ME Ph.D. Preliminary Exam

Part 1: Written Exam of 6 hours

This exam will be given during the first two weeks of each spring quarter. It consists of three subjects of the examinee's individual choice, among those listed at the end of this document. The exam will be at the entering M.S./first year Ph.D. level, focusing on the most fundamental topics of each area. All the examinees must submit their letters of intent for taking the exam to the Graduate Program Assistant, within the first seven weeks of the winter quarter.

The exam in each subject takes two hours, during which the examinees are allowed to use a simple calculator and two pages (8 by 11 in) of self-prepared hand-written notes.

Part 2: Oral Exam:

This exam should be completed within four weeks after the written exam. It evaluates the readiness of students for the dissertation work at the early stage. This exam should be given by a committee, consisting of three faculty members: the dissertation advisor (committee chair) and two members of the Academic Senate, of which one must be a ME regular or collaborative faculty member. The committee members shall be selected by the student together with his/her dissertation advisor. The committee should submit a written recommendation to the Graduate Committee within one week following the exam.

Notes:

1. A student, who plans to take the Ph.D. preliminary exam during the spring quarter, must submit a formal request, with the dissertation advisor's approval, to the Graduate Advisor, by the end of the 5th week of the winter quarter. See the appendix for the standard request form.
2. The written part of the Ph.D. Preliminary Exam will have the same content as the written part of the M.S. Comprehensive Exam, but they will be graded using different sets of criteria. A student in a Ph.D. program cannot use the Ph.D. Preliminary Exam as a substitute for the MS Comprehensive Exam to get a M.S. degree using the non-thesis option. An exemption may rarely be made on a case-by-case basis.
3. The Graduate Committee should review the exams and announce the decisions within two weeks following the exams.
4. Students are recommended to take the ME graduate courses offered during the fall and winter quarters for their preparation of the subject areas of the Exam.

The list of the exam areas (Note: More areas will be added as the Faculty grows in the future):

Dynamics and Vibrations:

- Motion Analysis of Particles and Rigid Bodies
- Newton's Laws of Motion
- Work and Energy Method
- Linear Impulse and Momentum Method
- Angular Impulse and Momentum Method
- Vibrations with and without damping

Suggested reading: W. F. Riley and L. D. Sturges: **Engineering Mechanics: Dynamics**. John Wiley

Engineering Analysis:

- Linear Equations
  Matrix operations, determinants, elimination methods, eigenvalue problems
- Ordinary Differential Equations
  Separable equations, first and second order ODEs, and system of ODEs
- Introductory PDEs
  Laplace, Poisson and wave equations and their solutions, including Fourier series solutions
- Vector Analysis
  Gradient and curl operations, Green's and Stokes's theorems.
- Complex Analysis
  Analytic functions, the residue theorem and contour integral
- Numerical Interpolation
  Lagrange polynomials and cubic splines
- Numerical Solutions
  Non-linear algebraic equations and ODEs

Suggested reading: Kreyzig: **Advanced Engineering Mathematics,** John Wiley.

Fluid Mechanics:

- Stresses in fluids, Hydrostatics, Newtonian fluids
- Equations of motion
- Inviscid flow, Bernoulli equation
- Incompressible internal and external flows, boundary layers, lift and drag forces
- Pipe flows, friction factors, loss coefficients, pump performance

Suggested reading: Fox and McDonald: **Introduction to Fluid Mechanics**

Heat Transfer:

- Conduction: balance of mass and energy in conduction, steady 1-D, 2-D and 3-D conduction, heat transfer from extended surfaces, conduction in moving media, unsteady lumped systems, unsteady distributed systems (1-D, 2-D, and 3-D), and Heisler charts
- Convection: balance of mass, momentum, and energy in convection, laminar and turbulent forced convection in internal and external flows, thermal and momentum boundary layers as well as heat transfer correlations in both forced convection and in natural convection,
- Radiation: Fundamental physics of thermal radiation, view factors and their algebra, and Radiation exchange between gray-diffuse surfaces
- Multimode heat transfer

Suggested reading: F. P. Incropera and D. P. DeWitt, **Introduction to Heat Transfer**, latest edition available, J. Wiley, New York

Materials Science:

- Atomic arrangements in crystalline solids: elements of crystallography
- Bonding of solids: covalent, metallic, ionic and mixed bonding
- Imperfections in solids: vacancies, impurities, dislocations and grain boundaries
- Strengthening mechanisms: dislocations and precipitates
- Phase diagrams: 2 components
- Basic properties of materials: mechanical, thermal, electrical

Suggested reading: William D. Callister, Jr: **Materials Science and Engineering An Introduction**

Solid Mechanics:

- Elements of tensor analysis
- Strains and stresses in solids
- Equations of motion
- Constitutive relations for linear elastic solids
- Stress waves in linear elastic isotropic solids
- Degeneralized 2D theories for anti-plane shear, plane stress, and plane strain
- Degeneralized 1D theories for bars, shafts and beams

Suggested readings: James M. Gere: **Mechanics of Materials**,
A.P. Boresi and K.P. Chong: **Elasticity in Engineering Mechancis**

Thermodynamics:

- Concepts of work and energy, first and second laws of thermodynamics,
- Energy balance, reversibility, open and closed system definitions,
- Concept of entropy and entropy balance for systems
- Definition of state properties, Rankine cycle,
- Concept of phase equilibrium and phase diagrams
- Ideal solution theory, Henry's law and Raoult's law,
- Concept of activity and Gibbs free energy equation,
- Reaction equilibria for ideal solutions, energy balance for reactions.

Suggested reading: Y.A. Cengel and M. Boles: **Thermodynamics**