ENGINEER 3N03
Electronics and Instrumentation
Winter 2018
Course Outline

CALENDAR/COURSE DESCRIPTION

This course introduces different important concepts in electronics for nonelectrical 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 3M03

SCHEDULE

Lectures: Mondays and Wednesdays 10:30 am - 11:20 pm, MDCL-1110
Tutorial: Thursdays 4:30 pm - 5:20 pm, MDCL-1110

Labs: Mondays, Tuesdays, and Wednesdays 5:30 PM – 7:00 PM, ITB-AB106

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Matiar Howlader
ITB-A216
mrhowlader@mail.ece.mcmaster.ca
905-525-9140 Ext. 26647

Office Hours:
Tuesday 1:30 – 2:30 PM
Or by appointment

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION
Course Outline

Course Website/Alternate Methods of Communication

http://avenue.mcmaster.ca/

Course Objectives

By the end of this course, the student will be able to:
1. Specify the current-voltage (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 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.

Assumed Knowledge

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

Course Materials

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:
### COURSE OVERVIEW

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Description</th>
<th>Chapter</th>
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<tbody>
<tr>
<td>0</td>
<td><strong>Organizational Meeting</strong></td>
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<tr>
<td>1</td>
<td><strong>Circuit Theory</strong>: Electrical Circuits and combination of elements, filters</td>
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<tr>
<td>2</td>
<td><strong>Semiconductors</strong>: Valence bonds, conduction band and valence band, doping, N-type and P-type materials, examples</td>
<td>Chapter 1, pages 1-16</td>
</tr>
<tr>
<td>3</td>
<td><strong>PN Diode 1</strong>: Structure, Depletion region, different bias conditions, IV characteristics, example</td>
<td>Chapter 1: pages 16-19, Chapter 2: pages 25-37</td>
</tr>
<tr>
<td>4</td>
<td><strong>PN Diode 2</strong>: Diode model, half-wave rectifier, full-wave rectifier, bridge rectifier, examples</td>
<td>Chapter 2: pages 38-51, pages 58-64</td>
</tr>
<tr>
<td>5</td>
<td><strong>PN Diode 3</strong>: Avalanche breakdown, Zener breakdown, examples</td>
<td>Chapter 3: Sections 3.1 and 3.2 Extra: 3.4</td>
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<td>6</td>
<td><strong>Operational Amplifiers (OpAmp) 1</strong>: ideal operational amplifier, realistic operational amplifier, parameters of an OpAmp, Applications of OpAmps</td>
<td>Chapter 12: Sections 12.1 and 12.2</td>
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<td>7</td>
<td><strong>Operational Amplifier 2</strong>: Inverting amplifier, non inverting amplifier, differential amplifier, examples</td>
<td>Chapter 12: Sections 12.3 and 12.4</td>
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<tr>
<td>8</td>
<td><strong>Operational Amplifier 3</strong>: Voltage follower, general OpAmp circuits</td>
<td>Chapter 13: Pages 657-672 (not including Page 665)</td>
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<td>9</td>
<td><strong>OpAmp 4</strong>: ideal integrator, ideal differentiator, examples</td>
<td>Chapter 13: Pages 672-682 Extra: Waveform Generation Application</td>
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<td>10</td>
<td><strong>Field Effect Transistors (FETs) 1</strong>: JFET structure, JFET operation</td>
<td>Chapter 8: Sections 8.1-8.4</td>
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<tr>
<td>11</td>
<td><strong>FETs 2</strong>: MOSFET structure, Characteristics and parameters, Biasing of MOSFET, examples</td>
<td>Chapter 8: Section 8.5-8.7 Extra: Section 8.8 IGBT, Application pH sensor circuit</td>
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<tr>
<td>12</td>
<td><strong>FETs 3</strong>: JFET Common Source Amplifier, MOSFET Common Source Amplifier, Examples</td>
<td>Chapter 9: Section 9.1</td>
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<tr>
<td>13</td>
<td><strong>FETS 4</strong>: Common Drain Amplifiers, Common Gate Amplifiers, Examples</td>
<td>Chapter 9: Sections 9.2-9.3 Extra: Section 9.4</td>
</tr>
</tbody>
</table>
### Digital Circuits 1:
Analog and digital signals, differences between analog and digital circuit, logic levels

### Digital Circuits 2:
Axioms of Boolean Algebra, AND gate, OR gate, De Morgan's theorems, examples

### Digital Circuit 3:
Logic Simplification, Karnaugh Maps

### Digital Circuit 4:
Arithmetic circuits, Half Adder, Full Adder, Half Subtractor

### Bipolar Junction Transistor (BJT) 1:
Transistor structure, I-V characteristics

### BJT2:
Modes of operation, voltage and current analysis, examples

### BJT3:
Transistor as a switch, transistor as an amplifier

### BJT4:
Small signal analysis, common emitter amplifier, examples

### BJT5:
Common collector amplifiers, example

### Oscillators

### Laboratory Overview

<table>
<thead>
<tr>
<th>Date/Week</th>
<th>Topic</th>
<th>Readings</th>
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<tbody>
<tr>
<td>Weeks 2 and 3</td>
<td>Utilizing Electronic Laboratory Equipment</td>
<td>Download through Avenue To Learn</td>
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<tr>
<td>Weeks 4 and 5</td>
<td>Operational Amplifiers</td>
<td>Download through Avenue To Learn</td>
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<tr>
<td>Weeks 6 and 7</td>
<td>MOSFET Transistors</td>
<td>Download through Avenue To Learn</td>
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<tr>
<td>Weeks 8 and 9</td>
<td>Digital Logic Gates</td>
<td>Download through Avenue To Learn</td>
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### Laboratory Operation

Please do any required preparation before the laboratory session
Reports to be submitted at the end of the laboratory session

### Assessment

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<th>Component</th>
<th>Weight</th>
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<tr>
<td>First Midterm Examination</td>
<td>15%</td>
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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 http://www.mcmaster.ca/academicintegrity

The following illustrates only three forms of academic dishonesty:

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

Academic Accommodations

Students who require academic accommodation must contact Student accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contact by phone at 905.525.9140 ext. 28652 or e-mail at sas@mcmaster.ca.

For further information, consult McMaster University’s Policy for Academic Accommodation of Students with Disabilities.

Notification of 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":
http://www.mcmaster.ca/msaf/
NOTICE REGARDING POSSIBLE COURSE MODIFICATION

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

ON-LINE STATEMENT FOR COURSES REQUIRING ONLINE ACCESS OR WORK

In this course, we will be using Avenue to Learn and YouTube. 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.

REFERENCE TO RESEARCH ETHICS

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf.

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

- **Telephone**
  On the wall of every lab near the door

- **First Aid Kit**
  ITB A111, or dial “88” after 4:30 p.m.

- **Fire Alarm Pulls**
  Near all building exit doors on all floors
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.

Who to Contact


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
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

<table>
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<th>Role</th>
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<tr>
<td>TA</td>
<td>The first point of contact for lab supervision</td>
</tr>
<tr>
<td>ECE Lab Supervisor</td>
<td>Steve Spencer - ITB 147, <a href="mailto:steve@mail.ece.mcmaster.ca">steve@mail.ece.mcmaster.ca</a></td>
</tr>
<tr>
<td>ECE Chair</td>
<td>Tim Davidson - ITB A111, <a href="mailto:davidson@mcmaster.ca">davidson@mcmaster.ca</a></td>
</tr>
<tr>
<td>ECE Administrator</td>
<td>Kerri Hastings - ITB A111, <a href="mailto:hastings@mcmaster.ca">hastings@mcmaster.ca</a></td>
</tr>
<tr>
<td>ECE Course Instructor</td>
<td>Please contact your specific course instructor directly</td>
</tr>
</tbody>
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