CE 689 – PLASTICITY THEORY

https://engineering.purdue.edu/COFFEE/ce689.html

Spring 2020
F 8:30-11:20 AM, HAMP 1113

Instructor: Rodrigo Salgado
CIVL G235, 4-5030, rodrigo@ecn.purdue.edu
Office Hours: by appointment

Course Description and Pre-Requisites:

CE 689 covers stress and strain analysis, elastic stress-strain response, inelasticity, visco-plasticity, classical plasticity, bounding-surface plasticity and basic numerical implementation of constitutive models. Models covered in class include basic (Mises, Tresca, Mohr-Coulomb, Drucker-Prager) and advanced constitutive models. Solution of collapse boundary-value problems is illustrated using limit analysis. The course also covers recent advances in finite deformation plasticity. Some knowedge of basic continuum mechanics (stress and strain analysis, elasticity) and tensor algebra and calculus is helpful, as these fundamental concepts are covered at a fast pace.

Course Objective:

The main objective of CE 689 is to enable students to understand, use and build constitutive models for materials that may deform plastically. A second objective is to help students understand how these models are implemented in computational applications. Use of the lower and upper bound theorems of plasticity theory are used to illustrate collapse boundary-value problems. Incorporation of plastic models in numerical analyses is discussed at an introductory level, with a focus on effective schemes for model integration and an overview of global solution algorithms.

Grades:

Grades (+/- system) will be assigned according to the regulations of Purdue University. They will be based on two exams and homework sets.

Exam No. 1 (lowest score):	35 % of the grade
Exam No. 2 (highest score):	45 % of the grade
Assignments + quizzes:	20 % of the grade

Text:

Lubliner, J. (1990). *Plasticity Theory.* MacMillan. 495pp.

Grade Appeals:

Appeals will only be considered in writing. Your appeal should be written in a clear, objective way. When an appeal is filed, the entire exam is regraded.

Academic Integrity:

We value academic honesty in this course. You should be aware of Purdue regulations regarding academic honesty. Any incidents involving academic dishonesty will have an impact on your grade and will be promptly referred to the office of the Dean of Students.

Pandemic Planning and Potential Campus Interruptions:

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. Assignments and information about the course will be provided via e-mail. Please make sure that you e-mail the instructor your preferred e-mail address and other contact information. We will test whether we can reach you by e-mail. Updates will be provided also on the course website, but these updates are no substitute to our ability of contacting you directly. Purdue's resource for Campus Emergency as well as a pandemic influenza plan are given in the following links:

http://www.purdue.edu/emergency_preparedness/
http://news.uns.purdue.edu/fluinfo/

TENTATIVE PROGRAM

TOPIC	WEEKS	SUGGESTED READING
1) MATHEMATICS • Notation • Tensors • Vector and tensor calculus	1 week	Ch 1 Lubliner
2) DEFORMATION ANALYSIS • Lagrangian and Eulerian Coordinates • Deformation gradient • Measures of strain • Small strains • Principal strains • Plane strain • Displacement boundary conditions	3 weeks	Ch 1, Ch 8 Lubliner
3) STRESS ANALYSIS • Measures of stress (stress tensor) • Power and energy conjugates for stress • Objectivity • Plane stress • Stress boundary conditions	2 weeks	Ch 8 Lubliner
4) CONSTITUTIVE RELATIONS • First and second laws of thermodynamics • Elasticity • Inelasticity • Viscoplasticity • Rate-Independent plasticity • Yield Criteria • Flow rules • Hardening rules • Elasto-Plastic Stiffness Matrix • Finite plasticity theory: fundamental principles (material-frame indifference, self-consistency, yielding stationarity, laws of thermodynamics in finite deformation) • Bounding-surface plasticity	6 weeks	Chs 1, 3 and 8 Lubliner
5) LIMIT ANALYSIS • Plastic dissipation • Drucker's postulate	2 weeks	Chs 3 and 6 Lubliner

• Lower bound theorem • Upper bound theorem • Applications (bending, punching, ground structures)		
6) NOTIONS OF NUMERICAL IMPLEMENTATION • Integration of constitutive model • Solution of BVP	1 week	Additional reading