

Western University
Faculty of Engineering
Department of Electrical and Computer Engineering

ECE 2231B: Introduction to Electronics

Course Outline 2023-2024

Description: This course provides an introduction to devices and circuits that form the foundation of electronics. Successful completion of this course will enable students to understand the physical operation of semiconductor devices such as diodes and transistors and enable students to model those devices characteristics. The objective of this course is the ability to analyze and design discrete analog electronic circuits to fulfill specific design requirements.

Academic Calendar Copy: Electronic properties of semiconductors. The P-N junction. Diodes and light-emitting diodes; bipolar and field-effect transistors. Biasing, small signal analysis, large signal analysis. Single transistor amplifiers.

Contact Hours: 3 lecture hours per week, 1 laboratory hours per week (four 3-hour laboratory exercises per term), 1 tutorial hours per week (eight per term), 0.5 course.

Antirequisite: N/A

Prerequisites: ECE2205A/B, Physics 1402A/B

Co-requisite: N/A

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

CEAB Academic Units: Engineering Science 100%.

Required Textbook: A. S. Sedra and K. C. Smith, *Microelectronic Circuits*, Oxford University Press, 8th Edition.

Other Required References: Extensive lecture notes will be provided as PDFs and distributed over OWL.

Recommended References: R.L Boylestad and L. Nashelsky, *Electronic Devices and Circuit Theory*, Canadian Edition, and Allan R. Hambley, *Electrical Engineering: Principles and Applications*, Pearson, Prentice Hall

General Learning Objectives (CEAB Graduate Attributes)

Knowledge Base	I	Use of Engineering Tools	I	Impact on Society and the Environment
Problem Analysis	I	Individual and Team Work		Ethics and Equity
Investigation		Communication Skills		Economics and Project Management
Design		Professionalism		Life-Long Learning

Notation: where x be I: Introductory, D: Intermediate, A: Advanced, or empty. I – The instructor will introduce the topic at the level required. It is not necessary for the student to have seen the material before. D – There may be a reminder or review, but the student is expected to have seen and been tested on the material before taking the course. A – It is expected that the student can apply the knowledge without prompting (e.g. no review).

Course Topics and Specific Learning Outcomes	CEAB Graduate Attributes Indicators
<p>1. Signals and Amplifiers: Section covers signals, frequency spectrum of signals, analog and digital signals, amplifiers, circuit models for amplifiers, and frequency response of amplifiers.</p> <p>At the end of this section, students will be able to:</p> <ol style="list-style-type: none"> Understand signals in the time and frequency domain. Understand the difference between analog and digital signals. Understand basics of electronic circuits. <p>2. Operational Amplifiers: Section covers ideal operational amplifiers (op amps); inverting and non-inverting configurations; applications of op amps including difference amplifiers, integrators, and differentiators; DC imperfections; effect of finite open loop gain and bandwidth on circuit performance; and large signal operation of op amps.</p> <p>At the end of this section, students will be able to:</p> <ol style="list-style-type: none"> Understand operating mechanism of op amps. Solve a given op amp circuit to understand how that circuit fulfills design requirements. Design circuits with op amps to fulfill specific design requirements. <p>3. Diodes: Section covers ideal diodes, terminal characteristics of junction diodes, modeling of forward and reverse operation of diodes, breakdown and Zener diodes, rectifier circuits, limiting and clamping circuits, and special diode types.</p> <p>At the end of this section, students will be able to:</p> <ol style="list-style-type: none"> Understand performance requirements of diodes and model current-voltage characteristics. Solve diode circuits and understand their applications. 	<p>KB 3 KB3 KB3, PA1</p> <p>KB3 KB3, PA1 PA2, PA3</p> <p>KB3 KB3, PA2, PA3</p>

4. Semiconductors: Section covers intrinsic and doped semiconductors, dynamics of current in semiconductors, practical application of semiconductors in *pn* junctions, performance of *pn* junctions under applied voltage, and capacitive effects of *pn* junctions.

At the end of this section, students will be able to:

- a. Understand physics of intrinsic and doped semiconductors.
- b. Understand physical operation of diodes and transistors.

**KB3, PA1, PA2
KB3**

5. Bipolar Junction Transistors: Section covers physical construction of BJTs, current-voltage characteristics, and BJT circuits under DC operating conditions.

At the end of this section, students will be able to:

- a. Understand physical structure and design of BJTs.
- b. Solve BJT circuits and understand their applications.

**KB3
PA1, PA2, PA3**

6. Metal-Oxide-Semiconductor Field-Effect Transistors: Section covers physical construction of MOSFETs, current-voltage characteristics, and MOSFET circuits under DC operating conditions.

At the end of this section, students will be able to:

- a. Understand physical structure and design of MOSFETs.
- b. Solve MOSFET circuits and understand their applications.

**KB3
PA1, PA2, PA3**

7. Transistor Amplifiers: Section covers the basic principles of transistor amplifiers, small-signal operation, models of transistor amplifiers, basic configurations, biasing, discrete-circuit amplifiers, and the amplifier frequency response.

At the end of this section, students will be able to:

- a. Understand the design of transistor amplifiers.
- b. Solve amplifier circuits and understand their applications.
- c. Design transistor circuits to obtain specific dc bias.

**KB3
PA1, PA2, PA3
PA2, PA3**

8. Circuit Construction and Simulation Tools: Section covers laboratory exercises involving simulating, constructing, and measuring circuits discussed in the course lectures.

At the end of this section, students will be able to:

- a. Employ the circuit simulation software Micro-Cap to calculate DC and AC properties of complicated circuits.
- b. Employ numeric software (Matlab, Scipy, etc.) to curve fit non-linear data to extract circuit parameters from measured current-voltage data of non-linear circuit elements.

**ET1
ET3**

Evaluation

Course Component	Weight
Homework Assignments	20%
Laboratory	20%
Written Report	10%
Midterm Test	10%
Final Examination	40%

To obtain a passing grade in the course, a mark of 50% or more must be achieved on the final examination as well as on the laboratory. A final examination or laboratory mark < 50% will result in a final course grade of 48% or less.

Homework Assignments: Assignments will be regularly announced and posted on the course OWL site. Students must provide their answers on OWL as instructed on the assignment and by the posted due date. These assignments will be problem based.

Laboratory: This course has four lab exercises, with the laboratory mark is evenly distributed among them. Labs must be completed individually and in-person. Laboratory reports should be submitted in-person at the completion of the lab, to locker 203 in TEB, or online using OWL by the posted due date.

Written Report: Each student should write a formal report, in the style of a journal manuscript, based on characterization measurements performed on a Zener diode. These measurements can be completed during the laboratory sessions. An example written report and more information on how to complete this report are posted on OWL. The written reports should be submitted electronically on OWL by the posted due date.

Midterm Test: The midterm test will be scheduled during the regular academic term; the exact date will be determined later. Students will be notified of the test date through the course OWL site with no less than 2 weeks of advance notice. The midterm test is **optional**, if students do not complete the midterm, that portion of their grade will be added to the final examination.

Final Examination: The final examination will take place during the regular examination period, as scheduled by the registrar. If a student receives a higher grade on their final exam than on their midterm exam, the midterm grade will be discarded, and the final exam grade will be used in its stead.

Late Submission Policy: Homework Assignments should be submitted by the posted deadlines. Accommodations for late submission might be made at student's request (assuming this request is made in a timely manner) at the instructor's discretion. The priority will be marking submitted assignments and posting the answers to OWL reasonably promptly after the assignment deadline as a study aid for students. No late assignments will be accepted, for any reason, after the answers are posted. Students should complete laboratory exercises according to the posted schedule. Students must contact the instructor promptly if they are unable to meet a laboratory submission deadline and seek an accommodation. Laboratory assignments will generally not be accepted after the posted deadline unless an accommodation is granted for exceptional circumstances.

Assignment Submission Locker: Submission of any and all course work (homework, lab reports) will be done online using OWL. A submission locker will not be used.

Academic Consideration: Students who require academic consideration due to medical or personal reasons should alert the instructor of their situation as soon as possible. As all homework assignments and laboratory reports can be completed over an extended period, academic consideration is generally **only** grounds for an extension on submitting that assessment, **not** an excuse for failing to complete that assessment. In particular, **each laboratory exercise must be completed**, or the student will receive 0% for that exercise. Students with academic consideration can have their lab session rescheduled, but under no circumstances will their grade for that lab exercise be waived. Students under exceptional circumstances (i.e. prolonged leave of absence) may qualify for having the grade of individual homework assessments redistributed or use their final exam grade instead; these will be assessed at the instructor's discretion based on circumstance.

Use of English: In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work (except final examination) may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Attendance: Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the department, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course. Attendance may be assessed by the frequency of that student's access to OWL.

Absence Due to Illness or Other Circumstances: Students should immediately consult with the instructor or department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see the attached "Instructions for Students Unable to Write Tests or Examinations or Submit Assignments as Scheduled"). The student should seek advice from the instructor or department Chair regarding how best to deal with the problem. Failure to notify the instructor or department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, see the relevant section of the Academic Handbook:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf

For more information concerning accommodations for religious holidays, see the relevant section of the Academic Handbook:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf

Missed Midterm Examinations: If a student misses a midterm examination, she or he must follow the Instructions for Students Unable to Write Tests and provide documentation to Undergraduate Services Office within 24 hours of the missed test. If accommodation is granted, the department will provide a make-up test.

If a student is going to miss the midterm examination for religious reasons, they must inform the instructor in writing within 48 hours of the announcement of the exam date or they will be required to write the exam.

Since the midterm is optional, any student who misses the midterm and does not provide a request for accommodation will have that portion of their grade automatically reweighted towards the final exam.

Cheating and Plagiarism: Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

Use of Electronic Devices: Not applicable.

Use of Personal Response Devices (“Clickers”): Not applicable.

Policy on Repeating All Components of a Course: Students who are required to repeat an Engineering course must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment, or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted by the student for grading in subsequent years.

Internet and Electronic Mail: Students are responsible for regularly checking their Western e-mail and the course website (<https://owl.uwo.ca/portal/>) and making themselves aware of any information that is posted about the course.

Accessibility: Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 519-661-2111 ext. 82147 for any specific question regarding an accommodation.

Support Services: Office of the Registrar, <http://www.registrar.uwo.ca/>
Student Development Centre, <http://www.sdc.uwo.ca/>
Engineering Undergraduate Services, <http://www.eng.uwo.ca/undergraduate/>
USC Student Support Services, <http://westernusc.ca/services/>

Students who are in emotional/mental distress should refer to Mental Health @ Western, http://www.health.uwo.ca/mental_health/, for a complete list of options about how to obtain help.