EECE 251: Digital Logic Design
Syllabus – Fall 2025

Department of Electrical and Computer Engineering, Binghamton University

Course Description

Fundamental and advanced concepts of digital logic. Boolean algebra and functions. Design and implementation of combinational and sequential logic, minimization techniques, number representation, and basic binary arithmetic. Logic families and digital integrated circuits and use of FPGA synthesis and implementation tools for logic design. Laboratory exercises and Instructor Information on Brightspace.

Course Instructor & Office Hours

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Office Hours: Monday, 11 am – 12 pm in LNG 109 (EDD CR)
Other times available by appointment (request by email)
Teaching assistant: Angelo DiTocco (aditocc1@binghamton.edu) hours: TBD
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Course Format

This course has the following key components:

- **Video Lectures:** Course lectures will be presented via a series of short, single-topic videos, which are designed to be compatible with all modern computers. Lectures will be accessible from our course page on Brightspace. In lieu of a traditional lecture, you will be required to watch at least one short lecture video prior to each class. These videos are designed to convey the core concepts which you will use and strengthen during each lecture activity. Failure to watch the videos regularly before class impacts your grade.
- **Classroom Activities:** Attendance is mandatory, as check off for each activity counts as your attendance for the class. Each lecture will have an assigned in-class activity. You will only get credit for the lecture activity/attendance if you are present in class

and participate. The students will work in pairs to solve the assigned activity and will have assistance from the course staff. The activities will be based on the concepts from the assigned video lectures. **It is required that the student watch the video lectures before coming to class.** They will be posted in advance. The attendance and participation must be in person.

- **Quizzes:** With few exceptions, there will be a short online quiz associated with each lecture. These quizzes are based on the activities and homework that precede the quiz. These are graded.
  - *You must work alone on the quizzes*; if you are receiving help from anyone on the quiz that is a violation of the academic honesty policy (stated in this document).
  - No quizzes will be dropped. There will be *no extensions* or quiz re-openings once the deadline has passed, and the quizzes are closed.
- **Lab Assignment:** Lab attendance, and successful completion of each lab is mandatory. You will work on the labs with a partner. These are fixed group assignments, once you find/assigned a partner it cannot be changed mid-semester without the approval or instruction of the course instructor. Lab partners receive the same grade. Make sure all lab files are shared between you and your lab partner so you both don't lose access to them, should one partner become unavailable.
- **Exams and Project:** There will be two midterm exams during the semester and one final project. You will work on the final project in a group of two students. The policies for the final project will be communicated by the instructor when the project is introduced.
- **Homework:** A homework is associated with most lectures. The assignments are graded automatically, and you can try each problem as many times as you want. You may collaborate on homework problems, but you should be able to do each problem on your own in preparation for the quiz. *These are not graded; they are assigned for self-study and practice.*

Binghamton University Policy on Credit Hours

This course is a 4-credit course, which means that students are expected to do at least 12.5 hours of course-related work or activity each week during the semester. This includes scheduled class lecture/discussion meeting times as well as time spent completing assigned readings, studying for tests and examinations, participating in lab sessions, preparing written assignments, and other course-related tasks.

Recommended Text

The following textbook is not required, but recommended if you would like a textbook to supplement the provided course materials. Frank Vahid, *Digital Design with RTL Design, VHDL and Verilog*, 2nd ed. Wiley. ISBN: 9780-47053108-2

Required Supplies

Hardware: This class will make use of an FPGA board. You have already purchased this kit through the course fee associated with this class. These kits will be distributed by the instructor and will be yours to keep. You will want to hold on to these kits as you will use them in several subsequent EECE classes. You are also responsible for them after the first week of the Lab.

Inoperable kits are your responsibility after the first lab. You will be responsible for replacing them, so make sure you take good care of your lab kits and test them in a timely manner i.e. as soon as you receive them.

Software: We will use the following software tools in the lab:

1. **Xilinx Vivado:** This software is available on the lab VMs. Virtual Machines have been setup to access this software outside of labs as well. Instructions on how to remotely access the virtual machines are provided with the course materials. There is also a free version of this software available online for download (not for MAC users). You may download a copy for offline use, but please note that the debugging associated with the installation is your responsibility.
2. **LogicDesigner:** This is an open-source tool that we created to help you design circuits with digital components discussed in class. The tool will convert your digital circuits to Verilog. You may also simulate circuits to understand the functionality of different components.
3. **DigitalSystemsDesigner:** This is an open-source tool that we created to help you design schematic diagrams of more complex logic than LogicDesigner, including busses and RTL level components. The tool can be used to simulate functionality, while also converting your digital circuits to Verilog.

Note that, while the LogicDesigner and DigitalSystemsDesigner help with schematic capture, design verification and Verilog exports, they are meant to be learning aides. It is imperative that you understand how the logic works, not just how to draw and simulate it. Likewise, the labs in the course introduce the FPGA board and associated programming. One objective of the course is to start developing an understanding of FPGA programming that will be built upon in future courses. Therefore, you are expected to be able to read, understand and debug Structural Verilog outside of these design tools.

Storage Drive: During labs we will use either Google File stream or the student U drive. It is important to have adequate space available to avoid system crashes and loss of files. *It is your responsibility to adequately maintain your drive and backup your work to avoid losing project files. No accommodation will be made for loss of work.*

Course Topics

1. Basics of digital systems: digital signals, encoding theory, number representation

2. Combinational circuit design: logic gates, switching algebra, standard representations and logic families, non-ideal timing properties
3. Sequential circuit design: memory elements (latches, flip-flops), clocked synchronous circuits, ideal and non-ideal timing properties, handling asynchronous inputs, metastability reduction strategies
4. Synchronous design abstractions: finite state machine design and analysis, validating FSM descriptions, creating circuits from finite state machine descriptions, control-Datapath partitioning
5. Data path elements: design of complex combinational elements and arithmetic circuitry, register files

Course Objectives

After completing this course, each student should be able to:

1. Determine whether a digital circuit will be an effective solution to a design problem.
2. Use standard and custom digital codes to represent abstract values, including numbers; and convert these codes between numeric bases, including binary and hexadecimal representations.
3. Represent the functional behavior of a combinational logic circuit using a Boolean expression, truth table, and circuit diagram; and convert between equivalent representations.
4. Create gate-level logic circuits from a Boolean expression or truth table using the AND-ORNOT, NAND-only, and NOR-only logic families.
5. Construct combinational logic circuit from a problem description using both basic gates and higher- level combinational components, such as multiplexers, decoders, adders, subtractors, and comparators.
6. Use techniques such as Boolean algebra and Karnaugh Mapping to find a size optimized form of a Boolean expression.
7. Analyze the timing of combinational logic circuits using a gate-delay model and identify the maximum and minimum timing path(s) through a circuit.
8. Design and analyze synchronous circuits which utilize latches and flip-flops as data storage elements.
9. Create timing diagrams which describe the behavior of ideal asynchronous and clocked synchronous sequential circuits.
10. Analyze the non-ideal timing behaviors of a flip-flop based clocked synchronous circuit and determine the maximum frequencies under which it should behave correctly.
11. Describe the conditions under which metastability can occur and apply strategies to reduce the risk of metastability in a synchronous circuit.
12. Create complex, synchronous data-processing circuits whose components include ALUs and register files.

Grade Components

COMPONENT	% OF TOTAL
Lectures	10%
Quizzes	15%
Labs	20%
Midterm Exams (2)	30%
Final Project	25%

Grade Scale

In addition to earning an average course grade of 65 or better, you must satisfactorily –

1. complete and demo each lab to a course assistant
2. complete and demo the final project to the instructor
3. pass the midterm exam.

At the end of the course, your letter grade will be assigned based on the following weighted scale:

SCORE	LETTER GRADE
≥95	A
≥90	A-
≥87	B+
≥83	B
≥80	B-
≥77	C+
≥73	C
≥70	C-
≥65	D

Important Policies

In addition to the course policies listed below, the students must adhere to the academic policies and procedures set by Binghamton University for all students. Please review the following link: https://catalog.binghamton.edu/index.php.

Announcements

All course announcements will be posted on Brightspace. I strongly recommend making sure you have some feature enabled that allows you to get notified when you have new announcements. **It is your responsibility to read them in a timely manner**.

Lectures, Labs and Assignments

1. You should come to each lab and lecture prepared and on time.
2. Lab and lecture activities will require you to use knowledge from our lecture videos, it is important that you watch each of the required lecture videos before coming to class and labs.
3. During lectures and labs, you will be working in pairs. No group should have more than 2 students. At least one person in a pair should have access to the lecture and lab activities on their laptops or phones. If that is not the case, please let me know in advance.
4. It is your responsibility to bring your lab kits to the lab and to replace them in case of damage. It is recommended that you also bring a laptop or tablet for use should you have any trouble accessing your account on the VMs.
5. You must work in the labs with your partner. Attendance and a balanced participation of both team members is required to get credit for the lab.
6. You may be asked to take turns working on the computer during labs to ensure balanced participation; or rotate partners at the discretion of the instructor
7. All labs assigned for the week should be completed within that week.
8. Attendance at the lectures and labs is mandatory.

Grading

1. **End of Semester Grade:** Do not ask to be moved up a grade, no matter how close you are to the cutoff. The letter grading is assigned automatically.
2. **Extra Credit:** Do not ask for extra credit; your course grade is designed to be an indication of how well you have mastered the course material.
3. **Dropped Grades:** No quizzes grades will be dropped. Quizzes are posted long before the due date and should be completed well in advance of the closing time to prevent events beyond your control from keeping you from completing the quiz. The earlier you start the quiz the more time you'll have to work on it.
4. **Missed Quizzes / Exams:** Once the due date has passed, the quizzes will not be reopened. **If you miss the midterm exam, there will be no makeup exam. If you have a conflict or are sick, email me before the exam.**
5. Grades for the week of lectures and lab will be posted at the end of each week. You must review your grades in a timely manner. There will be no changes to the grade two weeks after they have been posted.

Acceptable Collaboration

Any work you submit should be yours alone unless an assignment explicitly allows for groups of two or more students. You are encouraged to freely discuss any homework or project assignments, if those discussions are about high-level algorithms or solution approaches. You should never share or discuss specific code sequences, design implementations, or problem solutions. You should never use another student's code as a reference when writing your own.

Disruptive Behavior

Disruptive, rude and insulting behavior directed towards the instructor, course staff or students is disallowed. Any such perceived acts will be penalized by 10% under the Assignments grade.

Use of Generative Artificial Intelligence

While generative Artificial Intelligence (AI) tools can support student learning and understanding, they can also bypass important student learning outcomes. To maintain a community of integrity and respect, the following principles must be observed:

1. Without clear and explicit permission from the course instructor, using generative AI tools for any course assignment or exam (e.g., by entering exam or assignment questions) will be considered analogous to unauthorized collaboration and/or plagiarism.
2. The use of generative AI tools or apps for assignments in this course, including tools like ChatGPT and other AI writing or coding assistants, is prohibited.
3. The knowing use of generative AI tools, including ChatGPT and other AI writing and coding assistants, for the completion of, or to support the completion of, an examination, term test, assignment, or any other form of academic assessment, may be considered an academic offense in this course.
4. Representing one's own idea, or expression of an idea, that was AI-generated may be considered an academic offense in this course.
5. Students may not copy or paraphrase from any generative artificial intelligence applications, including ChatGPT and other AI writing and coding assistants, for the purpose of completing assignments in this course.
6. The use of generative artificial intelligence tools and apps is strictly prohibited in all course assignments unless explicitly stated otherwise by the instructor in this course. This includes ChatGPT and other AI writing and coding assistants. Use of generative AI in this course may be considered use of an unauthorized aid, which is a form of cheating.
7. This course policy is designed to promote your learning and intellectual development and to help you reach course learning outcomes.

Students who are unsure of policies regarding generative AI tools are encouraged to ask the instructor for clarification.

Academic Integrity

All students must adhere to the Student Academic Honesty Code of the University and the Watson School (below). The Department of Electrical and Computer Engineering has adopted a standard policy to enforce these codes for violations involving course work. Category I violations result in a grade of 0 for the graded work plus a one letter course grade reduction. A Report of Category I Academic Dishonesty form is filed with the Provost's Office; if a prior report is already on file, the offense is automatically elevated to Category II. Category II violations result in at least a failing grade for the course plus any additional penalties determined by the Watson Academic Integrity Committee.
Full details of the University Academic Honesty Code are available in the University Bulletin under "Academic Policies and Procedures for All Students". The Watson School Academic honesty policy can be found at
https://www.binghamton.edu/watson/about/academichonesty.html

Classroom Safety

Binghamton University takes physical safety very seriously and recommends and supports swift action and clear consequences if a student's non-compliance risks the safety of others. Non-compliance with face covering, social distancing, or classroom scheduling requirements constitute a serious public health risk and a disruption of the learning experience. The following rules must be always followed.

- If you become ill, exhibit symptoms of the flu or COVID-19, or are asked to go into quarantine/isolation, you are should not attend class in person. You should immediately notify the instructor for instructions on how to proceed with the class.
- When rules require everyone to wear a face covering in the classroom, it must be worn so that it completely covers both the nose and mouth tightly. If you forget your face covering or it does not meet current university requirements, you will be asked to leave the room immediately and may not return until you have a compliant face covering. Eating or drinking in the classroom is strictly prohibited when masks are required since such activity would require removing the face covering.
- When social distancing rules are implemented, adequate spacing must be maintained. If students are not seated in a manner that meets the necessary spacing requirements, the instructor will re-seat one or more students to comply with the requirements. It is at the instructor's discretion whom to re-seat.
- Seating in the classroom may be limited at times to allow a safe number of people in the room. For the health and safety of all concerned, you must follow your assigned attendance dates and only come to class on those dates. Attempts to attend class on other dates without the instructor's permission could jeopardize the safety of others and will be considered an attendance violation.
- Failure to comply with these requirements constitutes a public health risk to everyone in the learning environment and disrupts the class. If a student does not comply with the requirements and refuses to wear their face covering properly or to leave the classroom when directed, or to follow instructions for reseating when directed by the instructor, the instructor will immediately cancel the remainder of the class session and

inform the dean's office, which will work with the Student Records office to issue a failing grade ("F") for the course regardless of when in the semester the incident occurs. The dean's office will also inform the Office of Student Conduct. If a student's refusal to comply is a second offense, the Office of Student Conduct may recommend dismissal from the University.

- If an assignment, quiz, exam, or other graded assessment cannot be completed or turned in due to non-compliance with these rules, it will be treated in a manner consistent with any other unexcused absence (i.e. a late penalty or grade of zero will be assessed as appropriate).

Students in Distress

If you are experiencing undue personal or academic stress at any time during the semester or need to talk with someone about a personal problem or situation, you are encouraged to seek support as soon as possible. Course instructors are available to talk with you about stresses related to your work in your courses. Additionally, the campus has a wide range of resources, including:

- Dean of Students Office: 607-777-2804
- Decker Student Health Services Center: 607-777-2221
- University Police: On campus emergency, 911
- University Counseling Center: 607-777-2772