

COMP ENG 4TL4
Digital Signal Processing

COURSE OUTLINE

Please refer to course website for updated information.

COURSE DESCRIPTION

Sampled data systems, discrete-time Fourier transform, linear time-invariant systems, z-transforms, classical filter theory; discrete Fourier transform (DFT) and fast Fourier transform (FFT); FIR and IIR digital filters; implementation of DSP systems; adaptive filtering.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): Registration in Level IV or V of any Computer Engineering or Electrical Engineering Program, or level IV in an Electrical and Biomedical Engineering program, ELECENG 3TP3.

Antirequisite(s): ELECENG 4TL4

SCHEDULE

Lecture: Monday, Wednesday: 11:30am – 12:20pm, and Friday: 1:30pm and 2:20pm (BSB-135)

Tutorial: Monday 1:30pm – 2:20pm (ITB-137)

Lab: Every Other Week: L01 Monday 2:30 pm- 5:20 pm; L02 Monday 2:30 pm - 5:20 pm; L03 Tuesday 2:30 pm - 5:20 pm; L04 Tuesday 2:30 pm - 5:20 pm; L05 Thursday 2:30 pm - 5:20 pm; L06 Thursday 2:30 pm - 5:20 pm.

INSTRUCTOR

Dr. Jian-Kang Zhang

Email: jkzhang@mail.ece.mcmaster.ca

Office: ITB-A220

Phone: 905-525-9140 ext. 27599

Office Hours: Friday 3:00pm - 5:00pm; and by appointment

TEACHING ASSISTANTS

Contact information and office hours are provided on the course website.

- Jianfeng Hu
- Mehrshad Kafi

- Sahand Sephrevand
- Mehrnoosh Heidarpour
- Runchen Liang

COURSE WEBSITE/S

https://www.ece.mcmaster.ca/~jkzhang/4TL4_DSP/4TL4_DSP.pdf

COURSE OBJECTIVES

By the end of this course, students should be able to:

- Learn the fundamentals of processing discrete-time systems
- Perform various processing operations on the signals and systems
- Gain knowledge in implementation of linear shift-invariant discrete-time systems, frequency domain representations, digital filtering and adaptive systems
- Gain an appreciation of the operation of DSP processors.

ASSUMED KNOWLEDGE

Linear algebra and calculus, complex variables (EE2CI5, EE2CJ4), frequency domain decompositions (EE3TP4), circuit theory (EE2CI5 and 2CJ4), knowledge of MatLab.

COURSE MATERIALS

Required Texts:

Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, Discrete-Time Signal Processing, 2th or 3th 6th Edition, Prentice Hall, Inc. 2th or 3th Ed

Calculator:

Only the McMaster Standard Calculator (Casio fx-991 MS or MS Plus) will be permitted in tests and examinations. This is available at the Campus Store.

Other:

Lecture notes and the following reference books:

[1] Sanjit K. Mitra, "Digital Signal Processing," McGraw- Hill.

[2] John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing," Pearson Prentice Hall, 4th ed, 2007, ISBN 0-13-187374-1.

COURSE OVERVIEW

Week	Topic	Readings
1	Introduction, discrete-time signals and systems, LTI systems and properties (3 hours)	Text Chapters 1 and 2
2	Linear time-invariant systems and properties (3 hours)	Text Chapter 2 and lecture notes
3	Frequency domain analysis of discrete-time systems and the DTFT (3 hours)	Text Chapter 2 and lecture notes
4	The z-transform (3 hours)	Text Chapter 3 and lecture notes
5	The z-transform properties (3 hours)	Text Chapter 3 and lecture notes
6	Sampling of continuous-time signals	Text Chapter 4 and lecture notes
7	The discrete Fourier transform (3 hours)	Text Chapter 9 and lecture notes
8	Computation of the discrete Fourier transform (3 hours)	Text Chapter 9 and lecture notes
9	Classical filter theory and discrete-time filtering implementations (3 hours)	Text Chapter 9 and lecture notes
10	Optimum approximations of FIR filters (3 hours)	Text Chapter 7 and lecture notes
11	IIR filter designs (3 hours)	Text Chapter 7 and lecture notes
12	Adaptive filtering fundamentals (3 hours)	Lecture notes

A more detailed time line is available on the course web site.

At certain points in the course it may make good sense to modify the schedule. The instructor may modify elements of the course and will notify students accordingly (in class, on the course website).

LABORATORY OVERVIEW

Week	Topic	Readings
1	Late September	Linear systems
2	Early October	FIR digital filters
3	Late October	IIR digital filters
4	Mid November	Adaptive systems

LABORATORY OPERATION

- At the beginning of every term, every Undergraduate student using an ECE Lab is required to complete the ECE Lab Safety Quiz (one completed quiz covers every course that term). The quiz and other information is provided on the webpage:
<https://www.eng.mcmaster.ca/ece/resources#health-safety>
- Access to all labs is restricted in the interest of security and safety. Information on accessing and using the lab can be found on the webpage:
<https://www.eng.mcmaster.ca/ece/labs-and-health-safety#Labs-Access-and-Use>
- Please obtain your own Access Card for use during regular building hours / The TA will open the lab at regularly scheduled lab times
- The labs for this course will be held in ITB-157
- The labs will be performed in groups of two students

ASSESSMENT

Component	Weight
Midterm Exam	0% or 30% (see below)
Labs	20%
Final Exam	80% or 50% (see below)
Total	100 %

No make-up midterm tests will be granted. Weight of a missed midterm test will be transferred to final exam. 30% of the mark is taken as the best of the midterm and exam.

ACCREDITATION LEARNING OUTCOMES

Note: The *Learning Outcomes* defined in this section are measured throughout the course and form part of the Department's continuous improvement process. They are a key component of the accreditation process for the program and will not be taken into consideration in determining a student's actual grade in the course. For more information on accreditation, please ask your instructor or visit: <http://www.engineerscanada.ca>.

Outcomes	Indicators	Measurement Method(s)
Students become capable in analyzing, designing and implementing digital systems, including all forms of digital filters.	2.1, 2.2, 4.1, 4.3	Exam questions
Students become capable of using modern, state of the art tools. These include Matlab, C, and the TMS 320-series digital signal processing chips.	5.1, 5.2, 5.3	Lab 1
Students gain an understanding of the effects of group delay distortion and are capable of designing equalizer sections to correct this effect.	1.1, 1.3, 3.1, 3.2	Exam questions
Students gain experience in teamwork, by working together in the labs.	6.2, 6.3	Labs 1 and 2
Students gain experience in effective communication skills, by preparing lab reports.	7.1, 7.2, 7.3	Lab 2
Students acquire competence in mathematics and engineering science through discrete-time Fourier analysis, z-transforms and the DFT.	1.1, 1.3	Exam questions

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at www.mcmaster.ca/academicintegrity.

The following illustrates only three forms of academic dishonesty:

- Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- Improper collaboration in group work.
- Copying or using unauthorized aids in tests and examinations.

ACADEMIC ACCOMMODATIONS

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or e-mail sas@mcmaster.ca. For further information, consult McMaster University's Academic Accommodation of Students with Disabilities policy.

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students requiring a RISO accommodation should submit their request to the Engineering Student Services office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations.

Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

STUDENT ABSENCE AND SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work".

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be

communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

Electrical and Computer Engineering Lab Safety

Information for Laboratory Safety and Important Contacts

This document is for users of ECE instructional laboratories in the Information Technology Building.

This document provides important information for the healthy and safe operation of ECE instructional laboratories. This document is required reading for all laboratory supervisors, instructors, researchers, staff, and students working in or managing instructional laboratories in ECE. It is expected that revisions and updates to this document will be done continually. A McMaster University lab manual is also available to read in every laboratory.

General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following:

1. Food and beverages are not permitted in the instructional laboratories.
2. A Laboratory Information Sheet on each lab door identifying potential hazards and emergency contact names should be known.
3. Laboratory equipment should only be used for its designed purpose.
4. Proper and safe use of lab equipment should be known before using it.
5. The course TA leading the lab should be informed of any unsafe condition.
6. The location and correct use of all available safety equipment should be known.
7. Potential hazards and appropriate safety precautions should be determined, and sufficiency of existing safety equipment should be confirmed before beginning new operations.
8. Proper waste disposal procedures should be followed.

Location of Safety Equipment

Fire Extinguisher

On walls in halls outside of labs

First Aid Kit

ITB A111, or dial "88" after 4:30 p.m.

Telephone

On the wall of every lab near the door

Fire Alarm Pulls

Near all building exit doors on all floors

Who to Contact

Emergency Medical / Security: On McMaster University campus, call Security at extension **88** or **905-522-4135** from a cell phone.

Non-Emergency Accident or Incident: Immediately inform the TA on duty or Course Instructor.

University Security (Enquiries / Non-Emergency): Dial 24281 on a McMaster phone or dial 905-525-9140 ext. 24281 from a cell phone.

See TA or Instructor: For problems with heat, ventilation, fire extinguishers, or immediate repairs

Environmental & Occupational Health Support Services (EOHSS): For health and safety questions dial 24352 on a McMaster phone or dial 905-525-9140 ext. 24352 from a cell phone.

ECE Specific Instructional Laboratory Concerns: For non-emergency questions specific to the ECE laboratories, please contact 24103.

In Case of a Fire (Dial 88)

When calling to report a fire, give name, exact location, and building.

1. Immediately vacate the building via the nearest Exit Route. Do not use elevators!
2. Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm, and the nearest fire escape.
3. The safety of all people in the vicinity of a fire is of foremost importance. But do not endanger yourself!
4. In the event of a fire in your work area shout "*Fire!*" and pull the nearest fire alarm.
5. Do not attempt to extinguish a fire unless you are confident it can be done in a prompt and safe manner utilizing a hand-held fire extinguisher. Use the appropriate fire extinguisher for the specific type of fire. Most labs are equipped with Class A, B, and C extinguishers. Do not attempt to extinguish Class D fires which involve combustible metals such as magnesium, titanium, sodium, potassium, zirconium, lithium, and any other finely divided metals which are oxidizable. Use a fire sand bucket for Class D fires.
6. Do not attempt to fight a major fire on your own.
7. If possible, make sure the room is evacuated; close but do not lock the door and safely exit the building.

Clothing on Fire

Do not use a fire extinguisher on people

1. Douse with water from safety shower immediately or
2. Roll on floor and scream for help or
3. Wrap with fire blanket to smother flame (a coat or other nonflammable fiber may be used if blanket is unavailable). Do not wrap a standing person; rather, lay the victim down to extinguish the fire. The blanket should be removed once the fire is out to disperse the heat.

Equipment Failure or Hazard

Failure of equipment may be indicative of a safety hazard - You must report all incidents.

Should you observe excessive heat, excessive noise, damage, and/or abnormal behaviour of the lab equipment:

1. Immediately discontinue use of the equipment.
2. In Power Lab, press wall-mounted emergency shut-off button.
3. Inform your TA of the problem.
4. Wait for further instructions from your TA.
5. TA must file an incident report.

Protocol for Safe Laboratory Practice

Leave equipment in a safe state for the next person - if you're not sure, ask!

In general, leave equipment in a safe state when you finish with it. When in doubt, consult the course TA.

Defined Roles

TA	The first point of contact for lab supervision	
ECE Lab Supervisor	Steve Spencer- ITB 147	steve@mail.ece.mcmaster.ca
ECE Course Instructor	Please contact your specific course instructor directly	
ECE Administrator	Kerri Hastings- ITB A111	hastings@mcmaster.ca
ECE Chair	Tim Davidson- ITB A111	davidson@mcmaster.ca