Course Outline

Instruction Team
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Student Hours
- Open door policy

Teaching Assistant
- Andrew Bowman
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Locations
- **300 Human Ecology Bldg**
  MWF 10:30 - 11:20 am (A01-Lectures)
- **322 Human Ecology Bldg**
  T 2:30 – 3:45 PM (B01 - Labs)
  T 4:00 – 5:15 PM (B02 - Labs)

Contact Hours
- 4 credit hours
- Lectures:
  3 hours x 12 weeks = 36 hours
- Labs:
  1.5 hours x 12 weeks = 18 hours

Prerequisites:
- BIOE 2800 or CIVL 2800

Course Website:
http://umanitoba.ca/umlearn

Traditional Territories Acknowledgement

The University of Manitoba campuses are located on the original lands of Anishinaabeg, Ininiwak, Anisininewuk, Dakota Oyate and Dene, and on the National Homeland of the Red River Métis.

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.

BIOE 3590 Mechanics of Materials in Biosystems

Fall 2025

Course Description

In this course students will be exposed to both the theories and physical behaviour of materials when subjected to loads. The course will be delivered using a combination of lectures and hands-on labs. The materials presented include a wide range of design biosystems engineers may be involved with, including steel; wood; concrete; bone; and other biological materials and composites.

Course Goals

- to gain the knowledge of mechanical behavior of materials in biosystems
- to understand how the theories of mechanics of materials are applied to predict the mechanical behavior of materials.
- to learn how to conduct physical tests to assess the mechanical properties of materials.

Course Content

Lecture topics

1. Introduction
   - The role of mechanics of materials in design
   - Material behavior and modes of failure
2. Elastic and inelastic behavior of materials
   - Linear elastic behavior under uniaxial loading
   - Nonlinear and inelastic behavior
   - Yield criteria
   - Fracture mechanisms
3. Mechanical behavior of materials in biosystems
   - Steel
   - Concrete
   - Wood
   - Bone
   - Flexible materials
   - Other materials
4. Flexural analysis of beams
   - Serviceability of beam
   - Beam deflection equations
   - Methods of deflection analysis
5. Stability analysis of columns
   - Stability of structures
   - Euler's formula
   - Lateral support
   - Column design
6. Introduction to energy methods in structural analysis (optional)
   - Strain energy
   - Work-energy method
   - Castigliano's theorem

Important Dates

- **National Day for Truth and Reconciliation**
  Tue. Sept. 30
  No classes or examinations
- **Thanksgiving**
  Mon. Oct. 13
  No classes or examinations
- **Midterm Exam**
  Tue. Oct. 28
- **Remembrance Day**
  Tue. Nov. 11
  No classes or examinations
- **Fall Term Break**
  Nov. 10-14
  No classes or examinations
- **Voluntary Withdrawal Deadline**
  Tue. Nov. 18
- **Last Day of Classes**
  Mon. Dec. 8

Accreditation Details

Accreditation Units

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

Graduate Attributes

KB: A knowledge base for engineering
PA: Problem analysis
IN: Investigation
DE: Design
ET: Use of engineering tools
IT: Individual and team-work
CS: Communication skills
PR: Professionalism
IE: Impact of engineering on society/environment
EE: Ethics and equity
EP: Economics and project management
LL: Life-long learning

Competency Levels

I - Introduced
D – Intermediate (Developing)
A - Advanced

Lab topics:

- Calibration of loading frame
- Tensile test of steel and aluminum
- Structural failures (videos)
- Concrete making
- Compression and bending test of wood
- Concrete testing
- Bone testing
- Beam deflection test
- Stability test of column
- Site tours

Course Delivery

The course will be delivered using a combination of lectures and hands-on labs. While lectures cover theories of mechanics of materials, students will test different materials in weekly labs to observe material behaviors under loads. In-class discussion will be held after each lab to relate lab observations to the theories learned in the lectures.

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 be 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, Ferdinand P. Beer et al., McGraw-Hill.
2. Advanced Mechanics of Materials, Boresi et al., John Wiley & Sons, Inc.
3. Lecture notes will be posted on UM Learn for download.

By the end of this course, you will be able to:

No.	Learning Outcome
1	understand the role of knowledge of material behaviour in designing machines, structures, and other engineering systems
2	understand the mechanisms of material failure under loads
3	conduct common mechanical tests for assessing material behaviour, including uniaxial tension and compression, and three-point bending; use the test data to determine important material property parameters, such as modulus of elasticity and yield strength
4	characterize mechanical behaviour of materials in biosystems, such as steel, wood, concrete, and bones
5	understand the relationship between the mechanical behaviour and physical, chemical and biological properties of the material
6	perform flexural analysis of beams
7	perform stability analysis of columns

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 consistency of grading from year-to-year.

Letter	Mark
A+	92-100
A	85-91.99
B+	78-84.99
B	72-77.99
C+	66-71.99
C	60-65.99
D	50-59.99
F	<50

CEAB Graduate Attributes Assessed

This course will assess the following CEAB graduate attribute indicators shown below:

Indicator (Level)	Indicator Description	Assessment Point
KB.3 (A)	Recall, defines, and comprehend principles and concepts of stress-strain behaviour and failure modes of materials; apply knowledge of mechanics of material to predict mechanical behaviour of materials	Midterm and final exams; assignments
PA.1 (A)	Identify the stress states and failure modes of materials subjected to various loading conditions	Midterm and final exams; assignments
PA.3 (D)	Analyze stresses and strains in materials and predict material failures	Midterm and final exams; assignments
IN.1 (D)	Conduct material tests: gather information of test samples and load-deformation measurements; and analyzes test data	Lab reports
IN.3 (D)	Interpret results of material tests, and reach appropriate conclusions from the data on material behaviour (stress-strain characteristics and failure mechanisms)	Lab reports
IN.4 (D)	Understand the safe work procedures when using universal testing machines to conduct material tests	Lab reports

Evaluation

Component	Value (%)	Assessor	Method of Feedback*	Learning Outcomes Evaluated	I/T**
Final Exam	50	Delijani	S	1, 2, 3, 4, 5, 6, 7	I
Midterm Exam	20	Delijani	F	1, 2, 4, 5	I
Lab Reports	20	TA	F	3	T
Assignments (3)	10	TA	F	1, 2, 4, 5, 6, 7	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 Evaluation Components

A significant element of this course is testing various materials to determine their mechanical properties. Weekly lab reports will be required to analyze and summarize the test results. In each report, you will be asked to describe the test apparatus and procedure, perform data analysis, present the test results, and use the theories learned in the lectures to discuss/explain the results. The reports are to be typed, following the format below:

1. Title page
2. Description of apparatus and procedure
3. Data analysis (you must show sample data and calculations)
4. Results and discussion

NOTE: Data plots only are required. The data files compiled on the data acquisition (DAQ) system need not be submitted with the lab reports. Use only metric units in your reports.

You will be given assignments for each topic covered in the course. Assignments will be posted and submitted through UM Learn.

Lab reports and assignments are required to be completed on time. The lab reports and assignments are normally due one week after being assigned to you. **Submissions after the due date will be docked at 10% per day**. All lab reports must be submitted to pass the course.

There will be one (1) midterm examination and one (1) final examination in this course. The midterm examination will be scheduled before the VW deadline. The final examination will be based on 80% of the materials covered after the midterm and 20% before the midterm. The examinations will be closed book, and a formula sheet will be provided to you.

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

- Please copy the Instruction Team in all emails (Instructors and Teaching Assistants). All email communication must conform to the Communicating with Students university policy.

Communicating with Students

- As the Instruction Team, we will do our best to respond to all emails **within 48 hours during working hours** (8:30 AM – 5:30 PM Monday thru Friday). Ex. A Friday night email may not be responded to until the following Tuesday.
- 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 Form for Brief or Temporary Absence

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.

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