



COURSE OUTLINE

CIV237
Course Number

Mechanics of Materials Fundamentals
Course Title

4
Credits

3 / 3
Lecture/Laboratory Hours

COURSE DESCRIPTION

Study of the fundamental concepts of stress and strain of elastic bodies when subjected to axial or bending loads. Analyzes shear and bending moment diagrams, considers compression members, and introduces principles of torsion. The lab introduces various testing procedures to determine the physical properties of such materials as steel, aluminum, brass, cast iron, and wood. Fall offering.

Text (s): **Statics & Strength of Materials**
 Author: Cheng, Fa-Hwa
 Publisher: McGraw Hill/Glencoe
 2nd Edition, 1997
 ISBN#: 0-02-803067-2

Prerequisites: **CIV104 with a minimum C grade**

Co-requisites:

Course Coordinator: Jim Maccariella

Latest Review: 2009

I. GENERAL OBJECTIVES

- A. To have a clear understanding of the stresses developed in members subjected to tensile, compressive, shearing, and bending and torsional loads.
- B. To understand the basic principles involved in both the design and selection of members of proper cross-section to sustain specific load.
- C. To become familiar with the use of the moment of inertia and its effect upon bending, shear, torsional and compressive loads.
- D. To familiarize the student with the drawing of shear and bending moment diagrams and the proper interpretation of information yielded by these diagrams.
- E. To introduce the student to the use of the computer in materials problems, develop a familiarity with the basic input/output of the computer, and to provide him/her with a tool for solving more advanced problems than is normally covered in the course. This is done through use of a computer program.
- F. To familiarize the student with problems using the International System of Units.

II. SPECIFIC OBJECTIVES

WEEKS 1, 2, 3 – Simple Stresses and Strain

The student should be able to:

- A. Define "stress" in a brief sentence, and write the defining equation and the correct units.
- B. Define tension, compression, and shear and either sketch one example of each or be able to identify which of the conditions exist for a given loading configuration.
- C. Write a brief explanation of the limitations placed upon the use of the equations $\sigma = P/A$ with regard to relationship of direction of the applied load, to the cross-sectional area, and also regarding the location of the load on the cross sectional area.
- D. Locate and calculate the area subjected to stress at any designated cross section (or) given a member with holes, slots, pins, or any other irregularities in its cross section one must be able to calculate the stress at various points in the object and thereby locate the weakest cross section.
- E. Calculate the strain when given the original length and deformation or vice versa for a member subjected to a load in tension, compression, or shear.
- F. Calculate either the stress (σ) or strain (ϵ) using the defining relationship $\sigma = E \epsilon$.
- G. Determine the Modulus of Elasticity (E) for a given material when subject to a tensile, compressive, or shearing load.
- H. Calculate any of the following when given adequate initial information: area (A), load (P), deformation (δ), and initial length (L).
- I. Calculate "working stress", "Factor of Safety" or ultimate strength when given any two of the three items.
- J. Determine the missing dimension of either circular or rectangular cross sectional areas using the relationship $\sigma = F/A$ for a member subjected to a known load and given a working stress.

WEEKS 4, 5, 6, 7, 8, 9 – Stress in Beams

The student should be able to:

- A. Draw the free body diagram showing all forces, reactions, and calculate the unknown reactions for simply supported overhanging and cantilever beams.
- B. Calculate the shearing force at any section of the beam subjected to both concentrated and/or uniformly distributed loads.
- C. Determine the correct sign (plus or minus) for the shearing force.
- D. Draw the shear diagram for any of the loading modes mentioned above (proportional but not to scale).
- E. Locate the shear diagram in the proper relationship to the free body diagram of the beam.
- F. Label and calculate the bending moment at any section in the beam and apply the accepted sign convention to the magnitude of the moment for the types of loading mentioned above.
- G. Draw the bending moment diagram for a simply supported or cantilever beam subjected to concentrated and/or uniformly distributed loads.
- H. Locate the points of zero shears on the shear diagram by inspection.
- I. Locate and calculate the maximum bending moment.
- J. Properly choose the maximum bending moment on the absolute value of the moments calculated.
- K. Locate the neutral axis and the greatest distance to the outer fibers for a given cross section.
- L. Calculate the stress and/or maximum stress due to bending moment substituting with correct units into the "Flexure Formula" $\sigma = Mc/I$.
- M. Calculate the section modulus either by knowing the maximum bending moment and working stress or by calculating them from a given simply supported beam with a known working stress.
- N. Calculate the diameter of a circular beam after calculating the section modulus given the information cited above.
- O. Determine the dimensions of a rectangular beam when given either one dimension or using the assumption that $b = h/2$ if no dimensions are given.
- P. Write and interpret the standard designations for I-beams, channels and angles of equal or unequal length legs.
- Q. Select the correct structural member of a specified type, when the section modulus, maximum bending moments, and working stress are calculated.
- R. Calculate the shearing stress in multiple beam types.
- S. Interpret the data in a free body diagram for input into a computer program.
- T. Perform the necessary steps in getting proper output from the computer, using a computer program.
- U. Interpret all data found in the above output, for any problem, acceptable to the program, relating to the beam data, calculated forces, reactions, and shear/moment values and diagrams.

WEEKS 10 & 11 – Compression Members

The student should be able to:

- A. Calculate and substitute the least moment of inertia with respect to the centroidal axes into the equation for the radius of gyration when given a dimensioned cross-sectional area.
- B. Calculate the radius of gyration.
- C. Calculate the slenderness ratio from the radius of gyration and given length in the appropriate units.
- D. The student should also develop a feel for calculating the least moment of inertia by visual inspection of the shape of the cross section at the outset of the process of determining the radius of gyration to reduce the number of calculations required.
- E. Use the Euler Formula to obtain the buckling load, i.e., short compression member in which crushing controls or long compression members in which buckling controls.

WEEKS 12 & 13 – Combined Stresses

The student should be able to:

- A. Calculate the maximum tensile and compressive bending stresses (for short members) subjected to bending and axial loads. Members will include rectangular and circular sections, and structural steel shapes.

Weeks 13 & 14 – Shafts Subjected to Torsion

The student should be able to:

- A. Calculate the reactions for shafts subjected to loading in two perpendicular planes parallel to the axis of the shaft.
- B. Determine the torque at different positions throughout the length of a shaft subjected to various torsional loading configurations.
- C. Calculate either the maximum permissible torque or maximum torsional shearing stress for both solid and hollow circular shafts when given the shaft size and applied loads.
- D. Select the proper diameter solid circular shaft when given the applied loads and working stress.
- E. Calculate the angle of twist for a shaft or given material and dimensions and applied load.

Week 15

Review of Semester Work & Examination

III. LABORATORY

General Objectives

Work in the materials laboratory is based on two major objectives. The first being that the student is able to verify the theory learned in the classroom. Experiments are conducted so that each student must be able to calculate and/or determine such physical properties as Modulus of Elasticity and Rigidity, ultimate strength, yield point, strength of riveted joints, Rockwell hardness number, and the usefulness and sensitivity of impact tests. The second major objective is that the student becomes familiar with both materials testing procedures and equipment in the laboratory.

IV. LAB SCHEDULE

Week No. 1 Introduction - During the first meeting of the laboratory the "Outline of a Laboratory Report" will be discussed to make clear what is required in the reports. The grading system will also be discussed (see subheading "Grading System" contained within the course outline).

Weeks 2-3 - Tension Test of Ductile & Brittle Materials.

Week No. 4 - Write-up Session

Weeks 5 & 6 - Tensile Tests of Riveted Steel Joints

Week No. 7 - Write-up Session

Week No. 8 - Wood in Compression

Weeks 9 & 10 - Stresses in Determinate Beams

Week No. 11 - Write-up Session

Week 12 - Columns

Week 13 - Write-up Session

Week 14 - Torsion Test, Steel & Cast Iron

Week 15 - Write-up Session

V. EVALUATION/GRADE WEIGHTS

3 Tests	30%
Quizzes	10%
Laboratory	20%
Computer Analysis-Homework, Class Participation	10%
FINAL EXAM	30%

Academic Integrity Statement:

Students are expected to comply with the college-wide requirements for academic integrity. Mercer County Community College is committed to Academic Integrity—the honest, fair, and continuing pursuit of knowledge, free from fraud or deception. This implies that students are expected to be responsible for their own work. Presenting another individual's work as one's own and receiving excessive help from another individual will qualify as a violation of Academic Integrity. The entire policy on Academic Integrity is located in the Student handbook and is found on the college website (http://www.mccc.edu/admissions_policies_integrity.shtml).

VI. ATTENDANCE:

Students are expected to attend all classes unless excused by the instructor. Unexcused absences in excess of 2 lectures and 1 lab will result in a reduction of the average in calculation the final grade. Perfect attendance will result in an increase in the final average.

Special Services

Any student in this class who has special needs because of a disability is entitled to receive accommodations. Eligible students at Mercer County Community College are assured services under the Americans with Disabilities Act and Section 504 of the Rehabilitation Act of 1973. If you believe you are eligible for services, please contact Arlene Stinson, the Director of Academic Support Services. Mrs. Stinson can be reached at 609-570-3525.