AE 6111 Elasticity II

1. Course summary

This course focuses on the analysis of stresses and deformations in continuum media. Stress and strain measures used in nonlinear elasticity are discussed in detail. Equilibrium equations and energy principles are derived. Applications to nonlinear beam, plate, and shell formulations are discussed.

2. Topics to be covered in this course

1. Vectors and Tensors. Coordinate transformations. Tensors. Permutation symbol and tensor. Cross product. (6 hours)
2. Kinematics of the deformation of a continuum:

Strain measures: the engineering strains components, the deformation gradient tensor, the metric tensor, the Green-Lagrange strain tensor, the Almansi strain tensor, the infinitesimal strain tensor. (6 hours)

Strain measures for various differential elements: stretch of a material line, angle change between material lines, surface dilation, volume dilatation. (2 hours)

Decompositions of the strain tensor: additive and multiplicative decompositions, polar decomposition. (3 hours)

Principal stretches. (1 hours)

3. Stresses in a continuum. Stress measures: the Cauchy stress tensor, the first and second Piola -Kirchhoff stress tensors. (4 hours)

4. Differential equations of equilibrium. Principle of virtual work. (3 hours)

5. Constitutive laws: the strain energy density function, linear elastic isotropic and anisotropic materials, nonlinear elastic, isotropic, incompressible materials. (4 hours)

6. The small strain approximation. The finite rotation tensor. Applications to large deflections and rotations of cables, beams and plates. (6 hours)

7. Introduction to curvilinear coordinate system. Christoffel symbols. Covariant derivatives. Strain and stress measures in curvilinear coordinates. (5 hours)

8. Applications to large deflections and rotations of curves beams and shells. (5 hours)

3. Reference books

The following reference text books are on reserve in the library for the course:

S.P. Timoshenko and J.N. Goodier: **Theory of Elasticity**. McGraw-Hill Book Company, 1987.
W. Flugge: **Tensor Analysis and Continuum Mechanics**. Springer-Verlag, 1972.
L.E. Malvern: **Introduction to the Mechanics of a Continuous Medium**. Prentice-Hall, Inc., 1969.
A.E. Green and W. Zerna: **Theoretical Elasticity**. Oxford: Clarendon Press, 1954.
G. Wempner: **Mechanics of Solids with Applications to Thin Bodies**. Sijthoff & Noordhoff, The Netherlands, 1981.
K. Washizu: **Variational Methods in Elasticity and Plasticity.** Pergamon Press, Oxford, U.K., 1975. (QA931.W33)

J.N. Reddy: **Energy and Variational Methods in Applied Mechanics**. John Wiley & Sons, 1984. (TA350.R39)