**WESTERN UNIVERSITY**
**FACULTY OF ENGINEERING**

**DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING**

# ECE 9201 - INTRODUCTION TO DIGITAL IMAGE PROCESSING
# COURSE OUTLINE: FALL 2017

## DESCRIPTION

This introductory course provides a solid background in the fundamentals of digital image processing, and covers many of the major topics in the field, including image representation, 2D linear systems theory and Fourier analysis, digital filtering, registration 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.

## CONTACT HOURS: 3 lecture hours/week

Lecture days/times/locations:

- Mondays from 5:30 pm to 6:20 pm in Spencer Engineering Building, Room 1200
- Thursdays from 9:30 am to 10:20 am in Spencer Engineering Building, Room 2200
- Fridays from 10:30 am to 11:20 am in Spencer Engineering Building, Room 1200

Starting date: Thursday, September 7, 2017

## PREREQUISITES

Undergraduate courses in signal processing (e.g., ECE 3331b at Western) and statistics (e.g., SS 2141a at Western)

## COURSE CONTENT

The following topics will be covered:

1) The digital image and its properties
2) The gray-level histogram and point operations
   - Computation of the histogram
   - Histogram equalization
   - Histogram matching
   - Photometric calibration
3) Algebraic operations
   - Applications in noise reduction, motion detection, and background removal
4) Geometric operations
   - Gray-level interpolation
   - Spatial transformations
   - Applications in geometric calibration, image rectification and registration
5) Review of 1-D linear systems theory; extension to 2-D
   - Definitions
   - Harmonic signals and complex signal analysis
   - Convolution

6) Review of the 1-D Fourier Transform; extension to 2-D
   - Definition and properties of the Fourier Transform
   - Linear systems and the Fourier Transform
   - Correlation and the power spectrum
7) Digital filters
   - Linear filters for smoothing and edge enhancement
   - Homomorphic filters
   - Order-statistic filters
8) Image segmentation
   - Thresholding and binary image processing
   - Gradient-based methods
   - Edge-detection and linking
   - Region growing

## REQUIRED TEXTBOOK

K.R. Castleman, Digital Image Processing, Prentice-Hall, Inc., Englewood Cliffs, 1996.

## RECOMMENDED REFERENCES

1. R. Jain, R. Kasturi, B.G. Schunck, Machine Vision, McGraw-Hill, New York, 1995.
2. A.K. Jain, Fundamentals of Digital Image Processing, Prentice-Hall, Inc., Englewood Cliffs, 1989.
3. M. Sonka, V. Hlavac, R. Boyle, Image Processing, Analysis, and Machine Vision, Brooks/Cole Publishing Co., Pacific Grove, 1999.
4. T.M. Peters and J. Williams, editors, The Fourier Transform in Biomedical Engineering, Birkhäuser, Boston, 1998.
5. Documentation on Matlab and the Image Processing Toolbox can be found on the Mathworks' Web site at http://www.mathworks.com/access/helpdesk/help/fulldocset.shtml.

## SPECIFIC LEARNING OBJECTIVES

1. To expose the student to a broad range of image processing techniques and their applications as listed above, and to provide the student with practical experience using them.
2. To familiarize the student with the image processing facilities in Matlab.
3. To examine several industrial, scientific and medical applications of digital image processing. Real-world examples drawn from these areas will be discussed in class and, as a part of the assignments, students will be required to implement aspects of these examples. Furthermore, speakers will be invited from London's research institutes to discuss how they use image processing in their work.

## EVALUATION

| | | Maximum Penalties* | |
|---|---|---|---|
| Component | Value | English | Presentation |
| • Assignments | 20% | 5% | 5% |
| • Midterm tests | 10% | 5% | 5% |
| • Project | 20% | 5% | 5% |
| • Final Examination | 50% | 5% | 5% |

Two midterm tests worth 5% each will be done during class time on **Thurs., Oct. 19, 2017** and **Thurs.,**

**Nov. 9, 2017**. These will be closed book. Non-programmable calculators will be allowed.

Late assignments will be penalized at a rate of 5% per day overdue. In order to pass the course, a student must obtain a passing grade in the final examination. A student who fails the final examination shall receive a final grade not greater than 48%. Use of calculators is restricted to non-programmable ones (see listing of acceptable calculators); no other aids (e.g., textbooks) are allowed in the final exam.

*In accordance with the policy of the University, the grade assigned to all written and oral work presented in English shall take into account syntax, diction, grammar and spelling. In addition, in the professional life of an engineer, the manner in which oral and written communications are presented is extremely important. An engineering student must develop these skills as an integral part of the undergraduate program. To encourage the student to do so, the grades assigned to all written and oral work will take into account all aspects of presentation including conciseness, organization, neatness, use of headings, and the preparation and use of tables and figures.

**All work will be marked first for content** after which a penalty not to exceed the maximum shown above may be applied for lack of proficiency in English and/or presentation.

## ATTENDANCE

Any student, who, in the opinion of the instructor is absent too frequently from class or laboratory periods in any course, will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular examination in the course.

## ACADEMIC OFFENCES

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a *scholastic offence*, at the following Web site:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

## INTERNET/BULLETIN BOARD POLICY

It is the student's responsibility to read the course web site and/or bulletin board and be aware of any information that is posted about the course. If the student fails to act on information that has been posted on these sites and does so without a legitimate explanation (i.e., those covered under the illness/compassionate form), then there are NO grounds for an appeal.

*Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.*

*Students that are in emotional/mental distress should refer to Mental Health@Western, http://www.uwo.ca/uwocom/mentalhealth/, for a complete list of options about how to obtain help.*

**INSTRUCTOR:** Hanif M. Ladak, Ph.D., P.Eng.
Medical Sciences Building, Room M 403
Phone: 661-2111 ext. 86551
E-mail: hladak@uwo.ca

**Consultation Hours:** Tuesdays from 1:30 pm to 3:30 pm

Updated August 1, 2017