PURDUE UNIVERSITY
REQUEST FOR ADDITION, EXPIRATION, OR REVISION OF A GRADUATE COURSE
(500-800 LEVEL) Graduate Council Document No. 08-9a

DEPARTMENT: Civil Engineering EFFECTIVE SESSION: Fall 2008

INSTRUCTIONS: Please check the items below which describe the purpose of this request:

1. New course with supporting documents (complete proposal form)
2. Add existing course offered at another campus
3. Expiration of a course
4. Change in course number
5. Change in course title
6. Change in course credit/length

PROPOSED:
Subject Abbreviation: CE
Course Number: 01-01
Long Title: Plasticity Theory
Short Title: Plasticity Theory

EXISTING:
Subject Abbreviation: 
Course Number: 

PROPOSED CREDIT TYPE:
1. Fixed Credit: Cr. Hrs.: 3
2. Variable Credit Range: Minimum Cr. Hrs: 
   Maximum Cr. Hrs: 
   (Check One) To
   Or
3. Equivalent Credit: Yes [ ] No [ ]
4. Thess Credit: Yes [ ] No [ ]

PROPOSED COURSE ATTRIBUTES:
1. Pass/No Pass Only
2. Satisfactory/Unsatisfactory Only
3. Repeatable
4. Credit by Examination
5. Designated Required
6. Special Fees

INSTRUCTIONAL TYPE:
- Lecture: 75 Minutes Per Mg.
- Recitation: 2 Meetings Per Week
- Presentation: 16 Weeks Offered
- Laboratory: 120% of Credit Allocated
- Studio: (Asyn. Or Syn.)
- Distance: Live
- Clinic: 
- Experiential: 
- Research: 
- Ind. Study: 
- Pract/observe: 

COURSE DESCRIPTION (INCLUDE REQUISITES):
Sem: 1, 4sem C: 3.
Prerequisites: AE553 or AE5612, or equivalent, or consent of Instructor.
The course covers stress analysis, strain analysis, elastic and inelastic constitutive relations, with emphasis on plasticity, and the solution of plastic boundary-value problems for a wide range of materials, including metals, alloys, and materials of various types. Specific topics covered by the course include: tensors, stress analysis, strain analysis, laws of thermodynamics, basic concepts from 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, nonproportional plasticity, finite analysis, method of characteristics (strip method) and cavity expansion analysis. Professor Salgado.

Calumet Department Head: Date
Calumet School Dean: Date
Calumet Undergrad Curriculum Committee: Date

Fort Wayne Department Head: Date
Fort Wayne School Dean: Date
Fort Wayne Chancellor: Date

Indianapolis Department Head: Date
Indianapolis School Dean: Date
Undergrad Curriculum Committee: Date

North Central Department Head: Date
North Central Chancellor: Date

North Central Department Head: Date
North Central Chancellor: Date

West Lafayette Department Head: Date
West Lafayette College/School Dean: Date
Graduate Council Secretary: Date

Graduate Area Committee Convener: Date
Graduate Dean: Date

OFFICE OF THE REGISTRAR

APPROVED 3/20/08
Date Approved by Graduate Council

Marilyn D. Kent 3/23/08
Graduate Council Secretary

West Lafayette Registrar
**PURDUE UNIVERSITY**

**REQUEST FOR ADDITION, EXPIRATION, OR REVISION OF A GRADUATE COURSE**

**500-600 LEVEL**

**DEPARTMENT:** Civil Engineering

**EFFECTIVE SESSION:** Spring 2008

**INSTRUCTIONS:** Please check the items below which describe the purpose of this request.

- [ ] 1. New course with supporting documents (complete proposal form)
- [ ] 2. Add existing course offered at another campus
- [ ] 3. Expiration of a course
- [ ] 4. Change in course number
- [ ] 5. Change in course title
- [ ] 6. Change in course credit/Type
- [ ] 7. Change in course attributes
- [ ] 8. Change in instructional hours
- [ ] 9. Change in course description
- [ ] 10. Change in course requisites
- [ ] 11. Change in semesters offered
- [ ] 12. Transfer from one department to another

**PROPOSED:**

<table>
<thead>
<tr>
<th>Subject Abbreviation</th>
<th>CE</th>
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</thead>
</table>

| Course Number | 689 |

| Long Title | Plasticity Theory |

| Short Title | Plasticity Theory |

**EXISTING:**

| Subject Abbreviation | |

| Course Number | |

| Long Title | |

| Short Title | |

**TERMS OFFERED:**

- [ ] Summer
- [ ] Fall
- [ ] Spring

**CAMPUS(ES) INVOLVED:**

- Calumet
- Cont Ed
- Ft. Wayne
- Indianapolis
- Tech Statewide
- N. Central
- W. Lafayette

**ABBREVIATED TITLE:** (20 CHARACTERS ONLY)

**CREDIT TYPE:**

<table>
<thead>
<tr>
<th>1. Fixed Credit Cr. Hrs.</th>
<th>3</th>
</tr>
</thead>
</table>

| 2. Variable Credit Range: |

<table>
<thead>
<tr>
<th>Minimum Cr. Hrs. (Check One)</th>
<th>To</th>
<th>Or</th>
</tr>
</thead>
</table>

| Maximum Cr. Hrs. | |

<table>
<thead>
<tr>
<th>3. Equivalent Credit</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>

| 4. Thesis Credit | Yes | No |

**INSTRUCTIONAL TYPE:**

<table>
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<tr>
<th>Lecture Per Wig</th>
<th>75</th>
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</thead>
</table>

| Minutes Per Week | 2 |

| Seminars | 16 |

| % of Credit Offered | 100 |

| Delivery Method | Syn |

| Delivery Medium | (Asyn. Or Syn.) |

| Cross-Listed Courses | |

**COURSE DESCRIPTION:**

Sem. 1, Class 3, Cr. 3.

Prerequisites: AE450 or ME512 or equivalent, or consent of instructor.

The course covers stress analysis, strain analysis, elastic and inelastic constitutive relations, with emphasis on plasticity, and the solution of plastic boundary-value problems for a wide range of materials, including metals, soils and alloys of various types. Specific topics covered by the course include: tensors, stress analysis, strain analysis, laws of thermodynamics, basic concepts from elasticity, viscoelasticity as an extension of viscoelastic concepts, classical plasticity, principles 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 (spline method) and cavity expansion analysis.

**Calumet Department Head**

| Date | Calumet School Dean | Date |

**Calumet Undergraduate Curriculum Committee**

| Date |

**Fort Wayne Department Head**

| Date | Fort Wayne School Dean | Date |

**Fort Wayne Chancellor**

| Michael J. Nordski | 3/26/10 |

**Undergraduate Curriculum Committee**

| Date |

**Indianapolis Department Head**

| Date | Indianapolis School Dean | Date |

**North Central Department Head**

| Date | North Central Chancellor | Date |

**North Central Registrar**

| Date |

**North Central Graduate Council**

| Date |

**West Lafayette Department Head**

| Date | West Lafayette College/School Dean | Date |

**West Lafayette Registrar**

| Date |

**Graduate Dean**

| Date |

**Associate Area Committee Convener**

| Date |

**OFFICE OF THE REGISTRAR**

| Date |
A. Justification for the Course

Explain how this course relates to other courses offered in the department or other departments and how this course fulfills a recognized need.

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.

This course is intended primarily for students from within this department.

B. Level of the course:

Justify request for graduate course level by indicating anticipated enrollments of undergraduate and graduate students.

Anticipated Undergraduate Student Enrollment: None

Anticipated Graduate Student Enrollment: 100%

C. Prerequisites: (If none, please explain reasons for absence)

Prerequisites: AAE553 or ME612 or equivalent, or consent of instructor.

D. Course Instructor:

Instructor's Name: Rodrigo Salgado

E1. Course Outline:

(An outline of topics to be covered and an indication of the relative emphasis or time devoted to each topic is necessary. If laboratory or field experience is involved, the nature of this component should be explained as well).

See attached

E2. Method of Evaluation or Assessment:

Mid-term and Final Exam

F. Reading List:

A reading list or bibliography should be limited to material the students will be required to read in order to successfully complete the course. It should not be a compilation of general reference material.

Lubliner, J., Plasticity Theory, Macmillan; Class notes by the instructor; Technical papers.
MEMORANDUM

TO: The Faculty of the College 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, Cr 3

Prerequisites: CE 297 and MA 261 or consent of instructor.

The course covers stress analysis, strains analysis, elastic and inelastic constitutive relations, with emphasis on plasticity, and the solution of plastic boundary-value problems. Specific topics covered by the course include: tensors, stress analysis, strain analysis, laws of thermodynamics, basic concepts from 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) and 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 times the course was offered the enrollment was 16 students in fall 2003 and 21 students in spring 2006.

M. Katherine Banks, Head
School of Civil Engineering

APPROVED FOR THE FACULTY
OF THE SCHOOLS OF ENGINEERING
BY THE ENGINEERING
CURRICULUM COMMITTEE

ECC Minutes #9
Date 11/26/07
Chairman ECC
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.

2. Level: Graduate Level

3. Prerequisites: CE 297 and MA 261 or consent of instructor

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.
   - Identify conditions in which rate of loading may be important.
   - Use the basic viscoelastic models.
   - Use the classical plasticity models to predict mechanical response.
   - Identify the different components of and different ways of building an advanced constitutive model, including models with viscoplastic and hypoplastic components.
   - Relate 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.
   - Perform cavity expansion analysis.
6. **Course Outline:**

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Indicial notation. Tensors and related mathematics.</td>
</tr>
<tr>
<td>2</td>
<td>Review of strain analysis.</td>
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<tr>
<td>3</td>
<td>Review of stress analysis.</td>
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<tr>
<td>4</td>
<td>Thermodynamic laws.</td>
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<tr>
<td>5</td>
<td>Elasticity.</td>
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<tr>
<td>6</td>
<td>Viscoelasticity</td>
</tr>
<tr>
<td>7</td>
<td>Viscoelasticity and Classical Plasticity</td>
</tr>
<tr>
<td>8</td>
<td>Classical Plasticity -- <strong>Midterm Exam</strong></td>
</tr>
<tr>
<td>9</td>
<td>Classical plasticity</td>
</tr>
<tr>
<td>10</td>
<td>Bounding surface plasticity</td>
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<tr>
<td>11</td>
<td>Viscoelasticity</td>
</tr>
<tr>
<td>12</td>
<td>Limit analysis</td>
</tr>
<tr>
<td>13</td>
<td>Limit analysis/Method of characteristics</td>
</tr>
<tr>
<td>14</td>
<td>Method of characteristics</td>
</tr>
<tr>
<td>15</td>
<td>Cavity expansion analysis</td>
</tr>
<tr>
<td>16</td>
<td>Final Exam</td>
</tr>
</tbody>
</table>

7. **Textbook and class notes**

Class notes by the instructor.
Technical papers.