University of Manitoba
Department of Biosystems Engineering

Course Details

Course Title & Number:	BIOE 2800 Solid Mechanics
Number of Credit Hours:	4
Class Times & Days of Week:	Lectures: TR 10:00-11:15 Tutorial: W 2:30-4:20
Location for classes/labs/tutorials:	WebEx (through UM Learn)
Pre-Requisites:	ENG 1440 (or ENG 1441) and MATH 1710 (or MATH 1700 or MATH 1701).

Course Description:
Analysis of deformable bodies; stress and strain in three dimensions; equilibrium equations and strain-displacement relations; constitutive relations and mechanical behaviour of materials; radially symmetric and plane problems in elasticity; relevant experimental demonstrations

Instructor Information

Instructor(s) Name:	Dr. Qiang (Chong) Zhang, P.Eng. (Professor) I prefer to be addressed as Dr. Zhang
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Office Hours or Availability:	Flexible hours
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Contact:	You may contact me by phone, email, or WebEx. Emails sent after business hours will not likely be answered until the next day.
Teaching Assistant:	Mr. Emeka Ndulue
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General Course Information

Solid Mechanics is a fundamental engineering course covering the principles that constitute the foundations upon which other more advanced and related courses are built. This course establishes a working knowledge of the relationships between applied loads to a deformable body or a structure and the deformations (strains) and stresses developed in the body or the structure.

How does this course fit into the curriculum?
Students take this course in the second year of their program. This course gives the students fundamental knowledge of stress-strain analysis, which is required for an advanced course of Mechanics of Materials in Biosystems. The combination of these two mechanics courses provides a foundation for analyzing load response behaviour of materials in designing structures, machines, and other engineering systems.

Course Goals

The intent of this course is to provide students with knowledge of analyzing stress-strain behavior of deformable bodies under typical loading conditions.

Intended Learning Outcomes

At the conclusion of the course, the student should:

1) understand internal forces incurred from external loads
2) understand the concept of stress and strain
3) be able to determine axial force and deformation of an axially-loaded member
4) be able to calculate stresses and twisting of a bar subjected to torsion
5) know the behaviour of a beam subjected to loading
6) be fluent in constructing shear force diagram (SFD) and bending moment diagram (BMD)
7) be able to evaluate bending (normal) and shear stresses in a beam
8) be able to calculate the state of stress at different points of structure due to combined loading
9) be able to evaluate the principal stresses/strains, maximum shear stress/strain using stress/strain transformation equations or Mohr's circles

Textbook, Readings, Materials

Required textbook – None

Supplementary Reading

"Mechanics of Materials" the 7th Edition, 2014 (or the 8th Edition, 2020), by Ferdinand Beer, Jr., E. Russell Johnston, John DeWolf, and David Mazurek.

Additional Materials

Lecture notes (pdf files) will be posted on UM Learn for download.

Using Copyrighted Material

Please respect copyright. We will use copyrighted content in this course. The content used is appropriately acknowledged and is copied in accordance with copyright laws and University guidelines. Copyrighted works, including those created by us, are made available for private study and must not be distributed in any format without permission.

Recording Class Lectures

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Course Technology

As a courtesy to both the instructors and your classmates, use of cell phones is not permitted during class time. Please remember to switch your cell phone to vibrate mode to avoid interruptions. Computers may be used during lectures only for the purpose of taking notes. The electronic copy of all course materials will be available through UM Learn.

Class Communication

All communication between you as a student and your instructors/TAs must comply with the Electronic Communication with Student Policy. You are required to obtain and use your U of M email account for all communication between yourself and the university. For full details of the Electronic Communication with Students Policy please visit:
http://umanitoba.ca/admin/governance/governing_documents/community/electronic_communication_with_students_policy.html.

Expectations: You Can Expect Us To

Learning is most effective when both the teacher and the student are engaged in the subject material. The role of the teacher, therefore, is to create an environment that facilitates students' engagement and learning.

Expectations: We Expect You To

We expect you to be in attendance, and on time, for all scheduled lectures and tutorials. If you must be absent, please show us the courtesy of sending an e-mail notifying us of your absence.

In this course, dissemination of fundamental knowledge will occur using the online lecture format. An important component of this course is the weekly tutorials which will help you digest the contents covered in the lectures. Your attendance of tutorials is mandatory.

Academic Integrity:
Plagiarism or any other form of cheating in examinations, term tests or academic work is subject to serious academic penalty. Cheating in examinations or tests may take the form of copying from another student or bringing unauthorized materials into the exam room. Exam cheating can also include exam impersonation. A student found guilty of contributing to cheating in examinations or assignments is subject to serious academic penalty. Students should acquaint themselves with the University's policy on plagiarism, cheating, exam impersonation, and duplicate submission.

Students Accessibility Services

Student Accessibility Services (SAS)
If you are a student with a disability, please contact SAS for academic accommodation supports and services such as note-taking, interpreting, assistive technology and exam accommodations. Students who have, or think they may have, a disability (e.g. mental illness, learning, medical, hearing, injury-related, visual) are invited to contact SAS to arrange a confidential consultation.

Student Accessibility Services
520 University Centre
204-474-7423
http://umanitoba.ca/student/accessibility/index.html

Class & Tutorial Schedule

A preliminary schedule is provided below. The schedule is subject to change at the discretion of the instructors and/or based on the learning needs of the students but such changes are subject to Section 2.8 of the ROASS Procedure.

	Topic	Lecture hours
CHAPTER 0	**INTRODUCTION**	1
CHAPTER 1	**PROPERTIES OF PLANE AREAS**	4
1.1	Centroid of an arbitrary area	
1.2	Moment of Inertia of an Area	
1.3	Parallel axis theorem	
CHAPTER 2	**STRESS AND STRAIN**	6
2.1	Static equilibrium and free body diagrams	
2.2	Internal forces and stresses	
2.3	Deformations and strains	
2.4	Stress-strain relationship and Hooke's law	
2.5	Allowable stresses and factor of safety	
CHAPTER 3	**AXIALLY-LOADED MEMBERS**	4
3.1	Basic theory of axial deformation	
3.2	Thermal effects on axial deformation	
3.3	Saint Venant' s principle and stress concentration	
CHAPTER 4	**TORSION**	4
4.1	Geometry and deformation	
4.2	Stress distribution and equilibrium equations	
4.3	Twisting moment and angle of twist	
4.4	Torsion of thin-walled tubes	
4.5	Comparison with axially-loaded members	
CHAPTER 5	**SHEAR FORCE AND BENDING MOMENT DIAGRAMS**	5
5.1	Bending moments and shear force diagrams for beams	
5.2	BMD and SFD by graphics	
5.3	How to construct the SFD and BMD	
5.4	BMD using the Method of Superposition	
CHAPTER 6	**STRESSES DUE TO BENDING**	5
6.1	Pure bending	
6.2	Stresses in symmetric beams	
6.3	Shear stress distribution in symmetric beams	
6.4	Combined loads	
CHAPTER 7	**STRESS AND STRAIN TRANSFORMATION**	10
7.1	State of stress at a point in an arbitrary loaded member	
7.2	Principal stresses and maximum shear stress	
7.3	Mohr's Circle for plane stress	
7.4	Principal stresses and the absolute maximum shear stress in 3-D	
7.5	Thin-walled pressure vessels	
7.6	State of strain at a point	
7.7	Principal strains and maximum shear strain	
7.8	General stress-strain relationship for isotropic materials	

Important Dates:

February 10:	Mid-term exam 1
February 16-19:	Term break – No classes
March 24:	Mid-term exam 2
March 31:	Last date for Voluntary Withdrawal for winter term courses

Course Evaluation Methods

Assignments and Tutorials:	20%
Mid-Term 1:	20%
Mid-Term 2:	20%
Final Exam:	40%
Total:	100%

Grading

Letter Grade	Percentage out of 100
A+	92-100
A	85-91
B+	78-84
B	72-77
C+	66-71
C	60-65
D	50-59
F	Less than 50

Assignment Description

1. Weekly assignments will be posted on UM Learn, and tutorials will be distributed at the beginning and handed in at the end of each tutorial session.
2. Solutions of assignment problems shall be **neatly laid out** and all intermediate and final **answers clearly highlighted**. The detailed working out of the solution must also be included.
3. Solutions MUST BE WRITTEN ON ONE SIDE OF EACH PAGE ONLY.
4. Every question should be started on a new page.
5. A declaration form (will be posted on UM Learn) has to be filled, signed and attached to each assignment submission.
6. Late submission of assignments will be accepted up to 5 **days** (including weekends and holidays) following the due date. Each late day after the due date will result in 10% reduction of the marks for each individual assignment. Assignments submitted after 5 days will have no credit.

Examination Description

Term tests (2):
1.5-hour each, open-book. Lecture notes, books, and other references are allowed; communication and discussion with others are NOT allowed, neither in person nor electronically.

Final exam:
3-hour, open-book, **covering the entire course**. Lecture notes, books, and other references are allowed; communication and discussion with others are NOT allowed, neither in person nor electronically. The date will be determined by the Student Records Office.