Western Engineering

Western University
Faculty of Engineering
Electrical and Computer Engineering Program

ECE 4429 – Advanced Digital Signal Processing

Course Outline Fall 2025

COURSE DESCRIPTION: Digital Signal Processing (DSP) is at the heart of many applications in a wide array of fields: speech and audio processing, system monitoring and fault detection, biomedical signal analysis, mobile and internet communications, radar and sonar, vibration measurement and analysis, seismograph analysis, image/video coding and decoding etc. In this course, students will learn and apply advanced signal processing theory and techniques. In the first half of the course, students will learn the theoretical aspects of sampling and quantization, and apply them in specifying the sampling and quantization requirements for a specific signal processing application. Students will learn popular signal processing algorithms for convolution, correlation, and spectrum analysis. Students will solidify their practical knowledge on implementation and assessment of these algorithms in MATLAB. The second half of the course will focus on filter design, where students will learn and apply design techniques for finite impulse response (FIR) and Infinite Impulse Response (IIR) digital filters. The course will end with an introduction to multi rate digital signal processing, along with an exploration of its applications.

ACADEMIC CALENDAR: ECE 4429
https://westerncalendar.uwo.ca/Courses.cfm?CourseAcadCalendarID=MAIN_018593_1&SelectedCalendar=Live&ArchiveID=

Digital Signal Processing (DSP) is widely used in speech and audio processing, biomedical engineering, and telecommunication applications. The objectives of this course are to strengthen the students' knowledge of DSP fundamentals, to introduce them to advanced DSP topics, and to familiarize them with the practical aspects of DSP algorithm implementation.

PRE OR COREQUISITES: ECE 3331A/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. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

CEAB ACADEMIC UNITS: Engineering Science 65%, Engineering Design 35%.

CONTACT HOURS:

LECTURE:	Wednesdays, 2:30 PM – 5:30 PM Lectures start September 10, 2025.
LAB:	2hrs /5 times during the term. Labs start September 22, 2025.

Recommended Textbook: Tan, L., & Jiang, J. (2013). Digital Signal Processing: Fundamentals and Applications. Boston, USA: Academic Press.

Reference Textbook: Orfanidis, S. J. (2010). Introduction to signal processing. Prentice-Hall, Inc. https://rutgers.app.box.com/s/5vsu06pp556g9dfsdvayh4k50wqpataw

GENERAL LEARNING OBJECTIVES (CEAB GRADUATE ATTRIBUTES)

Knowledge Base	A	Use of Engineering Tools	A	Impact on Society and the Environment	
Problem Analysis	D	Individual and Teamwork		Ethics and Equity	
Investigation		Communication Skills	D	Economics and Project Management	
Design	D	Professionalism		Life-Long Learning	

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 and guides for the laboratories will be available on the course OWL site. The material for this course will be taught in both lectures and labs; therefore, it is imperative that you attend each lecture and lab.

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. Sampling and quantization At the end of this section, students will be able to: **a.** Understand the theory behind sampling and quantization processes. **b.** State the sampling, quantization and signal conditioning requirements for a given DSP application.	KB1, KB3 **PA1,** PA2**, PA3** CS1, CS3 (lab portion)
2. Discrete Fourier Transform (DFT) and its applications At the end of this section, students will be able to: **a.** Understand the theory behind DFT and Fast Fourier Transform (FFT). **b.** Apply FFT for spectrum analysis, convolution, and correlation. **c.** Apply FFT for filtering applications using overlap-add and overlap-save methods.	KB3 PA1, PA2, PA3 ET1, ET2 (lab portion) **CS1**, CS3 (lab portion)
3. Z-transform and its applications At the end of this section, students will be able to: **a.** Understand Z-transform and related topics such as transfer function, frequency response, and pole-zero analysis. **b.** Design digital filters based on pole-zero placement.	KB3 **PA1,** PA2**, PA3** ET1, ET2 (lab portion) CS1, CS3 (lab portion)
4. Design of FIR filters At the end of this section, students will be able to: **a.** Understand the importance of linear phase and the different types of FIR filters. **b.** Design lowpass, highpass, bandpass, and bandstop FIR filters using the Kaiser window, frequency sampling and optimal design methods. **c.** Design FIR filters with arbitrary frequency response using frequency sampling method.	KB3 **PA1,** PA2**, PA3** **D1,** D2 ET1, ET2 (lab portion) **CS1**, CS3 (lab portion)
5. Design of IIR filters At the end of this section, students will be able to: **a.** Understand IIR filters and the structures for their implementation. **b.** Design lowpass, highpass, bandpass, and bandstop IIR filters using Butterworth and Chebyshev prototypes.	KB3 **PA1,** PA2**, PA3** **D1**

	ET1, ET2 (lab portion) **CS1**, CS3 (lab portion)
6. Multirate Signal Processing At the end of this section, students will be able to: **a.** Understand the theory behind interpolators, decimators, and sampling rate converters. **b.** Design and application of filterbanks.	KB3 **PA1,** PA2**, PA3**

EVALUATION:

Course Component	Weight	CEAB GAI Assessed
Quizzes	15%	PA1, PA2, PA3
Midterm	20%	PA1, PA2, PA3, D1
Laboratory	15%	CS1
Final Examination	50%	PA1, PA2, PA3, D1, D2

Marks will be assigned on the basis of method of analysis and presentation, correctness of solution, clarity and neatness. To obtain a passing grade in the course, a mark of 50% or more must be achieved on the final examination, midterm, quizzes and on the laboratory reports. A final examination, quiz, midterm or laboratory mark < 50% will result in a final course grade of 48% or less.

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.

Quizzes: Students are expected to complete online or in-class quizzes throughout the term. The schedule of these quizzes will be posted to OWL course site.

Midterm: The midterm will take place on October xx, 2025, between 2:30 PM – 5:00 PM in XXX (exam location TBA). The midterm is limited open book with a duration of 2 hours. Use of calculators is limited to an acceptable make and model without large memory programming capability.

Laboratory: The laboratory portion of this course will consist of MATLAB-based experiments. Labs will be held roughly every other week in ACEB 2415/1400. Students are required to successfully complete the experiments and submit their MATLAB session (code & data) to OWL course site before the deadline. Attendance at all laboratory sessions is mandatory – lab reports will not accepted without attendance.

Final Examination: The final examination will take place during the regular examination period. The final examination is limited open book, with a duration of 3 hours. Use of calculators is limited to an acceptable make and model without large memory programming capability.

Late submission policy: Applies to laboratory reports only**.** Laboratory reports will be penalized by 25% of the available marks per day for late submission. Advise the instructor if you are having problems completing the assignment on time prior to the due date of the assignment and be prepared to submit an Academic Consideration Request and provide documentation if requested by the instructor at: https://www.eng.uwo.ca/undergraduate/academic-consideration-for-absences.html

If you are granted an extension, establish a due date with the instructor. The approval of the Chair of your Department is not required if assignments are completed prior to the last day of classes. Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies. Documentation is mandatory.

Designated Assessment: Please note that the midterm is considered to be central to the learning objectives for this course. Accordingly, students seeking academic consideration for the midterm exam (designated assessment) will be required to provide formal supporting documentation. Approved requests will result in the weight of the midterm exam being shifted to the final exam, as no make-up midterm exam will be offered.

Attendance: All classes, laboratories, and tutorials are mandatory unless otherwise stated. Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the department, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

FACULTY OF ENGINEERING POLICIES:
Students must familiarize themselves with the policies of the Faculty of Engineering
https://www.eng.uwo.ca/electrical//pdf/2025-UG-Policy-and-Procedures.pdf