

**Western University
Faculty of Engineering
Electrical and Computer Engineering Program**

ECE 4445 – Introduction to Digital Image Processing

Course Outline Fall 2025

COURSE DESCRIPTION: The aim of this introductory course is to provide a solid background in the fundamentals of digital image processing. The course covers many of the major topics in the field, including image representation, histograms, contrast enhancement, algebraic operations, registration, digital filtering, and segmentation. The course concentrates on those techniques that have proven most useful in practice. A major aim of this course is to expose students to real-world applications of image processing in industry, science, and medicine. Through assignments, students will become familiar with the image processing facilities available in the popular MATLAB numeric computation and visualization environment.

ACADEMIC CALENDAR:

https://www.westerncalendar.uwo.ca/Courses.cfm?CourseAcadCalendarID=MAIN_017546_1&SelectedCalendar=Live&ArchiveID=

This course covers the fundamentals of digital image processing, including image representation, histograms, contrast enhancement, geometric operations, registration, digital filtering and segmentation. Emphasis is placed on implementation of algorithms and on practical applications in industry, science and medicine.

PRE OR COREQUISITES: ECE 3331A/B or AISE 3351A/B or the former ECE 3351A/B

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record.

ANTIREQUISITES: MEDBIO 4445A/B

CEAB ACADEMIC UNITS: Engineering Science 75%, Engineering Design 25%

CONTACT HOURS:

One hour lectures occur three times per week

RECOMMENDED/REQUIRED TEXT: None. Complete lectures will be provided.

RECOMMENDED/ REQUIRED SOFTWARE: MATLAB (Available free of charge from Western. Instructions for accessing will be given in class before the first assignment.)

RECOMMENDED RESOURCES/REFERENCES:

1. K.R. Castleman, *Digital Image Processing*, Prentice-Hall, Inc., Englewood Cliffs, 1996. (Forms basis of many of the lectures. On reserve at Allyn & Betty Taylor Library.)
2. Gonzalez, R.C., & Woods, R.E. (2018). *Digital Image Processing*, 4th ed. Pearson. (Forms basis of lectures on segmentation. On reserve at Allyn & Betty Taylor Library.)
3. Documentation on Matlab and the Image Processing Toolbox can be found on the Mathworks' Web site at <https://www.mathworks.com/help/>

GENERAL LEARNING OBJECTIVES (CEAB GRADUATE ATTRIBUTES)

Knowledge Base	D	Engineering Tools	A	Impact on Society	
Problem Analysis	A	Individual & Teamwork		Ethics and Equity	
Investigation		Communication		Economics and Project Mgmt.	
Design	A	Professionalism		Life-Long Learning	D

Notation: x represents the content level code as defined by the CEAB. blank = not applicable; I = introduced (introductory); D = developed (intermediate) and A = applied (advanced).

Rating: I – The instructor will introduce the topic at the level required. It is not necessary for the student to have seen the material before. D – There may be a reminder or review, but the student is expected to have seen and been tested on the material before taking the course. A – It is expected that the student can apply the knowledge without prompting (e. g. no review).

COURSE MATERIALS: Weekly content will be available on the course OWL site. The material for this course will be taught in the lectures; therefore, it is imperative that you attend each lecture.

UNITS: SI

COURSE TOPICS AND SPECIFIC LEARNING OUTCOMES:

The following table summarizes the course learning outcomes along with CEAB GAIs where the GAIs in bold indicate ones to be measured and reported annually.

Course Topics and Specific Learning Outcomes	CEAB Graduate Attributes Indicators
1. The digital image and its properties At the end of this section, students will be able to: a. Define in words terminology related to digital image processing b. Define a digital image mathematically	Taught, but not assessed
2. The gray-level histogram and point operations At the end of this section, students will be able to: a. Compute the histogram b. Define what is meant by a point operation and be able to predict the effects of a point operation on the output histogram c. Describe and perform linear point operations, window-and-level, histogram equalization, and histogram matching	KB3 KB4, PA2 KB4, ET2
3. Algebraic operations At the end of this section, students will be able to describe applications of the following operations in digital image processing: a. Image addition for noise reduction b. Image subtraction for motion detection and background removal c. Image division for background non-uniformity correction d. Image multiplication for region of interest processing	KB3, PA2 PA2, D1, ET3 KB4 KB4
4. Spatial domain filtering At the end of this section, students will be able to: a. Define and perform image convolution b. Define and apply convolution kernels for lowpass filtering and for enhancement c. Define and perform order-statistic filtering	KB3, ET2, PA2 KB4, ET2, PA2 KB4, ET2, PA2
5. Geometric operations At the end of this section, students will be able to: a. Mathematically define and implement geometric operations of translation, rotation, and scaling b. Define and implement gray-level interpolation techniques, particularly nearest neighbour interpolation and bilinear interpolation c. Describe applications such as geometric calibration, and registration. Be able to implement landmark-based rigid-body registration	KB3, PA2 KB4, ET2, PA2 KB4, D1, ET3
6. Segmentation At the end of this section, students will be able to: a. Perform manual and automatic threshold selection and binary image processing	KB4, ET2, PA2

b. Perform region growing	KB4
c. Perform edge detection and linking	KB4, LL2

EVALUATION:

Name	% Worth	Assigned	Due Date	CEAB GAS ASSESSED
Assignment 1	5%			ET2, LL2
Assignment 2	5%			ET2
Assignment 3	5%			ET3
Assignment 4	5%			ET3
Test 1	15%			KB3, KB4, P2, ET2
Test 2	15%			KB3, KB4, P2
Final Examination	50%	TBD	TBD	KB3, KB4, P2, D1, ET2

Note that the dates listed above are **tentative** and may be adjusted if needed. Marks will be assigned on the basis of method of analysis and presentation, correctness of solution, clarity and neatness.

COURSE POLICIES:

All work submitted must be of professional quality in the requested format. Material that is handed in dirty, illegible, disorganized, or in an unapproved format will be returned to the student for resubmission and the late submission penalty will take effect. An additional penalty of 10% may be deducted for poor grammar, incoherence, or lack of flow in the written reports.

FINAL EXAMINATION: The final exam will take place during the regular examination period. The final exam will be three hours long, closed book. Only simple, nonprogrammable calculators are allowed.

TESTS: Both tests will each take place during the normal lecture hour. Each test will last 45 minutes. All tests will be closed book. Only simple, non-programmable calculators are allowed.

ASSIGNMENTS: Students will work in groups of three (3) individuals. One report can be submitted by each group. All assignments will involve programming in MATLAB and will be distributed via OWL. All assignments are expected to be submitted via OWL by 11:59 pm on the due date. Each assignment is worth 5% of your overall grade.

LATE SUBMISSION POLICY:

This course employs flexible deadlines for assignments. The assignment deadlines can be found above in the course outline. For each assignment, students are expected to submit the assignment by the deadline listed. Should illness or extenuating circumstances arise, students are permitted to submit their assignment up to 72 hours past the deadline without academic penalty. Should students submit their assessment beyond 72 hours past the deadline, a grade of zero (0) will be given for the assignment. **As flexible deadlines are used in this course, requests for academic consideration will not be granted.** If you have a long-term academic consideration or an accommodation for disability that allows greater flexibility than provided here, please reach out to your instructor at least one week prior to the posted deadline.

ATTENDANCE: Attendance is mandatory for all lectures.

FACULTY OF ENGINEERING POLICIES:

Students must familiarize themselves with the policies of the Faculty of Engineering

<https://www.eng.uwo.ca/electrical/pdf/2024-UG-BOILERPLATE-OUTLINES.pdf>

USE OF GENERATIVE ARTIFICIAL INTELLIGENCE (GenAI) Platforms

You are permitted to use GenAI platforms such as Copilot (integrated into MATLAB) or similar tools for the assignments.

Assignment Reports: You may use GenAI to gather information, brainstorm ideas, or write answers. However, you must manually verify all references if required, cite any summaries used, and include a statement of use in your submission.

Coding Task: You may use GenAI platforms to assist with basic functions. Comment your code to indicate where GenAI was used and explain what was modified. You are responsible for final functionality and correctness.

Rationale for Policy: This policy encourages responsible experimentation with emerging tools while ensuring that your academic contributions remain transparent, authentic, and attributable. It also promotes metacognitive skills essential in modern digital literacy.