Doctor of Philosophy in Mechanical Engineering

Doctor of Philosophy (Ph.D.) Degree

The Department of Mechanical Engineering offers a dissertation option for a Doctor of Philosophy degree. Areas of study in Mechanical Engineering include:

1. **Biomechanics and Biomaterials:** biomechanics of human motion, biomaterials, orthopedic biomechanics and biomedical product design, transport phenomena, and drug delivery.
2. **Computational Mechanics and Mathematics of Computations:** computational mechanics, finite element analysis, finite element methods and software
3. **Thermal-Fluid Systems and Heat Transfer:** energy and thermal-power system design, heat transfer and computational fluid dynamics
4. **Mechanical Design, Manufacturing, and Mechatronics:** computer-aided mechanical design, continuum mechanics, computer-integrated manufacturing, computational mechanics, finite element analysis, machine stress analysis, mechatronics, material science,, and automatic control systems

Mission

The broad discipline of mechanical engineering enables students to have productive and rewarding careers, and to develop and improve new technologies in both traditional and emerging fields. Mechanical engineers apply fundamental principles to develop, design, manufacture, and test machines and other mechanical devices. Such devices include, but are not limited to power-producing machines, as well as power-consuming machines. Mechanical engineers are employed in diverse areas, including but not limited to the energy and power industries, the automotive and aerospace industries, and industrial manufacturing. Mechanical Engineering graduates also have careers in medicine and medical device development, patent law, engineering and corporate management, forensic engineering, and engineering sales.

The mission of the Mechanical Engineering Department is to provide our students with a high-quality education, to generate and apply knowledge, and to serve both society and the engineering profession.

Graduates holding the Ph.D. degree in Mechanical Engineering will be able to:

1. *An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.*
2. *An ability to develop and conduct appropriate physical and/or numerical experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.*
3. *An ability to read, analyze, and critically assess scientific literature.*
4. *An ability to effectively communicate advanced mechanical engineering concepts in writing and orally at a professional level and an ability to articulate and address critical issues in their field of study.*
5. *An ability to independently acquire new information, learn new concepts, and build new skills.*
6. *An ability to recognize ethical and professional responsibilities.*

Standard Admission Requirements for all Graduate Programs

- All applicants must meet the requirements outlined in the Admission to Graduate Study (https://policy.ku.edu/graduate-studies/admission-to-graduate-study/) policy.
- Bachelor's degree: A copy of official transcripts showing proof of a bachelor's degree (and any post-bachelor's coursework or degrees) from a regionally accredited institution, or a foreign university with equivalent bachelor's degree requirements is required.
- English proficiency: Proof of English proficiency (https://gradapply.ku.edu/english-requirements/) for non-native or non-native-like English speakers is required. There are two bands of English proficiency, including Admission and Full proficiency. For applicants to online programs, Full proficiency is required.

Admission Requirements

To qualify for graduate study in any of the graduate programs in the Department of Mechanical Engineering, a student generally must have earned a baccalaureate degree from an accredited mechanical engineering program. However, a student with good preparation in some other engineering discipline or a related program, such as physics, may qualify by taking appropriate undergraduate courses specified by the Mechanical Engineering Department Graduate Admissions Committee **.** Application information can be found at the graduate admissions (https://gradapply.ku.edu/apply/) website.

Minimum English Proficiency Requirements

These guidelines are subject to change by official action of the appropriate Graduate School governance bodies. Visit the full English Proficiency Requirements for Admission to Graduate Study policy (http://policy.ku.edu/graduate-studies/english-proficiency-international-students/) for the current requirements.

GTA and GRA Eligibility

Graduate teaching and research assistant eligibility requirements are distinct from admission requirements. Additional information on eligibility for graduate teaching assistants and graduate research assistants may be found in the GTA, GRA, and GA Appointments: General Guidelines and Eligibility (https://policy.ku.edu/graduate-studies/GRA-GTA-GA-guidelines-eligibility/).

Contact Information

Please contact the Mechanical Engineering Graduate Program Coordinator at kume@ku.edu or +1 (785) 864-3181, to schedule a visit or with questions about the application process.

The University of Kansas
Mechanical Engineering Graduate Program
3138 Learned Hall
1530 W. 15th Street
Lawrence, KS 66045

Doctor of Philosophy (Ph.D.) Degree

A minimum of 72 credit hours of graduate credit beyond the bachelor's degree is required for a Ph.D. For students with a 30-credit Master's degree in Mechanical Engineering, a minimum of an additional 18 credits hours of graduate course work and 24 credit hours of dissertation are required. If a Master's degree is not sought, 42 credit hours of graduate course work beyond the bachelor's degree and 30 credit hours of dissertation credit are required. A minimum of 9 credit hours of the 18 (or 21 of the 42) must be mechanical engineering courses numbered 700-900 (excluding ME 702, ME 801, ME 899, ME 901, and ME 999). A minimum of 9 credit hours of advanced mathematics beyond the bachelor's degree is required.

Doctoral Qualifying Examination

For a student with a Master's degree, a qualifying examination will normally be taken in the first semester of participation in the doctoral program on regular status. It should not be taken later than the end of the second semester. For a direct admit with a bachelor's degree, a qualifying examination will typically be taken after completion of 30 hours of graduate course work.

The Qualifying Examination Committee consists of three or more members of the graduate faculty within the area of emphasis and are normally expected to be members of the Research and Graduate Studies Committee of the Department of Mechanical Engineering. A grade of pass or fail will be assigned and be kept in the departmental records.

Criterion #1: The student must demonstrate an understanding in a core set of fundamental undergraduate mechanical engineering knowledge.

Criterion #2: The student must demonstrate an understanding in a subset of core advanced mechanical engineering knowledge.

Criterion #3: The student must demonstrate the ability to communicate effectively through writing, oral presentation, and open questioning.

The faculty from the four areas of study in Mechanical Engineering, as defined by the Graduate Student Handbook, are responsible for developing separate methods to evaluate the criteria. The areas of study are: Biomechanics and Biomaterials; Computational Mechanics and Mathematics of Computations; Thermal-Fluid Systems and Heat Transfer; and Mechanical Design, Manufacturing, and Microprocessor Applications. The methods for the four areas to assess the three criteria area listed below.

Criterion #1

This criterion will be assessed and satisfied with the current policies for entrance to the KUME graduate program. This includes the current requirements for satisfying deficiencies in the undergraduate mechanical engineering curriculum. At the time of the Ph.D. qualifying exam, the student must have satisfied and completed all requirements and conditions specified by the Department of Mechanical Engineering and the SOE to address deficiencies.

Criterion #2

A) The student will identify three 3-credit mechanical engineering technical elective courses (excluding courses required for the KU BSME degree, ME 702, ME 801, ME 860, ME 899, and ME 999) and one 3-credit mathematics course from the approved list in the KUME Graduate Handbook (or approved prior by the Graduate Director). The chosen ME courses should reflect three specific subjects in the focus area of study. Equivalent graduate courses that are completed at other institutions may be used to satisfy the requirements. All courses must meet the approval of the student's advisor and the Qualifying Examination Committee including a review by the Graduate Director.

B) **OR, DEPENDING ON ADVISOR PREFERENCE,** the student will be required to demonstrate an understanding of three specific ME subjects and mathematics by passing written exams in each of these four subjects. The series of written exams will be scheduled during one week each fall and/or spring semester. Each exam will be graded separately on an A to F basis and count similarly to a 3-credit course towards this assessment. Scheduling and generation of the exams is the responsibility of the student's major advisor with other faculty assistance.

In order to pass this criterion, the student must achieve at least a cumulative 3.7 GPA over all four courses or exams. A *conditional* pass may be awarded for a 3.5 GPA or greater (up to 3.7 GPA) with the student required to address said deficiency in the lowest graded course by either (depending on advisor preference): (1) completing extra coursework in that subject while achieving an A grade, or (2) re-taking the exam in that subject area and passing with an A grade. The student must address this deficiency before taking the Ph.D. comprehensive exam.

Criterion #3

The student will give an oral presentation that will last 20 minutes or less, and including questions from the Qualifying Examination Committee, the overall presentation will last 60 minutes or less. The material for the presentation will be a summary of one to three pertinent and related papers (with no conflict of interest) to the student's Ph.D. topic area given to the student one week prior to the oral presentation date. These paper(s) will be approved by the advisor and the Qualifying Examination Committee.

Two days before the oral presentation, the student will provide a one-page summary (single-spaced, 12 point font, Times New Roman, 1" margins) to the committee of the material to be presented. *No outside help will be allowed*. To receive a passing grade, the student must demonstrate to the committee their ability to effectively communicate the information. For a student that receives a grade of conditional pass, the committee will recommend appropriate remedies. If a student receives a grade of fail, a second and final attempt will be granted.

Plan of Study

Within the first year of graduate studies, the student selects a major professor from the Department to serve as the chairperson of the advisory committee and to direct the research.

A complete plan of study (https://engr.ku.edu/plan-study/) must be submitted before the end of the first semester and include the specific courses and all other requirements (research skills, research topic, etc.), and filed electronically with the Department and the Graduate Division of the School of Engineering. Courses completed without an approved program of study filed may not necessarily count toward the degree.

On successful completion of the qualifying examination, an advisory committee of at least five Graduate Faculty members from the School of Engineering with at least three from the Mechanical Engineering faculty is selected by the student and their adviser to assist the student in preparing the plan of study, to conduct the comprehensive examination, and to assist the student in planning research. This committee can be added to the plan of study once formed.

Proficiency in Research Skill Area and Responsible Scholarship

All doctoral students must meet the Research Skills requirement before proceeding to comprehensive exams. The requirement must include at least two components:

- Every doctoral student is required to have training in responsible scholarship pertinent to the field of research.
- Every doctoral student is required to obtain research skills pertinent to the doctoral level of research in their field(s).

The responsible scholarship requirement may be met by taking ME 801, in addition to all other course and credit requirements. The Ph.D. student must demonstrate proficiency in at least one research skill area. Since the needs of students differ, the research skills are determined with the advice and approval of the advisory committee. Possible areas may include:

1. *Foreign Language.* The aspirant may demonstrate a reading knowledge in a foreign language in either of two ways:
   a. Receive a score in the language on the Educational Testing Service Graduate School Foreign Language Test at, or above, the minimal level prescribed by the Graduate Studies Office.
   b. Complete a language course approved by the advisory committee with a grade of B or better.
2. *Computer Science.* To establish competence in computer science, it is necessary to satisfy the advisory committee by demonstrating proficiency in a commonly used programming language and creating at least one original program.
3. *Laboratory Training.* Specific training on research skills relevant to the topic of dissertation by the advisor in their respective laboratory with the help of senior students.

All research skill and responsible scholarship requirements must be satisfied prior to the comprehensive examination and reported to the Graduate Division.

Doctoral Comprehensive Examination

When a doctoral aspirant has completed the major portion of the course work at a level satisfactory to the graduate degree program and school (*typically 18 credit hours beyond the Master's degree, or 42 beyond the Bachelor's degree*) and met all other program, school, and general requirements prerequisite to the comprehensive oral examination, including the research skills requirement as appropriately applied and established for the student's particular program, the degree program must request the Graduate Division of its school to schedule the comprehensive oral examination. It should be determined that the student is in good academic standing (3.0 or higher grade-point average) before scheduling the examination. The examination request (*using the Progress to Degree system*) must be submitted in advance of the examination date by at least the period specified by the Graduate Division, normally a minimum of two weeks. The Graduate Division ascertains whether all pertinent requirements have been satisfied and if reports of any previously scheduled comprehensive oral examinations have been properly submitted and recorded. http://policy.ku.edu/graduate-studies/doctoral-oral-exams (http://policy.ku.edu/graduate-studies/doctoral-oral-exams/)

The committee for the comprehensive oral examination must consist of at least five members, all of whom must be members of the Graduate Faculty *and at least three of whom must be tenured / tenure track Mechanical Engineering Faculty including the committee chair*. Its members are appointed by the Graduate Division of the school or college on the basis of nominations submitted by the graduate degree program. At least one member must be from a department other than the aspirant's major department. This member represents Graduate Studies and must be a regular member of the Graduate Faculty. The Graduate Studies representative is a voting member of the committee and has full right to participate in the examination. In the case of any unsatisfactory or irregular aspects of the exam or violation of Graduate Studies policy, the Graduate Studies representative shall provide a written report to the Dean of Graduate Studies for consideration of further action. The examination may be scheduled provided that at least five months have elapsed from the time of the aspirant's first enrollment at KU *considering the Qualifying Exam has been successfully passed*.

The comprehensive oral examination covers the major field and any extra-departmental work for which the program wishes to hold the aspirant responsible (*students should discuss the oral examination requirements with their advisor and committee*). For every scheduled examination, the degree program reports a grade of Honors, Satisfactory, or Unsatisfactory. If the aspirant receives a grade of Unsatisfactory on the comprehensive oral examination, it may be repeated on the recommendation of the degree program, but under no circumstances may it be taken more than three times. In any case, the examination may not be repeated until at least 90 days have elapsed since the last unsuccessful attempt. *The schedule for the examination should be announced throughout the Department at least 7 days in advance.*

Post-comprehensive Enrollment

Post-comprehensive enrollment is defined by university policy (https://policy.ku.edu/graduate-studies/doctoral-candidacy/). Doctoral candidates are required, after passing the comprehensive oral examination, to be continuously enrolled each fall and spring semester in one or more hours of dissertation or programmatically equivalent coursework (for example, document hours for DMA students) that both moves the student towards degree completion and reflects, as accurately as possible, the candidate's demands on faculty time and university facilities. During this time, until all requirements for the degree are completed (including the filing of the dissertation) or until 18 post-comprehensive hours have been completed (whichever comes first), the candidate must enroll for a minimum of 6 hours a semester.

Post-comprehensive enrollment may include enrollment during the semester or summer session in which the comprehensive oral examination has been passed. If after 18 hours of post-comprehensive enrollment the degree is not completed, the candidate must continue to enroll each semester until all degree requirements have been met. The number of hours of each enrollment must be determined by the candidate's advisor and must reflect as accurately as possible the candidate's demands on faculty time and university facilities.

Dissertation

The doctoral candidate must present a dissertation showing the planning, conduct, and results of original research and/or scholarly creativity. The purpose of the dissertation is to encourage and ensure the development of broad intellectual capabilities and to demonstrate an intensive focus on a problem or research area. The dissertation itself should be an evident product of the candidate's growth and attainment of the ability to identify significant problems; organize, analyze, and communicate scholarly results; and bring to bear on an area of scholarly or scientific interest a variety of research skills and scholarly or creative processes. The dissertation must show some original accomplishment (*sufficient quality to merit publication(s) in refereed journals and it is anticipated*

that the student will submit one or more journal publications prior to their defense), but it should also demonstrate without doubt the candidate's potential to make future contributions to knowledge and understanding. Furthermore, a candidate for a doctoral degree must satisfy all Graduate School requirements for the degree.

Both the dissertation research and the dissertation itself are to be completed under the guidance and direction of the committee appointed as described in the Doctoral Student Oral Exam Committee Composition policy:

1. Doctoral committees are composed of at least five voting members;
2. The majority of committee members serving on a doctoral student oral examination committee must be tenured/tenure-track faculty holding regular or dissertation graduate faculty status in the candidate's department/program of study. Tenured/tenure-track faculty who are appointed as courtesy faculty within the program/department are considered (for the purposes of committee composition) to be faculty of that program/department;
3. One member must meet the requirements for serving as the Graduate Studies representative. A faculty member from a different department with a courtesy appointment in the student's department may serve as the Graduate Studies representative or in fulfillment of the committee majority, but cannot serve in both roles at the same time; and
4. Beyond the majority requirement, the additional member may hold any graduate faculty status, including regular, dissertation, or special status. This fifth member can be, but need not be, a member of the candidate's department/program.

As long as the conditions above are met, the committee may include more than five members.

The doctoral committee chair must hold dissertation status. While committees are not required to have a co-chair, the student or the committee members may decide to select a co-chair. The co-chair can hold any graduate faculty status.

Substitutions of the committee chair (and/or co-chair) are prohibited after the committee has been approved by the Graduate Division of the school/college. If a committee chair (and/or co-chair) needs to be replaced, the revised committee must be approved by the Graduate Division in advance of the exam.

Substitutions of the committee members are permitted as long as the new members hold regular or dissertation graduate faculty status. Special members can be added after the committee has been approved by the Graduate Division of the school/college, but these additions must be approved by the Graduate Division in advance of the exam.

Dissertation Oral Examination

Completion of the dissertation is the final academic phase of a doctoral program, culminating in the final oral examination and defense of the dissertation. In all but the rarest cases, tentative approval of the dissertation is followed promptly by the final oral examination. When the completed dissertation has been accepted by the committee in final draft form, and all other degree requirements have been satisfied, the chair of the committee requests the Graduate Division to schedule the final oral examination. This request must be made in advance of the desired examination by at least the period specified by the Graduate Division (normally three weeks). The submission of the request must allow sufficient time to publicize the examination so that interested members of the university community may attend. The final oral examination may be held no earlier than one (1) month after the successful completion of the comprehensive oral examination. Departments, programs, schools, or the College may require a longer minimum interval between the oral comprehensive exam and the final dissertation defense.

The committee for the final oral examination must consist of at least five members (the members of the dissertation committee plus other members of the Graduate Faculty recommended by the committee chair and the department and appointed by the Graduate Division). At least one member must be from a department other than the major department. This member represents Graduate Studies and must be a regular member of the Graduate Faculty. Before the examination, the Graduate Division provides a list of responsibilities to the Graduate Studies representative. The Graduate Studies representative is a voting member of the committee and has full right to participate in the examination. In the case of any unsatisfactory or irregular aspects of the exam or violation of Graduate Studies policy, the Graduate Studies representative shall provide a written report to the Dean of Graduate Studies for consideration of further action.

The Graduate Division ascertains whether all other degree requirements have been met and it reports of any previously scheduled final oral examinations have been submitted and recorded. Upon approval of the request, the final oral examination is scheduled at the time and place designated by the Graduate Division. This information must be published in a news medium as prescribed by the Graduate Faculty. Interested members of the university community are encouraged to attend these examinations.

For every scheduled final oral examination, the department reports to the Graduate Division a grade of Honors, Satisfactory, or Unsatisfactory for the candidate's performance. If an Unsatisfactory grade is reported, the candidate may be allowed to repeat the examination on the recommendation of the department.

When the candidate has passed the final oral examination and the members of the dissertation committee have signed the dissertation, a title page and acceptance page with original signatures are to be delivered to the Graduate Affairs office of the school/college in which the student's program resides so that completion of degree requirements may be officially certified. As a requirement of graduation, the candidate must arrange publication of the dissertation and payment of all applicable fees, through the electronic submission process.

Moreover, the candidate must provide a bound copy to the major professor, and one bound copy to the Mechanical Engineering Department.

Program Time Constraints

University policies on enrollment, recognition of prior work, and maximum time to degree can be found in the university policy library. (https://policy.ku.edu/graduate-studies/doctoral-candidacy/)

At the completion of this program, students will be able to:

- Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- Develop and conduct appropriate physical and/or numerical experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- Read, analyze, and critically assess scientific literature.
- Effectively communicate advanced mechanical engineering concepts in writing and orally at a professional level and an

ability to articulate and address critical issues in their field of study.
- Independently acquire new information, learn new concepts, and build new skills.
- Recognize ethical and professional responsibilities.