ECE 3600 – Physical Electronics  

**Winter 2022**

**IMPORTANT NOTICE – In-Person Laboratories**

Lectures will initially be conducted via remote instruction but will return to *in-person instruction* the week of February 28th 2022. All students are required to be present for in-person instruction at that time. All laboratories will be conducted in-person and will be subject to masking and social distancing requirements. Furthermore, University policy requires all students to be fully vaccinated against COVID-19 in order to attend campus and participate in this course.

**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**


**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**

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<th>Outcome</th>
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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.

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.

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

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<th>Component</th>
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<th>Method of Feedback</th>
<th>Learning Outcomes Evaluated</th>
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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.
- 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.

Copyright Notice

All materials provided in this course are copyright and are provided under the fair dealing provision of the Canadian Copyright Act. This material may not be redistributed in any manner without the express written permission of the relevant copyright holder.
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.