Course Number and Title: ELC 265 Introduction to Digital Systems

Campus Location:
Georgetown, Dover, Stanton

Effective Date:
2018-51

Prerequisite:
CEN 100, CSC 114

Co-Requisites:
none

Course Credits and Hours:
3.00 credits
2.00 lecture hours/week
4.00 lab hours/week

Course Description:
This course covers analysis and design of logic circuits. Topics include Boolean algebra and its application to switching circuits, simplification of switching functions, and design of logic circuits at gate level and with medium scale integration (MSI) and low scale integration (LSI) components. Analysis and design of synchronous and asynchronous sequential state machines are also covered.

Required Text(s):
Obtain current textbook information by viewing the campus bookstore - https://www.dtcc.edu/bookstores online or visit a campus bookstore. Check your course schedule for the course number and section.

Additional Materials:
Digilent's Real Digital - A hands-on approach to digital design http://www.digilentinc.com/classroom/realdigital/

Schedule Type:
Classroom Course

Disclaimer:
None

Core Course Performance Objectives (CCPOs):

1. Discuss introductory electronic circuits. (CCC 1, 2, 5, 6; PGC 2, 4)
2. Operate programmable logic design circuit boards. (CCC 2, 3; PGC 1, 2, 4)
3. Operate circuit design and computer aided design (CAD) tools. (PGC 1, 2, 4)
4. Examine introductory combination logic circuits. (CCC 2, 3; PGC 1, 2, 4)
5. Apply logic minimization to digital circuits. (CCC 2, 6; PGC 1, 2, 4)
6. Use very high speed integrated circuit hardware description language (VHDL) to design digital circuits. (CCC 1, 2; PGC 1, 2, 4)
7. Design and apply combinational circuit blocks. (CCC 1, 2, 3; PGC 1, 2, 3, 4)
8. Design and apply combinational circuits that perform arithmetic operations. (CCC 1, 2, 3, 6; PGC 1, 2, 3, 4)
9. Design and apply digital circuits with signal propagation delay considerations. (CCC 1, 2, 6; PGC 1, 2, 3, 4)
10. Apply basic memory circuits in digital systems. (CCC 1, 2, 6; PGC 1, 2, 4)
11. Design and apply sequential circuits. (CCC 1, 2, 3, 6; PGC 1, 2, 3, 4)

See Core Curriculum Competencies and Program Graduate Competencies at the end of the syllabus. CCPOs are linked to every competency they develop.

Measurable Performance Objectives (MPOs):
Upon completion of this course, the student will:

1. Discuss introductory electronic circuits.
    1. Define *voltage current* and *resistance.*
    2. Apply Ohm's Law to basic circuits.
    3. Identify and describe the function of electronic components such as: capacitors, transistors, Light Emitting Diodes (LEDs), Liquid Crystal Displays (LCD), and logic circuits.
    4. Identify digital devices that are used to implement logical functions.
    5. Demonstrate how voltage levels are used to represent digital quantities.
    6. Describe the operation and list truth tables for AND, OR, NAND, NOR, NOT, EX OR, and EX NOR logic gates.
2. Operate programmable logic design circuit boards.
    1. List the benefits of using programmable logic design circuit boards.

2. Describe the architecture of programmable logic design circuit boards.
3. Sketch and describe the architecture of programmable logic devices such as Simple Programmable Logic Devices (SPLD), Complex Programmable Logic Devices (CPLDs), Field-Programmable Gate Arrays (FPGAs), and Application-Specific Integrated Circuits (ASICs).

3. Operate circuit design and computer aided design (CAD) tools.
    1. Install and use manufacturer specific software to configure the FPGAs on the digital design circuit board.
    2. Install and use software that will upload and download software programs, register data, and input/output (I/O) to and from the FPGA.
4. Examine introductory combination logic circuits.
    1. Sketch a logic circuit based on a logic equation.
    2. Write a logic equation based on a logic schematic.
    3. Construct a truth table based on a logic equation.
    4. Construct a truth table based on a logic schematic.
    5. Use AND-OR and AND-OR-INVERT circuits to implement Sum-of-Products (SOP) and Product-of-Sums (POS) expressions from truth tables.
    6. Identify Exclusive Or (XOR) and Exclusive Nor (XNOR) relationships from truth tables.
5. Apply logic minimization to digital circuits.
    1. Apply the basic laws and rules of Boolean algebra to minimize logic equations.
    2. Apply DeMorgan's Theorems to Boolean expressions.
    3. Use Karnaugh Maps to simplify Boolean expressions.
    4. Use Karnaugh Maps to simplify truth table functions.
6. Use very high speed integrated circuit hardware description language (VHDL) to design digital circuits.
    1. Use a schematic editor and a text editor to implement a combinational circuit.
    2. Use a schematic editor and a VHDL text editor to simulate circuits.
    3. Use a schematic editor and a VHDL text editor to verify circuit behavior.
7. Design and apply combinational circuit blocks.
    1. Describe the function and applications of combinational circuit blocks such as: decoders, encoders, multiplexers, de-multiplexers, and shift registers.
    2. Sketch combinational circuit blocks such as: decoder, encoder, multiplexer, de-multiplexer, and shift register circuits.
    3. Use truth tables to describe the conditions for combinational circuit blocks such as: decoder, encoder, multiplexer, de-multiplexer, and shift register circuits.
    4. Implement combinational circuit blocks such as: decoder, encoder, multiplexer, de-multiplexer, and shift register circuits using VHDL methods.
    5. Download simulated combinational circuit blocks to digital design circuit boards.
8. Design and apply combinational circuits that perform arithmetic operations.
    1. Describe the function and applications of combinational circuits that perform arithmetic operations such as: comparator, adder, subtractor, and multiplier circuits.
    2. Sketch combinational circuits that perform arithmetic operations such as: comparator, adder, subtractor, and multiplier circuits.
    3. Use truth tables to describe the conditions for combinational circuits that perform arithmetic operations such as: comparator, adder, subtractor, and multiplier circuits.
    4. Implement combinational circuits that perform arithmetic operations such as: comparator, adder, subtractor, and multiplier circuits using VHDL methods.
    5. Download simulated circuit blocks to digital design circuit boards.
9. Design and apply digital circuits with signal propagation delay considerations.
    1. Analyze combinational circuits to determine whether outputs will suffer from logic noise and circuit delays.
    2. Implement circuit delays and logic noise using VHDL methods.
    3. Use timing diagrams to describe the behavior of sequential circuits.
10. Apply basic memory circuits in digital systems.
    1. Describe the design, function, and applications of basic memory circuits.
    2. Explain the differences between an S-R latch and a D latch.
    3. Cite the differences between a latch and a flip-flop.
    4. Explain how S-R, D, and J-K flip-flops differ.
    5. Explain how master-slave flip-flops differ from the edge-triggered devices.
    6. Sketch timing diagrams showing the proper time relationships of inputs and outputs for the various flip-flop devices.
    7. Explain the significance of propagation delays, set-up time, hold time, maximum operating frequency, minimum clock pulse widths, and power dissipation in the application of flip-flops.
    8. Explain the potential problems that may arise when memory circuits sample an input signal.
11. Design and apply sequential circuits.
    1. Use flip-flop devices to design counters.
    2. Apply counter circuits in the design of a clock divider circuits.
    3. Compare the differences between Mealy and Moore machines.
    4. Design a sequential circuit using state diagrams, state tables, transition tables, and Karnaugh maps.
    5. Implement sequential circuits using VHDL methods.

Evaluation Criteria/Policies:
Students must demonstrate proficiency on all CCPOs at a minimal 75 percent level to successfully complete the course. The grade will be determined using the Delaware Tech grading system:

92	–	100	=	A
83	–	91	=	B
75	–	82	=	C
0	–	74	=	F

Students should refer to the Student Handbook - https://www.dtcc.edu/handbook for information on the Academic Standing Policy, the Academic Integrity Policy, Student Rights and Responsibilities, and other policies relevant to their academic progress.

Core Curriculum Competencies (CCCs are the competencies every graduate will develop):

1. Apply clear and effective communication skills.
2. Use critical thinking to solve problems.
3. Collaborate to achieve a common goal.
4. Demonstrate professional and ethical conduct.
5. Use information literacy for effective vocational and/or academic research.
6. Apply quantitative reasoning and/or scientific inquiry to solve practical problems.

Program Graduate Competencies (PGCs are the competencies every graduate will develop specific to his or her major):

1. Integrate modern tools of the engineering discipline into the field of study.
2. Apply mathematics, science, engineering, and technology theory to solve electrical and computer engineering and electronics engineering technology problems.
3. Conduct, analyze, and interpret experiments using analysis tools and troubleshooting methods.
4. Identify, analyze, and solve electrical and computer engineering and electronics engineering technology problems.
5. Explain the importance of engaging in self-directed continuing professional development.
6. Demonstrate basic management, organizational, and leadership skills that commit to quality, timeliness, and continuous improvement.

Disabilities Support Statement:
The College is committed to providing reasonable accommodations for students with disabilities. Students are encouraged to schedule an appointment with the campus Disabilities Support Counselor to request an accommodation needed due to a disability. A listing of campus Disabilities Support Counselors and contact information can be found at the disabilities services - https://www.dtcc.edu/disabilitysupport web page or visit the campus Advising Center.