Credit Hours: 3-0-0

Prerequisites: Knowledge of strength of material and differential equations is required to take the class. Elementary knowledge of elasticity and plasticity is strongly recommended.

Catalog Description: Applications of energy and variational methods in engineering mechanics to elastic, plastic and dynamical behavior of deformable media.


Instructors: Qu, Jasiuk, Lynch, McDowell, Neu, Zhou
Mechanics of Materials Research Group

Goal:

- This class will emphasize the applications of energy and variational methods in engineering mechanics. Several energy and numerical methods that are derived from the variational principles will be introduced and their use will be illustrated through various examples including elasticity, plasticity, dynamics, etc.

Audience:

- First and second year graduate students in ME, AE, CE and MSE.

Topics

Review of Fundamental Equations
- Stresses, strains and their relationships
- Equations of equilibrium
- Compatibility conditions
- Boundary conditions

Review of variational calculus
- Functional and its first variation
- Euler equations
- Natural and essential boundary conditions
- Constraint conditions and Lagrange multiplier

Virtual work
- Principle of virtual work
- Principle of complimentary virtual work

Variational Principles
- Principle of minimum potential energy
- Principle of minimum complimentary potential energy
- Hellinger-Reissner principle
- Hu-Washizu principle

Energy theorems in mechanics
- Castigiano's theorems
- Rayleigh-Betti reciprocity theorem

Approximate methods
- Rayleigh-Ritz method
- Galerkin method
- Weighted residual methods
- Finite element method
- Boundary element method

Applications
- Mechanics of materials
  - Flow theory
  - Limit analysis
- Composite materials
  - Upper and lower bounds of effective properties

Course Approval Form