

CARLETON UNIVERSITY

Department of Mechanical & Aerospace Engineering

MAAE 2202 Mechanics of Solids I

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Course Outline

This course is designed to introduce the fundamental concepts of Solid Mechanics and enable the students to solve general engineering problems in stress-strain analysis effectively. The course comprises the theoretical part and experimental part.

Chapter 1 Review of Statics and Friction Problems

- (1) Force equilibrium analysis
- (2) Free body diagram
- (3) Friction concepts
- (4) Various types of friction problems

Chapter 2 Concepts of Stress and Strain

- (1) Normal stress and shear stress
- (2) Deformation and strain
- (3) Stress ~ strain relations

Chapter 3 Statically Determinate and Indeterminate Systems

- (1) Principles of solid mechanics
- (2) Various statically determinate systems
- (3) Various statically indeterminate systems

Chapter 4 Torsion of Circular Sections

- (1) Torsion of thin-walled cylinders
- (2) Torsion of uniform solid circular shafts
- (3) Torsion of non-uniform solid circular shafts
- (4) Torque transmission by gear wheels

Chapter 5 Symmetric Bending of Beams (I) — Stresses

- (1) Shear force diagram and bending moment diagram
- (2) Relationships between load, shear force and bending moment
- (3) Determination of bending stress
- (4) Neutral axis, first moment of area and second moment of area
- (5) Shear stresses in beam bending

Chapter 6 Symmetric Bending of Beams (II) — Deflection

- (1) Moment ~ curvature relation
- (2) Determination of deflections
- (3) Macaulay's step function
- (4) Superposition method
- (5) Statically indeterminate beams

Chapter 7 Buckling Instability

- (1) Stability of equilibrium
- (2) Buckling of struts/slender columns (Euler theory)
- (3) Buckling characteristics of real struts
- (4) Applications of Euler theory

Course Materials

1. Textbook: Mechanics of Engineering Materials, P. P. Benham, R. J. Crawford and C. G. Armstrong, Second Edition, Longman, 1996, ISBN 0-582-25164-8.
2. cuLearn on-line materials: Course Outline, Timetable of Lab and PA, Course Notes, Lab Manual, Samples of Mid-term and Final Exams, Exercises-Answers

Learning Objectives

- Knowledge base — CEAB graduate attribute 1 — 1.8 Discipline-specific concept MAE-5: Solid mechanics
Introduce the fundamental concepts of solid mechanics; analyze force equilibrium of stable systems, stress and strain of statically determinate and indeterminate systems, stress and deformation of shafts under torsion, stress and deflection of beams under bending, buckling failure of struts/slender columns
- Problem analysis — CEAB graduate attribute 2
Solve general engineering problems in stress-strain analysis; determine the stress and strain in a single component and multiple-member systems; solve the problems involving components or structures subjected to various loading modes

- Investigation — CEAB graduate attribute 3
Further understand stress and strain behavior of metallic materials under tension, obtain basic material properties such as the modulus of elasticity, yield stress, tensile strength, elongation, via a tensile test; investigate shear stress and twisting angle of shafts under a torsion test; complete a beam bending test to investigate the normal stress variations along the beam and through the beam thickness
- Communication — CEAB graduate attribute 7
Prepare lab report; discuss problems with course instructor and teaching assistants; write mid-term and final exams; do exercises with the help of teaching assistants; conduct experiments under the supervision of teaching assistants

Marking Scheme

Total marks: 100%

Mid-term examination: 15%

Final exam: 60%

Laboratory experiments: 25%

Note: Failure in either the final examination or the laboratory component will constitute failure in this course.

Requirements of the Experiments

Each student will complete **Three** experiments, A, B and C in the Lab. All students must submit their ‘log books’ to their teaching assistant (TA) by the end of the laboratory session for grading. Penalty for absenteeism from each laboratory session is 25% of the total laboratory grade. Penalty for late submission of log book is 20% of laboratory grade for each day late.

Accommodation Statement:

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

Pregnancy obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: <http://www2.carleton.ca/equity/>

Religious obligation: write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist. For more details visit the Equity Services website: <http://www2.carleton.ca/equity/>

Academic Accommodations for Students with Disabilities: The **Paul Menton Centre** for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website for the deadline to request accommodations for the formally-scheduled exam (if applicable) at <http://www2.carleton.ca/pmc/new-and-current-students/dates-and-deadlines/>

You can visit the Equity Services website to view the policies and to obtain more detailed information on academic accommodation at <http://www2.carleton.ca/equity/>