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

Course Outline

Instruction Team

- Dr. Mohammad Nadimi (he/him)
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TA
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Student Hours
- Dr. Nadimi: Mon 2:30 – 3:30 PM (by appointment)

Location
- **Lecture E2-304**
  Mon 1:30 PM – 2:20 PM
  Wed 1:30 PM – 2:20 PM
  Fri 1:30 PM – 2:20 PM

- **Laboratory E2-304**
  Wed 2:30 PM – 4:20 PM

Contact Hours
- 4 credit hours
- Lectures:
  3 hours x 12 weeks = 36 hours
- Laboratories:
  2 hours x 12 weeks = 24 hours

Prerequisites:
- BIOE 3270

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

BIOE 4414 Imaging and Spectroscopy for Biosystems Fall 2025

Course Objectives

The purpose of this course is to familiarize senior Biosystems Engineering students with the fundamentals of imaging and spectroscopy for biosystems. Techniques of image acquisition, storage, processing, and pattern recognition will be taught. Various spectroscopy techniques and their applicability to biological materials will be discussed. Analysis of data using statistical, artificial neural networks and chemometric methods will be covered. This course introduces the student to several fundamental principles of optics instruments associated with it. The skills obtained in this course will come in handy when doing the undergraduate thesis, post-graduate research, and doing on-site measurements in the industry (upon graduation or during co-op).

Course Content

This course deals with imaging and spectroscopy that aim at quality control and analytical instrument in various domains including biomedical, environmental, and bioprocessing. The principles of this course are built based on physics, optics, electronics. This course will assist students in understanding the principles involved in the designing aspect of hardware and software design.

LECTURES: The following is a basic list of topics/lectures to be covered during this course. The order in which they have been presented does not, however, necessarily imply the order in which they will be encountered.

1. Course outline, Introduction
2. Light
3. Human visual system, Color
4. Digital image
5. Image enhancement
6. Image file formats
7. Image sensors, machine vision cameras
8. NIR spectroscopy
9. Hyperspectral imaging
10. Chemometrics
11. X-ray imaging
12. Biophotonics

Laboratories:

One two-hour period per week. Labs will be conducted on Wednesdays at 2:30 PM. Laboratory work will require students to conduct experiments and/or perform data analysis, followed by written reports outlining the results.

Please note: The laboratory schedule is provided below. Topics may be adjusted at the instructor's discretion to best meet course objectives.

(Sep. 03)	**No Lab**
(Sep. 10)	Introduction, lab organization, project discussion
(Sep. 17)	MATLAB for image processing and data analysis
(Sep. 24)	Image processing 1
(Oct. 01)	Image processing 2
(Oct. 08)	Lab tour

(Oct. 15)	Thermal imaging
(Oct. 22)	**No Lab-Midterm exam**
(Oct. 29)	Spectroscopy
(Nov. 5)	Hyperspectral imaging
(Nov. 12)	**No-Lab (Fall break)**
(Nov. 19)	Project Presentations
(Nov. 26)	Project Presentations
(Dec. 3)	**No-Lab**

Assignment Extension and Late Submission Policy

All assignments should be submitted before the specified deadlines. Late submission of assignments and reports would result in loss of 20% marks for each working day. No labs reports will be accepted after the end date (5 days after the deadline). Students registered with accessibility service should contact the instructor in advance and specify the need for required time. No extension for lab reports and assignments deadlines. All enquiries regarding the lab reports grading should be addressed to the course instructor and TA.

If you miss the mid-term exam, the marks for it will be rolled over to the final (there will be no 'make-up' mid-term). There will be a few guest lectures. Material covered during guest lectures, could be asked in the exams. For group project, students will be assigned a topic, research it, prepare a report and make a presentation.

E-mailing rule

Use UM assigned e-mail ONLY with subject line "BIOE 4414, enquiry"

Textbook

Lecture materials: A set of class presentations in pdf format will be available on UM Learn
Instructional materials for labs will be posted on UM Learn
Assignments will be posted on UM Learn

Evaluation

The basis of the final grade is agreed upon with the students at the beginning of the term. The usual weighting is:

- 20% on midterm test
- 25% on assignments and lab reports
- 20% major design project (presentation: 50% and written report: 50%)
- 35% on the written final examination

Late submission of assignments or laboratory reports would result in loss of 20% marks for each working day.

Accreditation Details

- Mathematics: 0%
- Natural Science: 0%
- Complementary Studies: 0%
- Engineering Science: 75%
- Engineering Design: 25%

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

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+	95–100
A	87–94
B+	78–86
B	72–77
C+	66–71
C	60–65
D	50–59
F	< 50

Learning Outcomes

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

No.	Learning Outcome	Transferable Skill
1	Understand the theory and principles involved in imaging and spectroscopic methods. Image processing and enhancement, multivariate spectral data analysis.	A knowledge base for engineering
2	Prepare a conceptual design of imaging/spectroscopic method(s) and engineering solution(s) for solving a real-world problem.	Teamwork; design
3	Collaborate with group members in a team setting to manage an engineering design project.	Design, project management
4	Apply data processing methods and theories to practical solutions.	Problem analysis
5	Communicate orally and in writing a design solution.	Communication skills

CEAB Graduate Attributes Assessed

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

Indicator (Level)	Indicator Description	Assessment Point
KB.3	Recalls, defines, comprehends and applies information and concepts in fundamental engineering science	Midterm Exam, Final Exam, Assignments & Lab Reports
PA.2	Analyzes and solves complex engineering problems	Final Exam
DE.3	Develops possible solutions to an open-ended design problem, leading to an appropriate recommendation	Major Design Project
CS.2	Designs, produces, and delivers effective technical presentations for specific audiences	Major Design Project (Oral Presentation)
IT.2	Exhibits appropriate interpersonal skills when interacting with team members, including giving and receiving constructive feedback	Major Design Project (Team Collaboration & Peer Evaluation)

Important Dates

- **First day of classes**
  Sep. 03, 2025
- **Early Withdrawal Deadline**
  Sep. 16, 2025
- **Thanksgiving Day**
  Oct. 13, 2025
  No classes or examinations
- **Midterm Exam Date**
  Oct. 22, 2025
  1:30 pm to 3:30 pm
- **Fall Term Break**
  Nov. 10-14, 2025
  No classes or examinations
- **Voluntary Withdrawal Deadline**
  Nov. 18, 2025
- **Last Day of Classes**
  Dec. 08, 2025
- **Final Examination Dates**
  Dec. 09 -20, 2025

Evaluation

Component	Value (%)	Assessor	Method of Feedback*	Learning Outcomes Evaluated	I/T**
Final Exam	35	MN	S	1, 2, 4	I
Design assignments and lab report	25	TA & MN	F, S	2,3,4	I
Major design project (presentation 50% and written report 50%)	20	TA & MN	F, S	2, 3, 4, 5	I/T
Midterm test	20	MN	S	1, 2, 4	I

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

** I/T: **I** – Individual effort, **T** – Team effort

TA – Teacher Assistant, MN – Mohammad Nadimi

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

- No programmable devices or systems (such as calculators, PDAs, iPods, iPads, cell phones, smart watches, wireless communication, or data storage devices) are allowed in examinations unless approved by the course instructor.
- All email communication must conform to the Communicating with Students university policy.

Communicating with Students

- Attending lectures and laboratories is essential for the successful completion of this course.
- Self-declaration forms may be completed for missed tests, exams, or assignments during short-term absences (≤72 hours) for extenuating circumstances. Students don't need to share personal information about their situation beyond declaring the nature of the extenuating circumstance on the self-declaration form.

Self-Declaration Form for Brief or Temporary Absence

- 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*, as well as Section 3 of the Faculty of Engineering *Academic Regulations* dealing with incomplete term work, deferred examinations, attendance, and withdrawal.

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

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.

Updated: July 11, 2022

Accessibility Offices as well as documentation of key University policies e.g. Academic Integrity, Respectful Behaviour, Examinations and related matters.

Supplemental Resources

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/or 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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Copyright Office