Fall 2019

**ME 620-101: Mechanics of Materials**

Siva Nadimpalli

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**Mechanics of Materials ME620 Fall 2019**
Room: CKB 313  Day and Time: Thu 6 - 9 pm

**Prof. Siva Nadimpalli**  
MEC 325A  596-3678  nadimpal@njit.edu  
Office hours: Thu 5 - 6 pm (or schedule by sending an email)

**OUTLINE**

**Required Text:** There is no required text for this course. A very detailed notes (based on lecture notes by Prof. Lallit Anand, MIT, Prof. Kelly, University of Auckland, and Prof. Allan Bower, Brown University) will be provided in the lectures, and the students are encouraged to read the following text books that will supplement the notes.

This course uses an OAT (Open Affordable Textbook). An “open” textbook means that its authors have made it free to own, share, and adapt for non-commercial purposes. Instead of having to buy it, you can just read it online. The book for this course Free online text book by Prof. Bower “Advanced Mechanics of Solids” [http://solidmechanics.org/](http://solidmechanics.org/).

**Highly Recommended Text books:**
2. Engineering Materials: An introduction to their properties and applications, Michael Ashby and David Jones, Pergamon Press

**Other Useful References:**
3. Theory of Elasticity by S.P. Timoshenko and J. N. Goodier (Well written and contains lot of useful solutions to elastic boundary value problems)

**Grading:**  
- Homework 20%  
- Exam1 20% (Oct 17, 2019)  
- Exam2 30% (Nov 26, 2019)  
- Term Paper 30% (presentation on Dec 5, 2019)  

*Changes to the exam dates if any will be notified in advance*

**Term Paper**  
Chose one of your favorite topic relevant to this course (i.e., on the constitutive behavior of a materials, fracture, or fatigue) and select a journal article on that topic. Once I approve the journal article, you and your group members will undertake a detailed critical review of that journal paper. Finally, give a short oral presentation to the rest of the class (10-20 min depending on the class size and number of groups). The presentation must have the following:
- Analyze the methods used in that study
- What are the assumptions behind the study
- Given a chance, could you have explained the results differently?
- What could improve the study *(THIS IS THE MOST IMPORTANT PART)*

*Project dates:* Registration of the project team and topic with me by September 19, 2019 by 6:00PM (late penalty 2% per day). Register by sending me an email with the names and email addresses of the team
members and the title of the topic. **Final Presentations will be December 5, 2019.** Make sure you discuss your plans and project progress with me regularly during office hours. This is a significant part of the grade and don’t take it lightly.

**Expectations from students:**
- A thorough knowledge of undergraduate course such as stress analysis/strength of materials/solid mechanics is expected.
- Students should understand that this is not an undergraduate course. Hence, they are expected to read suggested reference textbooks (using the topics presented in the class as a guide) and solve problems from these references to strengthen the concepts discussed in the class.
- To excel in this course, you are expected to be able to locate and use web and library resources effectively and to cite them correctly. Raymond Vasquez is the Research and User Services librarian within the Robert W. Van Houten Library. He has prepared online research guides which you may find useful. Take advantage of his expertise at [http://researchguides.njit.edu/vasquez](http://researchguides.njit.edu/vasquez).

**Prerequisites:** ME315 Stress Analysis or an equivalent, ME614 Continuum Mechanics, and Courses on Engineering Mathematics

**Reading Assignment**
To follow along with the lectures, it is recommended that you read: Ch.1 (especially 1.11), A First Course in Continuum Mechanics, 3rd Edition, by Y. C. Fung, Prentice-Hall, 1994.

**ME 620 Course Outline**
1. Topics in Linear Elasticity
   a. Introduction to Vectors and Tensors
   b. Kinematics & Strain
   c. Stress & Equilibrium
   d. Boundary Value Problems in Linear elasticity
2. Linear elastic fracture mechanics
3. Fatigue of materials
4. Small Deformation Plasticity
   a. Microscopic origins
   b. Theory of rate-dependent and rate-independent plasticity

**Course objective:** to provide basis for further study within solid mechanics, including advanced topics in continuum mechanics, finite element methods, plasticity, fracture mechanics, structural mechanics and nonlinear behavior of materials.

**Student outcomes:**
- Learn mathematical framework to understand the concepts of displacement, stress, strain in a fully three-dimensional solid deformable body
- Understand the stress-strain behavior (or constitutive law) of different materials and learn the deformation mechanism of such materials
- Learn the principles of the mechanics of nonlinear material behavior
- Learn the principles of linear elastic fracture mechanics and understand the role of the theory in predicting the failure of materials
Tentative schedule of ME 620

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Date</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction and vectors and tensors; kinematics and strain</td>
<td>Sep 5, 2019</td>
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<tr>
<td>2</td>
<td>Stress and equilibrium</td>
<td>Sep 12, 2019</td>
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<tr>
<td>3</td>
<td>Linear elasticity</td>
<td>Sep 19, 2019</td>
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<td>4</td>
<td>Applications of linear elasticity</td>
<td>Sep 26, 2019</td>
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<tr>
<td>5</td>
<td>Applications of linear elasticity</td>
<td>Oct 3, 2019</td>
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<tr>
<td>6</td>
<td>Applications of linear elasticity</td>
<td>Oct 10, 2019</td>
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<tr>
<td>7</td>
<td><strong>Exam 1</strong></td>
<td>Oct 17, 2019</td>
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<tr>
<td></td>
<td>Linear elastic fracture mechanics</td>
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<tr>
<td>8</td>
<td>Linear elastic fracture mechanics</td>
<td>Oct 24, 2019</td>
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<tr>
<td>9</td>
<td>Fatigue of materials</td>
<td>Oct 31, 2019</td>
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<tr>
<td>10</td>
<td>Fatigue fracture of materials</td>
<td>Nov 7, 2019</td>
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<tr>
<td>11</td>
<td>Small deformation rate-independent plasticity</td>
<td>Nov 14, 2019</td>
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<tr>
<td>12</td>
<td>Small deformation rate-independent plasticity</td>
<td>Nov 21, 2019</td>
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<tr>
<td>13</td>
<td><strong>Exam 2</strong></td>
<td>Nov 26, 2019</td>
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<tr>
<td></td>
<td>Rate-dependent plasticity</td>
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<tr>
<td>14</td>
<td>Rate-dependent plasticity (Term project presentation)</td>
<td>Dec 5, 2019</td>
</tr>
<tr>
<td>15</td>
<td><strong>Final Exam</strong></td>
<td>No Final Exam</td>
</tr>
</tbody>
</table>

- **Exam 1**
- **Exam 2**