ELEC ENG 3N03
Electronics and Instrumentation

COURSE OUTLINE

Please refer to course website for updated information.

COURSE DESCRIPTION

This course introduces different important concepts in electronics for non-electrical engineers. The course materials cover the following topics:
1-Review of circuit theory
2-Semiconductor devices
3- Diodes
4-Transistors and silicon-controlled rectifiers
5-Transistor characteristic and load lines
6- Amplifier circuits with and without feedback. Rectifier and passive filter circuits
7-Operational amplifiers and active filters
8- Digital circuits

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): One of ENGINEER 2M04, ENGINEER 2MM3 or ENGINEER 3M03

SCHEDULE and MODE OF DELIVERY

Lectures: Thursday and Friday: 11:30 AM -12:20 PM
Tutorial: Friday 10:30 AM – 11:20 AM
Labs: **L01:** Tuesday 2:30 PM -5:20 PM
L02: Wednesday 2:30 PM -5:20 PM
L03: Thursday 2:30 PM -5:20 PM

All labs sessions will be in-person.

INSTRUCTOR

Dr. Haitham Khallaf
Email: khallafh@mcmaster.ca
Office: ITB-A301
Phone: 2899412435
Office Hours**:** Thursday 12:30 PM – 1:20 PM (In Person)

TEACHING ASSISTANTS

Names, contact information, and office hours are provided on the course website

COURSE WEBSITE/S

http://avenue.mcmaster.ca

COURSE OBJECTIVES

By the end of this course, the student will be able to:
1. Specify the current-voltage (*I-V*) characteristics of diodes, MOSFETs, and BJTs graphically and analytically.
2. Identify device parameters from data sheets for diodes, MOSFETs, and BJTs.
3. Extract device parameters from *I-V* characteristics for diodes, MOSFETs, and BJTs.
4. Calculate DC or large signal currents & voltages in circuits containing diodes, MOSFETs, and BJTs.
5. Identify, describe behavior, and design standard diode, MOSFET, and BJT circuits for rectification, biasing, and digital logic.
6. Calculate small signal currents and voltages in circuits containing diodes, MOSFETs, and BJTs.
7. Identify, describe behavior, and design standard MOS and BJT amplifier topologies and design single stage MOS and BJT amplifiers.
8. Represent the small signal behavior of amplifier circuits using two port models.
9. Describe the open loop and closed loop behavior of op-amps.
10. Identify, describe behavior, and design standard op-amp circuits for amplification, instrumentation, and filtering.

CEAB GRADUATE ATTRIBUTES (GAS)

Note: 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	1.4	Competence in specialized engineering knowledge	Questions in the lab reports, mid-term exam or final exam

Attributes	Indicators		Measurement Method(s)
	Number	Description	
Problem Analysis	2.1	Identifies and states reasonable assumptions and suitable engineering fundamentals, before proposing a solution path to a problem.	Questions in the lab reports, mid-term exam or final exam
Investigation	3.2	Synthesizes the results of an investigation to reach valid conclusions.	Questions in the lab reports, mid-term exam or final exam
Design	4.1	Defines the problem by identifying relevant context, constraints, and prior approaches before exploring potential design solutions	Questions in the lab reports, mid-term exam or final exam
Use of Engineering Tools	5.2	Successfully uses engineering tools	Lab interviews and questions in the lab reports

ASSUMED KNOWLEDGE

Electrical Engineering: Kirchhoff's laws, resistors, capacitors, inductors

COURSE MATERIALS

Required Texts:
[1] Thomas L. Floyd, Electronic Devices (Electron Flow Version), 10th Edition
Extra Text: Suggested readings by Instructor

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

Course Notes and Assignments Guide:
Available for download from Avenue

COURSE OVERVIEW

Lecture	Description	Reading
0	**Organizational Meeting**	

1	**Circuit Theory:** Electrical Circuits and combination of elements, filters	
2	**Semiconductors:** Valence bonds, conduction band and valence band, doping, N-type and P-type materials, examples	Chapter 1, pages 1-16
3	**PN Diode 1:** Structure, Depletion region, different bias conditions, IV characteristics, example	Chapter 1: pages 16-19, Chapter 2: pages 25-37
4	**PN Diode 2:** Diode model, half-wave rectifier, full-wave rectifier, bridge rectifier, examples	Chapter 2: pages 38-51, pages 58-64
5	**PN Diode 3:** Avalanche breakdown, Zener breakdown, examples	Chapter 3: Sections 3.1 and 3.2 Extra: 3.4
6	**Operational Amplifiers (Ocampo) 1:** ideal operational amplifier, realistic operational amplifier, parameters of an OpAmp, Applications of OpAmps	Chapter 12: Sections 12.1 and 12.2
7	**Operational Amplifier 2:** Inverting amplifier, non-inverting amplifier, differential amplifier, examples	Chapter 12: Sections 12.3 and 12.4
8	**Operational Amplifier 3:** Voltage follower, general OpAmp circuits	Chapter 13: Pages 657-672 (not including Page 665)
9	**OpAmp 4:** Ideal integrator, ideal differentiator, examples	Chapter 13: Pages 672-682 Extra: Waveform Generation Application
10	**Field Effect Transistors (FETs) 1:** JFET structure, JFET operation	Chapter 8: Sections 8.1-8.4
11	**FETs 2:** MOSFET structure, Characteristics and parameters, Biasing of MOSFET, examples	Chapter 8: Section 8.5-8.7 Extra: Section 8.8 IGBT, Application pH sensor circuit
12	**FETs 3:** JFET Common Source Amplifier, MOSFET Common Source Amplifier, Examples	Chapter 9: Section 9.1
13	**FETS 4:** Common Drain Amplifiers, Common Gate Amplifiers, Examples	Chapter 9: Sections 9.2-9.3 Extra: Section 9.4
14	**Digital Circuits 1:** Analog and digital signals, differences between analog and digital circuit, logic levels	
15	**Digital Circuits 2:** Axioms of Boolean Algebra, AND gate, OR gate, De Morgan's theorems, examples	
16	**Digital Circuit 3:** Universal Logic Gates	
17	**Bipolar Junction Transistor (BJT) 1:** Transistor structure, I-V characteristics	Chapter 4: Sections 4.1-4.2
18	**BJT2:** Modes of operation, voltage and current analysis, examples	Chapter 4: Section 4.3
19	**BJT3:** Transistor as a switch, transistor as an amplifier	Chapters 4 and 5: Sections 4.4-4.5, 5.1-5.3

20	**BJT4:** Small signal analysis, common emitter amplifier, examples	Chapter 6: Sections 6.1-6.3
21	**BJT5:** Common collector amplifiers, example	Chapter 6: Sections 6.4 Extra: Section 6.5
22	Multistage Amplifiers, examples	Chapter 6: Section 6.6
23	**Oscillators**	Chapter 16: Sections 16.1-16.4 Extra: Section 16.5

LABORATORY OVERVIEW

Week	Topic	Reading
Week 2-3	Laboratory Safety: Each student in the course is required to pass the lab safety quiz prior to attempting any of the laboratories. The video and quiz will be on Avenue to Learn.	
Week 4-5	Utilizing Electronic Laboratory Equipment	Download through Avenue To Learn
Week 6-7	Operational Amplifiers	Download through Avenue To Learn
Week 8-9	MOSFET Transistors	Download through Avenue To Learn
Week 10-11	Digital Logic Gates	Download through Avenue To Learn

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). This is required even if you are doing labs at home.
- The labs for this course will be held at ITB-A114. A TA dedicated to each lab will assist you.
- Each lab will involve a significant amount of pre-lab work. You may submit one pre-lab report per group.
- The pre-lab work will be assessed at the beginning of the lab.

ASSESSMENT

Component	Weight
Midterm Eamination	30%
4 Quizzes in Tutorial	10%
4 Laboratory Experiments	10%
Final Examination	50%

Total	100%

Students are expected to attend all lectures and tutorials, as well as their assigned laboratory section. Students will be responsible for all material covered in these venues.
No make-up midterm tests will be granted. Weight of a missed midterm test will be transferred to final exam.

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. The 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 DETECTION

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., online search, other software, etc.). For more details about McMaster's use of Turnitin.com, please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ONLINE ELEMENT

Some courses may use online elements (e.g., email, Avenue to Learn (A2L), 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 email 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 online 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.

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.

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.

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 ACCOMMODATIONS

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.

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.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC WORK

McMaster Student Absence Form (MSAF): 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.

www.eng.mcmaster.ca/ece

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 conditions.
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 the 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 protocol 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.
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 (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 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 labs, press the 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 Chair	Mohamed Bakr - ITB A111	mbakr@mcmaster.ca
ECE Administrator	Shelby Gaudrault - ITB A111	gaudraus@mcmaster.ca
ECE Course Instructor	Haitham Khallaf – ITB A301	khallafh@mcmaster.ca