ELEC ENG 2EI4
Electronic Devices and Circuits I

COURSE OUTLINE

Please refer to course website for updated information.

COURSE DESCRIPTION

Semiconductor devices and electronic circuits; electrical characteristics, principles of operation, circuit models of diodes, field-effect and bipolar transistors, and operational amplifiers; analysis and design of basic application circuits.

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): ELECENG 2CI5 or 2CI4
Antirequisite(s): ELECENG 2EI5

SCHEDULE AND MODE OF DELIVERY

This class contains 8 modules of study over 12 weeks. Each module will contain (a) a package of pre-recorded videos and exercises to be studied by the student before lecture; (b) an in-person lecture that will focus on the application of the material through worked examples and group work; and (c) a weekly quiz to test the material learned. In addition, there are four design projects for the student to put the knowledge gained into practice. The labs in the timetable are working sessions for the design projects. Attendance in labs is expected.

Lecture: Th 7:00 – 10:00 pm. (Begins January 11.)
Tutorial: M 12:30 – 1:20 pm. (Begins January 15.)
Labs: T 7:00 – 10:00 pm. (See schedule on Mosaic.)

INSTRUCTOR

Dr. Yaser M. Haddara
Email: yaser@mcmaster.ca
Office: ITB-A223
Office Hours: TBA on Avenue

TEACHING ASSISTANTS

Contact information and office hours TBA on Avenue.

COURSE WEBSITE/S

http://avenue.mcmaster.ca

COMMUNICATION POLICY

1. The most effective way to reach the instructor is during office hours. Office hours are posted on Avenue.
2. To reach the instructor by email, send email to yaser@mcmaster.ca and include [2EI4] in the subject line. Emails sent to a different address or not including the course code in the subject line will not be received.
3. Avenue and MS Teams are NOT available as channels of communication for this course. I will not check or respond to messages sent through either of these.
4. Any announcement regarding class will be posted on Avenue. Some emergency announcements may additionally be sent by email via Mosaic. It is your responsibility to check Avenue regularly and to ensure that you can receive emails sent to your McMaster email through Mosaic.
5. During the term, some specific types of communication (e.g. test re-mark requests) may be assigned to a specific TA or required to be submitted through Avenue. When that is the case, an announcement will be made on Avenue. It is your responsibility to monitor Avenue and to follow such instructions.
6. Not all information communicated during live class sessions can be captured in Avenue announcements. In particular, some detailed information regarding Test coverage, format, and examples may be discussed in class in more detail than is posted on Avenue, and may be discussed in class in advance of being posted on Avenue. It is your responsibility to be aware of announcements made during class.

COURSE OBJECTIVES

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

1. Specify the iv-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 iv-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 level shifting, limiting, clamping, rectification, biasing, and digital logic.
6. Calculate static and dynamic properties of NMOS and CMOS logic gates.
7. Design complex CMOS gates, including proper transistor sizing.
8. Calculate small signal currents and voltages in circuits containing diodes, MOSFETs, and BJTs.

9. Identify, describe behavior, and design standard MOS and BJT amplifier topologies and design single stage MOS and BJT amplifiers.
10. Represent the small signal behavior of amplifier circuits using two port models.

ASSUMED KNOWLEDGE

Voltage, current, power, energy, KCL, KVL, VDR, CDR, nodal and mesh analysis, Thevenin's and Norton's theorems, superposition, DC steady state behavior of capacitors & inductors.

COURSE MATERIALS

Required Texts

- Sedra & Smith. Microelectronic Circuits. Oxford Universtiy Press, 8th ed.
  - This is available in print edition from the Campus Store
  - There are also digital options available but please keep in mind that you need this same text for Elec Eng 3EJ4.

Reference Texts

- R.C. Jaeger and T.N. Blalock. Microelectronic Circuit Design. McGraw-Hill.
- D.A. Neamen. Microelectronics: Circuit Analysis and Design. McGraw-Hill.
- B.M. Wilamowski and R.C. Jaeger. Computerized Circuit Analysis Using SPICE Programs. McGraw-Hill.

Other Supplies

- Supplies for Labs & Projects as explained on Avenue.

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.

COURSE OVERVIEW

The course topics are:

1. Diodes
2. MOSFETs in DC
3. BJTs in DC
4. Small signal analysis
5. Transistor amplifiers
6. Transistor logic circuits

More details are posted on Avenue as and when needed.

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 are 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
- Labs and projects will be conducted by students using a PC based module and a parts kit. Deliverables will be submitted online.

ASSESSMENT

The course grade will be based on 1050 points assigned to student work and assessment tools as detailed below. Your final mark will be your total number of points earned divided by 10.

Weekly Quizzes (at least 10 will be given; best 6 will count)	100
Participation	100
Projects	250
Two term tests	300
Final Exam	300

Policies:

1. **The instructor reserves the right to determine the format for make-up for any missed tests or exams. This includes term tests and the final exam. In particular, a make-up test or deferred final examination may be an oral exam. A make-up for some items of term work (including tests) may not be offered (in which case the weight of the missed work will be shifted to other course components).**
2. The total points available before applying any bonuses is 1050. The final mark is obtained by dividing the number of points by 10. This provides a certain degree of flexibility for students to manage their own learning and prioritize activities that they find more helpful.
3. There will be weekly online quizzes. A minimum of 10 quizzes in total will be given throughout the term. The quiz grade will be based on the best six quizzes.
4. Participation marks are not attendance marks. They are based on participation in class in discussion and/or problem solving.
5. If a student performs better on the term tests than the quizzes and/or participation the term test marks will replace the lower marks.
6. There are two term tests. The better test mark will have twice the weight as the lower test mark to obtain the combined 300 points.
7. Throughout the term, there will be some bonus points awarded for in-class and additional activities. Bonus points are added to a students' total points before dividing by 10 to obtain the final mark.

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; and
• 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., 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 (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 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.

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.

This course if fully online. As such, we will be using multiple on-line resources including Avenue To Learn, zoom, and other tools as detailed on Avenue. Students should be aware that, when they access the electronic components of this course, 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 this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

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) 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.

ACCREDITATION LEARNING OUTCOMES

Note: The *Learning Indicators* 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)

Problem Analysis	2.2 Proposes problem solutions supported by substantiated reasoning, recognizing the limitations of the solutions.	Tests
Investigation	3.1 Selects appropriately from relevant knowledge base to plan appropriate data collection methods and analysis strategies.	Projects
Design	4.2 Explores a breadth of potential solutions, considering their benefits and trade-offs as they relate to the project requirements.	Projects
	4.4 Justifies and reflects on design decisions, giving consideration to limitations, assumptions, constraints and other relevant factors.	Projects
Use of Engineering Tools	5.2 Successfully uses engineering tools.	Projects

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 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 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 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	Please contact your specific course instructor directly	