Ph.D. Qualifying Exam: Mechanics of Materials

Department of Mechanical Engineering University of Utah

Exam Description:

This qualifying exam will test the student's graduate-level knowledge of mechanics of materials. The reference textbooks and course material that serve as a basis for this exam are taken from ME EN 3310 and ME EN 6200. The exam is focused on testing concepts learned in mechanics of materials, along with survey of advanced topics. Includes advanced stress analysis in structural members and prediction of their failure; advanced topics in beam bending; torsion of non-circular cross- sections and thin-walled tubes; inelastic bending and torsion; energy methods; and elastic instability. Students should be able to:

- Understand and evaluate complex states of stress and strain for a variety of loading scenarios
- Understand factors influencing material failure and accurately predict its likelihood for complex states of loading
- Identify limitations of traditional mechanics of materials, or elementary, techniques
- Utilize solutions from Theory of Elasticity to solve complex problems that can't be accurately addressed using traditional mechanics of materials techniques (e.g. torsion and bending of non-circular cross-sections, concentrated loads, etc.)
- Apply energy methods to predict multiaxial structural deformation under complex loading
- Apply fundamental principles of plasticity to predict structural deformation beyond the elastic regime

Recommended References:

Advanced Mechanics of Materials and Applied Elasticity, 5th Ed., A.C. Ugural & S.K. Fenster, Prentice Hall, 2012.

Exam Materials:

An equation sheet will be provided to students for their preparation before the exam. The same sheet will be provided with the exam. Students may bring a department issued calculator. No other materials will be allowed during the exam.

Topics:

Topics covered include:

- Stress
- Strain
- Material properties
- Failure criteria
- Fracture
- Fatigue
- Impact, dynamic loading
- Overview of Elasticity
- Concentrated loads and stresses
- Contact stresses
- Beam bending
- Torsion
- Axisymm loading – pressure vessels
- Axisymm loading – rotating discs
- Energy methods
- Stability of columns
- Stability of columns
- Plasticity
- Plates and shells