

# COURSE SYLLABUS



COURSE TITLE: ELEN 186 Digital Signal Processing

CLASS SECTION: X01

TERM: 2022F

COURSE CREDITS: 3

DELIVERY METHOD(S):

Camosun College campuses are located on the traditional territories of the Lək̓ʷəŋən and W̱SÁNEĆ peoples. We acknowledge their welcome and graciousness to the students who seek knowledge here.

Learn more about Camosun's [Territorial Acknowledgement](#).

The COVID-19 pandemic has presented many challenges, and Camosun College is committed to helping you safely complete your education. Following guidelines from the Provincial Health Officer, WorkSafe BC, and the B.C. Government to ensure the health and wellbeing of students and employees, Camosun College is providing you with every possible protection to keep you safe. Our measures include COVID Training for students and employees, health checks, infection control protocols including sanitization of spaces, PPE and ensuring physical distancing. For details on these precautions please follow this link: <http://camosun.ca/covid19/faq/covid-fags-students.html>. However, if you're at all uncomfortable being on campus, please share your concerns with your Instructor. If needed, alternatives will be discussed.

---

*Camosun College requires mandatory attendance for the first class meeting of each course. If you do not attend, and do not provide your instructor with a reasonable explanation in advance, you will be removed from the course and the space offered to the next waitlisted student.*

## INSTRUCTOR DETAILS

---

NAME: Joyce van de Vegte

EMAIL: [vandevgte@camosun.ca](mailto:vandevgte@camosun.ca)

OFFICE: TEC 208

*As your course instructor, I endeavour to provide an inclusive learning environment. However, if you experience barriers to learning in this course, do not hesitate to discuss them with me. Camosun College is committed to identifying and removing institutional and social barriers that prevent access and impede success.*

## CALENDAR DESCRIPTION

---

This course in digital signal processing starts with DSP fundamentals, including sampling, quantization, A/D and D/A conversion, digital signals, difference equations, impulse and step responses, convolution, z transforms, transfer functions, poles and zeros, and stability.

It then moves on to investigate frequency response, filter shape, digital signal spectra, finite impulse response filters, infinite impulse response filters, correlation and autocorrelation, discrete time Fourier transforms and fast Fourier transforms, and basics of DSP hardware. In addition, the course surveys a variety of signal processing applications of DSP.

PREREQUISITE(S): Enrollment in DND program

## COURSE LEARNING OUTCOMES / OBJECTIVES

---

Upon successful completion of this course a student will be able to:

- describe the elements of a DSP system
- define sampling, aliasing and quantization and the errors they introduce
- use non-recursive and recursive filter difference equations to determine filter outputs
- draw a difference equation diagram
- compute the impulse and step responses of a filter
- perform convolution to find filter outputs
- convert between a system's transfer function and its difference equation
- use z transforms to find filter outputs
- identify poles and zeros of a filter and assess filter stability and filter behaviour
- apply a discrete time Fourier transform to find spectra and frequency responses
- apply a discrete time Fourier transform to find the frequency response of a filter
- describe the behaviour and characteristics of FIR filters
- explain principles of FIR windowing
- design FIR filters using basic techniques
- apply the bilinear transformation to create an IIR filter
- list differences between Butterworth and Chebyshev filters
- select filter order given IIR filter specifications
- list significant DSP architecture issues, including hardware and software
- describe signal and image processing applications
- explain the principles of DSP applications in CANTASS, Link11, and STIRS

## REQUIRED MATERIALS & RECOMMENDED PREPARATION / INFORMATION

---

Website on D2L.

Text: van de Vegte, Fundamentals of Digital Signal Processing

## COURSE SCHEDULE, TOPICS, AND ASSOCIATED PREPARATION / ACTIVITY / EVALUATION

---

The following schedule and course components are subject to change with reasonable advance notice, as deemed appropriate by the instructor.

HOURS	TOPIC
3	<b>Overview</b> Applications of DSP Signals Spectra A/D and D/A conversion Filters Linear time invariant systems

HOURS	TOPIC
8	<p><b>A/D and D/A Conversion</b></p> <ul style="list-style-type: none"> <li>Simple DSP system</li> <li>Sampling</li> <li>Quantization</li> <li>Aliasing</li> <li>A/D conversion</li> <li>D/A conversion</li> </ul> <p>Ch. 2 2.1 - 2.7, 2.9, 2.11, 2.13, 2.15, 2.19, 2.25, 2.27</p>
4	<p><b>Digital Signals</b></p> <ul style="list-style-type: none"> <li>Notation and representation</li> <li>1D digital signals (impulse, step, exponential, sinusoidal)</li> <li>2D digital signals (images, sonar)</li> </ul> <p>Ch. 3 3.1 - 3.6, 3.9, 3.10, 3.16 - 3.19, 3.23</p>
5	<p><b>Difference Equations</b></p> <ul style="list-style-type: none"> <li>Digital filtering</li> <li>Difference equation structure</li> <li>Non-recursive difference equations</li> <li>Moving average filters</li> <li>Recursive difference equations</li> <li>Difference equation diagrams</li> <li>Impulse response (FIR and IIR)</li> <li>Step response</li> <li>General outputs</li> </ul> <p>Ch. 4 4.9, 4.11, 4.13, 4.15, 4.16, 4.24, 4.25, 4.27, 4.28, 4.30, 4.32</p> <p>Problem Set 1</p>
4	<p><b>Convolution</b></p> <ul style="list-style-type: none"> <li>Filtering by convolution</li> <li>Moving average filters by convolution</li> <li>Filtering digital images</li> </ul> <p>Ch. 5 5.4, 5.5, 5.6, 5.13, 5.17, 5.18, 5.19</p>

HOURS	TOPIC
4	<p><b>Correlation and Autocorrelation</b></p> <p>Correlation definition and uses  Autocorrelation definition and uses  Signal detection in noise</p> <p>Problem Set 2</p>
7	<p><b>z Transforms</b></p> <p>Table of z transforms  Transfer functions  Poles, zeros and stability  Inverse z transforms  Computing filter outputs</p> <p>Ch 6  6.15abdef, 6.6 - 6.8, 6.17, 6.18, 6.23, 6.28, 6.30, 6.31, 6.34</p> <p>Problem Set 2</p>
2	<p><b>Filters</b></p> <p>Filter behaviour  Filter types  Bode plots</p>
8	<p><b>Frequency Response</b></p> <p>Frequency response  Filter shape  Filter shape from poles and zeros</p> <p>Ch. 7  7.7, 7.10, 7.17, 7.24, 7.25</p>
11	<p><b>Finite Impulse Response Filters</b></p> <p>FIR filter specification and characteristics  Phase distortion  Ideal low pass filter  Windowing  Designing low pass FIR filters  Band pass, high pass and band stop FIR filters  Practical considerations</p> <p>Ch. 9  9.1, 9.4, 9.6ab approx c, 9.12, 9.13, 9.15, 9.16, 9.20a, 9.21, 9.23, 9.26</p>
8	<p><b>Discrete Fourier Transform (DFT) and Fast Fourier Transform</b></p> <p>Computing the DFT  DFT resolution</p>

HOURS	TOPIC
	Interpreting the DFT Spectrograms Relationship between FFT and DFT  Ch. 11 11.2a, 11.4, 11.12, 11.13, 11.15, 11.16, 11.18, 11.21  Problem Set 3
4	<b>Infinite Impulse Response Filters</b> Characteristics of IIR Filters IIR Filters Derived from Analog Designs Bilinear Transformation Impulse Invariance IIR Design  Ch. 10 10.3, 10.4abcd, 10.5, 10.6a, 10.7, 10.8, 10.15a, 10.21
3	<b>DSP Hardware and Applications</b> DSP architectures DND Applications (CANTASS Sonar, STIR Fire Control, LINK-11) Digital audio Speech recognition Image processing

Students registered with the Centre for Accessible Learning (CAL) who complete quizzes, tests, and exams with academic accommodations have booking procedures and deadlines with CAL where advanced notice is required. Deadlines can be reviewed on the [CAL exams page](http://camosun.ca/services/accessible-learning/exams.html). <http://camosun.ca/services/accessible-learning/exams.html>

Lab posting and due dates may be found on D2L.

WEEK	LAB ACTIVITY
1	<b>Labour Day</b>
1	Lab 1 DSP applications
2	Lab 2 Spectra of common signals and aliasing
2	Lab 3 Antialiasing filter
3	Lab 4 Sampling & quantization
3	Lab 5 Introduction to MATLAB
4	Lab 6 Signals & spectra in MATLAB (2 lab periods)
4	<b>Truth &amp; Reconciliation Day</b>
5	Lab 6 continued
5	Lab 7 Non-recursive difference equations & moving average filters
6	<b>Thanksgiving Day</b>

WEEK	LAB ACTIVITY
6	Lab 8 Recursive difference equations
7	Lab 9 Convolution
7	Lab 10 Correlation & finding a known signal in noise
8	Lab 11 Autocorrelation & detection of periodicity
8	Lab 12 Poles, zeros & stability
9	Lab 13 Frequency response of digital filters
9	Lab 14 Filter specifications & performance (2 lab periods)
10	Lab 14 continued
10	<b>Remembrance Day</b>
11	Lab 15 Windowing & FIR filter design in MATLAB
11	Lab 16 IIR filter design in MATLAB
12	Lab 17 Introduction to Audio Weaver
12	Lab 18 Audio Effects (2 lab periods)
13	Lab 18 continued
13	Lab 19 Voice Scrambling
14	Lab 20 DTMF Tones, FFT, & correlation
14	Lab 21 FFTs, DTMF detection and spectrograms

Week	Lectures	Labs
1	Section 1 3h/3h; Section 2 2h/8h	Labour Day/Lab 1
2	Section 2 6h/8h	Lab 2, Lab 4
3	Section 3 4h/4h; Section 4 2h/5h	No Lab 3 (Queen), Lab 5
4	Section 4 3h/5h; Section 5 2h/4h	Lab 6a/Truth &Rec
5	Section 5 2h/4h; review/test 3h; Section 6 1h/4h	Lab 6b, Lab 7
6	Section 6 3h/4h; Section 2h/7h;	Thanksgiving/Lab 8
7	Section 7 5h/7h; Section 8 1h/2h	Lab 9, Lab 10
8	Section 8 1h/2h; Section 9 5h/8h	Lab 11, Lab 12
9	Section 9 3h/8h; Section 10 3h/11h	Lab 13, Lab 14a
10	Section 10 2h/11h; review/test 3h	Lab 14b/Remembrance
11	Section 10 6h/11h	Lab 15, Lab 16
12	Section 11 6h/8h	Lab 17, Lab 18a
13	Section 11 2h/8h; Section 12 4h/4h	Lab 18b, Lab 19
14	Section 13 3h/3h; review 3h	Lab 20, Lab 21

## EVALUATION OF LEARNING

DESCRIPTION	WEIGHTING
Tests (2 hours each) Test 1 (week 5): Wednesday 5 October Test 2 (week 10): Wednesday 9 November	35%
Labs	25%

DESCRIPTION	WEIGHTING
Final exam: <b>week of 12-20 December 2022</b> To pass the course, students must obtain a minimum of 50% on the final exam.	40%
<b>TOTAL</b>	100%

If you have a concern about a grade you have received for an evaluation, please come and see me as soon as possible. Refer to the [Grade Review and Appeals](http://camosun.ca/about/policies/education-academic/e-1-programming-and-instruction/e-1.14.pdf) policy for more information.  
<http://camosun.ca/about/policies/education-academic/e-1-programming-and-instruction/e-1.14.pdf>

## COURSE GUIDELINES & EXPECTATIONS

Problem sets will be assigned but not graded. Solution sets will be posted. To be successful in the course, you must achieve 60% on theory and 60% on lab, including a minimum 50% on the final exam.

## SCHOOL OR DEPARTMENTAL INFORMATION

Electronics & Computer Engineering Technology  
Chair: James van Oort

## STUDENT RESPONSIBILITY

Enrolment at Camosun assumes that the student will become a responsible member of the College community. As such, each student will display a positive work ethic, assist in the preservation of College property, and assume responsibility for their education by researching academic requirements and policies; demonstrating courtesy and respect toward others; and respecting expectations concerning attendance, assignments, deadlines, and appointments.

## SUPPORTS AND SERVICES FOR STUDENTS

Camosun College offers a number of services to help you succeed in and out of the classroom. For a detailed overview of the supports and services visit <http://camosun.ca/students/>.

Support Service	Website
Academic Advising	<a href="http://camosun.ca/advising">http://camosun.ca/advising</a>
Accessible Learning	<a href="http://camosun.ca/accessible-learning">http://camosun.ca/accessible-learning</a>
Counselling	<a href="http://camosun.ca/counselling">http://camosun.ca/counselling</a>
Career Services	<a href="http://camosun.ca/coop">http://camosun.ca/coop</a>
Financial Aid and Awards	<a href="http://camosun.ca/financialaid">http://camosun.ca/financialaid</a>
Help Centres (Math/English/Science)	<a href="http://camosun.ca/help-centres">http://camosun.ca/help-centres</a>
Indigenous Student Support	<a href="http://camosun.ca/indigenous">http://camosun.ca/indigenous</a>
International Student Support	<a href="http://camosun.ca/international/">http://camosun.ca/international/</a>

---

Support Service	Website
Learning Skills	<a href="http://camosun.ca/learningskills">http://camosun.ca/learningskills</a>
Library	<a href="http://camosun.ca/services/library/">http://camosun.ca/services/library/</a>
Office of Student Support	<a href="http://camosun.ca/oss">http://camosun.ca/oss</a>
Ombudsperson	<a href="http://camosun.ca/ombuds">http://camosun.ca/ombuds</a>
Registration	<a href="http://camosun.ca/registration">http://camosun.ca/registration</a>
Technology Support	<a href="http://camosun.ca/its">http://camosun.ca/its</a>
Writing Centre	<a href="http://camosun.ca/writing-centre">http://camosun.ca/writing-centre</a>

---

If you have a mental health concern, please contact Counselling to arrange an appointment as soon as possible. Counselling sessions are available at both campuses during business hours. If you need urgent support after-hours, please contact the Vancouver Island Crisis Line at 1-888-494-3888 or call 911.

## COLLEGE-WIDE POLICIES, PROCEDURES, REQUIREMENTS, AND STANDARDS

---

### Academic Accommodations for Students with Disabilities

The College is committed to providing appropriate and reasonable academic accommodations to students with disabilities (i.e. physical, depression, learning, etc). If you have a disability, the [Centre for Accessible Learning](#) (CAL) can help you document your needs, and where disability-related barriers to access in your courses exist, create an accommodation plan. By making a plan through CAL, you can ensure you have the appropriate academic accommodations you need without disclosing your diagnosis or condition to course instructors. Please visit the CAL website for contacts and to learn how to get started:

<http://camosun.ca/services/accessible-learning/>

### Academic Integrity

Please visit <http://camosun.ca/about/policies/education-academic/e-1-programming-and-instruction/e-1.13.pdf> for policy regarding academic expectations and details for addressing and resolving matters of academic misconduct.

### Academic Progress

Please visit <http://camosun.ca/about/policies/education-academic/e-1-programming-and-instruction/e-1.1.pdf> for further details on how Camosun College monitors students' academic progress and what steps can be taken if a student is at risk of not meeting the College's academic progress standards.

### Course Withdrawals Policy

Please visit <http://camosun.ca/about/policies/education-academic/e-2-student-services-and-support/e-2.2.pdf> for further details about course withdrawals. For deadline for fees, course drop dates, and tuition refund, please visit <http://camosun.ca/learn/fees/#deadlines>.



### Grading Policy

Please visit <http://camosun.ca/about/policies/education-academic/e-1-programming-and-instruction/e-1.5.pdf> for further details about grading.

### Grade Review and Appeals

Please visit <http://camosun.ca/about/policies/education-academic/e-1-programming-and-instruction/e-1.14.pdf> for policy relating to requests for review and appeal of grades.

### Mandatory Attendance for First Class Meeting of Each Course

Camosun College requires mandatory attendance for the first class meeting of each course. If you do not attend, and do not provide your instructor with a reasonable reason in advance, you will be removed from the course and the space offered to the next waitlisted student. For more information, please see the “Attendance” section under “Registration Policies and Procedures” (<http://camosun.ca/learn/calendar/current/procedures.html>) and the Grading Policy at <http://camosun.ca/about/policies/education-academic/e-1-programming-and-instruction/e-1.5.pdf>.

### Medical / Compassionate Withdrawals

Students who are incapacitated and unable to complete or succeed in their studies by virtue of serious and demonstrated exceptional circumstances may be eligible for a medical/compassionate withdrawal. Please visit <http://camosun.ca/about/policies/education-academic/e-2-student-services-and-support/e-2.8.pdf> to learn more about the process involved in a medical/compassionate withdrawal.

### Sexual Violence and Misconduct

Camosun is committed to creating a campus culture of safety, respect, and consent. Camosun’s Office of Student Support is responsible for offering support to students impacted by sexual violence. Regardless of when or where the sexual violence or misconduct occurred, students can access support at Camosun. The Office of Student Support will make sure students have a safe and private place to talk and will help them understand what supports are available and their options for next steps. The Office of Student Support respects a student’s right to choose what is right for them. For more information see Camosun’s Sexualized Violence and Misconduct Policy: <http://camosun.ca/about/policies/education-academic/e-2-student-services-and-support/e-2.9.pdf> and [camosun.ca/sexual-violence](http://camosun.ca/sexual-violence). To contact the Office of Student Support: [oss@camosun.ca](mailto:oss@camosun.ca) or by phone: 250-370-3046 or 250-3703841

### Student Misconduct (Non-Academic)

Camosun College is committed to building the academic competency of all students, seeks to empower students to become agents of their own learning, and promotes academic belonging for everyone. Camosun also expects that all students to conduct themselves in a manner that contributes to a positive, supportive, and safe learning environment. Please review Camosun College’s Student Misconduct Policy at <http://camosun.ca/about/policies/education-academic/e-2-student-services-and-support/e-2.5.pdf> to understand the College’s expectations of academic integrity and student behavioural conduct.

**Changes to this Syllabus:** Every effort has been made to ensure that information in this syllabus is accurate at the time of publication. The College reserves the right to change courses if it becomes necessary so that

course content remains relevant. In such cases, the instructor will give the students clear and timely notice of the changes.