ENGG*3450 Electronic Devices

Fall 2019
Section(s): C01

School of Engineering
Credit Weight: 0.50
Version 1.00 - September 04, 2019

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1 Course Details

1.1 Calendar Description

This course explores the theory and principles of modern electronic devices and their applications in circuits. Course topics include: intrinsic and doped semiconductors; drift and diffusion currents; metal-semiconductor contacts and MOS capacitors; pn junctions and breakdown phenomena; solid-state diodes; bipolar and MOS field-effect transistors; current-voltage characteristics and biasing; small-signal models and operation; circuit integration; analysis and design of application circuits, operational transconductance amplifiers, and logic gates.

Pre-Requisites: ENGG*2450

1.2 Timetable

Lectures

Monday	08:30–09:20	RICH 2520
Wednesday	08:30–09:20	RICH 2520
Friday	08:30–09:20	RICH 2520

Laboratory sessions

Section 1	Tuesday	15:30–17:20	RICH 1504
Section 2	Wednesday	15:30–17:20	RICH 1504
Section 3	Monday	15:30–17:20	RICH 1504

1.3 Final Exam

Tuesday, 10 December 2019, 8:30–10:30. Please verify the time and location of the final exam on the course webpage, on the exam schedule webpage and on WebAdvisor.

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2 Instructional Support

2.1 Instructional Support Team

Instructor: Stefano Gregori
Email: sgregori@uoguelph.ca
Telephone: 519-824-4120 ext. 56191
Office: RICH 3521
Office Hours: Friday, 17:30–18:20

Lab Technician: Hong Ma
Email: hongma@uoguelph.ca
Telephone: 519-824-4120 ext. 53873
Office: RICH 1506

2.2 Teaching Assistants

Teaching Assistant: Evan Fallis
Email: efallis@uoguelph.ca

Teaching Assistant: Daljit Josh
Email: djosh@uoguelph.ca

Teaching Assistant: Junfei Li
Email: jli64@uoguelph.ca

Teaching Assistant: Reza Mohammadi Tamanani
Email: rmoham05@uoguelph.ca

Teaching Assistant: Abu Siddique
Email: asiddi04@uoguelph.ca

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3 Learning Resources

3.1 Required Resources

Course webpage (Website)
Course materials, announcements, and grades will be posted to the course webpage on CourseLink. You are responsible for checking the site regularly.

Course textbook (Textbook)
A. S. Sedra and K. C. Smith, Microelectronic Circuits, Oxford, 7th ed., 2014, TK7867 .S39

3.2 Recommended Resources

Readings (Readings)
Readings from the textbook will be posted on the course webpage. The readings are assigned with the intention that you will read them before class, so that you will be

prepared to discuss the concepts and follow the examples presented in class.

Lecture notes (Notes)
Lecture notes will be posted on the course webpage. The notes are prepared with the intention that you will fill in the blanks, take additional notes and write down examples in class. Attendance at lectures is expected, because material and interpretations not present in the notes or other resources will be discussed.

Problem sets (Other)
Problem sets will be available on the course webpage. The problems are selected with the intention that you will solve them throughout the term as a way to reinforce and self-assess your understanding of the topics in the course.

Laboratory manuals (Lab Manual)
Laboratory manuals will be posted on the course webpage. The manuals are prepared with the intention that you will read them before each laboratory session to be ready for a safe and successful activity, and that you will consult them during the laboratory while taking your own notes. Attendance at laboratories is mandatory.

Datasheets and instruction manuals (Other)
Datasheets of electronic components and instruction manuals will be available on the course webpage to be consulted before and during the laboratory activity.

3.3 Additional Resources

Recommended books for consultation (Textbook)
S. Dimitrijev, Principles of Semiconductor Devices, Oxford, 2nd ed., 2011, TK7871.85 .D54697

D. A. Neamen, Microelectronics: Circuit Analysis and Design, McGraw-Hill, 4th ed., 2010, TK7867 .N412

Library resources (Textbook)
The textbook and the recommended books above are available on Course Reserve and through the bookstore. Additional references are indexed by library call numbers TK7800 to TK8360 (i.e. located on the 5th floor of the library).

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4 Learning Outcomes

This course aims to help you with:

1. Gaining knowledge about the properties of semiconductor materials and about the models and the principles of operation of electronic devices.
2. Understanding the connections between device-level characteristics and circuit-level performance as the means to analyzing electronic circuits and designing

applications that operate as you desire.
3. Developing your knowledge-integration, problem-solving, and investigation skills to prepare for your career in engineering.

4.1 Course Learning Outcomes

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

1. Relate the properties of semiconductor materials to the models of diodes and transistors, and describe the principles of operation of these devices.
2. Bias a circuit for linear operation, and solve circuit problems by applying device models and by executing mathematical operations based on the large-signal and small-signal abstractions.
3. Understand that you can use ideal models to predict experiments with physical devices, and identify in which aspects the behaviour of a real device deviates from its model.
4. Draw schematic diagrams correctly, and apply systematic analysis methods to evaluate the performance of circuits with diodes, transistors, gain stages, and logic gates.
5. Interpret schematic diagrams, deduce functions from combination of elements, and identify the device parameters that determine performance of gain stages and logic gates.
6. Operate bench-top instrumentation for characterizing electronic devices, assemble and troubleshoot circuits on a breadboard, and communicate about data sheets and performance of electronic devices and circuits.

4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome
1	Knowledge Base	1, 2
1.2	Recall, describe and apply fundamental principles and concepts in natural science	1
1.3	Recall, describe and apply fundamental engineering principles and concepts	1, 2
1.4	Recall, describe and apply program-specific engineering principles and concepts	1, 2
2	Problem Analysis	1, 2, 3, 4
2.1	Formulate a problem statement in engineering and non-engineering	1, 2, 4

#	Outcome	Learning Outcome
	terminology	
2.2	Identify, organize and justify appropriate information, including assumptions	1, 2, 4
2.3	Construct a conceptual framework and select an appropriate solution approach	2, 4
2.4	Execute an engineering solution	2, 4
2.5	Critique and appraise solution approach and results	2, 3, 4
3	Investigation	3, 5, 6
3.1	Propose a working hypothesis	3, 5
3.2	Design and apply an experimental plan/investigative approach (for example, to characterize, test or troubleshoot a system)	3, 5, 6
3.3	Analyze and interpret experimental data	3, 6
3.4	Assess validity of conclusions within limitations of data and methodologies	3, 5
4	Design	4, 5, 6
4.1	Describe design process used to develop design solution	4, 5
4.2	Construct design-specific problem statements including the definition of criteria and constraints	4, 6
5	Use of Engineering Tools	3, 5, 6
5.1	Select appropriate engineering tools from various alternatives	5, 6
5.2	Demonstrate proficiency in the application of selected engineering tools	5, 6
5.3	Recognize limitations of selected engineering tools	3, 6
6	Individual & Teamwork	6
6.3	Execute and adapt individual role to promote team success through, for example, timeliness, respect, positive attitude	6
7	Communication Skills	4, 5, 6
7.2	Interpret technical documentation such as device specification sheets, drawings, diagrams, flowcharts, and pseudocode	5, 6
7.3	Construct the finished elements using accepted norms in English, graphical standards, and engineering conventions, as appropriate for the message and	4, 6

#	Outcome	Learning Outcome
	audience	

5 Teaching and Learning Activities

5.1 Lecture schedule

Week	Dates	Lecture topics	References	Learning objectives
1	Sep. 9–13	Signals and amplifiers	ch. 1	2
2	Sep. 16–20	Semiconductors and pn junctions	ch. 3	1
3	Sep. 23–27	Diodes	ch. 4	1, 2
4	Sep. 30–Oct. 4	Diode circuits	ch. 4	1, 2, 3, 4, 6
5	Oct. 7–11	Transistors	ch. 5, 6	1, 2
6	Oct. 14–18	Transistor circuits in dc	ch. 5, 6	1, 2, 3, 4, 6
7	Oct. 21–25	Transistor amplifiers	ch. 7	2, 3, 4, 5
8	Oct. 28–Nov. 1	Amplifier building blocks	chs. 8, 9	3, 4, 5
9	Nov. 4–8	Inverters	ch. 14	3, 4, 5
10	Nov. 11–15	Logic gates	ch. 14	3, 4, 5
11	Nov. 18–22	Advanced topics, if schedule permits	—	—
12	Nov. 25–29	Review	all	all

Topics schedule will be adjusted throughout the course as needed.

5.2 Laboratory schedule

Week	Dates	Laboratory topics	Due date
2	Sep. 16–20	Laboratory 1, diodes and diode circuits	Sep. 30
5	Oct. 7–11	Laboratory 2, transistors and gain stages	Oct. 28
9	Nov. 4–8	Laboratory 3, inverters and logic gates	Nov. 18

Topics schedule will be adjusted throughout the course as needed.

5.3 Other Important Dates

Monday, 14 October 2019: Holiday (i.e. no classes scheduled)

Tuesday, 15 October 2019: Study break day (i.e. no classes scheduled)

Thursday, 28 November 2019: Tuesday schedule in effect

Friday, 29 November 2019: Monday schedule in effect and drop date

Please consult the Undergraduate Calendar to verify the schedule of dates for this term: http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c03/c03-fallsem.shtml

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6 Assessments

6.1 Marking Schemes & Distributions

Name	Scheme A (%)
Laboratories	30
Midterm exam	30
Final exam	40
Total	100

6.2 Assessment Details

Laboratories (30%)

Learning Outcome: 3, 5, 6

It consists of three laboratory reports equally weighted. Please see section 5.2 for schedule and due dates.

Midterm exam (30%)

Date: Fri, Oct 25, 8:00 AM - 9:20 AM

Learning Outcome: 1, 2, 3

It is a closed-book exam, and it includes all the material covered in lectures and laboratories to-date. Please verify time and location on the course webpage.

Final exam (40%)

Date: Tue, Dec 10, 8:30 AM - 10:30 AM

Learning Outcome: 1, 2, 3, 4, 5

It is a closed-book exam, and it includes all the material covered in lectures and laboratories to-date. Please verify the time and location on the course webpage, on the exam schedule webpage and on WebAdvisor.

6.3 Course grading policies

Missed assessments:

If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please advise the course instructor in

writing (with your name, student number and email contact) before the assessment time or due date. Please see the undergraduate calendar for information on regulations and procedures for academic consideration: https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Accommodation of religious obligations:

If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. Please see the undergraduate calendar for information on regulations and procedures for academic accommodation of religious obligations: https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Missed exams:

Any student not taking an exam receives a grade of zero for that exam. There are no makeup midterm exams. In case you have a legitimate reason for missing the midterm exam, the instructor may consider an accommodation upon presentation of a written request and suitable documentation before the time of the exam.

Laboratory work:

Attendance is mandatory for submitting laboratory reports. There are no laboratory exemptions and no makeup laboratory sessions. In case you have a legitimate reason for missing a session, the instructor may consider an accommodation upon presentation of a written request and suitable documentation before the time of the session.

Late laboratory reports:

Any student not handing in a report receives a grade of zero for that submission. There are no makeup reports. Non-complying submissions, including late and incomplete submissions, are not accepted for marking. When you upload a report to the course webpage, you have to verify that the file can be opened and that it is the one you intended to upload.

Copies of reports:

Please keep reliable back-up copies of all out-of-class assignments, because you may be asked to resubmit your work.

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7 Course Statements

7.1 Communication and email policy

Communication is through announcements in class. Some information will be posted on the course webpage or sent via email messages to your University address. It is your responsibility to keep yourself informed about the course.

Please use lectures and laboratory sessions as your main opportunity to receive information about the course. Please meet the instructor during the office hours when you have specific questions about concepts, problem sets, and laboratory experiments, and any question that cannot be answered easily or briefly with a reply email.

The course email policy is as follows:

- Use your University email account for correspondence relating to the course.
- Start the subject header with the course identifier "ENGG*3450" and add the topic of your message.
- Include a clearly written message and your name and student number.
- You will normally receive a reply in a timely manner (with the exception of nights, weekends, and holidays). If you do not receive a reply within two days, please resubmit your question or phone (leaving a message if necessary).

7.2 Relationships with other courses

Previous courses

ENGG*2450, Electric Circuits:

Lumped-element models, node and mesh analysis, linearity and superposition, Thévenin and Norton theorems, operational amplifier, transformers, RLC circuits in dc, ac, and transient conditions.

Follow-on courses

ENGG*3490, Introduction to Mechatronic Systems Design:

Modelling and design of mechatronic systems with electronic and mechanical

components.

ENGG*4080, Micro and Nano-Scale Electronics:

Circuit integration and operating principles of integrated micro and nano electronic circuits.

ENGG*4390, Bio-Instrumentation Design:

Electronic instrumentation and measurements for biological systems.

ENGG*4550, VLSI Digital Design:

CMOS gates, latches, registers, pipelining, adders, multipliers, and shifters.

7.3 Recommendations about studying

You are encouraged to spread the learning periods over the entire term (e.g. it is a good idea to start studying from today). Try to avoid distractions while studying and during lectures and laboratory sessions. Take notes and outlines while reading or listening. Work on the assigned readings and problems regularly. Note down the questions and doubts that arise and get clarifications at the earliest possible time. When you are in a classroom or laboratory, as a courtesy to instructors and classmates, please keep your cellphone silenced and use your tablet or laptop only for course-related applications.

7.4 Recommendations about obtaining help

You can obtain help from the instructor during the office hours and from the laboratory technician and the teaching assistants during the laboratory time slots.

Please contact the instructor if you need help or you have fallen behind in your work. He is willing to put in as much effort to help you as you are willing to put in to help yourself. He is happy to work with you on difficult concepts and to hear your suggestions for improving the course. If you are busy during his office hours, then email him with some days and times you are free, and he will set an appointment that works for both you and him.

If you are ill, please call the Student Health Services or a medical doctor. If you have emotional, family, or living environment problems that affect your ability to study, please visit the Counselling Services or your academic advisor. If you have a disability (including a short-term disability), please refer to the Student Accessibility Services. You are encouraged to use the available services and programs, and you are welcome to discuss with the instructor your specific learning needs in this course at the earliest possible time.

7.5 Recommendations about laboratory safety

You have to follow the posted laboratory policies at all times, and you are not allowed to let unauthorized people in, or to wedge the laboratory doors open. Food and drinks are prohibited from all laboratories. Food is prohibited from all computer rooms and drinks are permitted only if stored in a sealed, reusable container.

Please use good judgement and safe working habits. Before the first laboratory session, you must read the course manual on Safety and Laboratory Policies. In case of doubts about

safety procedures, you must consult with the laboratory technician. Please be advised that food and drink are not allowed in RICH 1504, and that any violation of laboratory policies may result in loss of laboratory privileges.

7.6 Recommendations about academic integrity

You are encouraged to familiarize yourself with your responsibilities, review the tutorial on Academic Integrity, and discuss any question you may have with the instructor or a faculty member.

When writing laboratory reports, please remember that copying text, data, or figures is plagiarism, even if you received the material from a friend, if you found the material on the Internet, or if you are reusing material for which you have previously received credit. Letting others use your work is also not allowed. Therefore please keep your reports and data in a secure location.

Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

A tutorial on Academic Integrity produced by the Learning Commons can be found at:
http://www.academicintegrity.uoguelph.ca/

A section on Academic Misconduct and the Code of Ethics adopted by the School of Engineering are available in the Rules and Procedures Guide for engineering students.

Turnitin

In this course, Turnitin, integrated with the CourseLink Dropbox tool, will be used to detect possible plagiarism, unauthorized collaboration or copying as part of the ongoing efforts to maintain academic integrity at the University of Guelph.

All submitted assignments will be included as source documents in the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers. Use of the Turnitin.com service is subject to the Usage Policy posted on the Turnitin.com site.

7.7 Course materials and copyright

The instructor reserves the right to all materials made available for this course and all interpretations presented, which may not be reproduced, retained, or transmitted to others without the written consent of the instructor. Audio or video recording of lectures and instructional sessions are not allowed without the written consent of the presenter. All the

materials available on the course webpage and on Course Reserve, and the materials distributed in class, in the laboratory and during the exams may be protected by copyright and are only for the use of students enrolled in this course for the purposes associated with this course and may not be further disseminated or retained beyond the duration of this course.

This course outline includes sections and standard statements adapted with permission from the course outline template of the School of Engineering and from the course outline checklist of the University of Guelph.

8 School of Engineering Statements

8.1 Instructor's Role and Responsibility to Students

The instructor’s role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

8.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

8.3 Lab Safety

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

9 University Statements

9.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

9.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a

teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Graduate Calendar - Grounds for Academic Consideration
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions
https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml

9.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml

Graduate Calendar - Registration Changes
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml

Associate Diploma Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml

9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance and not later than the 40th Class Day.

For Guelph students, information can be found on the SAS website
https://www.uoguelph.ca/sas

For Ridgetown students, information can be found on the Ridgetown SAS website
https://www.ridgetownc.com/services/accessibilityservices.cfm

9.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community-faculty, staff, and students-to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

Graduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars
https://www.uoguelph.ca/academics/calendars