MEES PhD Qualifying Exam Syllabus
Solid Mechanics

Mechanical Engineering and Engineering Science

August 18, 2012

The student is expected to be knowledgeable in elementary Mechanics of Materials (equivalent to MEGR2144) and an introductory graduate level class on elasticity (equivalent to MEGR6141). The purpose of the exam is to test the student's understanding of the fundamental concepts, ability to formulate and solve boundary value problems correctly, and assess the readiness of the student for doctoral studies.

The exam will be closed-book. However, an equation sheet containing the basic formulae developed in MEGR2144 and the governing equations developed in MEGR6141 will be provided.

For the purposes of studying for the exam, the following books are recommended:

- Elementary Mechanics of Materials
  1. Mechanics of Materials by B.J. Goodno and J.M. Gere, 7th edition or 8th edition.
  2. Mechanics of Materials, An Integrated Approach, by T.A. Philpott, Any of the editions
  3. Any other book on Mechanics of Materials at the same level as the above two.
- Theory of Elasticity
  1. Linearized Theory of Elasticity by W.S. Slaughter, Birkhauser, 2001.
  2. Continuum Mechanics for Engineers, by G.T. Mase, R.E. Smelser and G.E. Mase, 3rd Edition, CRC Press, 2009.

Topics for Elasticity

Kinematics

- Deformation
- Approximations of Infinitesimal Deformation
- Infinitesimal Strain Tensor
- Geometrical Interpretation of the Infinitesimal Strain Tensor
- Principal Strains, Invariants
- Compatibility Conditions

Balance Laws

- Conservation of Mass for Infinitesimal Deformations
- Cauchy's Stress Principle

- Balance of linear momentum and angular momentum
- The Stress Tensor
- Equations of Motion
- Principal stresses and principal directions
- Stress Invariants

Elastic Constitutive Equation

- Isotropic Materials
- Hooke's Law

Basic Equations of Linear Elasticity

- Summary of the Equations
- Boundary and Initial Conditions
- Uniqueness in the context of Elastostatics

Some Elementary Problems

- Tension of a Bar
- Extension of a Bar by its Own Weight
- Torsion of a Right Circular Cylinder

Saint-Venant Beam Theory

- Saint-Venant's Principle
- Extension
- Pure Bending
- Torsion
- Bending by Transverse Shear (Plane-Stress solution only)

Plane Problems

- Plane-stress and Plane-strain
- Solutions in terms of Airy's Stress Function
- Solutions in Polar coordinates

Thermoelasticity

- Uncoupled Quasistatic Thermoelasticity
- Basic Equations
- Formulation of the Problems for Simply-Connected Bodies

Topics for Strength of Materials

Equilibrium Equations

- Principles of Equilibrium
- Statically Determinate and Indeterminate Systems

Axial Loading of Bars

- Calculation of elastic strain, elongation
- Calculation of stress
- Saint-Venant's Principle
- Temperature Effects (Uniform Temperature Change Only)

Torsion of Right Circular Bars

- Torsion Formula
- Calculation of Shear-Stress and Twist

Bending of Beams

- Pure Bending
- Transverse Bending

Calculation of Principal Stresses

- Mohr's Circle
- Principal Stresses in Beams

Pressure Vessels

- Cylindrical and Spherical Pressure Vessels
- Principal Stresses

Buckling of Beams

- Euler-Bernoulli Theory of Buckling
- Various Support Conditions