CE 57000: Advanced Structural Mechanics

School of Civil Engineering
Purdue University

Instructor: Arun Prakash
E-mail: arunprakash@purdue.edu
Office Hours: 4119, Civil Engineering building
Mondays and Wednesdays: 1pm-3pm; Or email for an appointment.
Class Webpage: http://www.itap.purdue.edu/tlt/blackboard

Lecture Time and Location: M-W-F 11:30am-12:20pm, HAMP-2118

Course Description:
Studies of stress and strain, failure theories, and yield criteria; flexure and torsion theories for solid and thin-walled members; and energy methods. (See the list of topics for details).

Prerequisites: Graduate Standing; CE-270 Introductory Structural Mechanics;
Vector Calculus, Some Computer Programming (MATLAB)

Text Book (required):
- KD Hjelmstad, *Fundamentals of Structural Mechanics,* Springer, 2005.
  (Available freely through Purdue Libraries)

Grading Basis:

• Homeworks	15%	Assigned and due **before** lecture time on most Fridays.
• Quizzes (4 @ 15% each)	60%	6:30pm on: **Sep 15**, **Oct 6**, **Oct 27**, **Nov 17**
• Final Exam	25%	TBA.
Total	**100%**	

Make-up quizzes / exams for absences will **not** be given. Students must notify the instructor about any unavoidable conflicts with the scheduled quizzes / exams. Only under extremely unavoidable situations, the score for a missed quiz / exam may be adjusted at the sole discretion of the instructor.

Academic Integrity
- All work (assignments and exams) that you submit must be strictly **your own work**.
- Obtaining solutions from another student or from any other external source (and/or letting others copy from you) is **absolutely not** allowed.
- Collaboration in the form of giving and receiving help on concepts **is allowed and encouraged**.

Emergency Procedures
In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Information regarding these changes will be posted on the course webpage and you will be intimated using the class email list.

CE 57000: Advanced Structural Mechanics

School of Civil Engineering
Purdue University

List of Topics:

1. *Introduction and Mathematical Preliminaries*: Mechanics of solids/structures; Vector algebra; Tensors and matrices; Vector and tensor calculus
2. *Kinematics of deformation*: Deformation map and deformation gradient, rotation and stretch; Strain and physical significance; compatibility; Eulerian & Lagrangian formulations*; Time dependent motion; material derivatives; objective rates*
3. *Stress and equilibrium of deformable bodies*: Free body diagrams; Traction and stress; Equilibrium and balance principles; First and second Piola-Kirchhoff stresses; objective stress rates*
4. *Material models*: Material frame indifference; objectivity; Hyperelasticity; Isotropy; Hooke's model; Thermodynamic considerations*; Plasticity*; Damage models*
5. *Boundary value problems in solid mechanics*: Strong and Weak forms, 1D problems; 2D Plane stress/strain, examples; 3D strong forms and solution methods, examples; Principle of virtual work
6. *Numerical solutions to boundary value problems*: Ritz method; Introduction to the Finite element method; Non-linear solution methods*
7. *Structural mechanics of beams*: Kinematic hypothesis; Stress resultants; Planar beam: Timoshenko & Bernoulli-Euler formulations
8. *Energy Methods and Variational principles*: Directional derivative; Vainberg's theorem; Energy principles; Stability
9. *Static stability and examples**: Basic concepts of Static stability; Bifurcation**;** Linearized buckling analysis

(* if time permits)

Other Reference Books:

- S. P. Timoshenko and J. N. Goodier, *Theory of Elasticity*, McGraw-Hill, 1970.
- Gerhard A. Holzapfel*, Nonlinear Solid Mechanics: A Continuum Approach for Engineering*, John Wiley & Sons, 2000.
- J. E. Marsden and T.J.R. Hughes, *Mathematical Foundations of Elasticity*, Dover Publications, 1994.
- J. Bonet and R. D. Wood, *Nonlinear continuum mechanics for finite element analysis*, Cambridge University Press, 1997.
- P. Chadwick, *Continuum Mechanics: Concise Theory and Problems*, Dover Publications, 1999.
- L. E. Malvern, *Introduction to the Mechanics of a Continuous Medium*, Prentice Hall Series in Engineering of the Physical Sciences, 1969.
- M. E. Gurtin, *An Introduction to Continuum Mechanics*, Academic Press, 1981.
- Y. C. Fung, *Foundations of Solid Mechanics*, Prentice Hall, 1965.
- I. S. Sokolnikoff, *Mathematical theory of elasticity*, 2nd ed., McGraw Hill, 1956.
- A. E. H. Love, A treatise on the mathematical theory of elasticity, Dover Publications, 1944.
- R. W. Ogden, *Non-linear Elastic Deformations*, Dover, 1997.
- A. J. M. Spencer, *Continuum Mechanics*, Longman, 1980.
- C. Truesdell and R. A. Toupin, *The classical field theories*, In S. Flugge, ed., *Encyclopedia of Physics*, Vol III/1, Springer-Verlag, 1960.
- C. Truesdell and W. Noll, *The Non-Linear Field Theories of Mechanics*, 3rd ed., Springer, 2004.
- P. G. Ciarlet, *Mathematical Elasticity, Volume I: Three Dimensional Elasticity*, North Holland, 1988.
- P. G. Ciarlet, *Mathematical Elasticity, Volume II: Theory of Plates*, North Holland, 1997.
- P. G. Ciarlet, *Mathematical Elasticity, Volume III: Theory of Shells*, North Holland, 2000.