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 exam is focused on testing concepts learned in mechanics of materials, along with survey of advanced topics.

Students should be able to:

- Evaluate complex states of stress and strain for a variety of loading scenarios
- Analyze the mechanical behavior of linear elastic materials, including the predict of failure for complex states of loading
- Identify limitations of traditional mechanics of materials, or elementary, techniques
- Utilize (not derive) 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. (Note that a free online version of this text is available through the Marriott Library website; search for the text, click the "View It" tab, and sign into the service with your university email.)

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:

- Advanced analysis of stress and strain
- Properties of linear elastic materials
- Failure criteria, including fatigue
- Concentrated loads, including contact stress
- Asymmetric beam bending
- Torsion, including non-circular cross sections and thin-walled tubes
- Axisymm loading, including pressure vessels and rotating disks
- Structural displacement – energy methods
- Elastic stability – columns
- Plasticity and residual stress in axial loading, bending, and torsion