College of Engineering

Graduate Programs

The College of Engineering offers graduate programs in bioengineering, chemical, civil, computer science and engineering, electrical, industrial and mechanical engineering. In addition, and jointly with the College of Medicine, the College of Engineering also offers a graduate program in biomedical engineering. Requirements for the engineering graduate programs are identified below. In addition, students should be familiar with the general College of Graduate Studies requirements (found in a preceding section of this catalog).

Entrance Requirements

The graduate program is open to all qualified individuals with a bachelor of science (B.S.)/master of science (M.S.) in engineering. Applicants should have a grade point average (GPA) of at least 3.0 in previous undergraduate work and at least 3.3 in previous graduate work. Students with a degree in another field may be eligible for admission, provided they meet the minimum background requirement, which includes two years of calculus through differential equations and one year of engineering physics. In some cases, other prerequisite courses may be required. Course credits for meeting undergraduate prerequisites are not applied toward the graduate degree.

An applicant for admission must do the following:

a. Submit a completed application for admission to the College of Graduate Studies.
b. Submit the application for graduate assistantship to the College of Graduate Studies.
c. Submit a complete financial statement (for international students).
d. Pay the relevant application fee.
e. Submit three letters of recommendation.
f. Submit a statement of purpose on the application and indicate those areas of engineering in which one is interested.
g. Submit official transcripts of all previous college-level work.
h. Submit scores of the Graduate Record Exam (GRE), if required.
i. All students from non-English speaking countries must submit scores for the Test of English as a Foreign Language (TOEFL). The minimum acceptable score for the TOEFL is 550 (for paper-based test) or 213 (for computer-based test) or 80 (for internet-based test).

The above documentation should be sent to the College of Graduate Studies, The University of Toledo, Toledo, Ohio 43606-3390, USA. Admission to the graduate program is contingent on the availability of openings for incoming students. To receive full consideration for financial support starting from the fall semester, the application should be received by March 15. Normally, however, all applications are considered as they are received. Because of the sequential nature of courses, full-time students are admitted for the fall semester of the academic year. Please be advised that only complete application files will be considered.

Admission

Except for the biomedical engineering program, application for admission should be made to one of the engineering departments for study in specific focus areas. Applications to the biomedical engineering program should be made to this specific program. Application materials should be sent directly to the College of Graduate Studies.

To be admitted to a graduate program in the College of Engineering, the applicant must have a bachelor's degree in engineering or a closely related field. Admission is made on an individual basis, taking into account the applicant's

previous academic record, the intended area of study and professional experience. Individual departments may have additional requirements, which are listed in their departmental descriptions. Generally, a GPA of at least 3.0 is required for admission. Applicants having a GPA of less than 3.0 who demonstrate potential for graduate study may be admitted to the master's program on a provisional or other basis at the option of the department. All students from non-English speaking countries must submit scores for the TOEFL; some departments will require completion of the GRE, as well. Application procedures and general requirements for admission to doctoral programs are described elsewhere in this catalog. The completed College of Graduate Studies application form and all required accompanying materials should be sent directly to the College of Graduate Studies.

The graduate program director of the department that houses the student's proposed area of study will make the admission decision, subject to departmental policies and review by the College of Graduate Studies. Therefore, the applicant should clearly indicate an area of intended concentration and/or the department of intended study. The criteria for admission include the baccalaureate and previous graduate record (grades and curricular content), the student's potential for success as indicated by professional references and relevant post-baccalaureate experience, and, for international students, the scores on required standardized tests.

Most successful applicants for the Ph.D. program will have completed a master's degree in the intended area of study or a closely related field. For an applicant who has an outstanding undergraduate record and no master's degree, direct admission to the doctoral program is available. Applicants seeking direct admission must satisfy all prerequisites for graduate study in the intended field of study and must have achieved an undergraduate GPA of at least 3.0.

Early Admission to M.S. in Engineering

The College of Engineering encourages students who wish to continue their education and earn graduate degrees in engineering to take the M.S. in engineering early admission option. By entering the M.S. program prior to completing their B.S. degree requirements, talented students may begin working on their graduate research while completing B.S. degree requirements. They may apply certain graduate courses toward selected B.S. course requirements (subject to departmental restrictions).

Students enrolled in a B.S. degree program in engineering at The University of Toledo who are within 18 hours of graduation, have a minimum 3.3 cumulative undergraduate GPA, and have completed their minimum co-op work requirements may be accepted for early admission into an M.S. engineering degree program. Applications will be accepted no earlier than one year (33 semester credit hours) prior to the expected completion of the B.S. program. An expedited application package contains 1) a completed regular application for graduate admission (special student application is not accepted); 2) three letters of recommendation; and 3) a biographical sketch (one page). Students accepted through this process will be granted provisional admission to allow them to enroll in graduate level courses and will be admitted to the M.S. program in the College of Engineering upon completion of their B.S. degrees.

A student must file an M.S. plan of study immediately after being granted early admission to the M.S. program. The plan must specify up to nine credit hours of graduate course work that will be applied in lieu of specific B.S. degree requirements. The student must meet all the requirements of the M.S. program as specified by the College of Graduate Studies, the college and the department.

Master of Science Programs

The master's degree programs are intended to provide advanced study in a relevant area of engineering. The programs provide sufficient flexibility to allow students to develop an area of specialization, broaden their educational experience into additional areas of engineering, or synthesize an integrated program of interdepartmental studies through a thesis or project.

Plan of Study

The master of science in engineering, master of science in bioengineering, master of science in chemical engineering,

master of science in civil engineering, master of science in electrical engineering, master of science in industrial engineering, and master of science in mechanical engineering are offered with the following options:

1. **Master of science degree with thesis option:** A minimum of 30 credit hours of approved graduate study, including nine credit hours of master of science thesis under the supervision of a faculty member, is required. Students are required to submit a written thesis and successfully complete the oral defense of the thesis work. Additional guidelines and requirements may exist for individual departments.
2. **Master of science degree with non-thesis option:** The master of science with non-thesis option is available with the approval of the department chair or the department graduate program director:
    a. **Master of science degree with project option:** Students are required to complete 30 credit hours of approved graduate study, including six hours of master of science project as specified by individual department guidelines and requirements. Students are required to submit a written project report to the department.

    b. **Master of science degree with course work-only option:** Students are required to complete 36 credit hours of approved graduate-level course work. Additional hours of course work to replace thesis or project are selected from departmental electives approved by the department chair or the graduate program director.

A plan of study that specifies the entire master's program to include thesis or project and graduate course work, as well as any specified preparatory undergraduate course work, is to be developed by the student working with his/her adviser. This plan of study is to be submitted for review and approval to the department's graduate director, the department chair, the college's associate dean of graduate studies, and the College of Graduate Studies before 10 graduate credits are completed. Graduate course work is selected from that available in engineering, math, science, business and related fields to include required core courses and/or to satisfy course category restrictions specified by the individual programs. Students should consult the departmental program descriptions for additional requirements.

Doctoral Degree Program

The doctor of philosophy program in the College of Engineering is intended for academically outstanding students with appropriate bachelor's degrees. The program requires the completion and defense of a significant, original research dissertation. Potential fields of study are designated as areas of research focus by individual departments. Potential concentrations are bioengineering, chemical engineering, civil engineering, computer science and engineering, electrical engineering, environmental engineering, industrial engineering, manufacturing engineering, and mechanical engineering.

Advisory Committee

Doctoral students, in consultation with the graduate program director and departmental chair, should select an adviser during their first term of study. Since the adviser is expected to become the student's dissertation supervisor, selection should be based on mutual agreement and common interests, with the expectation that the student and adviser can work effectively together. Notification of the adviser's appointment should be forwarded to the department's graduate program director, the college's associate dean of graduate studies, and the College of Graduate Studies for approval.

When the student and adviser have agreed on a general area for the dissertation within the first year of study, an advisory committee should be appointed, subject to the approval of the graduate program director and departmental chair. This committee, in general, is composed of a minimum of five graduate faculty members, with at least one of whom from outside the focus area and one from outside the department of the adviser. The duties of the advisory committee include developing a plan of study that will prepare the student in the chosen field and facilitate successful completion of the dissertation; reviewing and approving the dissertation proposal; advising and assisting in the completion of the dissertation research and preparation of the manuscript; and conducting the dissertation defense. Students are referred to additional details and requirements provided in the Graduate Student Handbook of individual departments.

Plan of Study

The advisory committee's first responsibility is to develop and submit for approval a doctoral program plan of study that meets all University, college and departmental requirements. This document specifies the course work and other requirements for the Ph.D.; it sets a tentative schedule for the examinations, and for presentation and defense of the dissertation proposal. Submission of the plan of study for approval to the graduate director, the departmental chair and the College of Graduate Studies also accomplishes official appointment of the advisory committee.

The plan of study requires a minimum of 45 credit hours each of dissertation and course work. (Students admitted to the Ph.D. program with an M.S. degree are granted up to 30 course work credits for their M.S. degree.) Course work must satisfy core course and other requirements specified for the student's focus area by the department.

Residence Requirement

The minimum residence requirement for the Ph.D. degree is the completion of one academic year of full-time study and/or research conducted at The University of Toledo. This requirement will be met by the completion of 24 dissertation or course work credits in two consecutive semesters while in residence at the University.

Examinations

At the discretion of the student's department, either a qualifying examination, a comprehensive examination or both will be required prior to admission to candidacy. Please refer to departmental and University requirements for details of the qualifying or comprehensive examinations.

Admission to Candidacy

When notified the required qualifying or comprehensive examination(s) have been passed and all other departmental requirements for candidacy are fulfilled, the student should initiate formal admission to candidacy. This requires the signed approval of the graduate program director and department chair and notification to the College of Graduate Studies.

Dissertation Proposal

The student, working with the adviser, should develop a detailed written dissertation proposal for presentation to the advisory committee. The proposal should state the objectives, provide appropriate background, and describe the general approach to accomplish the research clearly and completely. Specific procedures and details for the timing, preparation, distribution and defense of this proposal are noted in departmental requirements. An approved copy of the accepted proposal, signed by each member of the advisory committee, will be kept in the student's file.

Dissertation Defense

After the adviser and committee have approved the dissertation proposal, the student should carry out the dissertation plan. When the adviser and student believe the work is complete and ready for defense, a dissertation manuscript should be prepared, with the adviser providing suggestions for improvement, until both the adviser and the student believe the document is ready for publication.

The student should distribute the final adviser-approved manuscript and schedule a defense before the advisory committee.

The defense is open to the public. Notice of the exam should be sent to the departmental graduate director, associate dean of graduate studies of the College of Engineering, and the College of Graduate Studies, and should be posted on College of Engineering bulletin boards.

Following the examination, the advisory committee will vote on whether to approve the dissertation and its defense. The

committee will advise the student on what additions or corrections are necessary before another defense is scheduled. When the examination is passed, there are generally revisions for improvement to be implemented before final approval of the document. When the final corrected, signed dissertation is submitted to the College of Graduate Studies through the departmental graduate director, the department chair and the associate dean of graduate studies, the student is certified academically for graduation.

Doctor of Philosophy in BIOMEDICAL ENGINEERING

Mohamed Samir Hefzy, Program Co-Director from the College of Engineering
Dorothea Sawicki, Program Co-Director from the College of Medicine

The Doctor of Philosophy in Biomedical Engineering at the University of Toledo is a joint program between The College of Engineering and The College of Medicine. The program is open to qualified students with either degrees in engineering or in science fields such as biology, chemistry, physics, mathematics, or computer science. Since prospective students have a variety of backgrounds, the requirements for admission vary.

The degree is conferred based on high scholarly attainment in the field of biomedical engineering. This program incorporates a formal entrepreneurship component in collaboration with the College of Business Administration (COBA) to encourage PhD students to commercialize the biomedical technology they may develop as part of their dissertation research. The curriculum also provides a PhD program for MD students from undergraduate engineering backgrounds that are interested in pursuing a dual degree and careers as physician scientists.

In addition to coursework requirements, continuation within the Ph.D. program requires that the student pass two major examinations: (1) the Ph.D. Qualifying Exam and (2) the defense of the Dissertation Research Proposal. Completion of the Ph.D. degree requires the writing and defense of the Dissertation and the writing of a business commercialization plan and/or publication of the research findings.

Curriculum

A minimum of 90 semester credit hours of approved graduate coursework are required beyond the B.S. degree. For students directly admitted into the Ph.D. program with a B.S. degree, the minimum coursework requirements specified below must be satisfied.

- Register and attend a weekly seminar series in the College of Engineering or the College of Medicine. Registration and attendance is mandatory every semester.
- Complete 13 hours of core coursework.
- Complete 12 hours of engineering/life sciences elective coursework.
- Complete 3-6 hours of entrepreneurship elective coursework.
- Complete 15 hours of other engineering/science elective coursework.
- Complete at least 45 semester hours of dissertation research. A student can register for dissertation research only after passing the *Qualifying Exam*.

The PhD curriculum requirements are designed to allow students maximum flexibility in selecting coursework appropriate for the research area. The curriculum for the PhD in Biomedical Engineering centers on several core course requirements in mathematics, engineering, and the life sciences. Additional technical courses are taken as needed to support the research area. In addition to the technical content, students take two courses from the College of Business on intellectual property and research commercialization, and develop a business plan to commercialize their

dissertation research. Individual course selections are made by the student and the student's research advisor and/or dissertation committee.

The core courses include the following: i) Computational Physiology, ii) a math course at the 7000 or 8000 level as a prerequisite for the mathematics core course, iii) choice of one of the following two mathematics core courses: MIME 8100 Advanced Engineering Mathematics II or MATH 8510 Partial Differential Equations, iv) INDI 802 On Being a Scientist, and v) a choice of 3+ credit hours from the following College of Medicine courses: BMSP 833 CPRA in Protein Structure and Function; BMSP 834 CPRA in Genes and Genomes; BMSP 835 CPRA in Cell Biology and Signaling; BMSP 836 CPRA in Biomembranes; ORTH 790 Orthopaedic Biomechanics I or equivalent; MPHY 804 Diagnostic Radiological Physics or equivalent. Students emphasizing the biological sciences must complete at least 5 credit hours of biomedical sciences program (BMSP) courses.

The PhD in Biomedical Engineering includes an entrepreneurial component which is nurtured through close interaction with the COBA Each student in this degree program completes the course EFSB 6590 New Venture Creation as part of the approved elective coursework. Students may also elect to complete the additional graduate level COBA course EFSB 6690 Technology Commercialization.

Qualifying Examination

The Qualifying Examination is an oral exam used to assess a student's critical thinking skills and understanding of the foundational material essential for success in the doctoral program. For students accepted into the Ph.D. program, the Ph.D. Qualifying Exam will occur after the completion of the required first year coursework comprising the core courses in physiology, mathematics and the courses from the College of Medicine. The students rotate through 3 different examination topics which are mediated by 2-3 faculty members. Each testing topic lasts no more than 25 minutes; each student is asked questions of increasing difficulty until the perimeter of the student's knowledge is determined. All students are tested on the common areas of mathematics and physiology. Each student selects the third test segment from the three broad specialization areas of biomechanics, bioprocessing/molecular & cellular biology, and bioelectrical systems.

Following the finalization of the examination outcomes, the Program Co-Directors immediately notify the students tested in writing of the testing outcome. If retesting is required, the student is also informed of the date of testing and the topic(s) to be retested. Students who do not receive an outright pass on the first examination have one opportunity to retest with a passing score or are dismissed from the program.

Ph.D. Dissertation Committee

Following the successful completion of the Qualifying Examination, students are expected to form their dissertation committees with the advice and consent of their research advisors. Each committee must consist of at least five UT Graduate Faculty. Affiliated Faculty must constitute the majority on each committee. Each committee must include at least one Affiliated Faculty member from the College of Engineering, one from the College of Medicine, and one external faculty member usually from the College of Business Administration.

Doctoral Candidacy

All doctoral students must meet the following requirements before being admitted to doctoral candidacy:

- Pass the Biomedical Engineering Qualifying Examination
- Select a dissertation committee
- Obtain at least a 3.0/4.0 for all graduate level coursework

Prior to initiating dissertation research, each student must complete and file a Graduate Research Advisory Committee Approval and Assurances Form (GRAD) with the College of Graduate Studies. Students must complete this form and receive the required approvals prior to beginning any research for a thesis involving humans, animals, radiation, or biohazardous substances.

Dissertation Research Proposal Examination

The dissertation research proposal is a document written by the student describing the research to be undertaken for the dissertation. The oral examination consists of the presentation of the written proposal by the student to the dissertation committee in a closed forum. The dissertation research proposal must be written and presented within one calendar year of passing the Qualifying Examination. A student may request an extension of up to one additional calendar year with the approval of the faculty advisor.

The dissertation research proposal should describe the background, goals, hypotheses, and general methods of the proposed research. The proposal should be structured in a manner similar to an NIH grant application. Copies of the proposal must be given to all members of the dissertation committee at least two weeks before the oral presentation. The dissertation proposal must then be formally presented to the dissertation committee and defended to their satisfaction.

Entrepreneurship component

Each student will integrates his/her COBA coursework with his/her research discoveries and submits a formal business plan to commercialize the dissertation research. This plan must be presented and approved by the dissertation committee prior to the final approval of the dissertation. The committee, which includes one faculty member from the COBA, may seek the advice of others in evaluating the submitted plan.

In recognition of the fact that some students will focus on more fundamental scientific research which may have limited commercial value, a student may request from the dissertation committee a substitution of the business plan by a research equivalent of this requirement. An example of such an equivalent requirement would be evidence of submission and/or publication of two peer-reviewed journal articles.

Ph.D. Dissertation and Defense

When the dissertation research is completed to the satisfaction of the faculty advisor, the student prepares a complete draft of the Ph.D. dissertation. The student must submit the final draft of the dissertation to each committee member for his or her critical evaluation and review at least two (2) weeks prior to the defense. The dissertation defense consists of a 45 minute formal oral presentation by the student, followed by open and closed question sessions. The dissertation committee then votes, and a majority of the committee must concur on the final decision. If the student does not pass the dissertation defense, then the dissertation committee, in consultation with the Program Director, will decide a course of future action.

Time Limit

Doctoral candidacy automatically terminates five (5) years after admission to candidacy. All requirements for the doctoral degree must be completed with seven (7) years of admission to the Ph.D. program (registration for first doctoral level class). To continue beyond the time limit, a written request for extension to the research advisor and the two Co-Directors of the Biomedical Engineering Committee must be submitted and approved.

J.D./M.S. Dual Degree Program

The J.D./M.S. dual degree program offers a student who has been admitted to The University of Toledo College of Law and one of The University of Toledo College of Engineering master of science programs the opportunity to complete requirements for both the J.D. and the M.S. degrees through a program of integrated curriculum in an accelerated period of study. The program is designed for full-time students who have an undergraduate degree in engineering or its equivalent. Students with a non-engineering undergraduate degree will be required to complete all prerequisite courses required by the College of Engineering, depending on the nature of the undergraduate degree.

Admission

Students should apply for the dual degree program using both the College of Law standard application form and the College of Graduate Studies application form. A joint admissions committee consisting of admission committee members from both colleges will review those College of Law applications that request dual admission. Although admission to both colleges is required before the student can begin the joint degree program, a student can begin a program in one college and later add the dual-degree program. In this case, only courses completed after admission to the dual-degree program can be counted toward the degree requirements in the discipline.

Advising

The College of Law and the College of Engineering, with the College of Graduate Studies, will administer and advise with regard to that school's curriculum, requirements and guidelines. Within the College of Engineering, advising is handled within the individual department of enrollment and coordinated through the associate dean of graduate studies. A dual program oversight committee will review policies and monitor the progress of students toward the dual degree completion.

Awarding of Degrees and Credit

A student enrolled in the dual degree program will not receive either the J.D. or M.S. degree until all the work required for both degrees has been completed. A student who withdraws from the dual degree program and remains in either the College of Law or College of Engineering shall receive only as much credit for work in the other college as the dean may authorize under the rules of that college.

No credit for work in the other college shall be awarded unless the student achieves an acceptable grade in the college offering the course. In addition, degrees must be awarded within time limits established by the College of Graduate Studies, the College of Law and the College of Engineering.

Description of the Curriculum

The integrated program and curriculum leads to the awarding of two degrees. The juris doctor degree will be awarded by The University of Toledo College of Law, and the master of science degree will be awarded by The University of Toledo College of Engineering.

Masters of Science in Engineering Degree: To fulfill requirements for the M.S. degree with thesis/project option, 30 credit hours at graduate level are required, while 36 credit hours at graduate level are required for the course work-only option. Students in the joint program may apply up to 12 credit hours of non-first year course work at the College of Law toward meeting the M.S. degree requirements. With the M.S. thesis/project option, students must complete at least 18 credit hours at the graduate level from the College of Engineering, including nine hours of M.S. thesis or six hours of M.S. project. With the M.S. course work-only option, students must complete at least 24 credit hours at the graduate level from the College of Engineering. The credit of up to 12 credit hours from the College of Law would be determined in consultation with the associate dean of graduate studies of The University of Toledo College of Engineering.

Juris Doctor Degree: The College of Law requires the successful completion of 89 credit hours. The dual degree program would permit up to 12 credit hours of core courses done in the College of Engineering to be applied toward the satisfaction of the 89-hour requirement. The 12 hours of course work from the College of Engineering would be determined in consultation with the associate dean of The University of Toledo College of Law.

Graduate Departments

Department of Bioengineering

Arunan Nadarajah, chair and acting graduate program director

Bioengineering is a relatively new discipline with rapidly growing job opportunities. Bioengineers apply engineering and life science principles to study, understand, modify and control biological systems. The goal of bioengineering is to develop new technologies and techniques that can be applied to a variety of problems in medicine and in the manufacture of bio-related products.

Achievement of these goals requires engineering graduates who are trained in engineering and the life sciences. The department of bioengineering is multidisciplinary in nature. It draws on faculty resources, collaborative research programs, and course offerings throughout the College of Engineering, the College of Arts and Sciences, the College of Pharmacy, and departments at the Medical University of Ohio and other area medical institutions.

The graduate programs in the Department of Bioengineering are open to all qualified individuals with a Bachelor of Science (B.S.) or Master of Science (M.S.) in Engineering. Students with a B.S./B.A. or M.S./M.A. degree in a related field are also eligible but students may be required to complete prerequisite courses without graduate credit. The Department of Bioengineering requires the GRE of all students for admission decisions to graduate programs.

Master of Science Program

The Master of Science program in bioengineering has two options: thesis and coursework. The thesis option requires the completion of a minimum of 30 credit hours of approved graduate course work and the successful defense of a research-based thesis. The coursework option requires the completion of at least 36 hours of approved graduate course work only. All course work must be approved by the student's adviser (or the graduate director). The M.S. curriculum is designed to provide a general, flexible framework for students in selecting course work that is relevant to their specific area of research. Each student must meet the following minimum general course work requirements:

- Register and attend the weekly bioengineering department seminar. Registration and attendance are mandatory every semester.
- Complete 12 hours of bioengineering core course work:.
  BIOE 5200 Physiology for Bioengineers or BIOE 6100 Computational Physiology
  BIOE 5260 Medical Imaging Systems I
  BIOE 6520 Orthopaedic Biomechanics
  BIOE 6310 Biochemical Engineering
- Complete six hours of elective course work as approved by the adviser to support the research area.
- Complete MIME 6000 Advanced Engineering Mathematics I to satisfy the mathematics requirement.
- Complete nine hours of bioengineering M.S. thesis research (thesis option) or 15 additional hours of graduate course work (course work option).

Doctor of Philosophy Program

The doctor of philosophy degree in engineering is conferred on the basis of extended study and high scholarly attainment in the field of bioengineering. The entrance requirement for the Ph.D. program in bioengineering is the M.S.

in bioengineering or another engineering field that meets the requirements of the bioengineering department. The M.D., D.D.S. and D.V.M. are acceptable, provided the student presents evidence of an appropriate engineering background at the undergraduate level, including a minimum of two years of calculus through differential equations and one year of physics. Highly qualified B.S. engineering graduates can be admitted directly into the Ph.D. program. Direct admission students will not write and defend an M.S. thesis or receive an M.S. degree en route to the Ph.D. degree.

The doctor of philosophy degree in engineering requires a minimum of 90 semester hours of approved graduate course work beyond the B.S. degree or 60 semester hours beyond the M.S. degree. For students directly admitted into the Ph.D. program with a B.S. degree, the M.S. course work and the Ph.D. course work requirements must be satisfied. All course work must be approved by the student's adviser. Each student must meet the following minimum general course work requirements beyond the M.S. degree requirements:

- Register and attend the weekly bioengineering department seminar. Registration and attendance are mandatory every semester.
- Complete BIOE 6100 Computational Physiology if not previously taken.
- Complete 9-12 hours of elective course work as approved by the adviser to support the research area.
- Complete MIME 8100 Advanced Engineering Mathematics II to satisfy the mathematics requirement.
- Complete at least 45 semester hours of dissertation research.

In addition to course work requirements, continuation within the Ph.D. program requires that the student pass two major examinations: (1) the qualifying exam and (2) defense of the dissertation research proposal. Completion of the Ph.D. degree requires the writing and defense of the dissertation, and presentation and publication of the research findings.

Admission to Candidacy

To be admitted to doctoral candidacy, all doctoral students must meet the following requirements:

- Pass the bioengineering qualifying examination.
- Select a faculty adviser and dissertation committee.
- Pass the bioengineering dissertation research proposal examination.
- Earn at least a 3.0/4.0 GPA for all graduate level course work.

Qualifying Exam

For students accepted into the Ph.D. program, the Ph.D. Qualifying Exam will occur after the completion of the required first year coursework comprising the core courses in physiology, mathematics and the bioengineering core courses (see MS course requirements). The students rotate through 3 different examination topics which are mediated by 2-3 faculty members. Each testing topic lasts no more than 25 minutes; each student is asked questions of increasing difficulty until the perimeter of the student's knowledge is determined. All students are tested on the common areas of mathematics and physiology. Each student selects the third test segment from the three broad specialization areas of biomechanics, bioprocessing/molecular & cellular biology, and bioelectrical systems.

Following the finalization of the examination outcomes, the Graduate Program Director will immediately notify the students tested in writing of the testing outcome. If retesting is required, the student is also informed of the date of testing and the topic(s) to be retested. Students who do not receive an outright pass on the first examination have one opportunity to retest with a passing score or are dismissed from the program.

Department of Chemical and Environmental Engineering

G. Glenn Lipscomb, chair

Constance A. Schall , graduate program director

The department of chemical and environmental engineering offers graduate courses and conducts research in the areas of advanced materials, alternative energy, biomass conversion to materials, polymer science and engineering, and membrane science and engineering. Students may select from a variety of courses and research topics in each area. The department offers two graduate degrees, a master of science in chemical engineering (M.S.Ch.E.) and a doctor of philosophy in engineering (Ph.D.).

Alternative energy research focuses on the production of fuels from ligno-cellulosic biomass and algae. Faculty also are developing processes for the conversion of biomass to advanced materials including polymers and carbons. Advanced materials are being developed for application in drug delivery, membrane materials, nano-sensors, and nano-composites. Packaging is the focus of work in polymer science and engineering, especially the development of packaging materials with enhanced barrier properties for product preservation. This work is conducted largely through the University's Polymer Institute. Finally, membrane materials and processes are being developed for desalination, waste water treatment, carbon dioxide capture, and energy production.

Degree Requirements

The graduate curriculum consists of four core classes, technical electives and a seminar. Master's and doctoral students must complete the following four core classes: Transport Phenomena I, Transport Phenomena II, Advanced Chemical Engineering Thermodynamics and Advanced Chemical Reaction Engineering. To complete the elective requirement, students may take most courses at the 5000 level or higher in the College of Engineering, the College of Pharmacy, or the College of Arts and Sciences departments of earth, ecological and environmental sciences; biology; chemistry; mathematics; or physics and astronomy. Students will choose specific courses with their advisers and will focus on classes in their specific research area. In addition, all graduate students must enroll continuously in seminars in chemical and environmental engineering.

Students may select one of two Master's of Science in Chemical Engineering (M.S.Ch.E.) degree programs: thesis or course work. The thesis option requires completion of 30 hours of course credit, successful defense of a thesis and typically takes two years to complete. The course work option requires completion of 36 hours of course credit, does not require a thesis and typically takes one year to complete. Minimum requirements are:

- Twelve (12) hours in four (4) core chemical engineering courses:

CHE-6500Advanced Chemical Reaction Engineering
CHE-6510Advanced Chemical Engineering Thermodynamics
CHE-6550Transport Phenomena I
CHE-6560Transport Phenomena II

- Nine (9) hours of graduate course work (excluding Graduate Seminar)
- Continuous registration for the Graduate Seminar
- Nine (9) hours of thesis work (thesis option) completed to the satisfaction of the thesis committee or fifteen (15) additional hours of graduate course work (course work option)

for a total of 30 credit hours for the thesis Masters and 36 credit hours for the course work Masters plus seminar credit hours. Only credit hours obtained with a letter grade of "C" or higher, or an "S" grade for the limited number of classes offered on a satisfactory or unsatisfactory basis, will fulfill degree requirements.

The graduate course work must satisfy the following restrictions:

- No more than three (3) hours of independent study, special problems, or special topics; six (6) hours if the student opts for the course work option will count towards the degree requirements
- No more than seven (7) hours in dual level courses; courses with a minority enrollment of selected undergraduates are not restricted

- All courses must be taken at the 5000 level or higher in the College of Engineering, the College of Pharmacy, or the Biology, Chemistry, Mathematics, and Physics Departments of the College of Arts and Sciences

Students should carefully select their courses to enhance their educational background and complement their research activities.

All students must register for one hour of Seminars in Chemical & Environmental Engineering, CHE-5930, each semester during the academic year. This course usually is graded on a satisfactory, unsatisfactory basis. To receive a grade of "S," students must attend all seminars or provide a written explanation for their absence.

Admission of Chemistry Majors

A special program is in place for students who are Chemistry Majors, and it requires them to take required pre-requisite courses. The plan assumes that two years of undergraduate calculus and one semester of physical chemistry have been completed. The student should contact the Graduate Director.

Polymer Option

Students may choose to pursue the Polymer Option for their M.S.Ch.E.. To complete the Polymer Option, students must obtain a "B" grade or higher in four (4) of the polymer option classes listed in the Graduate Courses section. Note that some classes are offered alternating years only. Students should contact the Director of the Polymer for more details regarding class content and schedule.

Degree Requirements for the Doctor of Philosophy in Engineering (Ph.D.)

The doctoral degree requires a total of 90 credit hours split equally between course work and dissertation research. However, to be formally admitted to candidacy for the degree, doctoral students must first pass the preliminary and qualifying examinations. After admission to candidacy, the completion of 45 credit hours of course work and 45 credit hours of dissertation research, doctoral candidates must prepare a written dissertation documenting their research efforts. Final approval for graduation is contingent upon a successful oral defense of the dissertation before the dissertation committee in a public forum.

The minimum requirements for the doctor of philosophy (Ph.D.) in engineering are:

- 12 hours in four chemical engineering courses:
  CHEE 8500 Advanced Chemical Reaction Engineering
  CHEE 8510 Advanced Chemical Engineering Thermodynamics
  CHEE 8550 Transport Phenomena I
  CHEE 8560 Transport Phenomena II
- An additional 33 hours of graduate course work (excluding the graduate seminar)
- Ph.D. degree candidates must continuously register for the graduate seminar and pass the preliminary and the qualifying exams. All students must register for one hour of CHEE 5930, Seminars in Chemical Engineering, each semester during the academic year. This course is usually graded on a satisfactory/unsatisfactory basis. To receive a grade of S, students must attend all seminars or provide a written explanation for their absence.
- Passage of the preliminary exam
- Passage of the qualifying exam
- 45 hours of dissertation research completed to the satisfaction of the dissertation committee for a total of 90 credit hours. Only credit hours obtained with a letter grade of C or higher, or an S grade for the limited number of classes offered on a satisfactory or unsatisfactory basis, will fulfill degree requirements.

The graduate course work must satisfy the following restrictions:

- No more than 15 hours of independent study, special problems or special topics
- No more than 11 hours of dual level courses, except for courses with a minority enrollment of selected undergraduates.
- All courses must be taken at the 5000 level or higher, including most graduate level courses, in the College of Engineering (see advisor for approved lists), the College of Pharmacy, or the College of Arts and Sciences departments of earth, ecological and environmental sciences; biology; chemistry; mathematics; or physics and astronomy.

The faculty may award students admitted with a master's in chemical engineering up to 30 hours of credit toward the Ph.D. This may include credit for core classes if the faculty deems classes taken as a master's student are comparable to the core classes. The student must satisfy all other requirements as listed above. Additional course work must satisfy the following restrictions:

- No more than three hours of independent study, special problems or special topics.
- No more than four hours of dual level courses, except for courses with a minority enrollment of selected undergraduates.
- All courses must be taken at the 5000 level or higher, including most graduate level courses, in the engineering departments of the College of Engineering (see advisor for approved list), the College of Pharmacy or the earth, ecological and environmental sciences, biology, chemistry, mathematics or physics departments of the College of Arts and Sciences.

Preliminary Examinations

The purpose of the preliminary exam is to provide evaluate whether a student possesses the background necessary to complete doctoral degree requirements. The exam consists of two parts, written and oral, given at the completion of the fall term for all new doctoral students.

The two hour written exam is a closed book exam covering the following core chemical engineering areas: transport phenomena, thermodynamics, and reaction engineering. However, the questions may be tailored to more closely match a student's background (for example, a student with a polymer background may be asked questions in the above areas with a polymer emphasis).

The exam tests material normally covered at the undergraduate level as well as material from the fall term graduate classes. A set of three problems is given in each core area and students must select one problem to work from each set. The faculty will evaluate students' written communication skills and their attention to the details of problem solving in addition to whether an appropriate answer is given.

The one hour oral exam covers the same material as the written exam. However, the questions are more open-ended and student responses are discussed in-depth. The faculty will evaluate students' oral communication skills and their ability to analyze problems qualitatively in addition to whether an appropriate answer is given.

Students either pass or fail the exam. The faculty as a whole will evaluate the results from both the written and oral parts as well as input from the student's advisor and classroom instructors to determine the final grade. Students that fail the exam may retake it at the end of the second term. If a student fails the exam twice, they may petition the Department to consider offering a third exam.

Students that enter with a B.S. and ultimately fail the exam are required to complete a Master's degree or leave the program. Students that enter with a M.S. are required to leave the program or pursue another M.S. degree.

Qualifying Exam

The qualifying exam consists of an oral defense of the proposed doctoral research project. The exam must be taken within one calendar year of passage of the preliminary exam. However, a student may petition the Department for extension of this time limit.

The student must submit a written proposal to their dissertation committee at least two weeks prior to the proposed exam date. The proposal should contain the following sections:

- Project Summary
- Research Objectives
- Research Significance
- Literature Review
- Research Plan
- Bibliography
- Budget

The entire proposal should be prepared using a 12 point font and one inch margins around the page. The project summary should be double spaced and extend not more than one page. Sections 2-5 should also be double spaced and not exceed 20 pages in length. The budget should indicate both monetary and time requirements.

There are no restrictions on the student concerning preparation of the proposal. Students may consult with both faculty and other students, if agreeable.

The oral defense consists of a brief presentation of the proposal, typically 30-45 minutes, followed by a question and answer session. During the exam, the committee will assess the appropriateness of the proposed project for a doctoral dissertation and the student's ability to successfully complete it; passage indicates that the committee believes the project is suitable and the student can complete it.

If a student fails the exam, they may petition the Department to retake the exam the following term. However, a second chance at passing the exam is not guaranteed.

Polymer Option

Students may choose to pursue the Polymer Option for their Ph.D.. To complete the Polymer Option, students must obtain a "B" grade or higher in all six (6) of the polymer option classes listed in the Graduate Courses section. Note that some classes are offered alternating years only. Students should contact the Director of the Polymer for more details regarding class content and schedule.

Department of Civil Engineering

Ashok Kumar, chair and acting graduate program director

The department of civil engineering offers graduate degree programs and conducts research in two focus areas – environmental and infrastructure engineering. Environmental engineering includes advanced study in areas such as outdoor and indoor air quality; sustainable buildings; water infrastructure sustainability, contaminated sediments; microbial degradation of organic compounds; microbial sensors; computer modeling of contaminant release and

dispersion in soils and in air; environmental decision making; air quality models for industries; risk assessment; and wastewater treatment processes. Infrastructure engineering includes structural and earthquake engineering, transportation engineering and geotechnical engineering. Geotechnical engineering includes advanced study in areas such as shallow and deep foundations, groundwater and seepage, and experimental and theoretical soil mechanics. Structural engineering includes advanced study in areas such as earthquake engineering;; structural repair and rehabilitation; structural health monitoring; numerical and experimental analysis; and design. Transportation engineering includes advanced study in areas such as traffic and facility design; urban transportation planning; pavement materials' properties and design; pavement management; intelligent transportation systems; and transportation system management and economics.

The department offers two graduate degrees – master of science in civil engineering and doctor of philosophy in engineering.

Master of Science in Civil Engineering Degree Requirements

For the master of science in civil engineering (M.S.C.E.) degree, a minimum of 30 credit hours is required – 21 hours of graduate course work (a minimum of nine credit hours should be at the 6000 level or above) and nine hours of thesis research (CIVE 6960) performed under the supervision of a full-time faculty member of the department of civil engineering. The department also offers a M.S.C.E. degree with a project or course work option with the written approval of the department chair or graduate program director. In the project option, a minimum of 30 credit hours is required – 24 hours of graduate course work (a minimum of 12 credit hours should be 6000 level or above) and six hours for the project report. In a course work option, a minimum of 36 credit hours in graduate course work is required, of which a minimum of 18 credit hours should be at the 6000 level or above. Courses taken on an audit basis do not count toward the degree. Additional requirements include:

- A maximum of six hours of independent study are allowed toward the degree.
- Students must prepare a plan of study in conjunction with the adviser (graduate program director for the first semester) with a concentration of required and elective courses in one of the department's research focus areas of graduate study and receive approval from the graduate program director. Required core courses in each area are determined by the faculty comprising that research area in conjunction with the graduate program director.
- No more than nine credit hours toward the M.S.C.E. may be earned at another university, and in no case may the thesis or project be satisfied by work completed at another institution.

Doctor of Philosophy Degree Requirements

The doctoral degree requires a minimum of 90 credit hours, of which 45 credit hours are for course work and 45 credit hours are for dissertation research. To be formally admitted to candidacy for the degree, however, doctoral students must first pass a qualifying examination. All Ph.D. students should note that admission to the doctoral program does not constitute admission to candidacy. The doctoral program is normally a full-time program throughout all of the course work and the dissertation. The department of civil engineering does not encourage part-time studies in the Ph.D. program.

For the Ph.D. degree, a minimum of 60 graduate credit hours beyond the M.S.C.E. degree (90 credit hours beyond the B.S. degree) are required, of which at least 12 credit hours are for graduate course work (largely departmental), an additional three credit hours for graduate level mathematics course work, and 45 credit hours for dissertation research under the supervision of a full-time faculty member of the department of civil engineering. A minimum of 45 credit hours beyond the M.S. must be completed at The University of Toledo.

To be awarded the Ph.D. degree, the student must have at least a B average (minimum GPA of 3.0) for all credits in the

program of study. In addition, the student must be admitted to doctoral candidacy and pursue an original research problem. The research must be completed and the dissertation written and successfully defended in public before the Ph.D. degree is conferred.

Admission to Candidacy for the Ph.D. Degree

To be formally admitted to candidacy for the doctoral degree, students must first pass the qualifying examination. The purpose of the qualifying exam is to determine whether a student possesses the necessary potential to complete doctoral degree requirements. The exam consists of two parts – a written examination and an oral proposal defense. The written exam is given in the middle of the fall or spring semester. It is intended to test the breadth and depth of the student's understanding of fundamentals and the most important and basic elements of the broad area of graduate studies in which the student is specializing.

The oral defense of the proposed dissertation research is held before an advisory committee of at least five faculty members. Prior to the defense, students submit a written proposal to the committee. The defense consists of a brief presentation of the written proposal followed by a question and answer session. During the exam, the committee will assess the appropriateness of the proposed research for a doctoral dissertation and the student's ability to successfully complete it. Students must defend their proposal in the fall or spring semester following passage of the written exam. Upon passing both parts of the qualifying exam, students may apply for admission to candidacy.

After completion of a minimum of 45 credit hours of course work beyond the bachelor's degree and 45 credit hours of dissertation research, doctoral candidates must prepare a written dissertation documenting their research results. Final approval for graduation is contingent upon a successful oral defense of the dissertation before the advisory committee in a public forum.

Students applying for admission are expected to have completed a B.S. in civil engineering. Those with degrees in other areas of engineering or science will have to take certain undergraduate courses to prepare for graduate courses. These courses will be identified prior to admission and will appear on the student's plan of study.

Department of Electrical Engineering and Computer Science

Mansoor Alam, chair

Mansoor Alam, graduate programs director

The department of electrical engineering and computer science (EECS) offers advanced study leading to M.S. and Ph.D. degrees. Graduate courses and research include topics in computer systems design and applications (hardware and software); communications; control and signal processing; intelligent systems; machine vision and imaging; power systems; power electronics; nanoelectronics materials and devices; photovoltaic devices; laser-based advanced processing; renewable energy and smart grid; microelectronics; VLSI design automation and testing; fault tolerance and reliability; computer networks; robotics; computer graphics and visualization; automotive systems; electromagnetics; computer aided design and simulation; Cyber security and high performance computing.

EECS department faculty members participate in five academic and research focus areas. Research activities of faculty often overlap the focus area, so several faculty participate in more than one focus area. Each focus area has a required and recommended list of courses for all graduate students pursuing that area of specialization. Courses to complete the degree requirements are to be selected by the student in consultation with an adviser. The focus areas are as follows:

- **High performance Computing Systems (HPCS):**

Members: **M. Niamat (Group Leader), M. Jamali, D. Kaur, M. Alam, V. Devabhaktuni**

High performance computing and visualization, Information security, Computer Networking, Cyber security, Wireless and sensor networks, **High performance scalable software, Information systems and services,** System software for parallel computing, Numerical computing and applications, Hypermedia & multimedia environments, Reliable computing, FPGAs, VLSI Testing and Fault Tolerance.

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§ **Communication and Signal Processing (CSP)**

Members: **M. Jamali (Group Leader), J. Kim, E. Salari**

The research in the Communication and Signal Processing focus group involves wide variety of topics such as data compression and image processing, satellite communication, sensor array processing and development of hardware for real time applications computation for digital receiver and passive radar systems.

· **Software and Intelligent Systems (SIS):**

Members: **G. Serpen (Group Leader), D. Kaur, and K. Shenai, J. Carvalho, L. Thomas**

Intelligent systems embody inquiries into artificial and computational intelligence fields. The Intelligent Systems (IS) faculty conducts research in several areas. Faculty research interests span fields of artificial intelligence, machine learning, artificial neural networks, data-mining, fuzzy logic and reasoning, and hybrid algorithms.

§ **Power Electronics and Energy Systems (PEES)**

Members: **T. Stuart (Group Leader), R. King, K. Shenai, and L. Wang**

Electrical Engineering basically consists of two primary functions: processing information and processing energy. The research in this focus group is primarily concerned with processing energy in electrical form, but to accomplish this it is necessary to also utilize many techniques from the information sector. Therefore the research in this area depends on fields such as power electronics, electro-mechanical machines, energy storage devices, control systems, computer analysis methods and modeling, and real time embedded systems.

§ **Solid-State and RF Devices and Systems (SRDS)**

Members: V. Devabhaktuni (Group Leader), R. Jha, A. Johnson, K. Shenai, L. Wang, R. Collins, A. Compaan, X. Deng, D. Georgiev, S. Khare, and S. Marsillac

The objectives of the group are to:

(i) **Exploit atomic scale phenomena in developing next generation of solid-state materials and devices targeted for electrical energy generation, electrical power conversion, and electronic sensing applications .The strategy is to develop research that carefully blends physics and electrical engineering disciplines to address growing demand for renewable/alternative energy, electrical energy conversion and storage, photovoltaics, solid-state lighting, low-power sensors and electronics, and harsh environmental electronics and,**

(ii) **Build on electromagnetic (EM) fundamentals and radio-frequency (RF) and microwave concepts for engineering new high-frequency components, circuits, materials and systems. The focus is to foster research leading to development of commercially viable products, patents, user-friendly CAD tools, publications in top-ranked international conferences and journals, and to secure external funding from various resources.**

Master of Science Programs

Two M.S. degrees are offered by the department – one in electrical engineering and the other in engineering. Students

studying under the HPCS or SIS focus groups receive the M.S. in engineering, with concentration in computer science and engineering, while those working under the other groups receive the M.S. in electrical engineering degree. The master of science degree is offered with the following options.

1. **Master of science degree with thesis option:** A minimum of 30 credit hours of approved graduate study, including nine credit hours of master of science thesis under the supervision of a faculty member, is required. Students are required to submit a written thesis and successfully complete the oral defense of the thesis work.
2. **Master of science degree with non-thesis option:** The degree requirements for master of science with non-thesis option are available with the approval of the department graduate program director:

    a. **Master of science degree with project option:** Students are required to complete 30 credit hours of approved graduate study including six hours of master of science project as specified by individual department guidelines and requirements. Students are required to submit a written project report to the department.

    b. **Master of science degree with course work-only option:** Students are required to complete 36 credit hours of approved graduate-level course work

Students must complete the following additional requirements:

- An approved plan of study.
- A minimum of 18 hours of EECS courses (including thesis/project and independent study).
- At least six hours of EECS courses at the 6000 level, excluding thesis and independent study.
- One credit hour (included in the required 30 hours for the program) of the EECS graduate seminar course EECS 5930 with a maximum of two excused absences in the semester.

Students are encouraged to include higher-level math courses in their program, subject to approval of their advisers.

Courses taken on an audit basis do not count toward the degree. Courses outside of the College of Engineering require prior approval.

In order to be awarded the master of science degree, the student must have at least a B average (a minimum GPA of 3.0/4.0) for all graduate course credits in the program of study as well as for the entire graduate transcript.

Doctor of Philosophy Program

Doctoral study in EECS leads to the degree of doctor of philosophy in engineering. A student must complete a total at least 90 hours of graduate credit (including dissertation) beyond the bachelor's degree, less allowances for transfer credits or other credits such as an M.S. degree. Doctoral candidacy requires satisfactory performance on the doctoral qualifying examination, selection of an academic adviser, and formation of a dissertation committee. Candidates are awarded the Ph.D. degree following: 1) satisfactory completion of a minimum of 60 credit hours beyond the M.S. degree or a minimum of 90 semester hours beyond the B.S. degree in a closely related field; and 2) successful defense of a dissertation that constitutes a fundamental advancement of knowledge in the field. The Ph.D. usually takes a minimum of three full years of graduate study beyond the M.S. degree.

The general requirements for the Ph.D. degree are:

- A minimum of 60 credit hours beyond the M.S. degree and a minimum of 90 credit hours beyond the B.S. degree.
- At least 45 credit hours of graduate-level course work beyond the B.S. degree, of which the credit allowance for the master's degree will not exceed 30 semester credit hours. Usually, 45 credit hours of dissertation research are required.
- No more than three credit hours of independent study for students with an M.S. degree and no more than 15 credit hours of independent study for students with a B.S. degree may be counted toward the Ph.D. course requirement.

- The student must pursue, complete and publish a research study that is demonstrated to be an original contribution to the field of study.
- The dissertation must be written and successfully defended publicly before the Ph.D. degree is conferred.
- The student must submit a minimum of two journal papers based on the dissertation research. Copies of the official letters of acknowledgments for the submitted papers should be given to the graduate director. Also, every student is required to attend the seminar class in EECS and maintain at least an 80 percent attendance rate.

It is the responsibility of the student and the faculty adviser to formulate a program of study to satisfy requirements for the Ph.D. degree. The student's program of study should contain both breadth of knowledge and depth of specialization in one of the focus areas outlined earlier. The program must be approved by the faculty adviser, the advisory committee, the graduate program director and the College of Graduate Studies.

Department of Mechanical, Industrial and Manufacturing Engineering

Abdollah A. Afjeh, chair
Efstratios Nikolaidis, graduate programs director

Graduate students enrolled in the Department of Mechanical, Industrial and Manufacturing engineering (M.I.M.E.) may pursue the following degree programs: Master of Science in Industrial Engineering, Master of Science in Mechanical Engineering and Doctor of Philosophy in Engineering.

The fields of Mechanical Engineering are very diverse offering opportunities in research, design, product development and manufacturing. Major parts of Mechanical Engineering include aerodynamics, fluid dynamics, solid mechanics, bio-engineering, material sciences, nanotechnology, dynamics, automotive engineering, production and process machine design, vibrations and control systems, and reliability-based design and optimization. The department features state of the art studies using modern equipment and techniques.

Research Focus Areas

The current research of the department focuses on the following areas:

- **Computational and Experimental Thermal Sciences:** The computational and experimental thermal science research focus group encompasses broad research activities. These include research in such areas as alternative energy, computational fluid dynamics and heat transfer, tribology, flow stability and transition, vortex dynamics, drag reduction, small and medium engine turbines, microgravity flows, thermal systems simulation, biofluid flow dynamics, turbulent boundary layer characterization, experimental methods using hot wire/film anemometry, laser Doppler velocimetry, particle image velocimetry, flow visualization techniques, and thin film heat flux gauge research. **T. Ng** (coordinator), A. Afjeh, S. Cioc,, D.R. Hixon, , K. C. Masiulaniec, D. Oliver, , C. Sheng.

- **Materials, Mechanics and Design:** The objectives of the materials, mechanics and design focus group are to conduct research that will advance the engineering knowledge base and lead to new processes and products in the broad areas of mechanical systems, dynamic systems and control, mechanical behavior of materials and mechanical design. More specifically, the research thrust of this group includes but is not limited to the dynamic behavior and control of mechanisms, machines, mechanical systems, processes, structures and smart material systems, including MEMS, biomechanics, design methodology, fatigue and fracture mechanics, machine dynamics, noise and vibration analysis and control, solid modeling and vehicle dynamics. **P. White** (coordinator), L. Berhan, M. Elahinia, A. Fatemi, Y. Gan, M. S. Hefzy, G. Naganathan, E. Nikolaidis, W. Olson, M. Pourazady, H. Zhang.

- **Manufacturing and Systems:** The manufacturing and systems focus group emphasizes solving manufacturing problems. Example problems include development of processes for products, basic understanding of metal

forming and cutting, design of assembly systems, and improving the environmental impact of industry. A key aspect of this group is the blend of practical plant expertise with the benefits of computational technologies, including computer-aided design and manufacturing. Processes are understood from a "hands-on" perspective and expanded through theoretical defining models. Engineering materials are studied throughout their life cycle, from raw material acquisition, product creation and usage, remanufacturing, recycling and final material disposal. Key expertise within this group includes internationally recognized faculty in rapid prototyping, process engineering, grinding and abrasives engineering, facilities planning and modeling, and environmentally conscious design and manufacturing. **A.H. Jayatissa** (coordinator), S. Bhaduri, M. Franchetti, , I. Marinescu, H. Zhang.

Master of Science Programs

Applicants must hold a bachelor of science in mechanical or industrial engineering, or a closely related field, from an accredited engineering program. If the baccalaureate is in a non-engineering or science area, students may be required to complete prerequisite courses without graduate degree credit. The master of science degree program may be pursued with thesis and non-thesis options.

1. **Master of science degree with thesis option:** The plan of study must include 30 hours of graduate work selected from those approved for graduate study (5000 level or above). A minimum of 12 hours of course work must be in the student's focus area of study. This option requires a minimum of nine hours of thesis credit.
2. **Master of science degree with non-thesis options:**
   a. **Master of science degree with project option:** Students are required to complete 30 credit hours at the graduate level, including six hours of master of science project under the supervision of a M.I.M.E. faculty member. The project option must be approved by the M.I.M.E. departmental chair or the graduate program director. Students are required to submit a professional, written project report to the department after due approval by the faculty adviser. The project report will then be logged and archived in the department as a technical report.

   b. **Master of science degree with course work-only option:** Students are required to complete a minimum of 36 credit hours of graduate level course work as specified by the department. This option has to be approved by the M.I.M.E. department chair or graduate program director.

The majority of a student's course work for all of the options will normally be from M.I.M.E. courses. Three or more hours of the course work must be from approved courses in advanced mathematics. An individual student may be required to complete more than the required minimum hours to satisfy prerequisite deficiencies specified as provisional admission conditions and/or to fulfill educational requirements of the program as specified by the adviser or department.

In addition to the above requirements, all students are required to enroll and/or participate in a graduate seminar (MIME 6930 or equivalent) each semester. The department, for satisfactory completion as well as enhancement of degree objectives, may specify additional credit or non-credit requirements. The plan of study for the master of science degree must be filed before 16 hours of academic course work has been completed. For full-time students, this normally will require that the plan of study be filed before registration for the second term.

For transfer credit, students should refer to the general policies of the College of Graduate Studies.

Doctoral Degree Program

A satisfactory doctoral degree plan is developed jointly by the student and the dissertation adviser, subject to the approval of the department chair or graduate program director.

A minimum of 15 credit hours of regular departmental courses taken for a letter grade beyond the M.S. degree is required

for the doctoral degree program. Twelve credit hours must be departmental courses. Students entering the direct doctoral program with a bachelor's degree must complete 27 credit hours of regular departmental courses beyond their bachelor's degree, of which at least 15 credit hours must be at the 6000/8000 level. Project credits may not be counted toward the 27 credit hours of regular, letter-grade course work. All required courses are at the advanced graduate level as determined by the department. Other courses taken may include courses not listed as departmental courses, independent study courses, and courses taken S/U.

In addition to the above course requirements, all students are required to enroll and participate in a graduate seminar (MIME 8930 or equivalent) each semester. The department, for satisfactory completion as well as enhancement of degree objectives, may specify additional credit or non-credit requirements.

For transfer credit, students should refer to the general policies of the College of Graduate Studies.

Doctoral Degree Candidacy

Doctoral candidacy requires satisfactory performance in the doctoral qualifying examination, filing an approved doctoral program plan, selection of an academic adviser, formation of a doctoral dissertation committee and maintaining good academic performance as specified in the M.I.M.E. department Graduate Student Handbook.

When the above requirements have been met, the student may file his/her application for doctoral candidacy. The department requires that the application be filed within one year of the time the doctoral qualifying examination is passed. Doctoral students must have established candidacy for the doctoral degree before presenting and defending dissertation research.

Doctoral Dissertation

After the student and the adviser have agreed on a dissertation topic, the student must write a dissertation proposal. The student will present the proposal to the doctoral dissertation committee and successfully defend his/her dissertation proposal.

The doctoral dissertation committee must consist of at least five members. The chair of the committee will be the candidate's principal adviser. The other members usually will be the co-adviser (if any), faculty members or experts in a related field, with at least one committee member outside the department. The signatures of the committee on the candidate's dissertation indicate approval of the dissertation research and represent the final certification of its adequacy.

Department of Engineering Technology

, Allen Rioux, interim chair
William T (Ted Evans), program director

The department of engineering technology administers the College of Engineering's part-time Master of Science in engineering with a concentration in general engineering program. This engineering master's degree program is intended for students who are full-time employees seeking the master's degree to facilitate career advancement or achievement of personal educational goals. To accommodate students who are full-time employees, course work for this degree program may be taken online via distance learning or as traditional on-campus courses.

Master of Science in Engineering Degree Requirements

The part-time master of science in engineering program requires 24 hours of approved graduate-level course work and a six-hour, work-related project, for a total of 30 credit hours. The student is expected to meet the following general requirements:

- Nine hours of engineering core courses to establish a common foundation in engineering. These courses include Management of Projects and Technological Innovation (CHEE 6700), Applied Probabilty and Statistics (GNEN

6980), and Applicationsof Engineering Analysis (GNEN 5500). The engineering core courses are designed to update computer analysis skills, provide a background in applied statistics and to furnish tools for the management of projects and technological innovation.

- Nine hours of business core courses that cover introduction to financial and managerial accounting, analysis of manufacturing and service systems, and business, government and society. These courses include Analysis of Manufacturing and Service Systems (OPMT 5520), Business: Government and Society (BLAW 6100) or Leading Through Ethical Decision Making (MGMT 6100), and Financial and Managerial Accounting (ACCT 5000). The business core is intended to acquaint engineers, scientists and technologists with financial, managerial, and social issues that can help the engineer succeed in today's marketplace.

- Six hours of engineering elective courses to support the student's focus area. Each elective course is worth three credit hours, so two courses are required. Graduate offerings in the bioengineering, chemical and environmental engineering, civil engineering, electrical engineering and computer science, engineering technology, or mechanical, industrial and manufacturing engineering departments are eligible for selection as electives.
- Six credit hours of a work-related project. The topic and other specifics of the project require prior approval of the program director and should include approval and cooperation of the employer.
- 30 credit hours total.

The project may be completed in two semesters plus the summer. Students may complete their course requirements in four semesters by taking the recommended two courses per semester.

For transfer credit, students should refer to the general policies of the College of Graduate Studies. No more than nine credit hours toward the Master of Science in engineering may be earned at another university, and in no case may the project be satisfied by work already completed at another institution or on the job.

In order to be awarded the Master of Science in engineering degree, the student must have at least a B average (minimum GPA of 3.0/4.0) for all graduate course credits in the program of study as well as for the entire graduate transcript.

Admission Requirements

To be admitted to the part-time Master of Science in engineering program, applicants must have a bachelor's degree in engineering, engineering technology or in a closely related field (e.g., one of the mathematical, physical or biological sciences). Applicants must be employed or have experience in private industry, government or nonprofit organizations. Admissions are made on an individual basis and take into account the applicant's previous record, the intended area of study, and the needs and capacity of the College of Engineering.

Generally, a minimum GPA of 2.7 is required for admission. Applicants having a GPA less than 2.7 who demonstrate potential for graduate study may be admitted to the master's program on a provisional or other basis, at the option of the department. Students with an undergraduate GPA below 2.7 must register and take the GRE. Information on the GRE is available on the GRE Web site: *http://www.gre.org.* Students who graduated with a bachelor's degree from The University of Toledo do not need to submit official transcripts. Students who did not graduate from The University of Toledo need to contact the office of the registrar at their undergraduate institution to arrange for transmission of the undergraduate transcripts. Students entering the program will be required to have at least: Calculus, through Ordinary Differential Equations (3 semesters), Physics (2 semesters) and Chemistry and/or Engineering Materials (1 semester) and any three out of the following six: statics, dynamics, electronics, electric circuits, fluid mechanics and thermodynamics.

For additional information regarding this program, please consult the College of Engineering's Web site at *http://www.eng.utoledo.edu/coe/practice_oriented_masters/* for specific program guidelines developed in cooperation with

the College of Business Administration.