



Course Outline

Instructor

- Douglas Buchanan, P.Eng.
E3-453 EITC
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Office Hours

- By appointment – please email.

Teaching Assistant

- Prabodha Rathnayaka
Mudiyanselage
rathnayp@myumanitoba.ca
- Udeshika Madushani Hettiarachchi
hettiaru@myumanitoba.ca

Contact Hours

- 4 credit hours
- Lectures:
3 hours x 13 weeks = 39 hours
- Laboratories:
3 hours x 5 weeks = 15 hours

Prerequisites:

- ECE 3670 Electronics 3
- PHYS 2152 Modern Physics for Engineers
- MATH 3132 Engineering Mathematical Analysis 3

Traditional Territories Acknowledgement

The University of Manitoba campuses are located on the original lands of the Anishinaabeg, Ininiwak, Anisininewuk, Dakota Oyate and Dene, and on the National Homeland of the Red River Métis.

We respect the Treaties that were made on these territories, we acknowledge the harms and mistakes of the past, and we dedicate ourselves to move forward in partnership with Indigenous communities in a spirit of reconciliation and collaboration.

ECE 3600 – Physical Electronics

Winter 2025

Course Objectives

In this course we will cover basic solid-state theory; properties of semiconductors; principles of metal-semiconductor junctions, p-n junctions and transistors; and optoelectronic processes.

Course Content

The following topics will be covered:

- Electrons in a solid, Ohm's law, Hall effect
- Electromagnetic fields in a solid, electron as a wave, de Broglie relation
- Quantum theory: Potential barriers and tunneling
- Free-electron model for metals, thermionic emission
- Band theory of solids, semiconductors
- Electrons, holes and effective mass
- Doping, law of mass action
- PN junctions: Rectification and capacitance
- Zener, avalanche and Schottky diodes
- MOSFETs, bipolar junction transistors (BJTs)
- Optoelectronics: Detectors and sources
- Dielectric materials: Polarization, ferroelectric and piezoelectric materials
- Magnetic materials: Properties, types, structures, uses.

Textbook

Principles of Electronic Materials and Devices, S.O. Kasap, McGraw-Hill, 4th edition, 2017.

Learning Outcomes

1. Summarize simple models that link the physical character of atoms and their bonding in solids to the bulk character of metallic semiconductor, dielectric and magnetic materials
2. Identify how these basic descriptions of materials underpin simple operational descriptions of electronic devices and systems including, diodes, transistors, transducers and power transformers.
3. Demonstrate a mastery of these concepts through comparisons of how different materials/ component designs can be used in examples including temperature sensing, optical detectors and data storage.

Expected Competency Levels

Outcome	KB	PA	IN	DE	ET	IT	CS	PR	IE	EE	EP	LL
1	A	A	D		D							
2	D	D	D		A				I	I		D
3	D	D	D		A			D	I	I	I	D

CEAB Graduate Attributes Assessed

- KB.4 – Recalls and defines, and/or comprehends and applies, first principles and concepts in specialized engineering science.
- IN.4 – Understands appropriate safe work procedures during experiments or laboratory exercises.

Important Dates

- **Term Test**
Wednesday, February 26th, 2025
6:00PM – 8:00PM
- **Voluntary Withdrawal Deadline**
March 19th, 2025
- **Louis Riel Day**
February 17th, 2025
No classes or examinations
- **Spring Break**
February 18th – 21st, 2025
No classes or examinations
- **Good Friday**
April 18th, 2025
No classes or examinations

Accreditation Details

Accreditation Units

- Mathematics: 0%
- Natural Science: 30%
- Complementary Studies: 0%
- Engineering Science: 70%
- Engineering Design: 0%

Graduate Attributes

KB: A knowledge base for engineering
PA: Problem analysis
IN: Investigation
DE: Design
ET: Use of engineering tools
IT: Individual and team work
CS: Communication skills
PR: Professionalism
IE: Impact of engineering on society/
environment
EE: Ethics and equity
EP: Economics and project
management
LL: Life-long learning

Competency Levels

I - Introduced (Introductory)
D - Developed (Intermediate)
A - Applied (Advanced)

Evaluation

Calculators are permitted for examinations. PDAs and other wireless electronic devices are forbidden. The student may be required to perform a hard reset on programmable calculators (programmable calculators are not required). Students must complete all assignments, laboratories, and must receive a minimum grade of 50% on the final examination in order to be eligible to receive a passing grade.

Component	Value (%)	Method of Feedback	Learning Outcomes Evaluated
Assignments	10	F, S	1, 2, 3
Laboratories	15	F, S	1, 2, 3
Term Test	25	F, S	1, 2
Final Examination	50	S	1, 2, 3

* Method of Feedback: F - Formative (written comments and/or oral discussion), S - summative (numerical grade)

Student Absences

Attendance in lectures, tutorials, and laboratories is mandatory. For short-term absences due to illness or other extenuating circumstances of 120 hours (5 days) or less, students are required to complete a *Self-Declaration Form for Brief or Temporary Absence* available on the University website. This form must be submitted to the course instructor within 48 hours of the absence. (No additional documentation is required.)

Note that students are responsible to complete any missed work and must consult with the instructor to make appropriate arrangements.

For absences longer than 120 hours, students must contact the instructor and ECE Undergraduate Advisor, Tammy Holowachuk (Tammy.Holowachuk@umanitoba.ca) for further instructions.

Deferred Final Examinations

Students who miss the regular scheduled writing of a final examination, for valid medical or compassionate reasons, may be given the opportunity to write a deferred examination, subject to approval by the Associate Dean (Undergraduate). All requests for a deferred examination must be made within 48 hours of the missed examination, and must follow the procedure described on the Faculty website, without exception. Course instructors do not have the discretion to grant deferred final examinations.

(<https://umanitoba.ca/engineering/student-experience#engineering-student-policies>)

Academic Integrity

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the *General Academic Regulations on Academic Integrity*, students are reminded that plagiarism or any other form of cheating in examinations, term tests, assignments, projects, or laboratory reports is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating by another student is also subject to serious academic penalty.

Requirements/Regulations

- Attendance at lectures and laboratories is essential for successful completion of this course. Students must satisfy each evaluation component in the course to receive a passing final grade.
- It is the responsibility of each student to contact the instructor in a timely manner if he or she is uncertain about his or her standing in the course and about his or her potential for receiving a failing grade. Students should also familiarize themselves with the University's *General Academic Regulations*, as well as Section 3 of the Faculty of Engineering *Academic Regulations* dealing with incomplete term work, deferred examinations, attendance and withdrawal.

Grading Scale

Letter	Mark
A+	95–100
A	85–94
B+	80–84
B	70–79
C+	65–69
C	55–64
D	45–54
F	< 45

Note: These boundaries represent a guide for the instructor and class alike. Provided that no individual student is disadvantaged, the instructor may vary any of these boundaries to ensure consistency of grading from year-to-year.

- No programmable devices or systems (such as calculators, PDAs, iPods, iPads, cell phones, smart watches, wireless communication or data storage devices) are allowed in examinations unless approved by the course instructor.
- Students should be aware that they have access to an extensive range of resources and support organizations. These include Academic Resources, Counselling, Advocacy and Accessibility Offices as well as documentation of key University policies e.g. Academic Integrity, Respectful Behaviour, Examinations and related matters.

 [Supplemental Resources](#)

Copyright Notice

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Retention of Student Work

Students are advised that copies of their work submitted in completing course requirements (i.e. assignments, laboratory reports, project reports, test papers, examination papers, etc.) may be retained by the instructor and/or the department for the purpose of student assessment and grading, and to support the ongoing accreditation of each Engineering program. This material shall be handled in accordance with the University's *Intellectual Property Policy* and the protection of privacy provisions of *The Freedom of Information and Protection of Privacy Act (Manitoba)*. Students who do not wish to have their work retained must inform the Head of Department, in writing, at their earliest opportunity.