COLLEGE OF
Engineering

Administration

Holmes 240
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Dean: Wai-Fah Chen
Assistant Dean: Tep Dobry

Contents

General Information

An engineering degree provides an excellent background for seeking solutions to many of the problems in the development and management of technology related to urban demands, the enhancement of our living environment, and the effective utilization of our nonrenewable resources. Engineering curricula include both general and theoretical course work designed to enable graduates to meet the challenges of a technology-oriented society. Particular emphasis is placed on problems related to energy and the preservation and enhancement of the environment.

Engineering has been a major program of study at this institution since its founding in 1907. The University has granted more than 6,500 engineering degrees, and many of the professional engineers practicing in industries, consulting firms, and governmental agencies throughout the state are graduates of the University of Hawai'i.

Accreditation

The undergraduate curricula in civil, electrical, and mechanical engineering are accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

Degrees and Certificates

Bachelor's Degrees: BS in civil engineering, BS in electrical engineering, BS in mechanical engineering

Master's Degrees: MS in civil engineering, MS in electrical engineering, MS in mechanical engineering

Doctoral Degrees: PhD in civil engineering, PhD in electrical engineering, PhD in mechanical engineering

Certificate Programs: Construction Engineering and Management Graduate Certificate, Renewable Energy Engineering Graduate Certificate

For information on programs in biosystems engineering, please refer to the College of Tropical Agriculture and Human Resources. For information on programs in ocean engineering, please refer to the School of Ocean and Earth Science and Technology.

Advising

Student Services
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All students in the College of Engineering must receive approval of their program of courses from their advisers prior to registration each semester.

Updated curriculum check sheets summarizing all of the requirements for each undergraduate curriculum are available in the college's Student Academic Services Office.

Undergraduate engineering students who are unusually well-qualified academically are encouraged to participate in the UH Mānoa Honors Programs (see the "Special Programs" section within the Colleges of Arts and Sciences).

New Students

An orientation session for new students is held each semester before classes begin. Incoming students receive approval of their program of courses at that time. In addition, incoming students with waived course work (e.g., advanced placement examination) must still fulfill credit hour requirements and should contact the College's Student Services Office for more information.

Undergraduate Programs

Each of the curricula offered by the College of Engineering provides a fundamental science-oriented university education with coverage of communications, the humanities, and social sciences, as well as the basic physical sciences of mathematics, physics, and chemistry. The curricula also encompass engineering sciences common to all engineering disciplines and elective engineering courses that introduce the engineering method of design.

Entering engineering freshmen may choose to attend any of the University of Hawai'i system campuses to complete lower division curriculum requirements in the areas of mathematics, chemistry, physics, lower division (100- and 200-level) engineering, history, humanities, and social sciences. As an engineering student on any system campus, students are entitled to benefits such as computer accounts, membership in engineering student clubs, invitations to student events, and scholarship eligibility. Students electing to defer enrollment are required to re-enter the Mānoa campus within three years of initial acceptance. Tuition and fees are based on the campus attended.

Any academic actions (e.g., probation, suspension, etc.) will be administered by the appropriate student services office of the attending campus. In addition, re-entering students must have a minimum 2.0 grade point average for all transfer-level courses (numbered 100 and above) based on the University of Hawai'i at Mānoa grading standard. Students are required to submit a common application form to the University of Hawai'i at Mānoa Office of Admissions and Records for the sole purpose of updating student records prior to re-entry no later than May 1 for fall semester re-entry or November 1 for spring semester re-entry.

Admission Requirements

Requirements for admission to the University are described in the front of the Catalog. High school students applying to the College of Engineering should have completed trigonometry, physics, and chemistry. The college also uses aptitude tests and high school records in its screening procedure.

Transfer students must have completed ENG 100, MATH 241 and 242/242L, PHYS 170/170L, and CHEM 161/161L and 162 or their equivalents and have an overall cumulative GPA of 3.0 or higher.

College Requirements

Course work in each curriculum consists of a set of required courses common to all engineering majors and additional courses to satisfy departmental requirements. The courses required of all engineering students, which also satisfies the General Education Core requirements of the University, consist of the following:

Communications

- ENG 100 Expository Writing (3)

Humanities

- SP 251 Principles of Effective Public Speaking (3)
- Two electives (3/3)

Social Sciences

- ECON 120 Introduction to Economics or ECON 130 Principles of Economics (3)
- Two electives (3/3)

World Civilizations

- HIST 151 World Civilizations I (3)
- HIST 152 World Civilizations II (3)

Quantitative and Logical Reasoning

- MATH 241 Calculus I (4)
- MATH 242 Calculus II (3)
- MATH 242L Calculus Computer Lab (1)
- MATH 243 Calculus III (3) or MATH 243 (3)
- MATH 244 Calculus IV (2) or MATH 244 (3)

Natural Sciences

- CHEM 161/161L, and 162 General Chemistry/Lab (3/1/3)
- PHYS 170/170L General Physics I/Lab (4/1)
- PHYS 272/272L General Physics II/Lab (3/1)

BS Degree Requirements

The undergraduate curricula are designed to be completed in eight semesters.

To receive a bachelor of science degree in engineering, a student must adhere to the following:

1. Complete the course work for one of the engineering curricula, which also satisfies all University requirements;
2. Maintain a minimum GPA of 2.0 for all registered credit hours; and
3. Maintain a minimum GPA of 2.0 for all upper division courses (numbered 300-499) in mathematics, science, and engineering.

Major Requirements

See appropriate departments for specific major requirements leading to a bachelor's degree.

Other Requirements

Undergraduate engineering students are subject to the policies of academic probation, suspension, and dismissal of the University of Hawai'i at Mānoa as specified in the Catalog. In addition, engineering students with either a cumulative GPA of less than 2.0 or an upper division GPA of less than 2.0 may be placed on academic probation. The student must raise his or her cumulative and upper division (if applicable) GPAs to 2.0 or higher by the end of the probationary semester. Failure to

meet any of the above conditions may result in suspension or dismissal. Engineering undergraduates may also be suspended when they fail to achieve a cumulative GPA of at least 1.7 after attempting 24 credit hours.

Students who are suspended must reapply for admission to the Office of Admissions and Records within specified deadlines. Students who do not take courses after being suspended for the required one semester are eligible to be readmitted to the College of the Engineering. Suspended students who attend another institution (including other University of Hawai'i system campuses) will be considered "transfer" students when reapplying to the University and must meet the transfer requirements of the College of the Engineering.

Graduate Programs

See appropriate department for specific description and requirements.

Certificate Programs

Construction Engineering and Management Graduate Certificate

A candidate for admission must have a bachelor's degree in engineering, architecture, or business administration. A GPA of 3.0 is required for regular admission. The certificate program requires 15 credit hours, of which 9 credit hours must be taken from core graduate construction engineering offerings. The other 6 credits can be taken from senior-level construction courses and a wide array of related courses from civil engineering or other departments.

CE 375 Construction Materials and CE 472 Construction Management or equivalents are mandatory requirements beyond the 15-credit-hour standard. Applicable credits earned in the certificate program may be transferred-upon approval of the graduate chair-to a master's degree in civil engineering provided other requirements for graduate admission are fulfilled.

Renewable Energy Engineering Graduate Certificate

The certificate program is designed for those students pursuing advanced degrees in a traditional discipline who also seek to develop interdisciplinary competence in renewable energy engineering. Students completing the certificate requirements will gain a rigorous understanding of the energy sciences, accompanied by an appreciation of the complex economic and societal issues that surround the coming transition to an energy economy based on renewable resources.

Students previously admitted as classified graduate students are eligible to apply for admission to the certificate program. Prerequisites for admission include 6 credit hours of calculus, 6 credit hours of physics, 3 credit hours of chemistry, and 3 credit hours of thermodynamics. Following a required introductory interview, the certificate candidate will be assigned an adviser from the program committee in addition to the student's field of study adviser. Through consultation with these two advisers, the student will select appropriate courses and a research topic that together will satisfy the requirements of both the student's field of study and the certificate program.

To earn a certificate in renewable energy engineering, students must participate in the Hawai'i Natural Energy Institute seminar series during each term of their residency and complete ME 629 and approved courses in a technical area, energy economics, and policy with a grade B (or higher). In addition, the student must complete a thesis or dissertation that involves renewable energy engineering.

The Renewable Energy Engineering Graduate Certificate will be awarded to students upon completion of an advanced degree in their field of study.

Student Organizations

Student chapters of professional engineering societies are active at the college, and all students are encouraged to participate. Honorary societies are represented in all three departments. The activities of these student organizations are coordinated by the Engineers' Council of the University of Hawai'i (ECUH).

Honors and Awards

The College of Engineering and its departments provide scholarships and awards to exceptional students. For a list of these scholarships, see the "Tuition, Fees, and Financial Aid" section of this Catalog.

Civil Engineering

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Faculty

*E. D. H. Cheng, PhD (Chair)—hydrology, hydraulics
R. Akiona, MS—construction management
*R. W. Babcock, PhD—environmental engineering
*H. Brandes, PhD—geotechnical engineering
W. F. Chen, PhD—structural engineering
*Y. S. Fok, PhD—hydrology, water resources system analysis
*R. A. Grace, PhD—hydrology, hydraulics
*C. C. K. Liu, PhD—hydrology, environmental and systems engineering
*C. Newtson, PhD—structures
*P. G. Nicholson, PhD—geotechnical engineering
*P. Ooi, PhD—geotechnical engineering
*C. S. Papacostas, PhD—transportation, systems engineering
*P. D. Prevedouros, PhD—transportation engineering
*C. Ray, PhD—groundwater hydrology
*H. R. Riggs, PhD—structures, numerical methods

* Graduate Faculty

*I. N. Robertson, PhD—structures
*A. Singh, PhD—construction management
*G. T. Taoka, PhD—applied mechanics
*M. H. Teng, PhD—hydraulics

Degrees Offered: BS in civil engineering, MS in civil engineering, PhD in civil engineering

The Academic Program

Civil engineering (CE) is concerned with the activities of people and the environment. The civil engineer conceives, plans, designs, constructs, operates, and maintains the physical works necessary for the environmental needs of people. Students who enter civil engineering today can look forward to one of the most rewarding careers open to men and women-rewarding in personal fulfillment, enduring service to humankind, and financial reward. The curriculum is uniquely designed to meet the demands of business, industry, and government where a broad, fundamental education is required.

Undergraduate Study

Bachelor's Degree

The BS degree requires completion of at least 124 credit hours of course work, the equivalent of four years of full-time work. These requirements include 61 credit hours of civil engineering courses from the following areas: applied mechanics, structural analysis and design, hydraulics, surveying, transportation, construction, soil mechanics, hydrology, water resources, and environmental engineering. There are additional required courses in mathematics, physics, and chemistry, as well as courses required by the University in humanities, social sciences, and foreign or Hawaiian language. The curriculum provides a broad-based background of fundamentals with coverage of the humanities and social sciences, basic sciences, mathematics, and the engineering design method. Course enrollment for all CE majors is subject to the approval of an adviser. The requirements are described below and reflected on the check sheet and the list of course prerequisites.

All electives are subject to the approval of an adviser.

College Requirements

Students must complete the General Education Core courses for engineering (see "Undergraduate Programs" within the College of Engineering).

Departmental Requirements

Students must complete the following courses as well as one course in engineering math, one non-CE engineering course, and one biological science elective (specific options are provided on the curriculum check sheet):

- CE 123 Computer Aided Design and Drafting (1)
- CE 211/211L Surveying I and Lab (2/1)
- CE 270 Applied Mechanics I (3)
- CE 271 Applied Mechanics II (3)
- CE 305 Applied Probability and Statistics (3)
- CE 320 Fluid Mechanics Fundamentals (4)
- CE 330 Environmental Engineering (3)
- CE 350 Geotechnical Engineering (4)
- CE 361 Fundamentals of Transportation (3)
- CE 370/370L Mechanics of Materials and Lab (3/1)
- CE 375 Construction Materials (3)
- CE 381 Structural Analysis (3)
- CE 421 Engineering Hydraulics (3)
- CE 431 Water and Wastewater Engineering (3)
- CE 450 Soils and Foundation Engineering (3) or CE 451 Soil and Site Improvement (3)
- CE 462 Traffic Engineering (3) or CE 464 Urban and Regional Transportation Planning (3)
- CE 472 Construction Management (3)
- CE 485 Reinforced Concrete Design (3)

Other important requirements:

1. C grade or better is required for CE 270 and CE 271.
2. All CE courses must be passed in two attempts.

Graduate Study

Master's Degree

The department offers a graduate program leading to the MS degree in civil engineering with several areas of concentration under Plan A (thesis) or Plan B (non-thesis). Close cooperation is maintained with other departments and the Water Resources Research Center. Details and requirements of each program may be obtained from the department office.

Applicants must present a BS in civil engineering or the equivalent and must submit either the EIT (Engineer-in-Training) exam or the results of the GRE General Test; the GRE subject test (engineering, mathematics, or physics) is recommended. If so required by the Graduate Division, applicants must supply the TOEFL score.

Requirements

Plan A requires a minimum of 30 credit hours, exclusive of seminars. Plan A includes 9 credit hours of thesis research and a minimum of 12 credit hours in graduate civil engineering courses, exclusive of thesis, seminar, and directed reading. Plan B requires a minimum of 38 credits including a minimum of 18 credit hours of graduate civil engineering courses, exclusive of seminar and directed reading, as well as a technical report. Both plans require a minimum of 2 credits of seminar.

Doctoral Degree

Applicants to the PhD program must have fulfilled the requirements for the MS in civil engineering at the University of Hawai'i or its equivalent. Those who have earned the MS at universities other than the University of Hawai'i must furnish the results of the GRE General Test. All applicants must furnish official transcripts of all previous undergraduate and graduate studies and three letters of reference clearly indicating that they are capable of completing a rigorous PhD program. Applicants must also supply a letter explaining in detail their career goals, specific area of concentration, work experience,

* Graduate Faculty

and reasons for applying to the program. If so required by the Graduate Division, applicants must supply the TOEFL score.

Requirements

Candidates for a PhD are required to pass a qualifying examination consisting of oral and written components. The examination will be confined to basic topics in civil engineering. One purpose of the qualifying examination is to identify possible deficiencies in the student's background with a view toward remedial measures. In addition, the examination will serve as a means of assessing the student's potential for doctoral studies.

In order to earn a PhD in civil engineering, a student must satisfactorily complete a minimum of 50 credit hours in course work beyond the BS and a minimum of 2 credit hours in civil engineering graduate seminar. Students must also complete and successfully defend a satisfactory doctoral dissertation. Based on a written recommendation of the student's dissertation committee and with the approval of the chair of graduate studies in civil engineering, students entering the PhD program may be granted an equivalence of up to 30 credit hours earned as part of the student's master's program. The 30-credit-hour equivalents may include up to 9 credit hours for the previous MS thesis work but exclude graduate seminar credit hours taken as part of the MS program.

The courses that a student undertakes in order to fulfill the PhD-credit-hour requirements must be selected by the student and approved by the student's dissertation committee. At least 24 credit hours must be from graduate-level civil engineering courses. The remaining courses may include graduate and advanced undergraduate courses offered by the civil engineering department or other appropriate departments of the University.

Comprehensive Examination

Every PhD student must pass a comprehensive examination. The purpose of this examination is to ascertain the student's comprehension of the advances in the chosen specialty. Examinations are given when, in the judgment of the dissertation committee, the student has had sufficient preparation, but not sooner than six calendar months after the student has passed the qualifying examination.

Students pass the examination upon favorable recommendation of the majority of the dissertation committee. Students who fail may, at the discretion of the graduate faculty, repeat the test once at least six months later. Students who fail the examination a second time are dropped from the program.

Students attain the status of doctoral candidate only after passing the comprehensive examination and submitting a dissertation proposal that receives the unanimous approval of the dissertation committee.

Final Examination

PhD candidates are required to take a final oral examination in defense of their dissertation. The examination is conducted by the candidate's dissertation committee. Students pass upon the favorable recommendation of the majority of the committee.

Electrical Engineering

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Faculty

*A. Kuh, PhD (Chair)—neural networks, communications
A. M. Bullock, PhD—physical electronics, lasers
*R. Chattergy, PhD—power electronics
*J. C. Chiao, PhD—microwaves, microelectromechanical systems, optoelectronics, optical networks
*M. DeLisio, PhD—electromagnetic theory, microwaves
*T. P. Dobry, PhD—digital systems, computers
*M. Fossorier, PhD—coding theory, communication algorithms, magnetic recording
*N. T. Gaarder, PhD—communication theory, information theory
*A. Hac, PhD—software systems, telecommunication networks
*J. W. Holm-Kennedy, PhD—applied solid-state physics, solid-state devices, IC technology
A. Host-Madsen, PhD—communications signal processing, CDMA communications, multiuser communications, equalization
*E. S. Kim, PhD—solid-state devices, integrated sensors
*F. T. Koide, PhD—biomedical engineering, operational amplifiers, electronic circuits
*V. Malhotra, PhD—physical electronics, solid-state devices
*A. E. Quilici, PhD—artificial intelligence, natural language processing
*G. H. Sasaki, PhD—computer communication networks, performance evaluation, optimization algorithms
*W. A. Shiroma, PhD—electromagnetic theory, microwaves
*M. J. S. Smith, PhD—computer-aided analog integrated circuit design
*V. L. Syrmos, PhD—linear system theory, control theory
*G. T. Uehara, PhD—integrated circuits, communication systems
*J. R. Yee, PhD—computer communications networks, network optimization, stochastic models
*D. Y. Y. Yun, PhD—networked computing, intelligent systems, 3D imaging, tele-health, resource planning

Cooperating Graduate Faculty

W. W. Peterson, PhD—computer software
R. Rocheleau, PhD—photovoltaics, sensors, thin films
S. K. Sharma, PhD—thin films, amorphous materials and ceramics, instrumentation development

Degrees Offered: BS in electrical engineering, MS in electrical engineering, PhD in electrical engineering

* Graduate Faculty

The Academic Program

Electrical engineering (EE) is concerned with the basic forms of energy that run our world and the exciting fields of electronics and information technology. Electronics continues to bring forth new breakthroughs in solid-state technology (transistors, integrated circuits, LSI and VLSI chips, microprocessors, lasers, optical fibers), which in turn fuel the unprecedented revolution in telecommunications (World Wide Web, voice, and data), computers (neural network, distributed, and intelligent), instrumentation (biomedical, intelligent), and many other areas.

The undergraduate and graduate programs focus on three major areas: computers (architecture, algorithms, networking, and software), electro-physics (solid-state devices and sensors, analog and digital circuit design, and electromagnetic fields and microwaves) and systems (telecommunications, automatic controls, and power). The undergraduate and graduate programs require students to major in one of these three areas.

The culmination of the undergraduate program is the capstone design project; this is a significant project that integrates the design content of previous courses while satisfying realistic constraints.

Undergraduate Study

Bachelor's Degree

The BS degree program requires a minimum of 124 credit hours. The departmental requirements consist of 48 credit hours of basic courses and 23 credit hours of technical electives. Students must major in one of the three tracks (computers, electro-physics, or systems).

All electives are subject to the approval of an adviser. Enrollment in EE courses requires a grade of C or better in all prerequisite courses.

College Requirements

Students must complete the General Education Core courses for engineering (see "Undergraduate Programs" within the College of Engineering).

Departmental Requirements

Students must complete a total of 71 credit hours including the following:

- EE 101 Electrical Engineering Skills (3)
- EE 160 Programming for Engineers (4)
- EE 260 Introduction to Digital Design (4)
- EE 211 Basic Circuit Analysis (4)
- EE 213 Basic Lab Measurements and Techniques (4)
- EE 224 Physical Electronics (3)
- EE 315 Signal and System Analysis (3)
- EE 323 Basic Electronics/Lab (3/1)
- EE 341 Introduction to Communication Systems/Lab (3/1)
- EE 342 Probability and Statistics (3)
- EE 371 Fields and Waves I (3)
- PHYS 274 General Physics III (3)
- ME 311 Thermodynamics (3) or CE 270 Applied Mechanics I (3)
- MATH 302 Introduction to Differential Equations I (3)
- Technical electives (23)

Technical Electives

There are 23 credits of technical electives required; at least 17 of these credits are in one of the major tracks (computers, electro-physics, systems,) and at least 3 of the credits are outside the major track. The major track requirements must include all courses in Group I and 6 credits of projects (EE 296/396/496) that culminate in the capstone design experience; the remaining major track courses are from Group II. The three credits outside the major track must be above the 300 level.

Computers Track:

- Group I: EE 361/361L, 366, 367/367L
- Group II: EE 449, 461, 467, 468

Electro-Physics Track:

- Group I: EE 326/326L, 327, 372/372L
- Group II: EE 328/328L, 422/422L, 423, 426, 427, 473, 474, 477

Systems Track:

- Group I: EE 351/351L, 415
- Group II: EE 331/331L, 435, 436, 437, 442, 446, 449, 452, 453

Graduate Study

Master's Degree

Intended candidates for the MS degree in electrical engineering must present the BS degree in electrical engineering or the equivalent.

Requirements

Only Plan A (thesis) is offered. This program requires 30 credit hours in approved technical courses including one graduate seminar in electrical engineering or a related field. This plan requires 9 credit hours in EE 700 Thesis Research and a minimum of 12 credit hours in 600-level courses in a major track (computers, electro-physics, or systems), 6 credit hours in 400- or higher-level courses outside of the major track (engineering, mathematics, science), and 3 credit hours of electives in 400- and higher-level courses.

Doctoral Degree

Intended candidates for the PhD degree in electrical engineering must present the BS degree in electrical engineering or its equivalent. Applicants are required to submit the GRE General Test scores. PhD students are required to achieve a good, broad understanding of electrical engineering fundamentals and a thorough knowledge, up to its present state, in a chosen specialty. Students must perform research in their special field under the guidance of a faculty adviser and present a dissertation that is an original contribution to electrical engineering. The dissertation must be a scholarly presentation suitable for publication.

Requirements

PhD students are required to specialize in a major track (computers, electro-physics, or systems) and show competence in a minor track. In addition to the MS course credit requirements, 9 credit hours of 600-level course work in the major track and 3 credit hours of 600-level course work in a minor track are required. All PhD students must also participate in a substantial teaching project and demonstrate competence in teaching.

Intended candidates for the PhD degree must take a qualifying examination covering electrical engineering fundamentals. Students must demonstrate superior understanding of these fundamentals and the potential to do research. The qualifying examination will be offered about one week after registration every fall and spring semester. It must be passed during a student's first three semesters in the PhD program. Students who do not pass will be dropped from the PhD program.

After passing the qualifying examination, students are advanced to candidacy and must have a doctoral committee appointed within two semesters. The committee should consist of at least five members, one of whom must be in a department other than electrical engineering. After appointment of the committee, students should work out a tentative program of courses that meets with the committee's approval.

Comprehensive Examination

When students have completed most of their course work, they must pass a comprehensive examination before research is undertaken. This consists of an oral examination given by the entire committee; it may be preceded, at the discretion of individual committee members, by an additional oral or written examination. Students who fail may repeat the examination only once, no sooner than three months after the first examination. Once students pass the comprehensive examination, they may proceed with dissertation research.

Final Examination

At the conclusion of the research, students write a dissertation that must be approved by a majority of the doctoral committee. Finally, students must pass another oral examination covering primarily the dissertation.

Mechanical Engineering

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Faculty

*L. H. Hihara, PhD (Chair)—materials, corrosion, mechanical behavior of materials
*B. H. Chao, PhD—combustion, perturbation methods
*C. F. M. Coimbra, PhD—applied math in multiphase flows, heat and mass transfer
*R. M. Fand, PhD—heat transfer, fluid mechanics
*M. N. M. Ghasemi Nejhad, PhD—thermomechanics, composite materials processing
*K. M. Htun, PhD—properties of materials, materials processing
*R. H. Knapp, PhD—solid mechanics, design
*B. E. Liebert, PhD—materials, corrosion, solid state ionics
*J. Yuh, PhD—control, robotics, design

Cooperating Graduate Faculty

M. J. Antal Jr., PhD—alternate energy, combustion
C. M. Kinoshita, PhD—combustion, energy systems, thermochemical systems
B. Y. Liaw, PhD—materials, energy conversion, solid-state ionics
S. M. Masutani, PhD—combustion, turbulent transport phenomena, energy systems
R. Rocheleau, PhD—thin film ceramic materials

Degrees Offered: BS in mechanical engineering, MS in mechanical engineering, PhD in mechanical engineering

The Academic Program

Mechanical engineering (ME) is concerned with the design of all types of machines, conversion of energy from one form to another, instrumentation and control of all types of physical and chemical processes, the manufacturing and utilization of engineering materials, and control of human and machine environments. Mechanical engineers conceive, plan, design, and direct the manufacture, distribution, and operation of a wide variety of devices, machines, instruments, materials, and systems used for energy conversion, heat and mass transfer, environmental control, control of human and machine environment, physical and chemical process control, materials processing, transportation, manufacture of consumer products, materials handling, and measurements. Mechanical engineers also employ Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Computer Aided Testing (CAT), Computational Fluid Dynamics (CFD), computer modeling and simulations, novel materials, robotics, and mechatronics (integration of computers with electromechanical systems) in their day-to-day activities. Mechanical engineers find opportunities for employment in every branch of industry and in a variety of government agencies. Work may involve research,

* Graduate Faculty

development, design, analysis, manufacture, testing, marketing, or management.

Undergraduate Study

Bachelor's Degree

The BS degree requires completion of at least 124 credit hours of course work. The curriculum consists of a group of required courses chosen to provide the students with the basic tools for the professional practice of mechanical engineering and to assist students in developing a sense of responsibility as professionals. The objectives of the lower division curriculum are to build a foundation in the basic sciences and mathematics, provide an introduction to engineering design and professional ethics, develop communications and computer programming skills, and acquire an appreciation for the humanities and social sciences. The objectives of the upper division program are to provide a sound foundation in the engineering sciences; build on that foundation for applications in the areas of energy conversion, mechanical systems and control, experimentation, and manufacturing; and encourage creativity culminating in a "capstone" design experience. To provide sufficient flexibility, technical elective courses enable students to acquire additional competence in areas compatible with their career objectives.

All electives are subject to the approval of an adviser.

College Requirements

Students must complete the General Education Core courses for engineering (see "Undergraduate Programs" within the College of Engineering).

Departmental Requirements

Students must complete the following coursework:

- ME 113 Introduction to Engineering Design (2)
- CE 270 Applied Mechanics I (3)
- CE 271 Applied Mechanics II (3)
- MATH 197 Basic and Fortran Programming (1)
- MATH 302 Introduction to Differential Equations I (3)
- ME 360 Computer Methods in Engineering (3)
- EE 211 Basic Circuit Analysis I (4)
- ME 213 Introduction to Engineering Design II (2)
- ME 331 Material Science and Engineering (3)
- ME 341 Manufactory Processes/Lab (3/1)
- ME 371 Mechanics of Solids (3)
- ME 372 Component Design (3)
- ME 374 Kinematics/Dynamics Machinery (3)
- ME 375 Dynamics of Machines and Systems (3)
- ME 311 Thermodynamics (3)
- ME 312 Applied Thermodynamics (3)
- ME 322 Mechanics of Fluids (3)
- ME 422 Heat Transfer (3)
- ME 301 Mechanical Engineering Experimentation (2)
- ME 401 Measurements Lab (2)
- ME 481 Design Project I (3)
- ME 482 Design Project II (3)
- Mathematics elective (3), which may include ME 403; MATH 300 or above
- Technical electives (9), which include at least two courses from ME 417, 418, 434, 436, 446, 451, 452, 454, or 455. Remaining course can be any ME elective course except ME 403.

Graduate Study

The department offers graduate programs leading to MS and PhD degrees in mechanical engineering, with areas of concentration in thermal and fluid sciences conversion (heat and mass transfer, thermodynamics, combustion, thermal environmental engineering), in materials/manufacturing (composite and smart materials, mechanical properties, electrochemistry and corrosion, solid-state ionics, processing, marine materials), and in mechanics, systems, and controls (robotics, dynamics, control, continuum mechanics). For qualified graduate students, teaching assistantships, research assistantships, and scholarships are available.

Students may elect to participate in the Renewable Energy Engineering Graduate Certificate Program. This program offers fellowship support and unique laboratory facilities to students interested in renewable energy (see "Certificate Programs" within the College of Engineering).

Master's Degree

Applicants for admission to the MS program must have completed a BS degree in engineering or its equivalent from a reputable institution.

Requirements

Students are required to follow the Plan A (thesis) program. However, under special circumstances, a petition to follow Plan B (non-thesis) may be granted by the graduate faculty. A minimum of 30 credit hours is required for graduation, including 1 credit hour for seminar. Plan A students must take 8 credit hours for thesis, 12 credit hours in the ME 600 course series, and 9 credit hours in technical electives. Technical elective courses must be at the 400 level or above, selected from engineering, mathematics, or physical sciences approved by the student's thesis committee. For those students completing the Renewable Energy Engineering Graduate Certificate, 3 credit hours of the electives may be in any area approved by the advising committee.

For graduation, each candidate must present an acceptable thesis (research report for Plan B) and must pass a final oral examination based on the thesis for Plan A or on the course work and the research report for Plan B.

Doctoral Degree

Applicants for admission to the PhD program must have completed the requirements for the MS in mechanical engineering at UH Mānoa or an equivalent degree from a reputable institution.

Requirements

Intended candidates for the PhD are required to pass an oral qualifying examination within the prescribed period of time. The purpose of the qualifying examination is to judge students' ability to pursue research. After passing the qualifying examination, the student will be admitted to the status of "candidate" in the PhD program. At the discretion of the qualifying examination committee, students who fail the qualifying examination will be dropped from the program.

Students must satisfactorily complete a minimum of 50 credit hours in course work beyond the BS level. They are required to select one major and one minor field of study within the following three areas of concentration: materials/manufacturing, mechanics/systems/controls, or thermal/fluid sciences.

Students who enter the program may, with the approval of the graduate chair, be credited with up to 30 credits for equivalent work to be counted toward their PhD-credit-hour requirement. Up to 8 of these 30 credit hours may be assigned for prior MS thesis work. Students who possess a second MS degree may be credited with up to 9 additional credit hours for equivalent work. Up to 6 credit hours may be assigned for course work taken as an unclassified graduate student. All courses shall be selected by students but must be approved in writing by their committees. These courses must form an integrated education plan. A minimum of 2 credit hours in ME 691 or its equivalent must be included in every PhD program.

Students who desire teaching experience may, with the approval of the PhD committee chair, request that the department chair assign them teaching responsibility for a particular undergraduate course. The department chair will determine whether students are qualified to teach the course in question, and, if they are deemed qualified, they may be given the teaching assignment. Students who teach a course or courses will be assigned a maximum of 3 credit hours toward their PhD course work requirements.

Comprehensive Examination

PhD candidates must pass an oral comprehensive examination to demonstrate their comprehension of the chosen areas of study relevant to their dissertation proposals and basic knowledge of courses taken in their major and minor fields. Students who fail the comprehensive examination may, at the discretion of the graduate faculty concerned, repeat it once after at least six months. Students who fail the examination a second time will be dropped from the program.

Final Examination

Students are required to complete a satisfactory doctoral dissertation and to pass an oral final examination based primarily upon the dissertation. The final examination will be administered by the respective PhD committee. A student passes the final examination upon the favorable recommendation of a majority of the PhD committee.