# Mechanical Behavior of Materials

**Course Number & Course Title:** ME XXX

**Instructor:** Haidong YU  
**Credits:** 3  
**Language of instruction:** Chinese / English

**Required Course or Elective Course:** Required

**Terms Offered:** Autumn/Spring semester

**Course Structure/Schedule:**
1. Two lectures per week at 90 minutes

**Pre-Requisites:**
- Mechanics of Materials
- Advanced Mathematics

**Assessment Tools:**
1. Homework — 15%
2. Quizzes — 15%
3. Mid-term exam — 30%
4. Final exam — 40%

**Professional Component:**

**Textbook/Reading List**

**Course Description:** This course will cover the basics of the mechanical behavior of materials. Special topics include the constitutive models for elastic and plastic deformation, deformation mechanism of metal and non-metal materials, the description of three dimensional stress-strain field, principle stress, fracture toughness and stress intensity factor, S-N curves, fatigue life on notched structures, crack growth rate and rate-dependent mechanical behavior. The classic methods to investigate the deformation, damage and fracture are presented. They can be used to analyze the mechanical behavior of materials directly.

**Course Outcomes**

1. Understand the mathematical description on the mechanical behavior of materials. Have a brief introduction on the mechanism of deformation, damage and failure according to the microscopic structures of materials. [A3,A4,A5]
2. Understand the concept on the stress, strain, fracture, fatigue and creep. Have a good know on the basic theory in the solid mechanics.[A3,A4]
3. Provide good applications for the mechanical behavior of engineering structures in terms of these primary theories. The evaluation methods can be used in safety prediction of structures. [A4,A5]
4. Understand the experimental method in the study of mechanical behavior of materials. The parameters in the mathematical model can be obtained according to testing data.[A4,A5]

**Related ME Program Outcomes:**
A1. Engineering fundamentals  
A2. Analytical skills  
A3. Design Skills

**Prepared By:** Haidong YU  
**Revision Date:** Oct. 28, 2012
ME XXX Mechanical behavior of Materials

Course Syllabus

COURSE INSTRUCTORS

<table>
<thead>
<tr>
<th>Name: Haidong YU</th>
<th>Name:</th>
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</thead>
<tbody>
<tr>
<td>Office: Mechanical Engineering Building A633</td>
<td>Office:</td>
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<tr>
<td>Email: <a href="mailto:hdyu@sjtu.edu.cn">hdyu@sjtu.edu.cn</a></td>
<td>Email:</td>
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</tbody>
</table>

COURSE DESCRIPTION

This course will cover the basics of the mechanical behavior of materials. Special topics include the constitutive models for elastic and plastic deformation, mechanism of deformation for metal and non-metal materials, the description of three dimensional stress-strain field, principle stress, fracture toughness and stress intensity factor, S-N curves, fatigue life on notched structures, crack growth rate and rate-dependent mechanical behavior. The classic methods to investigate the deformation, damage and fracture are presented. They can be used to analyze the mechanical behavior of materials directly.

TEXTBOOK


Students DO NOT need to buy the textbooks. It can be rented directly in School of Mechanical Engineering.

READING REFERENCE

WANG Lei, Mechanical Behavior of Materials, Northeastern University Press
ZHENG Xiulin, QIAO Shengru, QIN Xiongpu, Mechanical Behavior of Materials, Northwestern Polytechnical University Press

COURSE PRE-REQUISITES

Mechanics of materials is a pre-requisites for this course. The students are expected to have (i) a basic concept about the stress and strain in the materials, (ii) some basic knowledge on the failure criteria in terms of the strength of materials, (iii) a basic understand on the mechanical behavior of materials such as plasticity, fracture toughness, cyclic load and rate-dependent behavior.

COURSE LEARNING OBJECTIVES

This course includes the two parts of the mechanical behavior of materials. They are the deformation and the failure mechanism. The detailed contents include the description of three
dimensional stress and strain fields, the constitutive model of elastic and plastic deformation, the mechanical behavior of materials undergoing the cyclic load, fracture mechanics, fatigue mechanics and rate-dependent behavior of materials. The students can understand the mathematical description on the mechanical behavior of materials. These theories can be used to evaluate the mechanical behavior of materials and structures which undergo complex load conditions. The logical and original thinking can be raised during the study of this course. The detailed contents are listed as follows.

1. Know the basic concepts and these physical meanings on the mechanical behavior of materials. Their application in the engineering problems should be understood.
2. Know the constitutive models on the elasticity and plasticity of materials. The parameters in the model can be calculated in terms of the experimental data.
3. Know the stress and strain field of the structures contained the cracks. Understand the damage and failure mechanism of structures contained the cracks. The testing method of fracture toughness should be known.
4. Know the failure mechanism of the structures undergoing the cyclic load. Be familiar with the S-N curves. The mathematic description of fatigue life for notched structures and cracked structures will be presented.
5. Know the mechanical behavior with high and low strain rates. Understand the mathematical model on the creep.
6. The mathematic models can be used in the investigation of engineering problems.

**GRADING FORMAT AND POLICY**

The grade breakdown for the course is as follows:

- Homework: 15%
- In-class quiz: 15%
- Mid-term exam: 30%
- Final exam: 40%

Grading rules

1. Students are expected to work independently on all homework assignment and exams per honor code. Collaboration on homework is permitted, but each student must do his/her own work.
2. The homework should be submitted before the next lecture. Late assignment will not be accepted. Please talk to lecturer in case of an emergency.
3. The in-class quiz should be work independently. The students can use their textbook. But the discussion is not permitted.
4. The textbook is not permitted in the mid-term and final exam.

**DESIGN PROJECTS**

**TEAM-WORK**
<table>
<thead>
<tr>
<th>Week#</th>
<th>Lecture#</th>
<th>Lecture Topic</th>
<th>Lecturer</th>
<th>Reference</th>
<th>Homework</th>
<th>Lab/Recitation Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Introduction of the mechanical behavior of materials</td>
<td>Haidong YU</td>
<td>N.E. Dowling</td>
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<tr>
<td>1</td>
<td>2</td>
<td>Stress-strain relationship and behavior: linear</td>
<td>Haidong YU</td>
<td>N.E. Dowling</td>
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<tr>
<td>2</td>
<td>3-4</td>
<td>Stress-strain relationship and behavior: nonlinear</td>
<td>Haidong YU</td>
<td>N.E. Dowling</td>
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<td>3</td>
<td>5-6</td>
<td>Complex and principal states of stress and strain</td>
<td>Haidong YU</td>
<td>N.E. Dowling</td>
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<tr>
<td>4</td>
<td>7-8</td>
<td>Yielding and fracture under combined stress</td>
<td>Haidong YU</td>
<td>N.E. Dowling</td>
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<tr>
<td>5</td>
<td>9-10</td>
<td>Plastic deformation behavior and models for materials</td>
<td>Haidong YU</td>
<td>N.E. Dowling</td>
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<tr>
<td>6</td>
<td>11-12</td>
<td>Stress-strain analysis of plastically deforming mechanics</td>
<td>Haidong YU</td>
<td>N.E. Dowling</td>
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<td>7</td>
<td>13</td>
<td>Linear-elastic fracture mechanics: basic concept</td>
<td>Haidong YU</td>
<td>N.E. Dowling</td>
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<tr>
<td>7</td>
<td>14</td>
<td>Fracture mechanics: fracture toughness</td>
<td>Haidong YU</td>
<td>N.E. Dowling</td>
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<td>8</td>
<td>15-16</td>
<td>Fatigue mechanics: Introduction and stress-based approach</td>
<td>Haidong YU</td>
<td>N.E. Dowling</td>
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<td>9</td>
<td>17-18</td>
<td>Stress-based approach to fatigue: notched members</td>
<td>Haidong YU</td>
<td>N.E. Dowling</td>
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<td>10</td>
<td>19-20</td>
<td>Fatigue crack growth</td>
<td>Haidong YU</td>
<td>N.E. Dowling</td>
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<tr>
<td>11</td>
<td>21-22</td>
<td>Fatigue mechanics: strain-based approach</td>
<td>Haidong YU</td>
<td>N.E. Dowling</td>
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<td>12</td>
<td>23-24</td>
<td>Time-dependent behavior: creep and damping</td>
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<td>N.E. Dowling</td>
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