WELDENG 7201 (Approved): Engineering Analysis for Design and Simulation

Course Description
Fundamentals of engineering analysis of heat flow, thermal and residual stresses, and fracture and fatigue with applications to design and simulation in welding and manufacturing.

Prior Course Number: 620, 621
Transcript Abbreviation: Eng Anal Des & Sim
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Graduate
Student Ranks: Masters, Doctoral
Course Offerings: Autumn
Flex Scheduled Course: Never
Course Frequency: Every Year
Course Length: 14 Week
Credits: 4.0
Repeatable: No
Time Distribution: 3.0 hr Lec, 3.0 hr Lab
Expected out-of-class hours per week: 6.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: Prereq: Graduate Standing or permission of instructor.
Exclusions: Not open to students with credit for WE 620, 621, and 4201.
Cross-Listings:

The course is required for this unit's degrees, majors, and/or minors: No
The course is a GEC: No
The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.9999
Subsidy Level: Doctoral Course

Programs

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>WELDENG</td>
<td>Welding Engineering</td>
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General Information

This is a graduate level course that will be taught at the same time as WE4201. Lecture content will be the same as 4201, but graduate students will be required to submit a term project that may include a detailed design, a computer simulation or detailed review of research papers.

Course Goals
Obtain fundamental understanding of heat flow including heat conduction with moving heat sources.
Obtain basic understanding of causes for and development of thermal stresses, residual stresses and distortion.

Obtain basic understanding of linear elastic fracture mechanics including ability to apply fracture criteria.

Obtain basic understanding of high cycle fatigue, effect of mean stress using Goodman diagram, and life prediction for a variety of structures including welded structures.

Ability to analyze and design simple welded joints.

Obtain basic understanding of and ability to apply finite difference and finite element modeling to simple heat flow, stress analysis and fracture mechanics problems.

## Course Topics

<table>
<thead>
<tr>
<th>Topic</th>
<th>Lec</th>
<th>Rec</th>
<th>Lab</th>
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<th>IS</th>
<th>Sem</th>
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<tbody>
<tr>
<td>Introduction to heat flow including steady state conduction.</td>
<td>6.0</td>
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<td>Finite difference and finite element modeling of heat flow.</td>
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<td>Heat flow with moving heat sources including Cooling rates and peak temperature equations.</td>
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<td>Introduction to thermal stresses, residual stresses and distortion.</td>
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<tr>
<td>Three-bar analogy analysis for residual stresses and distortion.</td>
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<td>Residual stress measurement, stress relieving, and distortion analysis.</td>
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<td>Introduction to fracture mechanics, stress intensity factors and fracture toughness.</td>
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<tr>
<td>Introduction to high cycle fatigue, Goodman diagram, and fatigue of welded structures.</td>
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<td>Welded joint analysis and design.</td>
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<tr>
<td>Matlab programming and application to heat flow and finite difference modeling.</td>
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<td>Abaqus modeling of steady state and transient heat flow.</td>
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<td>Abaqus analysis of elastic, thermo-elastic and thermo-elastic-plastic problems.</td>
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<td>Abaqus analysis of fracture.</td>
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## Grades

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<tr>
<th>Aspect</th>
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<tr>
<td>Homework and quizzes</td>
<td>15%</td>
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<tr>
<td>Exam 1</td>
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<td>Exam 2</td>
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<td>Final exam</td>
<td>25%</td>
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<td>Term project</td>
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## Representative Textbooks and Other Course Materials

<table>
<thead>
<tr>
<th>Title</th>
<th>Author</th>
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<tbody>
<tr>
<td>Lecture and Lab Notes</td>
<td>A. Benatar</td>
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## ABET-EAC Criterion 3 Outcomes
### WELDENG ABET-EAC Criterion 9 Program Criteria Outcomes

<table>
<thead>
<tr>
<th>Course Contribution</th>
<th>College Outcome</th>
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<tbody>
<tr>
<td>a</td>
<td>An ability to apply knowledge of mathematics, science, and engineering.</td>
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<td>b</td>
<td>An ability to design and conduct experiments, as well as to analyze and interpret data.</td>
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<td>c</td>
<td>An ability to design a system, component, or process to meet desired needs.</td>
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<td>d</td>
<td>An ability to function on multi-disciplinary teams.</td>
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<td>An ability to identify, formulate, and solve engineering problems.</td>
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<td>An understanding of professional and ethical responsibility.</td>
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<td>An ability to communicate effectively.</td>
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<td>h</td>
<td>The broad education necessary to understand the impact of engineering solutions in a global and societal context.</td>
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<tr>
<td>i</td>
<td>A recognition of the need for, and an ability to engage in life-long learning.</td>
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<td>j</td>
<td>A knowledge of contemporary issues.</td>
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<td>k</td>
<td>An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.</td>
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**Prepared by:** Avraham Benatar