

**MIMU355**

**MECHANICS OF MATERIALS**

**FALL 2006**

**INSTRUCTOR** : Prof. Sinan Müftü, 369 SN, 617-373-4743, smuftu@coe.neu.edu

**T. A.** : Mr. Ernesto Lopez (244H-FR)

**CLASS HOURS** :

**OFFICE HOURS** : Prof. Müftü,

**CLASS LOCATION:**

**LAB HOURS** : 244 Forsyth (FR)

**PREREQUISITE** : Eng. Mechanics (MIM 1250); Eng. Mechanics & Design (MIM U350)

**TEXTBOOK** : F.P. Beer, E.R. Johnston and J.T. DeWolf, *Mechanics of Materials*, 4<sup>th</sup> Ed., McGraw Hill

**WEB PAGE** : <http://blackboard.neu.edu>

- Course announcements are made through this web page.
- Please log on to the blackboard and enter an e-mail address that you frequently use.

**COURSE DESCRIPTION:**

This course discusses concepts of stress and strain; transformation of stress and strain at a point; stress strain relations, material properties; second moments of cross-sectional areas; stresses and deformations in simple structural members due to axial, torsional and flexural loading for statically determinate and indeterminate cases; design of beams under combined loading; and stability of structures and buckling of columns with various supports.

**GOALS AND INDICATOR QUESTIONS:**

The following topics are considered essential in demonstrating understanding of the topics covered in this course.

1. The concepts of stress and strain and the inter-relation between them.
2. Two-dimensional transformation of stress.
3. Finding stresses and deformations in simple structural members.
4. The concept of second moment of areas of structural members.
5. Basic understanding of buckling of columns.

*Students should pass all indicator questions related to the course objectives in order to get a passing grade for the course.* All University courses are conducted in accordance with the Northeastern University honor code. Please read the honor code on the College of Engineering web site: [www.coe.neu.edu](http://www.coe.neu.edu)

## **EXAMS AND GRADING:**

- |                      |                     |
|----------------------|---------------------|
| Two Mid-Term Exams - | 25% each            |
| Final Exam -         | 35% (all inclusive) |
| Homework -           | 15%                 |
- Homework assignments are collected at the beginning of the class, one week after they are assigned, unless otherwise specified.
  - **No late homework will be accepted** as the solutions are distributed in the same class.
  - Make-up exams will only be given under unusual conditions with the *prior* approval of the instructor. A grade penalty may be applied.
  - Grades of Incomplete ("I" Grades) will be given only under extraordinary circumstances at the discretion of the instructor.

## **Topics Covered in the Course**

### **STRESS AND STRAIN**

1. Introduction, Equilibrium
2. Normal and Shear Stress
3. Allowable Stress and Design of Connectors
4. Concept of Strain

### **MECHANICAL PROPERTIES OF MATERIALS**

5. Stress vs. Strain
6. Elastic Stress-Strain Relations, Creep and Fatigue

### **AXIAL LOADING**

7. Axially Loaded Members
8. Statically Indeterminate Bars
9. Thermal Stress
10. *Stress Concentrations,*

### **TORSION**

11. Stresses in a Circular Shaft in Torsion, Power Transmission
12. Angle of Twist
13. Statically Indeterminate Torque-Loaded Members

### **BENDING AND TRANSVERSE LOADING OF BEAMS**

14. Second Moments of Areas
15. Review of Shear and Bending Moment Diagrams
16. Stresses in Pure Bending
17. Transverse Loading, Shear Stresses

### **COMBINED LOADING**

18. Thin-Walled Pressure Vessels

19. State of Stress Caused by Combined Loadings

**TRANSFORMATION OF STRESS**

20. Transformation of Plane Stress

21. Mohr's Circle for Plane Stress

22. Stresses in Shafts Due to Axial Load and Torsion and stresses in Beams

23. *General State of Stress, Maximum Shearing Stress*

**DEFLECTIONS OF BEAMS AND SHAFTS**

24. The Elastic Curve

25. Slope and Displacement by Integration

26. Method of Superposition

27. *Statically Indeterminate Beams and Shafts by Method of Superposition*

**BUCKLING OF COLUMNS**

28. Critical Load

29. Ideal Column with Pin Supports

30. Columns with Various Support Types

**THE ENERGY METHOD**

31. *Strain energy; various types of loading*

32. *Conservation of energy; deflections*

**BOOKS ON RESERVE:**

- Beer, F.P., and Johnston Jr., E.R., *Mechanics of Materials*, Second Edition, McGraw-Hill Inc., New York, 1992: **TA405 .B39 1992**
- Bickford, W.B., *Mechanics of Solids: Concepts and Applications*, Richard D. Irwin, Inc., Boston, 1993: **TA405 .B498 1993**
- Craig Jr., R.R., *Mechanics of Materials*, Second Edition, John Wiley & Sons, Inc., New York, 2000: **TA405 .C89 1996**
- Davis, H.E., Troxell, G.E., and Hauck, G.F.W., *The Testing of Engineering Materials*, Fourth Edition, McGraw-Hill Inc., New York, 1982: **TA410 .D3 1982**
- Gere, J.M., and Timoshenko, S.P., *Mechanics of Materials*, Third Edition, PWS-Kent Publishing Company, Boston, Massachusetts, 2001: **TA405 .G44 2001**
- Riley, W.F., Sturges, L.D., and Morris, D.H., *Mechanics of Materials*, Fifth Edition, John Wiley & Sons, New York, 1999: **TA405 .R55 1999**
- Popov, E.P., *Engineering Mechanics of Solids*, Second Edition, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1999: **TA405 .P677 1999**
- Shames, I.H., *Introduction to Solid Mechanics*, Second Edition, Prentice-Hall, Inc., Englewoods Cliff, New Jersey, 1989: **TA405 .S386 1989**

**CONTRIBUTION TO PROFESSIONAL COMPONENTS:** MIMU355 and MIMU356 contribute four and one semester hours to the engineering topic requirements, respectively. They also contribute to the general education requirement by including the following ACE goals: thinking skills, problem solving skills, information literacy, and connections between theory and practice.

**GOALS OF THE ACADEMIC COMMON EXPERIENCE (ACE):**

**SKILLS**

- Effective thinking
- Effective communication
- Information literacy
- Interpersonal skills

**AWARENESS**

- Contexts
  - Natural world
  - Social and cultural world
- Perspectives
  - Historical
  - Ethical
  - Aesthetic
  - Personal

**CONNECTIONS**

- Across disciplines
- Between theory and application
- Between college and work
- Between individual and society
- Between college study and lifelong learning

**RELATIONSHIP TO PROGRAM OBJECTIVES:**

The following MIE course objectives are addressed in this course, 1, 2, 4, 6, 7.

MIME Undergraduate Educational Objectives  
**December 1999**

Developed in conjunction with the students, faculty, alumni and industrial constituents, these objectives serve to (i) characterize the mechanical and industrial engineering programs at Northeastern University and (ii) support the missions of the department, college and university.

1. To educate students through a broad, theoretically based mechanical or industrial engineering curriculum. Mechanical engineers will achieve the ability to work professionally in both thermal and mechanical systems areas, including the design and realization of such systems. Industrial engineers will demonstrate the ability to design, analyze, improve and optimize integrated systems that include people, materials, information, equipment and energy.
2. To instill students with practical work skills involving current technology and technical tools, as well as an awareness of manufacturing, management and economic issues and commonly accepted norms for professional conduct.
3. To integrate academic learning with practice-oriented experience to promote professional development and career planning.
4. To provide students with learning experiences that instills a passion for life-long learning.
5. To involve students in leadership and contributing roles in interactive team environments.
6. To instruct our students to be effective communicators with good interpersonal skills.
7. To integrate our students' engineering coursework with industrial, ethical, cultural, historical and societal perspectives, leading to an appreciation of the broad educational objectives (as specified in the University's ACE goals).