ECE 4300: Electronic Circuits I

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Office Hours	**Thursdays: 5:00 – 5:30 pm**	**Office Hours**
	Fridays: 4:00 – 5:30 pm	

Course Info Site Materials for the course are posted on the course D2L site

Communication Students may contact the course instructor using MUN email or by visiting the instructor's office during Office Hours.

CALENDAR ENTRY

ECE 4300 Electronic Circuits I provides an introduction to semiconductor electronic devices and circuits. Topics covered include internal structure of electronic devices; working principles, dc and small-signal models and analysis of p-n junction diodes, bipolar junction transistors and field effect transistors; introduction to digital electronics; differential and multistage amplifier circuits; Miller's theorem; frequency response of discrete amplifiers; practical applications of the devices to the design of power supplies, amplifiers and switching circuits. CAD tools are used to illustrate the analysis and design of electronic circuits.

LH: eight 3-hour sessions per semester
OR: tutorial 1 hour per week
PR: ECE 3300 (or the former ENGI 3821), Physics 3000

LAB EXPERIENCE:

The experiments involve hands-on exercises and prelab problems that involve design and simulation of electronic circuits. Lab safety is emphasized.

CREDIT VALUE: 3 credit hours

COURSE TYPE: Core for EE and CE.

ACCREDITATION UNITS:

Contact hours/week on average over 12 weeks (Lecture/Lab/Tutorial): 3/2/1

CONTENT CATEGORIES: (expressed as %, no category can be 0 < c < 25)

Math	Natural science	Complementary Studies	Engineering Science	Engineering Design
			70%	30%

COURSE DESCRIPTION:

The broad aims of the course are to teach students:

- to learn the principles of operation, terminal characteristics and applications of the fundamental electronic devices: p-n junction diodes, metal-oxide-semiconductor field effect transistors (MOSFETs), and bipolar junction transistors (BJT);
- to develop critical thinking and problem-solving skills by emphasizing the application of conceptual understanding and the use of modelling, analytical, simulation, and experimental tools to solve problems in electronic circuits; and
- to learn the principles of electronic circuit design.

SCHEDULE:

	LECTURE: MWF, 2:00-2:50 pm	in EN-1054
	TUTORIAL: Thursdays, 4:00-4:50 pm	in EN-2040
	LABORATORY: Tuesdays and Wednesdays, 9 – 11:50 am	in CSF-2103

RESOURCES:

TEXT BOOK

- Microelectronic Circuits, 8th/ed., Sedra & Smith, Oxford University Press, 2020.

REFERENCES

- Additional Worked Examples, J.E. Quaicoe, Spring 2018 (To be posted on D2L).

LABORATORY MANUAL

- Manual of experiments, J.E. Quaicoe, Spring 2018 (To be posted on D2L).

Notes

- Lecture notes are instructed in class and posted on D2L

MAJOR TOPICS:

Unit 1 Review

1.1 Circuit convention

1.2 Review of circuit analysis: Superposition; Node-voltage analysis; Mesh-current analysis; Thévenin equivalent circuits.

Unit 2 Diodes, Diode circuits and Applications

2.1 The ideal diode: current-voltage characteristics; rectifier and logic applications

2.2 Terminal characteristics of junction diodes: regions of operation; modeling the forward characteristics of the diode; analysis of diode circuits; design of voltage regulators using diodes; small-signal model

2.3 Operation in the reverse breakdown region – Zener diodes: modeling of the zener diode; application as a shunt regulator; design of zener diode regulators

2.4 Rectifier circuits: the half-wave, full-wave and bridge rectifiers; the rectifier with filter capacitor; the peak rectifier; design of regulated power supply

2.5* Limiting and clamping circuits: limiter circuits; clamped capacitor circuits; voltage doubler (If time allows)

2.6* Other types of diodes (Directed Reading)

Unit 3 MOS Field Effect Transistors

- 3.1 Device structure and physical operation: n-channel MOSFET; p-channel MOSFET; Complementary MOS (CMOS)
- 3.2 Current-voltage characteristics: circuit symbol and conventions; n-channel MOS; finite output resistance; p-channel MOS
- 3.3 MOSFET circuits at DC: analysis of MOSFET circuits; design of MOSFET circuits

Unit 4 Bipolar Junction Transistor

- 4.1 Device structure and physical operation: npn-transistor, operation in the active mode; operation in the saturation mode; pnp-transistor
- 4.2 Current-voltage characteristics: circuits symbol and conventions; graphical representations; common emitter characteristics; Early Effect
- 4.3 BJT circuits at DC: analysis of BJT circuits; design of BJT circuits

Unit 5 Transistor Amplifiers

- 5.1 Basic amplifier principles: voltage amplification; voltage-transfer characteristics (VTC); linear amplification and biasing;
- 5.2 Small-signal models of the MOSFET and BJT; small-signal operation; small-signal voltage gain; theoretical maximum voltage gain
- 5.3 Discrete transistor biasing: MOSFET biasing; BJT biasing
- 5.4 Basic amplifier configurations: characterizing the performance of amplifiers; common-source (CS) and common-emitter (CE); common-gate (CG) and common-base (CB); source follower and emitter follower; comparisons
- 5.5 Discrete-circuit amplifiers: analysis and design of amplifier circuits
- 5.6 Useful transistor pairings: CC-CE, CD-CD, and CD-CE configurations; the Darlington configuration; CC-CB and CD-CG configurations; BiCMOS amplifiers

LEARNING OUTCOMES:

Course Level Graduate Attribute Focus: KB.D, PA.D, Des.D

Upon successful completion of this course, the student will be able to:

	LEARNING OUTCOMES	GRADUATE ATTRIBUTES. LEVEL*	Methods of Assessment
1	Describe the operation and characteristics of diodes, MOSFETs and BJTs.	KB.D	Quizzes, Midterm, Final Exam
2	Apply the concepts of electronic devices to describe the operation of electronic circuits.	KB.D, PA.D	Quizzes, Midterm, Final Exam
3	Understand the use of diodes, MOSFETs and BJTs in linear and digital applications.	KB.D, PA.D	Quizzes, Midterm, Final Exam
4	Design circuits with dc sources and resistors in diode, MOSFET and BJT circuits.	KB.D, PA.D, Inv.D, Des.D	Labs, Quizzes, Midterms, Final Exam
5	Understand and analyze MOSFET and BJT amplifier circuits with different properties.	KB. D, Inv.D	Quizzes, Midterm, Final Exam

6	Simulate electronic circuits containing diodes, MOSFETs and BJTs.	KB.D, Tools.D	Labs, Quizzes, Midterms, Final Exam
7	Conduct experiments, analysis and interpretation of results for electronic circuits.	PA.D, Inv.D	Labs, Quizzes, Midterms, Final Exam
8	Design electronic circuits and subsystems using the techniques of synthesis.	Des.D	Labs, Quizzes, Midterms, Final Exam
9	Apply simulation tools to analyze and design electronic circuits.	Tools.D	Labs, Quizzes, Midterms, Final Exam
10	Work as a member of a team.	Team.D	Labs
11	Comprehend and respond to clear instructions, as well as write effective reports.	Comm.D	Labs, Quizzes, Midterms, Final Exam

See www.mun.ca/engineering/undergrad/graduateattributes.pdf for more information on the 12 Graduate Attributes you are expected to be proficient in upon graduation.

Each Graduate Attribute for each learning outcome is rated at a level of proficiency between 1 and 3 (1=Introductory, 2=Intermediate Development, 3=Advanced Application).

ASSESSMENT:

		Approximate Due Dates
Quizzes (best 2 out of 3)	10% (5% each)	May 25; June 8; July 6
Laboratory	15%	May 26; June 2; June 9; June 16; July 7; July 14; July 21; July 28 (See the lab schedule in the course calendar on D2L)
Term Tests (2)	25% (12.5% each)	June 15; July 20
Final exam	50%	TBA

LABORATORY SESSIONS:
The laboratory component of the course will include 8 experiments/design exercises.

LAB SAFETY: Students are expected to demonstrate awareness of, and personal accountability for safe laboratory conduct. Appropriate personal protective equipment (PPE) must be worn (e.g. steel-toed shoes, safety glasses, etc.) and safe work practices must be followed as indicated for individual laboratories, materials and equipment. Students will immediately report any concerns regarding safety to the teaching assistant, staff technologist, and professor. Safety glasses must be worn throughout the experiments.

Participation: Full participation in all labs in the course is compulsory for all students. Failure to participate in all labs and complete all laboratory tasks will result in an INCOMPLETE grade.

Manuals: Lab manuals containing instructions for the labs will be posted on the course D2L site in advance.

Prelabs: Labs include prelabs which are to be completed prior to the lab session. The prelabs are to be submitted at the beginning of the lab session.

Reports*: Each experiment will be undertaken in groups of 2 students. Only one report per experiment is expected from each group but both students are required to contribute equally to every report. Additional

information on the lab reports will be posted on the course D2L site. (*see the section on **Academic Integrity and Professional Conduct** below)

Schedule: The lab schedule will be posted on the course D2L site in the course calendar.

TAs: Teaching assistants will be available to assist during the lab periods.

Due Dates: Lab reports must be submitted at the end of the lab session or before the specified due time. A report will be considered late if it is not submitted on time.

PRACTICE PROBLEMS/TUTORIALS/QUIZZES/TERM TESTS:
There will be no marked assignments in the course. Rather, practice problems (with numerical answers), along with additional worked examples will be made available through D2L. Three twenty-minute quizzes will be given during the Tutorial or Lecture slot as indicated in the course schedule. There will be no deferred or make-up quizzes. The Tutorial sessions will cover additional examples and address students' questions on the practice problems and course materials. Solutions to the practice problems will not be provided, but solutions to the quizzes will be posted on D2L. There will be two term tests in the course as scheduled in the course outline. There will be no deferred or make-up tests.
Changes and updates in the course will be announced in class and posted on the course D2L site.

CALCULATOR POLICY:
Only basic, non-programmable scientific calculators are allowed as aids during tests and exams. Other electronic aids, programmable calculators (e.g. TI-83 and TI-84) or calculators with symbolic manipulation, text storage and graphics capabilities, as well as other aids (books, notes, formula sheets electronic translators and devices, smart phones, etc.) are **NOT** allowed in term tests and final examinations. Unauthorized use of the above aids or devices during quizzes, test and examination will be considered as an academic offence.

ACADEMIC INTEGRITY AND PROFESSIONAL CONDUCT:
Students are expected to conduct themselves in all aspects of the course at the highest level of academic integrity. Any student found to commit academic misconduct will be dealt with according to the Faculty and University practices. More information is available at
http://www.mun.ca/engineering/undergrad/academicintegrity.php

Students are encouraged to consult the Faculty of Engineering and Applied Science Student Code of Conduct at http://www.mun.ca/engineering/undergrad/academicintegrity.php and Memorial University's Code of Student Conduct at http://www.mun.ca/student/conduct/.

INCLUSION AND EQUITY:
Students who require accommodations are encouraged to contact the Glenn Roy Blundon Centre, http://www.mun.ca/blundon/about/index.php. The mission of the Blundon Centre is to provide and co-ordinate programs and services that enable students with disabilities to maximize their educational potential and to increase awareness of inclusive values among all members of the university community.

The university experience is enriched by the diversity of viewpoints, values, and backgrounds that each class participant possesses. In order for this course to encourage as much insightful and comprehensive discussion among class participants as possible, there is an expectation that dialogue will be collegial and respectful across

disciplinary, cultural, and personal boundaries.

STUDENT ASSISTANCE:
Student Affairs and Services offers help and support in a variety of areas, both academic and personal. More information can be found at www.mun.ca/student.

Students requiring accommodation for a final exam should contact the Blundon Centre in advance to arrange the accommodation. All requests must be based on documented need in accordance with the Accommodations for Students with Disabilities Policy.

To allow sufficient time to arrange the accommodation, students should contact the Blundon Centre at least one month before a final exam and at least two weeks before a scheduled in-class assignment or test.

More information about arranging accommodations can be found here:
http://www.mun.ca/blundon/accommodations/