Engineering Faculty Document No. 39-06
February 2007

MEMORANDUM

TO: The Faculty of the Schools of Engineering

FROM: The Faculty of the School of Civil Engineering

RE: New Graduate Level Course CE 689

The Faculty of the School of Civil Engineering has approved the following new course. This action is now submitted to the Engineering Faculty for a recommendation for approval.

CE 689 Plasticity Theory

Sem.1, Class 3, Lab 0, Cr 3

Prerequisite: instructor consent

Tensors. Stress analysis. Strain analysis. Laws of thermodynamics. Review of elasticity. Viscoplasticity as an extension of viscoelastic concepts. Classical plasticity. Principle of maximum plastic dissipation. Drucker's inequality. Yield function and yield surface. Flow rule. Hardening rule. Classical models (Tresca, Von Mises, Mohr-Coulomb, Drucker Prager). Bounding surface plasticity. Thermodynamics and constitutive models. Causes of plasticity at the microstructural level. Non-coaxial plasticity. Limit analysis. Method of characteristics (slipline method). Cavity expansion analysis.

Reason: To provide students with knowledge of the theory of plasticity and the modeling of the mechanics of materials. Coverage includes behavior at the element level and the solution of boundary-value problems. The course coverage is unique, there being no other courses on plasticity theory at Purdue University that duplicate it. As a result, the course has been a useful resource to many students from several Engineering Schools the two times it was offered (enrollment was 16 students in Fall 03 and 21 in Spring 06).

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M. Katherine Banks, Head
School of Civil Engineering

Supporting Documentation

1. **Justification:** Plasticity theory is needed to model realistically the mechanical response of a wide range of materials, including metals, soils and alloys of various types. Both students interested in developing constitutive models for new or existing materials and students interested in solving boundary-value problems in which plastic deformations develop will benefit from the course. Students from civil engineering, aerospace engineering and mechanical engineering, among others, would find the course of interest.

2. **Level:** Graduate Level

3. **Prerequisites:** Instructor Consent

4. **Instructor**: Rodrigo Salgado

5. **Course Objectives:** Students who complete the course should be able to:

- Calculate stresses and strains at a point.
- Relate stresses to strains using elasticity.
- Understand conditions in which rate of loading may be important.
- Understand and use the basic viscoelastic models.
- Understand classical plasticity as the limit of viscoplasticty when rate of loading is not a factor.
- Understand and use the classical plasticity models to predict mechanical response.
- Understand the different components of and different ways of building an advanced constitutive model, including models with viscoplastic and hypoplastic components.
- Understand the relationship between observations at the macro level and microstructural processes.
- Perform calculations of the stability of bodies and structures using limit analysis.
- Perform calculations of the stability of bodies and structures using the slipline method.
- Understand and use cavity expansion analysis.

6. **Course Outline:**

Week	Topic
1	Indicial notation. Tensors and related mathematics.
2	Review of strain analysis.
3	Review of stress analysis.
4	Thermodynamic laws.
5	Elasticity.
6	Viscoelasticity
7	Viscoelasticity + Classical plasticity.
8	Classical plasticity (one class for Midterm exam)
9	Classical plasticity
10	Bounding surface plasticity
11	Viscoplasticity
12	Limit analysis
13	Limit analysis/ Method of characteristics
14	Method of characteristics
15	Cavity expansion analysis

7. Textbook and class notes

Lubliner, J. Plasticity Theory. MacMillan.
Class notes by the instructor.
Technical papers.