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ME 256 (JAN) 3:0

Variational Methods and Structural Optimization

Instructor(s): G K Ananthasuresh

Course description:

Calculus of variations: functionals, normed vector spaces, Gateaux variation, Frechet differential, necessary conditions for an extremum, Euler-Lagrange multiplier theorem, second variations and sufficient conditions. Weak form of differential equations, application of Euler- Lagrange equations for the analytical solution of size optimization problems of bars and beams, topology optimization of trusses and beams applied to stiff structures and compliant mechanisms. Material interpolation methods in design parameterization for topology optimization, optimization formulations for structures and compliant mechanisms involving multiple energy domains and performance criteria. Essential background for Karush-Kuhn- Tucker conditions for multi-variable optimization, numerical optimization algorithms and computer programs for practical implementation of size, shape and topology optimization problems.

Prerequisites:

Multivariable calculus and familiarity with finite element analysis.

Resources:

- Smith, D.R., Variational Methods in Optimization, Dover Publication, 1998.
- Haftka, R.T., and Gurdal, Z., Elements of Structural Optimization, Kluwer Academic Publishers, 1992.,
- Bendsoe, M.P., and Sigmund, O., Topology Optimization: Theory, Methods and Applications, Springer, 2003.

Outcomes:

After taking the course, the student should be able to:

- Write the Euler-Lagrange equations and boundary conditions for unconstrained and constrained variational problems involving multiple design variables, multiple independent variables, multiple local and global constraints as well as variable end conditions.
- Read classical and contemporary literature on variational methods and continuous and finite-variable optimization.
- Formulate and solve, analytically and computationally, structural optimization problems and do sensitivity analysis for single and multiphysics problems.

Additional information: This course involved programming in Matlab.

Course website: <https://mecheng.iisc.ac.in/suresh/me256>