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.

Prerequisites
ENG 1450 Introduction to Electrical and Computer Engineering

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 condition; NAND and NOR implementation; 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
- Serial Peripheral Interface and simple digital data communication
- 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, timing sequences, and Random Access Memory (RAM)
- Algorithmic State Machines (ASM): ASM chart, timing issues; data and control aspects of ASM design procedures.

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

Web Page
http://ece.eng.umanitoba.ca/undergraduate/ECE2220

Textbook
Other References


Evaluation Details
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.

Mid-Terms
Friday, October 10, 2014, 6:30-8:30 PM (location TBA)
Friday, November 7, 2014, 6:30-8:30 PM (location TBA)

Instructors
Room: EITC E1-552
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Ahmad Byagowi, Ph.D., P.Eng.
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Office Hours
By appointment.

Teaching Assistants
Charith Gunasekara (email: charith@umanitoba.ca)
Jose Juan Mijares Chan (email: ummijare@cc.umanitoba.ca)

Voluntary Withdrawal Date
Wednesday, November 12th, 2014

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 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 Sections 4 and 6 of the 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.

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 and Requirements of the University of Manitoba, Section 7.1, students are reminded that plagiarism or any other form of cheating in examinations, assignments, laboratory reports or term tests is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating in examinations or term assignments is also subject to serious academic penalty.

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).

**Expected competency level**

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<thead>
<tr>
<th>Learning Outcome</th>
<th>Attribute*</th>
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*Attributes:*
- A1: A knowledge base for engineering
- A2: Problem analysis
- A3: Investigation
- A4: Design
- A5: Use of engineering tools
- A6: Individual and team work
- A7: Communication skills
- A8: Professionalism
- A9: Impact of engineering on society/environment
- A10: Ethics and equity
- A11: Economics and project management
- A12: Life-long learning

**Competency Levels:**
- 1 - Knowledge (Able to recall information)
- 2 - Comprehension (Able to rephrase information)
- 3 - Application (Able to apply knowledge in a new situation)
- 4 - Analysis (Able to break problem into its components and establish relationships)
- 5 - Synthesis (Able to combine separate elements into whole)
- 6 - Evaluation (Able to judge of the worth of something)

**Student Contact Time (Hrs)**
- Lectures: 3 hrs lecture/week × 13 weeks/term = 39 hrs
- Laboratories: 3 hrs laboratory × 10 weeks = 30 hrs
- Tutorials: 0 hr tutorial × 0 weeks = 0 hrs

**Evaluation**

<table>
<thead>
<tr>
<th>Component</th>
<th>Value (%)</th>
<th>Methods of Feedback *</th>
<th>Learning Outcomes Evaluated</th>
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* Methods of Feedback: F - formative (written comments and/or oral discussion), S - summative (number grades)