University of Manitoba | Price Faculty of Engineering
Department of Biosystems Engineering

Course Outline

# BIOE 2800 Solid Mechanics

## Winter 2026

### Course Instructor


- Dr. Wen Zhong, P.Eng.
  W579 Duff Roblin
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Student Hours

- Dr. Zhong will be present during lecture
- Office hours: by appointment

### Teaching Assistant


- Mr. Shahriyar Salehi
salehis2@myumanitoba.ca


Student Hours

TBA

### Location

- **EITC E2 351**
  Lectures: TR 10:00-11:15 AM
  **EITC E2 351**
  Tutorials: W 2:30 – 4:20 PM

### Contact Hours

- 4 credit hours
- Lectures:
  3 hours ×13 weeks = 39 hours
- Tutorials:
  2 hours × 13 weeks = 26 hours

### Prerequisites:

- ENG 1440 (or ENG 1441) and MATH 1710 (or MATH 1700 or MATH 1701).

### Course Website:

## Traditional Territories Acknowledgement

The University of Manitoba campuses are located on the original lands of the Anishinaabeg, Cree, Oji-Cree, Dakota, and Dene peoples, and on the homeland of the Métis Nation.

We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

## 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

## Course Objective

To provide students with knowledge of analyzing stress-strain behavior of deformable bodies under typical loading conditions.

## Course Content

CHAPTER 0 **INTRODUCTION**
CHAPTER 1 **PROPERTIES OF PLANE AREAS**
- 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**
- 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**
- 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**
- 4.1 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**
- 5.1 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**
- 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**
- 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

- **Mid-term examination 1**
  Feb. 4, 2026 (2:30-4:00 pm)
- **Louis Riel Day**
  Feb. 16, 2026
  No classes or examinations
- **Winter Term Break**
  Feb. 16-20, 2026
- **Mid-term examination 2**
  Mar. 4, 2026 (2:30-4:00 pm)
- **Voluntary Withdrawal Deadline**
  Mar. 14, 2026
- **Last Day of Classes**
  Apr. 9, 2026

## Course Delivery

The course will be delivered through in-person lectures and tutorials. Ongoing pandemic note: The Department of Biosystems Engineering has devised a plan so that there is minimal impact on the delivery and content of the course, should the instructor fall sick and is unable to continue lectures in-person. Please be assured that the alternative plan outlining any deviation from the normal mode of instruction will be communicated to you as quickly as possible if/when the need arises.

## Recommended Reading

1. "Mechanics of Materials" the 7th Edition, 2014 (or the 8th Edition, 2020), by Ferdinand Beer, Jr., E. Russell Johnston, John DeWolf, and David Mazurek.
2. **LECTURE NOTES (PDF FILES) WILL BE POSTED ON UM LEARN FOR DOWNLOAD.**

## Learning Outcomes

By the end of this course, you will:

| No. | Learning Outcome |
|---|---|
| 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 |

## Accreditation Details

### Accreditation Units

- Mathematics: 0%
- Natural Science: 0%
- Complementary Studies: 0%
- Engineering Science: 100%
- Engineering Design: 0%

## CEAB Graduate Attributes Assessed

KB.3 –Recalls, defines, comprehends and applies information and concepts in fundamental engineering science

PA.1 – Identifies and defines complex engineering problems

## Graduate Attribute Competency Levels Developed

| Outcome | KB.3 | PA.1 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | I | I | | | | | | | | | | |
| 2 | I | I | | | | | | | | | | |
| 3 | I | I | | | | | | | | | | |
| 4 | I | I | | | | | | | | | | |
| 5 | I | I | | | | | | | | | | |
| 6 | I | I | | | | | | | | | | |
| 7 | I | I | | | | | | | | | | |
| 8 | D | D | | | | | | | | | | |
| 9 | D | D | | | | | | | | | | |

## Grading Scale

Note: These boundaries represent a guide for the instructor and class alike. Provided that no individual student is disadvantaged, the instructor may vary any of these boundaries to ensure year-to-year grading consistency.

| Letter | Mark |
|---|---|
| A+ | 92–100 |
| A | 85–91 |
| B+ | 78–84 |
| B | 72–77 |
| C+ | 66–71 |
| C | 60–65 |
| D | 50-59 |
| F | < 50 |

## Evaluation

| Component | Value (%) | Assessor | Method of Feedback* | Learning Outcomes Evaluated | I/T** |
|---|---|---|---|---|---|
| Final examination | 50 | Instructor | S | 1-9 | I |
| Midterm examination 1 | 20 | Instructor | S, F | 1-2 | I |
| Midterm examination 2 | 20 | Instructor | S, F | 3-4 | I |
| Assignments and Tutorials | 10 | TA | S, F | 1-9 | I |

* Method of Feedback: **F** - Formative (written comments / oral discussion), **S** - summative (numerical grade)

** I/T: **I** – Individual effort, **T** – A team effort

## Description of Assignments and Tutorials

- Throughout the term, 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.
- 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.
- Solutions must be written on one side of each page only.
- Every question should be started on a new page.
- A declaration form (will be posted on UM Learn) has to be filled, signed and attached to each assignment submission.
- Late submission of assignments will be accepted up to **7 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 7 days will have no credit.

## Description of Examinations

There will be two (2) midterm examinations and one (1) final examination in this course. Each midterm examination will be 1.5-hour and closed-book. A formula sheet will be provided. The final examination will be 3-hour and closed-book, **covering the entire course**. A formula sheet will be provided. Only regular calculators are allowed.

There is NO make-up examination for a missed mid-term examination. If missed for a valid medical certificate or compassionate reason, marks assigned to the missed mid-term examination will be added to the final examination. Students who miss the examination without a valid reason will receive a grade of zero (0) for the mid-term examination.

## Academic Integrity

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the *General Academic Regulations* on *Academic Integrity*, students are reminded that plagiarism or any other form of cheating in examinations, term tests, assignments, projects, or laboratory reports is subject to serious academic penalty (e.g., suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating by another student is also subject to serious academic penalty.

## Requirements/Regulations

- All email communication must conform to the Communicating with Students university policy.

*Communicating with Students*

- Self-declaration forms may be completed for missed tests, exams, or assignments during short-term absences (≤72 hours) for extenuating circumstances. This form cannot be used for planned absences like vacations. It is also not to be used for longer-term absences, or ongoing circumstances (e.g., Authorized Withdrawals, Leaves of Absence, or other accommodations), which will still require additional documentation.

*Self-Declaration Policy for Brief or Temporary Absences*

- It is the responsibility of each student to contact the instructor in a timely manner if he or she is uncertain about his or her standing in the course and about his or her potential for receiving a failing grade. Students should familiarize themselves with the University's *General Academic Regulations*.

*General Academic Regulations*

*Engineering Academic Regulations*

- Students should be aware that they have access to an extensive range of resources and support organizations. These include Academic Resources, Counselling, Advocacy and Accessibility Offices as well as documentation of key University policies e.g., Academic Integrity, Respectful Behaviour, Examinations, and related matters.

*Supplemental Resources*

## Deferred Final Examinations

Students who miss the regularly scheduled writing of a final examination for valid medical or compassionate reasons will only be allowed to write a deferred exam if the Associate Dean (Undergraduate) approves the request. All requests for a deferred examination must be made within 48 hours of the missed exam and follow the procedure described on the Faculty website without exception. Course Instructors do not have the discretion to grant deferred final examinations.

*Deferred Exam Policy (student experience website)*

## Retention of Student Work

Students are advised that copies of their work submitted in completing course requirements (i.e. assignments, laboratory reports, project reports, test papers, examination papers, etc.) may be retained by the Instructor and the Department for the purpose of student assessment and grading, and to support the ongoing accreditation of each Engineering program. This material shall be handled in accordance with the University's *Intellectual Property Policy* and the protection of privacy provisions of *The Freedom of Information and Protection of Privacy Act (Manitoba)*. Students who do not wish to have their work retained must inform the Head of Department, in writing, at their earliest opportunity.

## Copyright Notice



*Copyright Office*