University of Manitoba | Price Faculty of Engineering
Department of Electrical and Computer Engineering

Course Outline

Instructors

- Prof. Douglas Buchanan, P.Eng.
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Office Hours

- By appointment only

Teaching Assistant

- Isabelle Anderson-Gregoire
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- Leon Katsnelson
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- Chris Nguyen
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- David Xavier
  xavierd@myumanitoba.ca

Contact Hours

- 5 credit hours
- Lectures:
  3 hours x 13 weeks = 39 hours
- Laboratories:
  3 hours x 10 weeks = 30 hours

Prerequisites:

- ENG 1450 Introduction to Electrical and Computer Engineering

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 2220 – Digital Logic Systems

Fall 2024

Course Objectives

Boolean algebra and logic primitives, simplification of Boolean functions, number systems and codes, digital encoder, decoder, multiplexer, de-multiplexer, Boolean based adding, subtraction, multiplication and different primitive elements of the CPU. Introduction to hardware description languages such as Verilog. Analysis and design of synchronous sequential circuits; applications to computation, measurement, and control.

Course Content

The following topics will be covered:

- Digital systems: digital computers and digital systems; binary, octal and hexadecimal number systems; complements; signed binary numbers; decimal and binary codes; introduction to binary logic.
- Boolean algebra: basic definitions, theorems, and properties of Boolean algebra; Boolean functions; standard forms of Boolean functions; logic operations.
- Introduction to Verilog (Verilog will be used throughout the course).
- Simplification of Boolean functions: Karnaugh map method, don't care conditions, NAND, and NOR implementation, and exclusive-OR function.
- Combinational circuits: analysis and design procedures; digital encoder, decoder, multiplexer and de-multiplexer and their application to realize a Boolean function; adders, subtractors, multilevel NAND/NOR circuits and code conversion.
- Analysis of synchronous sequential circuits: flip-flops; analysis of clocked sequential circuits; state reduction and assignment.
- Design of sequential circuits: flip-flop excitation tables, design procedures, counter designs, simplification of finite state machines.
- Registers, counters, and memory devices: shift registers, ripple counters, synchronous counters, and timing sequences.
- Finite State Machines (FSM): FSM charts, timing issues; data and control aspects of FSM design procedures.

Textbook

Fundamentals of Digital Logic with Verilog Design, Stephen Brown and Zvonko Vranesic, McGraw-Hill, 3rd edition, 2009.

Learning Outcomes

1. Interpret, convert, and represent different number systems and binary arithmetic.
2. Manipulate and examine Boolean algebra, logic operations, Boolean functions and their simplifications.
3. Design and analyze combinational logic circuits.
4. Design and analyze sequential logic circuits.
5. Represent a logic circuit design problem using a finite-state machines (FSM).

Important Dates

- **Term Test**
  October 25th, 2024
  6:00PM – 8:00PM
- **Voluntary Withdrawal Deadline**
  November 19th, 2024
- **National Day for Truth and Reconciliation**
  September 30th, 2024
  No classes or examinations
- **Thanksgiving Day**
  October 14th, 2024
  No classes or examinations
- **Remembrance Day**
  November 11th, 2024
  No classes or examinations
- **Fall Term Break**
  November 12th –15th, 2024
  No classes or examinations

Accreditation Details

Accreditation Units

- Mathematics: 0%
- Natural Science: 0%
- Complementary Studies: 0%
- Engineering Science: 60%
- Engineering Design: 40%

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)

Expected Competency Levels

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

Evaluation

The final course grade is determined by the student's performance on a design project, in laboratories, and on examinations. Students must complete all the laboratories, and receive a passing grade on the final exam, in order to be eligible to pass the course.

Component	Value (%)	Method of Feedback	Learning Outcomes Evaluated
Laboratories	16	F, S	1, 2, 3, 4, 5
Term Project	4	F, S	1, 2, 3, 4, 5
Assignments	5	F, S	1, 2, 3, 4, 5
Term Test	25	F, S	1, 2, 3
Final Examination	50	S	1, 2, 3, 4, 5

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

CEAB Graduate Attributes Assessed

KB.3 – Recalls and defines, and/or comprehends and applies information, first principles, and concept in fundamental engineering science.

DE.3 – Develops/implements possible solutions to an open-ended design problem, leading to an appropriate recommendation.

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)

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.

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.

Copyright Notice

Requirements and 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 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, 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

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.