Electrical and Computer Engineering
ELECENG 2CF3
Circuits and Waves
Winter 2024

McMaster University
ENGINEERING

Instructor Information

Natalia K. Nikolova
Email: talia@mcmaster.ca
Office Hours:
Monday 1:30 pm to 3:30 pm

Teaching Assistants

TBD

Course Information

Course Dates: 01/08/2024 - 04/10/2024
Units: 3.00
Course Delivery Mode: In Person
Course Description: Advanced circuit analysis; sinusoids and complex numbers; Laplace transforms with applications; frequency response; 2-port networks; fundamentals of wave propagation; transmission lines and impedance match; radiation and antennas Three lectures, one tutorial; second term Prerequisite(s): ELECENG 2CI5 or ELECENG 2CI4 and PHYSICS 1E03 Antirequisite(s): ELECENG 2FH3, ELECENG 2FH4, ELECENG 2FL3

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Pre-Requisite(s) and Anti-Requisite(s)

Pre-requisite(s): ELECENG 2CI5 and PHYSICS 1E03

Anti-requisite(s): ELECENG 2FH3 or ELECENG 2FH4

Meeting Details

Classes are in person. Lectures and Tutorials will be recorded on Echo360.

Important Links

- Mosaic
- Avenue to Learn
- Student Accessibility Services - Accommodations
- McMaster University Library
- eReserves

Course Learning Objectives

For accreditation reasons, these learning outcome statements must be tied back to CEAB graduate attributes (GAs), including those that are measured in this course. If you are unsure how to do this, please contact the Associate Chair Undergraduate in your department.

- Understanding the operation principles of circuits employing operational amplifiers and resistor networks. (Indicator 1.3)

- Performing variable-frequency circuit analysis in terms of: (i) frequency-dependent responses, (ii) network transfer functions, (iii) Bode diagrams. (Indicators 1.2 and 1.3)

- Understanding the purpose and the design principles of lumped-element filters, including anti-aliasing filters and basic active filters. (Indicators 1.3, 2.1, and 3.2)

- Representing two-port networks in terms of their Z, Y, and H parameters and use this representation in complex network analysis. (Indicators 1.3, 2.1, and 3.2)

- Understanding the Laplace transform and its applications in transient circuit analysis. (Indicators 1.2, 1.3, and 2.1)

- Understanding the fundamentals of wave motion and the basic parameters of voltage and current waves. (Indicators 1.2, 1.3, and 2.1)

- Carrying out analysis of transmission lines as distributed-parameter networks and understand their operation in both pulsed and sinusoidal regimes. (Indicators 1.3, 2.1, and 3.2)

- Understanding the concepts of maximum power transfer and impedance match as well as the parameters describing the performance of connectors, interconnects, and high-speed buses on printed circuit boards (PCBs). (Indicators 1.3, 2.1, 3.2, and 9.1)

- Understanding the basic parameters and uses of antennas in the context of wireless communications. (Indicators 1.3, 2.1, 3.2, and 9.1)

CEAB Graduate Attributes (GAs)

The CEAB Graduate Attributes (GAs) 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

Attributes	Indicators		Measurement Method(s)
	Number	Description	
Knowledge Base for Engineering	1.2	Competence in Natural Sciences	Assignment on Waves; Midterm Exam
Knowledge Base for Engineering	1.3	Competence in Engineering Fundamentals	Assignments on Operational Amplifiers and Transmission Lines; Midterm and Final Exams
Problem Analysis	2.1	Identifies and states reasonable assumptions and suitable engineering fundamentals, before proposing a solution path to a problem.	Assignments on Operational Amplifiers and Transmission Lines
Investigation	3.2	Synthesizes the results of an investigation to reach valid conclusions.	Quizzes
Impact of Engineering on Society and the Environment	9.1	Evaluates the environmental impact of engineering activities, identifies uncertainties in decisions, and promotes sustainable design.	Assignment on Logic Gate Design and on Industry Canada Safety Code 6

Assumed Knowledge

Assumed knowledge includes course material from:

- ElecEng 2CI5: nodal and mesh analyses, time response of first-order RC and RL circuits, analysis of RLC circuits using phasors;

- Physics 1E03: electrical charge, current and voltage; resistance, capacitance and inductance, Coulomb's law, Gauss law, Ampère and Biot-Savart Laws, electric and magnetic forces and field vectors, permittivity and permeability, one-dimensional wave motion.
- Math 1ZA3, 1ZB3, 1ZC3 and 2Z03: complex algebra, functions of complex variables, differentiation, integration, differential equations

Course Learning Goals

- By the end of this course, students should be able to: • understand the operation principles of circuits employing operational amplifiers and resistor networks; • perform variable-frequency circuit analysis in terms of: (i) frequency-dependent responses, (ii) network transfer functions, (iii) Bode diagrams; • understand the purpose and the design principles of lumped-element filters, including anti-aliasing filters and basic active filters; • understand the Laplace transform and its applications in transient circuit analysis; • represent two-port networks in terms of their Z, Y, and H parameters and use this representation in complex network analysis; • understand the fundamentals of wave motion and the basic parameters of voltage and current waves; • carry out analysis of transmission lines as distributed-parameter networks and understand their operation in both pulsed and sinusoidal regimes; • understand the concepts of maximum power transfer and impedance match as well as the parameters describing the performance of connectors, interconnects, and high-speed buses on printed circuit boards (PCBs) • understand the basic parameters and uses of antennas in the context of wireless communications

Required Materials and Texts

Textbook Listing: https://textbooks.mcmaster.ca

Required Texts:

- **lecture slides and example solutions posted on course webpage**
- **tutorial notes posted on course webpage**

- **assignment instructions posted on course webpage**

Software:

- **Software tool for circuit analysis and design: LTspice XVII**
- **Instructions for download and installation are available on the A2L course website.**

Optional Course Materials

Textbook Listing: https://textbooks.mcmaster.ca

Basic Engineering Circuit Analysis (11th Ed.)
Authors: J. D. Irwin and R. M. Nelm
Publisher: Wiley
Publication Date: 2015
Edition: 11

Introduction to Electric Circuits (10th Ed.)
Authors: H. W. Jackson, D. Temple, B. Kelly, K. Craigs; L. Fuentes
Publisher: Oxford University Press
Publication Date: 2019
Edition: 10

Fundamentals of Applied Electromagnetics (7th Ed.)
Authors: F. T. Ulaby and U. Ravaioli
Publisher: Pearson
Publication Date: 2014

Class Format

In Person

Classes are in person. Lectures and Tutorials will be recorded on Echo360.

Course Schedule

Lectures:

Mon, Wed from 11:30 am to 12:20 pm

Fri from 1:30 pm to 2:20 pm

Tutorials:

Wed 10:30 am to 11:20 am

Course Overview

Week	Topic	Readings
Week 1	Lectures: Operational amplifiers Tutorial: Review of mesh and nodal analyses	lecture and tutorial notes
Week 2,3	Lectures: (i) Frequency-dependent response, (i) Network transfer function, (iii) Bode diagram Tutorial: Review of Thevenin and Norton equivalents	same
Week 4	Lectures: Filters, anti-aliasing filters; active filters Tutorial: Operational amplifiers	same
Week 5	Lectures: Laplace transform with applications in transient circuit analysis Tutorial: Review of phasor analysis, phasor diagrams and complex numbers, steady-state power analysis	same
Week 6	Lectures: Two-port network parameters: Z, Y, H Tutorial: Frequency-dependent network analysis	same
Week 7	Lectures: (i) fundamentals of wave motion, (ii) traveling waves and phasors, (iii) working with complex numbers	same

	Tutorial: Filters	
Week 8	Lectures: Transmission lines – lumped-element model, telegrapher's equations, propagation constant and characteristic impedance, voltage and current traveling waves Tutorial: Laplace transform and transient circuit analysis	same
Week 9	Lectures: Transmission lines – per-unit-length parameters, the effect of losses, power flow Tutorial: Two-port network parameters	same
Week 10	Lectures: Reflection and transmission in terminated transmission lines; transients on transmission lines Tutorial: Traveling waves, wave analysis with phasors	same
Week 11	Lectures: Impedance match and power transfer Tutorial: Voltage and current traveling waves in transmission lines	same
Week 12	Lectures: Electric scalar potential and magnetic vector potential in electrodynamics, principle of radiation Tutorial: Transmission-line parameters - propagation constant and characteristic impedance, per-unit-length parameters	same
Week 13	Lectures: Hertzian dipole, power density of electromagnetic waves in free space and their polarization Tutorial: Reflection and transmission in transmission lines	same

A more detailed timeline is available on the course website.

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).

Course Evaluation

Component	Weight
Quizzes	10%
Assignments	26%
Midterm Test	24%
Final Exam	40%
Total	100%

Course Evaluation Details

NOTES: Quizzes will be announced during lectures and A2L/email announcements, and must be completed by the end of the next day. Quiz answers are submitted through Dropboxes on A2L.

Grading and Evaluation Policies

- If the marks of the final exam, the midterm test and the quizzes are all below 50%, the overall course grade is fail (F).
- Deferred exams may be oral.
- All grades are final unless error in marking is proven.
- Marking scheme is flexible only if the final-exam mark > 89 %.
- Late submissions of assignments are subject to 50% penalty per day (less than one day is counted as one day)
- No make-up midterm tests will be granted.
- Weight of missed midterm test will be transferred to final exam provided MSAF is filed. If MSAF is not filed, the mark is 0.

Grading Scale

Grade	Equivalent Grade Point	Equivalent Percentages

Grade	Equivalent Grade Point	Equivalent Percentages
A+	12	90-100
A	11	85-89
A-	10	80-84
B+	9	77-79
B	8	73-76
B-	7	70-72
C+	6	67-69
C	5	63-66
C-	4	60-62
D+	3	57-59
D	2	53-56
D-	1	50-52
F	0	0-49

Late Assignments

Late submissions of assignments are subject to 50% penalty per day (less than one day is counted as one day)

Absences, Missed Work, Illness

Missed work is handles through MSAF (McMaster Student Absence Form).

Illness and disability are handled through the Associate Dean Office and SAS (Student Accessibility Services).

Turnitin.com

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

Generative AI: Unrestricted Use

Students may use generative AI throughout this course in whatever way enhances their learning; no special documentation or citation is required.

APPROVED ADVISORY STATEMENTS

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. **It is your responsibility to understand what constitutes academic dishonesty.**

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. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/

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.

Authenticity / Plagiarism

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. Avenue to Learn, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

Courses with an On-line Element

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn, LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Online Proctoring

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other

applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

Conduct Expectations

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online.**

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

Academic Accommodation of Students with Disabilities

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

Academic Advising

For any academic inquires please reach out to the Office of the Associate Dean (Academic) in Engineering located in JHE-Hatch 301.

Details on academic supports and contact information are available from:

https://www.eng.mcmaster.ca/programs/academic-advising

Requests for Relief for Missed Academic Term Work

In the event of an absence for medical or other reasons, students should review and follow the Policy on Requests for Relief for Missed Academic Term Work.

Academic Accommodation for Religious, Indigenous, or Spiritual Observances (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty 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.

Copyright and Recording

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

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, Avenue to Learn and/or McMaster email.

Electrical and Computer Engineering Lab Safety

Information for Laboratory Safety and Important Contacts

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 and online: https://hr.mcmaster.ca/app/uploads/2019/07/2019-McMaster-Lab-Manual.pdf

General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following whether conducting lab work at school or at home:

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.

9. Personal ergonomics should be practiced when conducting lab work. https://bit.ly/3fOE71E

10. Current University health and safety issues, and protocols should be known. https://hr.mcmaster.ca/resources/covid19/workplace-health-and-safety-guidance-during-covid-19/

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.

Who to Contact	
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.

In Case of a Fire (On Campus 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 non-flammable 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 labs, 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

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	spencers@mcmaster.ca
ECE Chair	Mohamed Bakr- ITB A111	mbakr@mcmaster.ca

ECE Administrator	Shelby Gaudrault- ITB A111/B	gaudraus@mcmaster.ca
ECE Course Instructor	Please contact your specific course instructor directly	