



Course Outline

Instruction Team

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TA

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Student Hours

- Dr. Erkinbaev: Wed 3:00 – 4:00 PM
(by appointment)

Location

- **Lecture E2-160**
Tue 8:30 AM - 9:45 AM
Thur 8:30 AM - 9:45 AM

Laboratory E2-351

Mon 2:30 PM- 5:15 PM

Contact Hours

- 4 credit hours
- Lectures:
3 hours x 12 weeks = 36 hours
- Laboratories:
3 hours x 12 weeks = 36 hours

Prerequisites:

- BIOE 3270

Course Website:

<http://umanitoba.ca/umlearn>

BIOE 4414 Imaging and Spectroscopy for Biosystems Winter 2024

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: Two and a half hours per week for one term (13 weeks)

- (Jan. 9, 11) Course outline, Introduction
- (Jan. 16, 18) Light
- (Jan. 23, 25) Human visual system, Color
- (Jan. 30, Feb 1) Digital image
- (Feb. 6, 8) Image enhancement
- (Feb. 13, 15) Image file formats
- (Feb. 20, 22) **No classes (Reading week)**
- (Feb. 27, 29) **Mid-term Test**
- (Mar. 5, 7) Image sensors, machine vision cameras
- (Mar. 12, 14) NIR spectroscopy
- (Mar. 19, 21) Hyperspectral imaging (guest lecture #1)
- (Mar. 26, 28) Chemometrics, X-ray imaging
- (Apr. 2, 4) Biophotonics (guest lecture#3)
- (Apr. 09) Course discussion

Laboratories:

One three-hour period per week. Labs will be conducted on Mondays at 2:30 PM. Laboratory work will require students to conduct experiments and prepare written reports outlining the results.

- (Jan. 08) **No Lab**
- (Jan. 15) Introduction, lab organization, project discussion
- (Jan. 22) Image processing 1
- (Jan. 29) Image processing 2
- (Feb. 05) Thermal imaging

(Feb. 12)	Light scattering
(Feb. 19)	No Lab (Reading week)
(Feb. 26)	No Lab
(Mar. 04)	Spectral analysis
(Mar. 11)	Hyperspectral imaging
(Mar. 18)	Tour (TBD)
(Mar. 25)	Project Presentations
(Apr. 1)	Project Presentations
(Apr. 8)	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 written final examination

Late submission of assignments or laboratory reports would result in loss of 10% marks for each working day.

Accreditation Details

- Mathematics: 10%
- Natural Science: 40%
- Complementary Studies: 0%
- Engineering Science: 25%
- 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

Expected Competency Levels

Outcome	KB	PA	IN	DE	ET	IT	CS	PR	IE	EE	EP	LL
1	3											
2				3		2						
3				3		2						
4		3										
5							2					

CEAB Graduate Attributes Assessed

- KB.3 – Recalls, defines, comprehends and applies information and concepts in fundamental engineering science
- DE.3 – Develops possible solutions to an open-ended design problem, leading to an appropriate recommendation
- IT.2 – Exhibits appropriate interpersonal skills when interacting with team members, including giving and receiving constructive feedback
- PA.3 – Analyzes and solves complex engineering problems
- CS. 2 – Designs, produces, and delivers effective technical presentations for specific audiences

Important Dates

- **Early Withdrawal Deadline**
January 19, 2024
- **Louis Riel Day**
February 19, 2024
No classes or examinations
- **Winter Term Break**
February 19-23, 2024
No classes or examinations
- **Voluntary Withdrawal Deadline**
March 20, 2024
- **Last Day of Classes**
April 10, 2024
- **Examination Dates**
April 12 - 26, 2024

Evaluation

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

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

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

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

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

 [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](#)