

George Mason University
Volgenau School of Engineering
Department of Electrical and Computer Engineering

ECE 331: Digital System Design
Syllabus
Spring 2014

Professor:	Dr. Craig Lorie 3221 Nguyen Engineering Bldg. clorie@gmu.edu (703) 993 – 9616	Teaching Assistants:	Bilal Habib bhabib@gmu.edu Yamini Ravishankar yravisha@gmu.edu
Lecture:	Tuesday / Thursday, 9:00 – 10:15am	Innovation Hall, room 105	
Office Hours:	See class webpage (provided below).		
Prerequisites:	Grade of C or better in PHYS 260 and 261.		
Corequisites:	ECE 332 (Digital System Design Lab) ECE 280 (Electric Circuit Analysis) or ECE 285 (Electric Circuit Analysis I)		
Required Text:	<i>Fundamentals of Digital Logic with VHDL Design, 3rd Edition</i> , by Brown & Vranesic ISBN-13: 978-0-07-722143-0		
Hardware:	Digilent Basys2 Board	http://www.digilentinc.com/	
Software:	Xilinx ISE WebPack Logisim	http://www.xilinx.com http://ozark.hendrix.edu/~burch/logisim/	
Course Webpages:	https://mymasonportal.gmu.edu/ (Blackboard) http://ece.gmu.edu/~clorie/fall2013/ece331/		
Textbook Website:	http://www.elsevierdirect.com/v2/companion.jsp?ISBN=9780123944245		

COURSE DESCRIPTION

This course provides an introduction to the analysis and design of digital logic circuits. It takes a bottom-up approach, using basic logic gates as the fundamental building block, to design simple combinational and sequential logic circuits; these simple logic circuits are then used in the design of more complex digital circuits and systems. The course covers both an historic and a modern design methodology. The historic methodology makes use of Karnaugh maps for circuit simplification and discrete components for circuit realization. The modern methodology implements VHDL for circuit description, CAD tools for design entry and circuit simulation, and PLDs (programmable logic devices) for circuit realization. Equal time is devoted to these two methodologies. The course covers topics ranging from basic logic operations and Boolean expressions through complex Finite State Machines (FSMs). Credits: 3 (Lecture: 3, Lab: 0).

The associated laboratory course (ECE 332) provides practical experience in digital logic circuit design using discrete components, and using VHDL, CAD tools, and PLDs. Credits: 1 (Lecture: 0, Lab: 1).

LEARNING OUTCOMES

Following successful completion of ECE 331, the student will be able to:

- Convert between the binary, decimal, and hexadecimal number systems.
- Specify a Boolean equation from a truth table, and complete the truth table for a Boolean equation.
- Minimize Boolean equations using Boolean algebra and Karnaugh maps.
- Analyze combinational logic circuits.
- Design a two-level combinational logic circuit that implements a Boolean equation specified in either of the standard forms – sum of products (SOP) or product of sums (POS).
- Design a minimum-cost combinational logic circuit, given the circuit specification.
- Describe a combinational logic circuit using VHDL
- Design a latch and a flip-flop from basic logic gates.
- Describe a latch and a flip-flop using VHDL.
- Design registers and shift-registers from flip-flops.
- Describe registers and shift-registers using VHDL.
- Design counters from flip-flops and combinational logic.
- Describe counters using VHDL.
- Design a minimum-cost sequential logic circuit, given the circuit specifications.
- Describe a sequential logic circuit (or finite state machine) using VHDL.
- Analyze sequential logic circuits.
- Design a one-bit adder from basic logic gates.
- Design a multiple-bit adder/subtractor from one-bit adders and combinational logic.
- Describe a multiple-bit adder/subtractor using VHDL.
- Design complex digital logic circuits and systems from simple logic circuits (ie. hierarchical design).
- Write simple VHDL testbenches to simulate and test VHDL designs.

TOPICS TO BE COVERED INCLUDE:

1. Number systems and Binary codes.
2. Signed binary numbers.
3. Binary arithmetic
4. Basic logic gates, Electrical characteristics, and CMOS circuits.
5. Truth tables, Boolean expressions, and Logic circuits; Boolean algebra
6. Introduction to VHDL and VHDL Testbenches
7. Karnaugh Maps
8. Timing analysis and Hazards
9. Arithmetic Circuits
10. Multiplexers, Demultiplexers, Decoders and Encoders
11. Programmable Logic Devices
12. Arithmetic and Logic Unit (ALU)
13. Latches and Flip-Flops
14. Registers and Shift-Registers; Counters
15. Sequential Logic Circuits (Finite State Machines)
16. Memories

COURSE SCHEDULE:

The course schedule is provided in a separate document on Blackboard and the class website.

IN-CLASS EXERCISES AND I>CLICKERS

Learning is an active process, not a passive process. Active participation in class will lead to a deeper understanding of the material covered. To this end, each class meeting will include a set of exercises spaced throughout the lecture. The lecture, itself, will introduce the basic concepts, and provide explanations and examples of these concepts. The in-class exercises will provide you the opportunity to apply your understanding of the concepts to similar and more complex problems. To get the most out of these exercises, you should review the lecture slides and read the associated sections of the textbook *before each class meeting*. You are expected to participate in these in-class exercises, and will be assigned a grade based on your class participation (see "Course Grade" section of this syllabus, below).

GRADING OF IN-CLASS EXERCISES:

No response	0 pts.
Incorrect response	1 pt.
Correct response	2 pts.

I>CLICKERS:

To participate in the in-class exercises, you must purchase and register an I>clicker device. These devices can be purchased from the Bookstore or from the I>Clicker website:

<http://www1.iclicker.com/purchase-response-devices>

Since the in-class exercises will be multiple-choice questions, either the I>Clicker+ or the I>Clicker2 can be used. If you prefer to use your smartphone, you can purchase the I>Clicker app (I>ClickerGO). Please note that the Bookstore only carries the I>Clicker2. If you wish to purchase either of the other options, you must do so at the I>Clicker website.

Once purchased, the I>Clicker devices must be registered at the I>Clicker website:

<http://www1.iclicker.com/register-student-remote>

If you do not register your I>Clicker device, your responses will not be properly recorded, and you will not get proper credit for your participation.

Important information when registering your I>Clicker device:

- GMU uses a Learning Management System (Blackboard)
- Your student ID is the prefix of your email address
(for example, if your email address is xyz@gmu.edu, then your student ID is **xyz**).

READING AND HOMEWORK ASSIGNMENTS

Learning is a process that begins before you enter class, and continues long after you leave. This process includes, but is not limited to, the following steps:

1. Attending class, taking notes, and participating in in-class exercises.
2. Reading the assigned material from the course textbook (and any supplemental material).
3. Completing the assigned homework problems.

To learn the material, and to be successful in this course, you should expect to spend a considerable amount of time outside of class completing the assigned readings and problem sets.

There will be weekly reading assignments. These readings will, in general, be from the course textbook. When necessary, readings from a supplemental source will be assigned. The reading assignments will provide the details that cannot be covered in class. You are expected to complete the assigned reading before starting the corresponding problem set.

There will be weekly homework assignments. Each assignment will consist of the above mentioned reading assignment and a related problem set. These problems are intended to exercise your understanding of the material covered in class and in the reading, and to provide you with an opportunity to apply what you have learned to academic and practical problems. This practice should help you prepare for the exams. You are expected to complete all of the assigned problems to the best of your abilities. You are encouraged to work together on the homework assignments and to share ideas about how to solve the problems.

The homework assignments will be posted on Blackboard. The due date for each assignment is specified in the course schedule (provided in a separate document). Solutions to each problem set must be submitted at the BEGINNING of class on the specified due date. Late submissions will NOT be accepted.

Homework solutions should be formatted as follows:

1. Your name should appear at the top-left on all pages of your solutions.
2. The class number (ie. ECE 331) and the assignment number should appear below your name.
3. All pages should be numbered at the top-right.
4. All pages should be stapled together.
5. All solutions should be written neatly and clearly – if we cannot read it we will not grade it!
6. Solutions to individual problems should be clearly separated – you should either use a horizontal line to separate problem solutions or you should start the solution to a problem on a new page.

Failure to follow the above guidelines will result in a **zero** on the assignment!

GRADING OF EACH PROBLEM SET:

Two problems selected at random	Graded for completeness and correctness	4 pts. each
Remaining problems	Graded for effort	1 pt. each

The lowest homework grade will be dropped at the end of the semester.

EXAMS

There will be three exams in this course:

- Midterm Exam #1
- Midterm Exam #2
- Final Exam

See the course schedule for the date of each exam.

All exams are **closed book**. I will provide the necessary reference materials for all exams.

If you cannot make one of the scheduled exams, you must speak with me **in advance** to arrange for an alternate time to take the exam.

RECITATION

The recitation will be conducted by the teaching assistants. Each recitation meeting will include a brief lecture to supplement the material provided in class. You are responsible for all of the material covered in recitation. A schedule of the topics covered in recitation is provided in a separate document on Blackboard and the class website.

With the remaining time, the teaching assistants will answer questions regarding past and present homework assignments, the material covered in lecture and recitation, and the labs.

Attendance will be taken in recitation.

Homework assignments will be returned in recitation.

LABORATORY

The laboratory course (ECE 332) consists of a set of experiments to complement the material covered in the lecture course. The majority of the laboratory experiments focus on the use of VHDL (hardware description language), the Xilinx ISE (CAD tool), and the Digilent Basys2 development board, to design, simulate, synthesize, and test combinational and sequential logic circuits. Additional experiments provide experience in circuit design using discrete components, a breadboard, and circuit wiring.

You are expected to be prepared for each lab. This includes review of the associated lecture materials, completion of the associated reading, and, most importantly, completion of the pre-lab. To assess your preparation for the lab, a quiz will be given at the beginning of each lab meeting. You must pass the quiz to receive a full score for the lab. If you fail the quiz:

- the score for the lab will be reduced by 20%.
- no additional time will be provided to complete the lab (beyond the given lab time).
- lower priority will be given to your questions during lab.

You will be expected to complete a lab report for each laboratory experiment.

The laboratory course is administered by the teaching assistants. They will provide additional materials, including a course syllabus, lab schedule, pre-lab requirements, and lab report guidelines. A separate grade will be assigned for the laboratory course by the TAs.

The experiments to be performed include:

0. Lab introduction and overview of laboratory equipment.
1. Introduction to the Xilinx ISE and the Digilent Basys2 Development board.
2. Verify logical and electrical characteristics of digital logic gates.
3. Design of combinational logic circuits using discrete components.
4. Design of a BCD to 7-segment decoder using VHDL.
5. Design of binary adder circuits using VHDL.
6. Design of multiplexers and decoders using VHDL.
7. Design of an arithmetic and logic unit (ALU) using VHDL.
8. Design of a latch, flip-flop, and register using VHDL.
9. Design of a register file using VHDL.
10. Design of a finite state machine (FSM) using VHDL.
11. Design of a serial multiplier using VHDL.

Attendance in lab is **mandatory**. Attendance will be taken.

ATTENDANCE

You are expected to attend class, however attendance will not be formally recorded. Failure to attend class does not excuse you from the material covered. If you miss class you must consult with one of your classmates to obtain the notes and/or problem solutions that were presented. Furthermore, you will receive a zero for any in-class exercises that were missed.

You are expected to attend ALL recitation meetings.

You are expected to attend ALL lab meetings. Attendance in lab is mandatory.

COURSE GRADE

The final grade for the course is based on my best assessment of your understanding of the material and your participation in the class during the semester. The exams, projects, and homework assignments will be used to determine your final grade according to the following weighting:

Homework	10%
In-class Exercises	5%
Midterm Exam #1	25%
Midterm Exam #2	25%
Final Exam	35%

The final letter grade will be assigned accordingly.

ACADEMIC INTEGRITY

The George Mason University Honor Code is stated as follows:

"To promote a stronger sense of mutual responsibility, respect, trust, and fairness among all members of the George Mason University community and with the desire for greater academic and personal achievement, we, the student members of the University Community have set for this:

Student members of the George Mason University community pledge not to cheat, plagiarize, steal, and/or lie in matters related to academic work."

You are expected to abide by the Mason Honor Code. Violations of the Honor Code are taken very seriously and will be prosecuted to the fullest extent. This includes, but is not limited to, cheating on homework assignments, quizzes, projects, labs, and exams.

As indicated above, you are encouraged to work together on assessments, and share ideas about solutions to problems. However, you must submit your own work. Copy the solution from another student, or from the author's solution manual, is considered cheating and is a violation of the Honor Code.

For more information about the Mason Honor Code and about the Honor Committee, please visit the website for the Office of Academic Integrity (<http://oai.gmu.edu/>).

GMU EMAIL ACCOUNTS

Students must use their Mason email account to receive important University information, class-related messages, and to communicate with the professor and the teaching assistants.

See <http://masonlive.gmu.edu> for more information.

CLASSROOM ETIQUETTE

Cellphones are to be turned off during class; minimally they must be silenced. Emergency calls may be taken, but must be taken outside of the classroom.

Texting, using your laptop for something other than lecture-related work, etc. is considered a distraction to me and to the other students trying to learn in the class, and will not be tolerated.

OFFICE OF DISABILITY SERVICES (ODS)

If you are a student with a disability and require special accommodations, please contact me and the Office of Disability Services as soon as possible. All special accommodations must be arranged through ODS.

Office of Disability Services (ODS): (703) 993 – 2474; <http://ods.gmu.edu>

OTHER USEFUL CAMPUS RESOURCES

- Writing Center: A114 Robinson Hall; (703) 993 – 1200; <http://writingcenter.gmu.edu>
- University Libraries: “Ask a Librarian” <http://library.gmu.edu/mudge/IM/IMRef.html>
- Counseling and Psychological Services (CAPS): (703) 993 – 2380; <http://caps.gmu.edu>
- The University Catalog: <http://catalog.gmu.edu>
- University Policies: <http://universitypolicy.gmu.edu>