fluid dynamics, a technique used for solving fully three-dimensional fluid flow problems with no exact solution, will be discussed and applied to general engineering applications using commercially available software. Lec. **OTHER PREREQS:** ENGR 312 and (ENGR 331 or ME 331).

ME 569. SELECTED TOPICS IN FLUID MECHANICS (3). Topics in fluid mechanics emphasizing research applications of current interest.

ME 575. NUMERICAL METHODS FOR ENGINEERING ANALYSIS (3). Numerical solutions of linear equations, difference equations, ordinary and partial differential equations. Emphasis on partial differential equation solution techniques relevant to mechanical engineering. **OTHER PREREQS:** ME 373.

ME 577. SOLIDIFICATION (3). Thermodynamics, kinetics and structure of non-crystalline solids and liquids; glass transition and relaxation phenomena; mechanical properties and application of amorphous materials.

ME 578. THIN FILM MATERIALS CHARACTERIZATION AND PROPERTIES (3). Processing of thin films and characterization of the microstructure; diffusion and solid state reactions; mechanical, magnetic and electronic properties of thin films. **OTHER PREREQS:** ENGR 311 and ENGR 321 and ENGR 322.

ME 579. AMORPHOUS MATERIALS (3). Thermodynamics, kinetics and structure of non-crystalline solids and liquids; glass transition and relaxation phenomena; mechanical properties and applications of amorphous materials. **OTHER PREREQS:** ENGR 311 and ENGR 321 and ENGR 322.

ME 580. MATERIALS SELECTION (3). Selecting materials for engineering applications. The major families of materials, their properties, and how their properties are controlled; case studies and design projects emphasizing materials selection. **OTHER PREREQS:** ENGR 322.

ME 581. THERMODYNAMICS OF SOLIDS (3). Thermodynamics of solutions and phase equilibrium. Phase diagrams and invariant reactions. Order and disorder in solutions. Applications to advanced materials development. **OTHER PREREQS:** ENGR 321.

ME 582. RATE PROCESSES IN MATERIALS (3). Diffusion in solids, including vacancy and interstitial and short-circuit diffusion. Phase transformations including classic nucleation and growth theory. Applications to materials development. Laboratory will emphasize microstructural evaluation and quantitative metallography. **ENFORCED PREREQS:** ME 581

ME 583. COMPOSITE MATERIALS (3). Fibers and matrices, mechanics of composites, reinforcement and failure mechanisms, properties and applications. Lec/lab. **OTHER PREREQS:** ENGR 322.

ME 584. FRACTURE OF MATERIALS (3). Fracture mechanics and fatigue mechanisms: mechanisms of ductile and brittle fracture. Environmentally induced fracture and fatigue. Considerations in design of engineering materials and structures will be discussed. **OTHER PREREQS:** ENGR 322.

ME 586. CREEP (3). Time-dependent plasticity of solids at lower and especially elevated temperatures. Dislocation and diffusion theory as particularly relevant to the dependent flow. **ENFORCED PREREQS:** ME 581 **OTHER PREREQS:** ENGR 322.

ME 587. DISLOCATIONS AND THE MECHANICAL BEHAVIOR OF MATERIALS (3). Imperfections in crystalline solids. Planar, line and point defects in solids. Emphasis will be placed on vacancies and dislocations. The static and dynamic features of dislocations will be discussed. Discussions on role of imperfections on materials behavior and development will be included. **OTHER PREREQS:** ENGR 322.

ME 588. STRUCTURE OF MATERIALS (3). The space lattice; diffraction of x-rays by crystals; experimental techniques in x-ray and electron diffraction; electron microscopy; alloy phase transformations; microstructural examination techniques; other selected topics. Not offered every year. **OTHER PREREQS:** Graduate standing.

ME 589. SELECTED TOPICS IN MATERIALS (3). Topics in materials science to correspond to areas of graduate research. Topics will be chosen from the following list: optical materials, dielectrics, oxidation and corrosion, ceramics, thermophysical properties, polymers and viscoelasticity, coatings and thin films.

ME 593. MECHANICAL COMPONENT ANALYSIS (3). Advanced techniques for the analysis of mechanical components. Lec/rec. **OTHER PREREQS:** ME 383.

ME 596. SELECTED TOPICS IN THERMODYNAMICS (3). Topics in thermodynamics including advanced problems in classical thermodynamics and statistical thermodynamics of current interest. Topics will likely be considered, including extensive use of literature. Not all topics covered each year.

ME 597. RESEARCH IN MECHANICAL ENGINEERING (3). Research topics in mechanical engineering that are of current interest and that may involve multiple specialty areas. Not offered every year.

ME 599. SELECTED TOPICS IN MECHANICAL ENGINEERING (3).

ME 601. RESEARCH (1-16). May be repeated.

ME 603. THESIS (1-16). May be repeated many times. **OTHER PREREQS:** PhD students only.

ME 605. READING AND CONFERENCE (1-16). May be repeated many times. **OTHER PREREQS:** PhD students only.

ME 606. PROJECTS (1-16). May be repeated. **OTHER PREREQS:** PhD students only.

ME 607. SEMINAR (1-16). May be repeated many times. **OTHER PREREQS:** PhD students only.

ME 622. RANDOM VIBRATION, SYSTEM IDENTIFICATION AND FILTERING (4). Random mechanical vibration, experimental and analytical system identification, and filtering methods. Lec. **ENFORCED PREREQS:** ME 522 **OTHER PREREQS:** Or equivalent.

ME 667. COMPUTATIONAL FLUID DYNAMICS (3). Application of modern computational techniques to solve a wide variety of fluid dynamics problems including both potential and viscous flow with requirements for computer code development. **ENFORCED PREREQS:** (ME 560 or ME 565 or ME 566) and ME 575 **OTHER PREREQS:** Or equivalent.

ME 682. ADVANCED PHASE TRANSFORMATIONS (3). Solidification and melting; phase separation in the solid liquid state; structural magnetic and superconduction ordering phenomena, interfacial reactions; martensitic transformations. **ENFORCED PREREQS:** ME 581 and ME 582

NUCLEAR ENGINEERING AND RADIATION HEALTH PHYSICS

EAC/ABET Accredited
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FACULTY

Professors Higginbotham[1,9], Higley[9], Klein[1], Reyes[1]
Associate Professors Hamby, Palmer, Wu
Assistant Professor Hartman, Woods
Instructor Reese[9]
Emeritus Professors Binney[1,9], Johnson, Ringle, Robinson[1]
Senior Research Assistant Professor Paulenova
[1] *Licensed Professional Engineer,*
[9] *Certified Health Physicist*

Undergraduate Major

Nuclear Engineering (BS)
Radiation Health Physics (BS)

Minors

Nuclear Engineering
Radiation Health Physics

Graduate Majors

Nuclear Engineering (MEng, MS, PhD)

Graduate Areas of Concentration
Application of Nuclear Techniques
Arms Control Technology
Nuclear Instrumentation and Applications
Nuclear Medicine
Nuclear Power Generation
Nuclear Reactor Engineering
Nuclear Systems Design and Modeling
Nuclear Waste Management
Numerical Methods For Reactor Analysis
Radiation Shielding
Radioisotope Production
Space Nuclear Power
Thermal Hydraulics

Radiation Health Physics (MS, PhD)

Graduate Areas of Concentration
Application of Nuclear Techniques
Boron Neutron Capture Therapy
Emergency Response Planning
Environmental Monitoring
Environmental Pathways Assessment
Nuclear Medicine
Radiation Detection and Instrumentation

Radiation Dosimetry
Radiation Shielding
Radioactive Material Transport
Radioactive Waste Management
Research Reactor Health Physics
Risk Assessment

Master of Health Physics in Radiation Health Physics (MHP)

Graduate Minors
Nuclear Engineering
Radiation Health Physics

The Department of Nuclear Engineering and Radiation Health Physics at Oregon State University offers BS, MS, and PhD degrees in nuclear engineering and in radiation health physics and the Master of Health Physics in Radiation Health Physics degree (MHP). The BS in Radiation Health Physics degree may also be taken as a premedical track.

Excellent facilities are available for the instructional and research programs at the Radiation Center, including a TRIGA Mark II nuclear reactor and the AP-600 1/4 scale test facility. Instruction is integrated with an extensive research program, with opportunities to participate at both the undergraduate and graduate levels.

The mission of the Department of Nuclear Engineering and Radiation Health Physics is to educate students to become nuclear engineers and health physicists with the ability to achieve the highest standards of the profession and to support the needs of industry, government, and the nation.

The Nuclear Engineering undergraduate program objectives are:

1. To produce graduates with a high level of competency in the nuclear engineering core curriculum.
2. To produce graduates with a high level of competency in engineering and science.
3. To produce graduates that can work effectively in both individual and team environments.
4. To produce graduates with effective communication skills.
5. To produce graduates with a high regard for their profession and their responsibility to lifelong learning.

The objectives of the nuclear engineering and radiation health physics undergraduate curricula are to prepare students for careers related to the many beneficial uses of nuclear technology and energy. Nuclear engineers apply scientific principles to the research, design, and operation of a wide variety of nuclear technology applications including power generation, medicine, and radioactive waste management. Radiation health physicists study methods used to protect people and their environment from radiation hazards while enabling the beneficial uses of radiation and radioactive materials. In addition, emphasis is provided in nuclear instrumentation, nuclear systems and materials, radiation protection, reactor analysis and nuclear power economics and, particularly, safety and regulation in nuclear operations.

The Department of Nuclear Engineering and Radiation Health Physics aims to educate students majoring in Radiation Health Physics to become radiation health physicists with the ability to achieve the highest standards of the profession and to support the needs of industry, government, and the nation.

The Radiation Health Physics undergraduate program objectives are:

1. To produce graduates with a high level of competency in the radiation health physics core curriculum.
2. To produce graduates with a high level of competency in the biological and physical sciences.
3. To produce graduates that can work effectively in both individual and team environments.
4. To produce graduates with effective communication skills.
5. To produce graduates with a high regard for their profession and their responsibility to lifelong learning.

Radiation Health Physics is a specialized program in the Department of Nuclear Engineering and Radiation Health Physics for students with a professional interest in the field of radiation protection, also known as health physics. It involves an integrated study of the physical aspects of ionizing and non-ionizing radiation, their biological effects, and the methods used to protect people and their environment from radiation hazards while still enabling the beneficial uses of radiation and radioactive material.

PRE-MED TRACK

Students in radiation health physics can also pursue a pre-med track in which they fulfill the requirements for the BS in Radiation Health Physics degree, as well as the course work expected for entrance into most medical schools.

CERTIFIED HEALTH PHYSICIST

Students completing the radiation health physics degree will be eligible to take Part I of the Certified Health Physics (CHP) Examination of the American Board of Health Physics after one year of applied health physics practice. After six years of responsible professional experience in health physics, graduates will be eligible to take Part II of the CHP examination.

NUCLEAR ENGINEERING (BS, CRED, HBS)

The objectives of the nuclear engineering and radiation health physics undergraduate curricula are to prepare students for careers related to the many beneficial uses of nuclear technology and energy. Nuclear engineers apply scientific principles to the research, design, and operation of a wide variety of nuclear technology applications including power generation, medicine, and radioactive waste management. Radiation health physicists study methods used to protect people and their environment from radiation hazards while enabling the beneficial uses of radiation and radioactive materials. In addition, emphasis is provided in nuclear instrumentation, nuclear systems and materials, radiation protection, reactor analysis and nuclear power economics and, particularly, safety and regulation in nuclear operations.

Pre-Nuclear Engineering

Freshman Year (46)

CH 201. Chemistry for Engineering Majors (3)[E]
CH 202. Chemistry for Engineering Majors (3)
COMM 111. *Public Speaking (3)[E]
or COMM 114. *Argument and Critical Discourse (3)[E]
HHS 231. *Lifetime Fitness for Health (2)
HHS 241–HHS 248. *Lifetime Fitness: (various activities) (1)
MTH 251. *Differential Calculus (4)[E]
MTH 252. Integral Calculus (4)[E]
MTH 254. Vector Calculus I (4)[E]
NE 114. Intro to Nuclear Engineering and Radiation Health Physics (2)
NE 115. Intro to Nuclear Engineering and Radiation Health Physics (2)[E]
NE 116. Intro to Nuclear Engineering and Radiation Health Physics (2)
PH 211. *General Physics with Calculus (4)[E]
WR 121. *English Composition (3)[E]
Free Elective (3)
*Perspectives Courses (6)[1]

Sophomore Year (47)

Biological Science Elective (4)[1]
ENGR 201. Electrical Fundamentals (3)
ENGR 211. Statics (3)[E]
ENGR 212. Dynamics (3)[E]
ENGR 213. Strength of Materials (3)
ENGR 248. Engineering Graphics and 3-D Modeling (3)
MTH 256. Applied Differential Equations (4)[E]
MTH 306. Matrix and Power Series Methods (4)[E]
NE 234, NE 235. Nuclear and Radiation Physics I, II (4,4)
NE 236. Nuclear Radiation Detection and Instrumentation (4)
PH 212, PH 213. *General Physics with Calculus (4,4)[E]

Professional Nuclear Engineering

Junior Year (45)

ENGR 321. Materials Science (3)
ENGR 390. Engineering Economy (3)
ME 373. Mechanical Engineering Methods (3)
NE 311. Intro to Thermal-Fluid Sciences (4)
NE 312. Thermodynamics (4)
NE 331. Introductory Fluid Mechanics (4)
NE 332. Heat Transfer (4)
NE 481. Radiation Protection (4)
WR 327. *Technical Writing (3)[1]
Free Electives (3)
*Perspectives Course (3)[1]
Restricted Elective (4)[3]
*Synthesis Course (3)

Senior Year (42)

NE 407. Nuclear Engineering Seminar (3 terms) (1,1,1)
NE 415. Nuclear Rules and Regulations (2)[6]
NE 451, NE 452. Neutronic Analysis and Lab I, II, (4,4)
NE 467. Nuclear Reactor Thermal Hydraulics (4)
NE 474, NE 475. Nuclear Systems Design I, II (4,4)
NE 490. Radiation Dosimetry (4)
*Difference, Power, and Discrimination Course (3)[1]
*Perspectives Course (3)[1]
Restricted Elective (4)[3]
*Synthesis Course (3)[1]

Total=180

Footnotes

* Baccalaureate core course (BCC)
^ Writing intensive course (WIC)
[E] Required for entry into the professional program.
[1] Must be selected to satisfy baccalaureate core requirements.
[2] Approved engineering science elective from departmental list.
[3] Approved technical electives from departmental list.
[4] Recommended to satisfy core requirement.
[5] Prerequisite for several upper-division courses. Recommended for completion prior to entry into the professional program.
[6] Taught alternate years.

RADIATION HEALTH PHYSICS (BS, CRED, HBS)

Radiation health physics is a specialized program in the Department of Nuclear Engineering and Radiation Health Physics for students with a professional interest in the field of radiation protection, also known as health physics. It involves an integrated study of the physical aspects of ionizing and non-ionizing radiation, their biological effects, and the methods used to protect people and their environment from radiation hazards while still enabling the beneficial uses of radiation and radioactive material.

PRE-RADIATION HEALTH PHYSICS

Freshman Year (46)

CH 121, CH 122, CH 123. *General Chemistry (5,5,5)[E]
or CH 221, CH 222, CH 223. *General Chemistry (5,5,5)[E]
COMM 111. *Public Speaking (3)[1,E]
or COMM 114. *Argument and Critical Discourse (3)[1,E]
CS 101. Computers: Applications and Implications (4)
or CS 151. Intro to C Programming (4)
MTH 251. *Differential Calculus (4)[E]
MTH 252. Integral Calculus (4)[E]
MTH 268. Mathematical Ideas in Biology (4)
RHP 114. Intro to Nuclear Engineering and Radiation Health Physics (2)
RHP 115. Intro to Nuclear Engineering and Radiation Health Physics (2)[E]
RHP 116. Intro to Nuclear Engineering and Radiation Health Physics (2)
WR 121. *English Composition (3)[1,E]
*Perspectives Course (3)[1]

Sophomore Year (45)

BI 211, BI 212, BI 213. *Principles of Biology (4,4)[E]
BI 213. *Principles of Biology (4)
HHS 231. *Lifetime Fitness for Health (2)[1]
HHS 241–HHS 248. *Lifetime Fitness: (various activities) (1)[1]
PH 201, PH 202, PH 203. *General Physics (5,5,5)[E]
or PH 211, PH 212, PH 213. *General Physics with Calculus (4,4,4)[E]
plus free elective (3)
RHP 234, RHP 235. Nuclear and Radiation Physics I, II (4,4)
RHP 236. Nuclear Radiation Detection and Instrumentation (4)
*Perspectives Course (3)[1]

Professional Radiation Health Physics

Junior Year (44)

RHP 481. Radiation Protection (4)
ST 201, ST 202. Principles of Statistics (3,3)
or ST 314. Intro to Statistics for Engineers (3)
plus free elective (3)
WR 327. *Technical Writing (3)
Z 331. Human Anatomy and Physiology (3)
*Difference, Power, and Discrimination course (3)[1]
Electives (restricted in Health) (3)
Free Electives (3)
*Perspectives Courses (6)[1]
Restricted Electives (10)[3]
*Synthesis Course (3)[1]

Senior Year (45)

H 425. Foundations of Epidemiology (3)
RHP 406. ^Projects (3)
RHP 407. Seminar in Radiation Health Physics (3 terms) (1,1,1)
RHP 415. Nuclear Rules and Regulations (2)[6]
RHP 483. Radiation Biology (4)[6]
RHP 488. Radioecology (3)
RHP 490. Radiation Dosimetry (4)
Electives (restricted in Health) (9)
Free Electives (8)
Restricted Elective (3)[3]
*Synthesis Course (3)[1]

Total=180

RADIATION HEALTH PHYSICS (PRE-MED TRACK)

Students in radiation health physics can also pursue a pre-med track in which they fulfill the requirements for the BS in Radiation Health Physics degree, as well as the course work expected for entrance into most medical schools.

Freshman Year (47)

BI 109. Health Professions: Medical (1)
CH 221, CH 222, CH 223. *General Chemistry (5,5,5)[E]
COMM 111. *Public Speaking (3)[E]
or COMM 114. *Argument and Critical Discourse (3)[E]
CS 101. Computers: Applications and Implications (4)
or CS 151. Intro to C Programming (4)
MTH 251. *Differential Calculus (4)[E]
MTH 252. Integral Calculus (4)[E]
MTH 268. Mathematical Ideas in Biology (4)
RHP 114. Intro to Nuclear Engineering and Radiation Health Physics (2)
RHP 115. Intro to Nuclear Engineering and Radiation Health Physics (2)[E]
RHP 116. Intro to Nuclear Engineering and Radiation Health Physics (2)
WR 121. *English Composition (3)[E]
Perspectives Course (3)[1]

Sophomore Year (48)

BI 211. *Principles of Biology (4)[E]
BI 212. *Principles of Biology (4)[E]
BI 213. *Principles of Biology (4)
HHS 231. *Lifetime Fitness for Health (2)[1]
HHS 241–HHS 248. *Lifetime Fitness: (various activities) (1)[1]
PH 201, PH 202, PH 203. *General Physics (5,5,5)[E]
or PH 211, PH 212, PH 213. *General Physics with Calculus (4,4,4)[E]
plus free elective (3)
RHP 234, RHP 235. Nuclear and Radiation Physics I, II (4,4)
RHP 236. Nuclear Radiation Detection and Instrumentation (4)
Perspectives Courses (6)[1]

Professional Radiation Health Physics (Pre-Med Track)

Junior Year (43)

BI 311. Genetics (4)
BI 314. Cell and Molecular Biology (3)
CH 334, CH 335, CH 336. Organic Chemistry (3,3,3)
H 425. Foundations of Epidemiology (3)
RHP 481. Radiation Protection (4)
ST 351. Intro to Statistical Methods (4)
WR 327. *Technical Writing (3)
Z 331, Z 332, Z 333. Human Anatomy and Physiology (3,3,3)
Free Elective (1)
*Synthesis Course (3)[1]

Senior Year (42)
BB 450, BB 451. General Biochemistry (4,3)
CH 337. Organic Chemistry Lab (4)
RHP 406. ^Projects (3)
RHP 407. Seminar in Radiation Health Physics (3 terms) (1,1,1)
RHP 415. Nuclear Rules and Regulations (2)[6]
RHP 483. Radiation Biology (4)[6]
RHP 488. Radioecology (3)
RHP 490. Radiation Dosimetry (4)
*Difference, Power, and Discrimination course (3)[1]
Free Electives (2)
*Perspectives Course (3)[1]
*Synthesis Course (3)[1]

Total=180

Footnotes:
* Baccalaureate Core Course
^ Writing Intensive Course
[E] Required for entry into the professional program.
[1] Must be selected to satisfy the requirements of the baccalaureate core.
[2] Approved engineering science elective from departmental list.
[3] Approved technical electives from departmental list.
[4] Recommended to satisfy core requirement.
[5] Prerequisite for several upper-division courses. Recommended for completion prior to entry into the professional program.
[6] Taught alternate years.

NUCLEAR ENGINEERING MINOR

Students not majoring in nuclear engineering or radiation health physics may take a minor in nuclear engineering.

A minor in nuclear engineering consists of the following courses:
NE 234, NE 235. Nuclear and Radiation Physics I, II (4,4)
NE 451. Neutronic Analysis and Lab I (4)
NE 481. Radiation Protection (4)
Other NE courses (200-level or higher) (12)

Total=28

RADIATION HEALTH PHYSICS MINOR

Students not majoring in radiation health physics or nuclear engineering may take a radiation health physics minor, which consists of the following courses:
RHP 234, RHP 235. Nuclear and Radiation Physics I, II (4,4)
RHP 236. Nuclear Radiation Detection and Instrumentation (4)
RHP 415. Nuclear Rules and Regulations (2)
RHP 481. Radiation Protection (4)
RHP 482. ^Applied Radiation Safety (4)
RHP 483. Radiation Biology (4)
RHP 490. Radiation Dosimetry (4)

Total=30

NUCLEAR ENGINEERING (MEng, MS, PhD)

Graduate Areas of Concentration
Application of nuclear techniques, arms control technology, nuclear instrumentation and applications, nuclear medicine, nuclear power generation, nuclear reactor engineering, nuclear systems design and modeling, nuclear waste management, numerical methods for reactor analysis, radiation shielding, radioisotope production, space nuclear power, thermal hydraulics

The Department of Nuclear Engineering and Radiation Health Physics offers graduate work leading toward the Master of Engineering, Master of Science, and Doctor of Philosophy degrees in nuclear engineering and Master of Science, Master of Arts, and Doctor of Philosophy degrees in radiation health physics.

The nuclear engineering and radiation health physics graduate degree programs are designed to prepare students for careers involved with the many beneficial applications of nuclear energy, radiation, and radioactive materials. The nuclear engineering and radiation health physics professions are essential to society's well-being since they enable significant public benefits through energy security, national defense, medical health, and industrial competitiveness.

In nuclear engineering particular attention is directed toward application of scientific principles to the safe design and operation of nuclear installations. In addition, emphasis is provided in system safety and thermal hydraulic testing, high performance computational methods development, nuclear instrumentation, nuclear systems and materials, radiation protection, reactor analysis, nuclear power economics, and the regulation of nuclear operations.

The radiation health physics graduate curricula and research programs are designed for students with professional interests in the field of radiation protection. This specialized field involves an integrated study of the physical aspects of ionizing and non-ionizing radiation, their biological effects, and the methods used to protect people and their environment from radiation hazards while still enabling the beneficial uses of radiation and radioactive materials.

Competitive fellowships and research and teaching assistantships are available to incoming graduate students. The U.S. Department of Energy and National Academy for Nuclear Training support a number of fellowship programs each year. Oregon State University is one of eight participating universities in the U.S. where students may attend graduate school on the Nuclear Engineering, Health Physics, and Applied Health Physics fellowships sponsored by the U.S. Department of Energy. Each year the National Academy for Nuclear Training also supports fellowships for students entering nuclear engineering and radiation health physics at OSU. Research and teaching assistant opportunities are also available for students to support the educational and research programs conducted by the department.

World-class facilities are available for the instructional and research programs of the department. These are housed in the OSU Radiation Center and include a TRIGA Mark II nuclear reactor, the Advanced Thermal Hydraulic Research Laboratory, the APEX nuclear safety scaled testing facility, and laboratories specially designed to accommodate radiation and the use of radioactive materials.

For more information, visit the department's website at http://www.ne.orst.edu or contact Dr. Qiao Wu, Graduate Committee Chair; Department of Nuclear Engineering and Radiation Health Physics, Oregon State University, 116 Radiation Center, Corvallis, OR 97331-5902. E-mail: qiao.wu@oregonstate.edu.

RADIATION HEALTH PHYSICS (MA, MHP, MS, PhD)

Graduate Areas of Concentration
Application of nuclear techniques, boron neutron capture therapy, emergency response planning, environmental monitoring, environmental pathways assessment, nuclear medicine, radiation detection and instrumentation, radiation dosimetry, radiation shielding, radioactive material transport, radioactive waste management, research reactor health physics, risk assessment

The Department of Nuclear Engineering and Radiation Health Physics offers graduate work leading toward the Master of Science and Doctor of Philosophy degrees in nuclear engineering and Master of Health Physics (MHP), Master of Science, and Doctor of Philosophy degrees in radiation health physics.

The nuclear engineering and radiation health physics graduate degree programs are designed to prepare students for careers involved with the many beneficial applications of nuclear energy, radiation, and radioactive materials. The nuclear engineering and radiation health physics professions are essential to society's well-being since they enable significant public benefits through energy security, national defense, medical health, and industrial competitiveness.

In nuclear engineering particular attention is directed toward application of scientific principles to the safe design and operation of nuclear installations. In addition, emphasis is provided in system safety and thermal hydraulic testing, high performance computational methods development, nuclear instrumentation, nuclear systems and materials, radiation protection, reactor analysis, nuclear power economics, and the regulation of nuclear operations.

The radiation health physics graduate curricula and research programs are designed for students with professional interests in the field of radiation protection. This specialized field involves an integrated study of the physical aspects of ionizing and non-ionizing radiation, their biological effects, and the methods used to protect people and their environment from radiation hazards while still enabling the beneficial uses of radiation and radioactive materials.

Competitive fellowships and research and teaching assistantships are available to incoming graduate students. The U.S. Department of Energy and National Academy for Nuclear Training support a number of fellowship programs each year. Oregon State University is one of eight participating universities in the U.S. where students may attend graduate school on the Nuclear Engineering, Health Physics, and Applied Health Physics fellowships sponsored by the U.S. Department of Energy. Each year the National Academy for Nuclear Training also supports fellowships for students entering nuclear engineering and radiation health physics at OSU. Research and teaching assistant opportunities are also available for students to support the educational and research programs conducted by the department.

World-class facilities are available for the instructional and research programs of the department. These are housed in the OSU Radiation Center and include a TRIGA Mark II nuclear reactor, the Advanced Thermal Hydraulic Research Laboratory, the APEX nuclear safety scaled testing facility, and laboratories specially designed to accommodate radiation and the use of radioactive materials.

For more information, visit the department's website at http://ne.oregonstate.edu/ or contact Dr. Qiao Wu, Graduate Committee Chair; Department of Nuclear Engineering and Radiation Health Physics, Oregon State University, 116 Radiation Center, Corvallis, OR 97331-5902. E-mail: qiao.wu@oregonstate.edu.

MASTER OF HEALTH PHYSICS IN RADIATION HEALTH PHYSICS (MHP)

The program consists of a minimum of 45 credits of course work in the major. An oral examination is required, at a minimum.

Core (18 credits)

RHP 515. Nuclear Rules and Regulations (2)
RHP 581. Radiation Protection (4)
RHP 582. Applied Radiation Safety (4)
RHP 583. Radiation Biology (4)
RHP 590. Radiation Dosimetry (4)

Radiation Health Physics Electives (12 credits)

RHP 507. Seminar in RHP (1)
RHP 516. Radiochemistry (3)
RHP 535. Nuclear Radiation Shielding (3)
RHP 539. Selected Topics in Interaction of Nuclear Radiation (1–3)
RHP 542. Low-Level Radioactive Waste Management (3)
RHP 550. Principles of Nuclear Medicine (3)
RHP 580. Field Practices in Radiation Protection (1–3)
RHP 588. Radioecology (3)
RHP 593. Non-Reactor Radiation Protection (3)

Suggested Additional Electives (15 credits)

ENSC 515. Environmental Perspectives and Methods (3)
ENSC 520. Environmental Analysis (3)
H 511. Environmental Health Policy and Regulations (3)
H 512. Air Quality and Public Health (3)
H 525. Principles and Practice of Epidemiology (3)
H 529. International Health (3)
H 540. Environmental Health (3)
H 543. Environmental Sampling and Analysis (3)
H 549. Health Risk Communication (3)
H 583. Safety and Environmental Health Management (3)
TOX 530. Chemical Behavior in the Environment (3)

NUCLEAR ENGINEERING GRADUATE MINOR

For more details, see the departmental advisor.

RADIATION HEALTH PHYSICS GRADUATE MINOR

For more details, see the departmental advisor.

■ NUCLEAR ENGINEERING

NE 114. INTRO TO NUCLEAR ENGINEERING AND RADIATION HEALTH PHYSICS (2). Introduction to the nuclear engineering and radiation health physics fields; problem-solving techniques; careers in the nuclear industry; engineering ethics; nuclear history; elementary nuclear and reactor physics; basic nuclear fission and fusion theory; reactor types; nuclear safety; nuclear fuel cycle; and radiation protection. CROSSLISTED as RHP 114, RHP 115, RHP 116.

NE 115. INTRO TO NUCLEAR ENGINEERING AND RADIATION HEALTH PHYSICS (2). Introduction to the nuclear engineering and radiation health physics fields; problem-solving techniques; careers in the nuclear industry; engineering ethics; nuclear history; elementary nuclear and reactor physics; basic nuclear fission and fusion theory; reactor types; nuclear safety; nuclear fuel cycle; and radiation protection. CROSSLISTED as RHP 114, RHP 115, RHP 116.

NE 116. INTRO TO NUCLEAR ENGINEERING AND RADIATION HEALTH PHYSICS (2). Introduction to the nuclear engineering and radiation health physics fields; problem-solving techniques; careers in the nuclear industry; engineering ethics; nuclear history; elementary nuclear and reactor physics; basic nuclear fission and fusion theory; reactor types; nuclear safety; nuclear fuel cycle; and radiation protection. CROSSLISTED as RHP 114, RHP 115, RHP 116.

NE 234. NUCLEAR AND RADIATION PHYSICS I (4). Relativistic dynamics; basic nuclear physics; basic quantum mechanics; radioactivity; electromagnetic waves; interaction of ionizing radiation with matter; cross sections; basic atomic structure. CROSSLISTED as RHP 234. **OTHER PREREQS:** MTH 252.

NE 235. NUCLEAR AND RADIATION PHYSICS II (4). Radioactivity; radioactive decay modes; decay kinetics, interaction of neutrons with matter; nuclear reactions; fission and fusion basics; cross sections. CROSSLISTED as RHP 235. **ENFORCED PREREQS:** NE 234 or RHP 234 **OTHER PREREQS:** MTH 252.

NE 236. NUCLEAR RADIATION DETECTION AND INSTRUMENTATION (4). Principles and mechanisms underlying nuclear radiation detection and measurements; operation of nuclear electronic laboratory instrumentation; application of gas-filled, scintillation and semiconductor laboratory detectors for measurement of alpha, beta, gamma, and neutron radiation; experimental investigation of interactions of radiation with matter. CROSSLISTED as RHP 236. **ENFORCED PREREQS:** NE 235 or RHP 235

NE 311. INTRO TO THERMAL-FLUID SCIENCE (4). Basic concepts of fluid mechanics, thermodynamics and heat transfer are introduced. Conservation of mass, energy, moment and the second law of thermodynamics are covered. Lec. CROSSLISTED as ME 311. **ENFORCED PREREQS:** (ENGR 212 or ENGR 212H) and (MTH 256 or MTH 256H)

NE 312. THERMODYNAMICS (4). Energy destruction, machine and cycle processes, Law of Corresponding States, non-reactive gas mixtures, reactive mixtures, thermodynamics of compressible fluid flow. CROSSLISTED as ME 312. **ENFORCED PREREQS:** (NE 311 or ME 311) and MTH 256 **OTHER PREREQS:** NE 311/ME 311, MTH 256

NE 319. *SOCIETAL ASPECTS OF NUCLEAR TECHNOLOGY (3). Description and discussion of nuclear-related issues as they impact society. (Bacc Core Course)

NE 331. INTRODUCTORY FLUID MECHANICS (4). Introduces the concepts and applications of fluid mechanics and dimensional analysis with an emphasis on fluid behavior, internal and external flows, analysis of engineering applications of incompressible pipe systems, and external aerodynamics. CROSSLISTED as ME 331. **OTHER PREREQS:** MTH 254, MTH 256, ENGR 212, ME 311/NE 311.

NE 332. HEAT TRANSFER (4). A treatment of conductive, convective and radiative energy transfer using control volume and differential analysis and prediction of transport properties. CROSSLISTED as ME 332. **ENFORCED PREREQS:** MTH 256 and ENGR 212 and (NE 311 or ME 311) and (ME 331 or NE 331) **OTHER PREREQS:** MTH 256, ENGR 212, ME 311/NE 311, ME 331/NE 331.

NE 401. RESEARCH (1-16). Graded P/N.

NE 405. READING AND CONFERENCE (1-16).

NE 405H. READING AND CONFERENCE (1-16). OTHER PREREQS: Honors College approval required.

NE 406. PROJECTS (1-16).

NE 407. SEMINAR IN NUCLEAR ENGINEERING (1). Lectures on current nuclear engineering topics. CROSSLISTED as RHP 407/RHP 507/ RHP 607. Graded P/N.

NE 410. INTERNSHIP (1-12). Supervised technical work experience at approved organizations. Graded P/N. **OTHER PREREQS:** Upper-division standing.

NE 415. NUCLEAR RULES AND REGULATIONS (2). An introduction to the key nuclear regulatory agencies; major nuclear legislation; current radiation protection standards and organizations responsible for their implementation. Offered alternate years. CROSSLISTED as RHP 415/RHP 515. **OTHER PREREQS:** NE 481 or RHP 481.

NE 416. RADIOCHEMISTRY (3). Selected methods in radiochemical analysis. Actinide chemistry, activation analysis, radionuclide solvent extraction, and microbial reactions with radionuclides. Designed for majors in chemistry, chemical engineering, nuclear engineering, and radiation health physics. CROSSLISTED as CH 416/CH 516, CHE 416/CHE 516, RHP 416/RHP 516. **ENFORCED PREREQS:** (CH 201 and CH 202) or (CH 221 or CH 221H) and (CH 222 or CH 222H) and (CH 223 or CH 223H) or (CH 224H and CH 225H and CH 226H) **OTHER PREREQS:** Or equivalent or instructor approval required.

NE 429. SELECTED TOPICS IN NUCLEAR ENGINEERING (1-3). Topics associated with nuclear engineering not covered in other undergraduate courses; topics may vary from year to year. Course may be repeated for credit. **OTHER PREREQS:** Instructor approval required.

NE 451. NEUTRONIC ANALYSIS AND LAB I (4). Physical models of neutronic systems; nuclear physics; steady state and transient neutronic system behavior; introductory neutron transport theory, one speed diffusion theory; numerical methods; fast and thermal spectrum calculations; multigroup methods; transmutation and burnup; reactor fuel management; reactivity control; perturbation theory; neutronic laboratory sessions. **ENFORCED PREREQS:** (MTH 256 or MTH 256H) and NE 235 and (MTH 351* or ME 373*) **OTHER PREREQS:** CS 151. NE 451 and NE 452 must be taken in order.

NE 452. NEUTRONIC ANALYSIS AND LAB II (4). Physical models of neutronic systems; nuclear physics; steady state and transient neutronic system behavior; introductory neutron transport theory, one speed diffusion theory; numerical methods; fast and thermal spectrum calculations; multigroup methods; transmutation and burnup; reactor fuel management; reactivity control; perturbation theory; neutronic laboratory sessions. **ENFORCED PREREQS:** (MTH 256 or MTH 256H) and NE 235 and (MTH 351* or ME 373*) **OTHER PREREQS:** CS 151. NE 451 and NE 452 must be taken in order.

NE 467. NUCLEAR REACTOR THERMAL HYDRAULICS (4). Hydrodynamics and conductive, convective and radiative heat transfer in nuclear reactor systems. Core heat removal design; critical heat flux, hot spot factors, single- and two-phase flow behavior. Advanced thermal hydraulic computer codes. **ENFORCED PREREQS:** ENGR 332 or ME 332

NE 474. NUCLEAR SYSTEMS DESIGN I (4). Practical design of nuclear power systems using fundamental nuclear engineering skills. Design projects involve the integration of reactor neutronics, dynamics and control, thermal hydraulics, transient analysis, safety analysis, power production, nuclear materials, fuel management and economic optimization. Emphasis is placed on designing advanced reactor systems for power production purposes. State-of-the-art computer codes are used for design analysis and evaluation. **ENFORCED PREREQS:** NE 467 and NE 451* **OTHER PREREQS:** (ENGR 332 or ME 332). NE 474 and NE 475 must be taken in order.

NE 475. NUCLEAR SYSTEMS DESIGN II (4). Practical design of nuclear power systems using fundamental nuclear engineering skills. Design projects involve the integration of reactor neutronics, dynamics and control, thermal hydraulics, transient analysis, safety analysis, power production, nuclear materials, fuel management and economic optimization. Emphasis is placed on designing advanced reactor systems for power production purposes. State-of-the-art computer codes are used for design analysis and evaluation. **ENFORCED PREREQS:** NE 474 and NE 452* **OTHER PREREQS:** NE 474 and NE 475 must be taken in order.

NE 479. INDIVIDUAL DESIGN PROJECT (1-4). Individual project arranged by the student under the supervision of a faculty member. The design project is mutually agreed upon by the student and instructor and may be proposed by either. Number of credits are determined by the faculty member. Specific approval of the instructor is required before enrolling.

NE 481. RADIATION PROTECTION (4). Fundamental principles and theory of radiation protection: regulatory agencies; dose units; source of radiation; biological effects and risk; dose limits; applications of external and internal dosimetry; shielding and atmospheric dispersion. CROSSLISTED as RHP 481/RHP 581. **ENFORCED PREREQS:** NE 235 or RHP 235

NE 482. ^APPLIED RADIATION SAFETY (4). Application of radiation protection as practiced in the fields of nuclear science and engineering; application of health physics principles to reduce health hazards at each of the following stages: design, prevention, assessment, and post-incident. A history of key nuclear regulatory agencies; early and current radiation protection standards and organizations responsible for their formulation; major nuclear legislation; pertinent nuclear rules and regulations and their application. Lec/lab. Offered alternate years. CROSSLISTED as RHP 482/RHP 582. (Writing Intensive Course) **ENFORCED PREREQS:** NE 481 or RHP 481

NE 490. RADIATION DOSIMETRY (4). Further development and more in-depth treatment of radiation dosimetry concepts introduced in NE 481, including the theoretical basis of radiation dosimetry, microdosimetry, external, internal and environmental dosimetry. CROSSLISTED as RHP 490/RHP 590. **ENFORCED PREREQS:** NE 481 or RHP 481

NE 499. SPECIAL TOPICS (1-16).

NE 501. RESEARCH (1-16).

NE 503. THESIS (1-16).

NE 505. READING AND CONFERENCE (1-16).

NE 506. PROJECTS (1-16).

NE 507. SEMINAR IN NUCLEAR ENGINEERING (1). Lectures on current nuclear engineering topics. CROSSLISTED as RHP 407/RHP 507/RHP 607. Graded P/N.

NE 510. INTERNSHIP (1-12). Supervised technical work experience at approved organizations. Graded P/N. **OTHER PREREQS:** Graduate standing.

NE 515. NUCLEAR RULES AND REGULATIONS (2). An introduction to the key nuclear regulatory agencies; major nuclear legislation; current radiation protection standards and organizations responsible for their implementation. Offered alternate years. CROSSLISTED as RHP 415/ RHP 515. **OTHER PREREQS:** NE 481 or RHP 481.

NE 516. RADIOCHEMISTRY (3). Selected methods in radiochemical analysis. Actinide chemistry, activation analysis, radionuclide solvent extraction, and microbial reactions with radionuclides. Designed for majors in chemistry, chemical engineering, nuclear engineering, and radiation health physics. CROSSLISTED as CH 416/CH 516, CHE 416/CHE 516, RHP 416/RHP 516. **OTHER PREREQS:** (CH 201 and CH 202 and CH 205) or (CH 221 and CH 222 and CH 223) or (CH 224H and CH 225H and CH 226H) or equivalent or instructor approval required.

NE 526. COMPUTATIONAL METHODS FOR NUCLEAR REACTORS (3). Application of digital computers to problems in nuclear engineering. Topics include multigroup diffusion theory, kinetic equations, Monte Carlo methods, Sn, collision probability methods, criteria for selecting methods, and computer programming. Not offered every year.

NE 531. RADIOPHYSICS (3). Expands understanding of concepts and applications of atomic and nuclear physics to enable continued study in nuclear engineering and health physics. Includes fundamental concepts of nuclear and atomic physics, atomic and nuclear shell structure, radioactive decay, radiation interactions, radiation biology, and the characteristics of fission. **OTHER PREREQS:** Graduate standing.

NE 535. NUCLEAR RADIATION SHIELDING (3). Theoretical principles of shielding for neutron and gamma radiation; applications to problems of practical interest; analytical and computer solutions emphasized. Offered alternate years. CROSSLISTED as RHP 535. **ENFORCED PREREQS:** NE 581* or RHP 581* **OTHER PREREQS:** Or instructor approval required.

NE 536. ADVANCED RADIATION DETECTION AND MEASUREMENT (4). Principles and mechanisms underlying nuclear radiation detection and measurements; operation of nuclear electronic laboratory instrumentation; application of gas-filled, scintillation and semiconductor laboratory detectors for measurement of alpha, beta, gamma, and neutron radiation, liquid scintillation equipment; use of Bonner spheres for neutron energy profiles; experimental investigation of interactions of radiation with matter. **ENFORCED PREREQS:** NE 531 or RHP 531

NE 537. APPLICATIONS OF NUCLEAR TECHNIQUES (3). Description of nuclear-related techniques used for analytical and process measurements; discussion of associated nuclear instrumentation and facilities. Offered alternate years. CROSSLISTED as RHP 537. **ENFORCED PREREQS:** NE 531* or RHP 531* **OTHER PREREQS:** Or equivalent.

NE 539. SELECTED TOPICS IN INTERACTION OF NUCLEAR RADIATION (1-6). Topics associated with interactions of nuclear radiation not covered in other graduate courses; topics may vary from year to year. Course may be repeated for credit. CROSSLISTED as RHP 539. **OTHER PREREQS:** Instructor approval required.

NE 542. LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT (3). Low-Level Radioactive Waste Policy Act and Amendments; NRC regulations regarding LLW; waste quantities, types, forms, classification and acceptance criteria; disposal sites: history, site selection, site characterization, design options, environmental monitoring and closure; LLW treatment technologies, LLW transportation; LLW compacts. Offered alternate years. CROSSLISTED as RHP 542.

NE 543. HIGH-LEVEL RADIOACTIVE WASTE MANAGEMENT (3). Nuclear Waste Policy Act and Amendments; DOE, NRC, and EPA regulations related to high level radioactive waste; waste characteristics, forms, amounts, packages; geologic repositories and alternate disposal techniques; waste transportation; monitored retrievable storage; defense waste characteristics, amounts, disposal options;

disposal plans in other countries. Offered alternate years. CROSSLISTED as RHP 543.

NE 549. SELECTED TOPICS IN NUCLEAR FUEL CYCLE ANALYSIS (1-6). Topics associated with the nuclear fuel cycle not covered in other graduate courses; topics may vary from year to year. Course may be repeated for credit. CROSSLISTED as RHP 549.

NE 551. NEUTRONIC ANALYSIS AND LAB I (4). Physical models of neutronic systems; nuclear physics; steady state and transient neutronic system behavior; introductory neutron transport theory, one speed diffusion theory; numerical methods; fast and thermal spectrum calculations; multigroup methods; transmutation and burnup; reactor fuel management; reactivity control; perturbation theory; neutronic laboratory sessions. **OTHER PREREQS:** CS 151, MTH 256, NE 235. Should enroll concurrently in ME 373. NE 551 and NE 552 must be taken in order.

NE 552. NEUTRONIC ANALYSIS AND LAB II (4). Physical models of neutronic systems; nuclear physics; steady state and transient neutronic system behavior; introductory neutron transport theory, one speed diffusion theory; numerical methods; fast and thermal spectrum calculations; multigroup methods; transmutation and burnup; reactor fuel management; reactivity control; perturbation theory; neutronic laboratory sessions. **ENFORCED PREREQS:** NE 551 **OTHER PREREQS:** NE 551 and NE 552 must be taken in order.

NE 553. ADVANCED NUCLEAR REACTOR PHYSICS (3). Advanced analytic and numerical techniques for the prediction of the neutron population in nuclear reactor systems. Topics will include long characteristic neutron transport, collision probabilities, nodal methods, equivalence theory, and perturbation theory. Offered alternate years. **ENFORCED PREREQS:** NE 551 and NE 552 **OTHER PREREQS:** Computer programming experience or instructor approval.

NE 559. SELECTED TOPICS IN NUCLEAR REACTOR ANALYSIS (1-3). Topics associated with nuclear reactor theory not covered in other graduate courses; topics may vary from year to year. Course may be repeated for credit. **OTHER PREREQS:** NE 553.

NE 565. APPLIED THERMAL HYDRAULICS (3). Advanced topics in the computational modeling of the hydrodynamic and heat transfer phenomena of nuclear reactors. Steady-state and transient solutions of one-dimensional nuclear reactor thermal hydraulic models. Nuclear reactor behavior analysis during various accident scenarios. **OTHER PREREQS:** CS 151, ME 373, NE 467.

NE 567. NUCLEAR REACTOR THERMAL HYDRAULICS (4). Hydrodynamics and conductive, convective and radiative heat transfer in nuclear reactor systems. Core heat removal design; critical heat flux, hot spot factors, single- and two-phase flow behavior. Advanced thermal hydraulic computer codes. **OTHER PREREQS:** ENGR 332 or ME 332.

NE 568. NUCLEAR REACTOR SAFETY (3). Probabilistic risk assessment and system reliability analysis techniques applied to nuclear reactor safety. Examination of neutronic and thermal hydraulic transients, effectiveness of emergency systems, accident prevention and mitigation, assessment of radioactive releases to the environment. Offered alternate years. **OTHER PREREQS:** NE 451/NE 551, NE 467/NE 567.

NE 569. SELECTED TOPICS IN NUCLEAR REACTOR ENGINEERING (1-6). Advanced nuclear engineering design concepts, reactor systems analysis techniques and innovative nuclear engineering applications. Artificial intelligence and expert system applications to nuclear engineering problems. Topics may vary from year to year. Course may be repeated for credit.

NE 574. NUCLEAR SYSTEMS DESIGN I (4). Practical design of nuclear power systems using fundamental nuclear engineering skills. Design projects involve the integration of reactor neutronics, dynamics and control, thermal hydraulics, transient analysis, safety analysis, power production, nuclear materials, fuel management and economic optimization. Emphasis is placed on designing advanced reactor systems for power production purposes. State-of-the-art computer codes are used for design analysis and evaluation. **ENFORCED PREREQS:** NE 551 and NE 567 **OTHER PREREQS:** (ENGR 332 or ME 332). NE 574 and NE 575 must be taken in order.

NE 575. NUCLEAR SYSTEMS DESIGN II (4). Practical design of nuclear power systems using fundamental nuclear engineering skills. Design projects involve the integration of reactor neutronics, dynamics and control, thermal hydraulics, transient analysis, safety analysis, power production, nuclear materials, fuel management and economic optimization. Emphasis is placed on designing advanced reactor systems for power production purposes. State-of-the-art computer codes are used for design analysis and evaluation. **ENFORCED PREREQS:** NE 574 and NE 552 **OTHER PREREQS:** NE 574 and NE 575 must be taken in order.

NE 581. RADIATION PROTECTION (4). Fundamental principles and theory of radiation protection: regulatory agencies; dose units; source of radiation; biological effects and risk; dose limits; applications of external and internal dosimetry; shielding and atmospheric dispersion. CROSSLISTED as RHP 481/RHP 581. **OTHER PREREQS:** NE 235 or RHP 235 and graduate standing.

NE 582. APPLIED RADIATION SAFETY (4). Application of radiation protection as practiced in the fields of nuclear science and engineering; application of health physics principles to reduce health hazards at each of the following stages: design, prevention, assessment, and post-incident. A history of key nuclear regulatory agencies; early and current radiation protection standards and organizations responsible for their formulation; major nuclear legislation; pertinent nuclear rules and regulations and their application. Lec/lab. Offered alternate years. CROSSLISTED as RHP 482/RHP 582. **ENFORCED PREREQS:** NE 581 or RHP 581

NE 585. ENVIRONMENTAL ASPECTS OF NUCLEAR SYSTEMS (3). Federal and state regulations concerning environmental effects of nuclear power plants and other nuclear installations; development of analytical techniques for calculating quantities and effects of gaseous and liquid radioactive effluents released; effects of thermal discharge; atmospheric dilution and dispersion; cost-benefit studies. Not offered every year. CROSSLISTED as RHP 585. **OTHER PREREQS:** Graduate standing.

NE 590. RADIATION DOSIMETRY (4). Further development and more in-depth treatment of radiation dosimetry concepts introduced in NE 481, including the theoretical basis of radiation dosimetry, microdosimetry, external, internal and environmental dosimetry. CROSSLISTED as RHP 490/RHP 590. **ENFORCED PREREQS:** NE 581 or RHP 581

NE 599. SPECIAL TOPICS (1-16).

NE 601. RESEARCH (1-16). Graded P/N.

NE 603. THESIS (1-16).

NE 605. READING AND CONFERENCE (1-16).

NE 606. PROJECTS (1-16).

NE 607. SEMINAR IN NUCLEAR ENGINEERING (1). Lectures on current nuclear engineering topics. CROSSLISTED as RHP 407/RHP 507/RHP 607. Graded P/N.

NE 654. NEUTRON TRANSPORT THEORY (3). Properties of and methods for solution of the linear Boltzmann equation for nuclear reactors; spherical and double-spherical harmonics; integral equation methods; Monte Carlo methods. Offered alternate years. **ENFORCED PREREQS:** NE 551 and NE 552

NE 667. ADVANCED THERMAL HYDRAULICS (3). Advanced topics in single- and two-phase hydrodynamics and heat transfer for nuclear reactors. Two-phase flow patterns, flow instabilities, condensation induced transients, convective boiling heat transfer, and current topics in reactor safety thermal hydraulics. Offered alternate years. **ENFORCED PREREQS:** NE 567

NE 699. SPECIAL TOPICS (1-16).

NE 808. WORKSHOP (1-4).

■ RADIATION HEALTH PHYSICS

RHP 114. INTRO TO NUCLEAR ENGINEERING AND RADIATION HEALTH PHYSICS (2). Introduction to the nuclear engineering and radiation health physics fields; problem-solving techniques; careers in the nuclear industry; engineering ethics; nuclear history; elementary nuclear and reactor physics; basic nuclear fission and fusion theory; reactor types; nuclear safety; nuclear fuel cycle; and radiation protection. CROSSLISTED as NE 114, NE 115, NE 116.

RHP 115. INTRO TO NUCLEAR ENGINEERING AND RADIATION HEALTH PHYSICS (2). Introduction to the nuclear engineering and radiation health physics fields; problem-solving techniques; careers in the nuclear industry; engineering ethics; nuclear history; elementary nuclear and reactor physics; basic nuclear fission and fusion theory; reactor types; nuclear safety; nuclear fuel cycle; and radiation protection. CROSSLISTED as NE 114, NE 115, NE 116.

RHP 116. INTRO TO NUCLEAR ENGINEERING AND RADIATION HEALTH PHYSICS (2). Introduction to the nuclear engineering and radiation health physics fields; problem-solving techniques; careers in the nuclear industry; engineering ethics; nuclear history; elementary nuclear and reactor physics; basic nuclear fission and fusion theory; reactor types; nuclear safety; nuclear fuel cycle; and radiation protection. CROSSLISTED as NE 114, NE 115, NE 116.

RHP 234. NUCLEAR AND RADIATION PHYSICS I (4). Relativistic dynamics; basic nuclear physics; basic quantum mechanics; radioactivity; electromagnetic waves; interaction of ionizing radiation with matter; cross sections; basic atomic structure. CROSSLISTED as NE 234. **OTHER PREREQS:** MTH 252.

RHP 235. NUCLEAR AND RADIATION PHYSICS II (4). Radioactivity; radioactive decay modes; decay kinetics, interaction of neutrons with matter; nuclear reactions; fission and fusion basics; cross sections. CROSSLISTED as NE 235. **ENFORCED PREREQS:** RHP 234 or NE 234 **OTHER PREREQS:** MTH 252.

RHP 236. NUCLEAR RADIATION DETECTION AND INSTRUMENTATION (4). Principles and mechanisms underlying nuclear radiation detection and measurements; operation of nuclear electronic laboratory instrumentation; application of gas-filled, scintillation and semiconductor laboratory detectors for measurement of alpha, beta, gamma, and neutron radiation; experimental investigation of interactions of radiation with matter. CROSSLISTED as NE 236. **ENFORCED PREREQS:** RHP 235 or NE 235

RHP 401. RESEARCH (1-16). Graded P/N.

RHP 405. READING AND CONFERENCE (1-16).

RHP 406. PROJECTS (1-16).