

Wayne State University
Mechanical Engineering Department

Preliminary Qualifying Exams (PQE) Guidelines

These guidelines are intended to assist the mechanical engineering graduate students in preparing for the Ph.D. Preliminary Qualifying Examination, which is a requirement of all Ph.D. applicants in the Department of Mechanical Engineering.

Who is required to take the Preliminary Qualifying Exam? All students must pass the three PQE exams during their first year in the Ph.D. program. They will only have two chances to pass the examination. Students joining the Ph.D. program in the fall semester must take the PQE exams in October. Those who fail will have another chance to retake the exams in February of the same academic year. As for those who join the program in the winter semester, they have to take the PQE exams in February. If they did not pass then they have to retake the exams in October of the following academic year. **All PQE requirements must be fulfilled within the first year after the student joins the Ph.D. program.** Failure to meet this requirement within the specified time limit will result in the dismissal from the Ph.D. Program.

MSME students who have completed 20 graduate credits at WSU with a GPA of 3.5/4.0 or better will be eligible to one free chance to take the Ph.D. Preliminary Qualifying Examination. The results of such an examination would only count if the student passes. Failing grades would not count. Irrespective of the result of such an examination, the student has to go through the regular application process to be considered for admission to the Ph.D. program. These students would still be eligible for the two trials to pass the PQE exams after being admitted to the Ph.D. program.

Frequency of the Preliminary Qualifying Examination: The PQE exams are administered by the ME Graduate Program Committee and are offered twice a year during the first week of October and the first week of February of each academic year.

Guidelines of the PQE Exam: Students have to demonstrate mastery of the fundamentals in math (mandatory), thermodynamics, mechanics of materials or dynamics by passing the Preliminary Qualifying Examination. The latter consists of three separate exams. All students have to take the core math exam. They also have to select two exams pertaining to dynamics, thermodynamics or mechanics of materials. The passing guidelines for these exams will be set by the faculty. Each of these exams will involve four problems and the students are required to solve three out of the four problems in a two-hour period. The examination will be closed book and closed notes. Students will be provided with a formulae sheet pertaining to the subject matter that are being tested on.

The exam papers will be graded within two weeks after the exam date and the results will be approved by the faculty at the first faculty meeting following the PQE exam. The results will then be communicated to students through the ME Graduate Program Director. Within one week from receiving the examination results, students can appeal their results by stating all their questions and concerns in a formal written request addressed to ME Graduate Program Director. Students must refrain from discussing exam issues with the examiners after the exam is over.

Registration for the Preliminary Qualifying Exam: Students must fill out the “PQE Registration Form” that can be downloaded from the ME website and submit it to the ME Graduate Program Director or at the ME front desk no later than one week prior to the exam date. During their first attempt of the PQE, students must take the math exam (core exam) and two out of the remaining three exams, namely, dynamics exam, thermodynamics exam and mechanics of materials exam. In their second attempt, students would only have to retake the exam(s) of the PQE that they were not able to pass during their first attempt. **Absenteeism for any exam, without a written notice, will result in a failing grade for the exam.**

Under extreme circumstances such as illness or other emergency situations, the student will be allowed to postpone the examination, but only one such postponement will be allowed. The student must inform the ME Graduate Program Director of such situation on or before the examination date and present the supporting documents thereafter.

- **Medical Excuse:** A signed letter from a physician from the day of the examination indicating that the student had a valid medical reason for missing the exam. This letter must be on the physician’s letterhead and the name and phone number of the physician must be legible. For cases of extended medical treatment, the letter can be dated prior to the examination, if the physician’s recommendation for leave extends beyond the examination date.
- **Death in the Family or Family Illness:** A copy of the death certificate or obituary for the family member who has died. For illness of a family member for whom a student is the primary care-giver, a signed letter from the family member’s physician for the day of the examination.

Scope of the Preliminary Qualifying Exam (PQE):

The PQE consists of three separate exams. All students must take the ***Math Exam (mandatory exam)*** and select their second and third exams from the following list:

- Dynamics Exam
- Mechanics of Materials Exam
- Thermodynamics Exam

The scope of the exams will be based on topics listed below for each area. All exams will be closed book and closed notes. Students will be provided with a formulae sheet pertaining to the subject matter that are being tested on.

Dynamics: Based on course content of ME 3400

- **Kinematics of a particle:** Rectilinear motion, curvilinear motion (Rectangular coordinates, normal tangential coordinates, and polar coordinates), constraint motion, relative motion in pure translation
- **Kinetics of a particle:** Newton’s second law and free-body diagram (rectangular coordinates, normal tangential coordinates and polar coordinates), work and energy method, linear momentum, linear impulse, angular momentum, angular impulse and impact

- Kinematics of rigid bodies in plane motion: Instantaneous center, relative motion in rotating coordinates (Coriolis acceleration)
- Kinetics of rigid bodies in plane motion: Mass moment of inertia (parallel axes theorem), first moment of mass (Center of mass), Newton's second law and free-body diagram (pure translation, rotation about a fixed axis, center of percussion concept, general plane motion), Work and energy, linear momentum and linear impulse, angular momentum and angular impulse, and impact

Mechanics of Materials: Based on course content of ME 2420

- Axial loads: Elastic deformation of axially loaded member, principle of superposition for total effect of different loading cases and applying compatibility principles to solve statically indeterminate structures.
- Torsion: Shear stresses in a circular shaft due to torsion, angle of twist and analyze statically indeterminate torque-loaded members
- Bending: Determine the internal moment at a section of a beam, determine the stress in a beam member caused by bending and application of flexural formula
- Transverse shear: Shear stress in a prismatic beam, shear flow in a built-up and thin-walled beams
- Combined loading: Determine stresses developed in thin-walled pressure vessels, determine stresses developed in a member's cross section when axial load, torsion, bending and shear occur simultaneously
- Stress transformation: Navigate between rectilinear co-ordinate systems for stress components, determine principal stresses and maximum in-plane shear stress, determine the absolute maximum shear stress in 2-D and 3-D cases
- Deflections of beams: Determine the deflection and slope at specific points on beams and shafts, using various analytical methods including the integration method, the use of discontinuity functions and the method of superposition

Thermodynamics: Based on course content of ME 2200

- First Law of Thermodynamics: Energy balance of open and closed systems, conservation of mass, uniform flow, flow rates, flow work, boundary work, energy conversion efficiencies
- Properties of Pure Substances: Property tables, phase change process, P-v and T-v diagrams, ideal gas equation of state, compressibility factor, specific heats, internal energy, enthalpy, incompressible substances
- Second Law of Thermodynamics: Heat engines, refrigerators, heat pumps, reversible and irreversible processes, entropy, isentropic processes, entropy change, reversible work, compressor work, isentropic efficiencies, entropy balance
- Cycles: Gas power cycles, Carnot cycle, Otto cycle, diesel cycle, Brayton cycle, gas turbines, vapor cycle, Rankin cycle