Western Technical College

10662137 Digital Electronic Concepts

Course Outcome Summary

Course Information

Description	This course provides a foundation in digital electronic device and circuits. Topics include number systems, logic gates, digital circuits simplification techniques, device specifications, digital devices such as encoders/decoders, multiplexers/de-multiplexers, programmable devices, A/D and D/A circuits and interfacing circuits and considerations.
Career Cluster	Science, Technology, Engineering and Mathematics
Instructional Level	Associate Degree Courses
Total Credits	4
Total Hours	108

Textbooks

Digital Electronics: A Practical Approach with VHDL. 9th Edition. Copyright 2012. Kleitz, William. Publisher: Pearson. **ISBN-13**: 978-0-13-254303-3. Required.

Course Competencies

1. Analyze digital numbering systems.

Assessment Strategies

1.1. Written Objective Test

Criteria

You will know you are successful when

1.1. You identify the base or radix of a number system.
1.2. You convert among numbering system.
1.3. You identify number code systems.

Learning Objectives

1.a. Count in binary, octal, hexadecimal, and BCD.
1.b. Convert from one number system to another.
1.c. Add and subtract binary numbers.

2. Test functions of basic logic gates.

Assessment Strategies

2.1. Performance

Criteria

You will know you are successful when:

2.1. You verify the truth table of an AND logic gate.
2.2. You verify the truth table of an OR logic gate.
2.3. You verify the truth table of an INVERTER/NOT and BUFFER logic gates.
2.4. You verify the truth table of a NOR logic gate.
2.5. You verify the truth table of an XOR logic gate.
2.6. You verify the truth table of a NAND logic gate.

Learning Objectives

2.a. Draw the logic symbols for basic logic gates.
2.b. Write the Boolean expression for the output of each gate.
2.c. Predict the output of each gate when given the inputs.
2.d. Use a NAND and NOR gate as invertors.
2.e. Describe how to enable and inhibit each of the two-input gates.
2.f. Construct an exclusive-OR gate from basic gates.

3. Implement Boolean expressions using combinational logic circuits.

Assessment Strategies

3.1. Performance
3.2. Written Objective Test

Criteria

You will know you are successful when:

3.1. You confirm the correct operation of the circuit.
3.2. You complete the truth table.
3.3. You compare it to the circuit expression.

Learning Objectives

3.a. Predict the output waveforms for each of the basic gates given input waveforms.
3.b. Develop the Boolean expression for the output of a combinational logic circuit.
3.c. Design and construct a logic circuit to implement a given truth table using Boolean algebra.

4. Identify electrical signals or characteristics.

Assessment Strategies

4.1. Written Objective Test

Criteria

You will know you are successful when

4.1. You identify the supply specifications.
4.2. You apply ESD precautions in working with digital circuitry.
4.3. You identify the input/output voltage specifications for logic lows and highs.
4.4. You identify the input/output current specifications for logic lows and logic highs.

Learning Objectives

4.a. Identify TTL IC specifications.
4.b. Define fan in and fan out.
4.c. Identify CMOS IC specifications.
4.d. Identify ESD precautions needed when handling digital IC's.

5. Test the operation of medium scale logic blocks.

Assessment Strategies

5.1. Performance

Criteria

You will know you are successful when

5.1. You verify the function table of encoders.
5.2. You verify the function table of decoders.
5.3. You verify the function table of multiplexers.

Learning Objectives

5.a. Explain the operation and use of decoders, encoders, multiplexers, and demultiplexers.
5.b. Use a multiplexer to produce a desired truth table.

6. Test the operation of display devices.

Assessment Strategies

6.1. Performance

Criteria

You will know you are successful when

6.1. You verify the function table for an LCD.
6.2. You verify the function table for an LED.
6.3. You describe the concept of multiplexing displays.

Learning Objectives

6.a. Explain the operation of LED's.
6.b. Explain the operation of seven-segment LED's and their decoders.
6.c. Explain the operation of LCD's and how to drive them.
6.d. Construct a circuit that will multiplex two or more signals onto two or more displays.

7. Test the operation of sequential logic devices.

Assessment Strategies

7.1. Performance

Criteria

You will know you are successful when

7.1. You verify the function table for latches.
7.2. You verify the function table for flip/flops.
7.3. You verify the function table for asynchronous and synchronous counters.
7.4. You verify the function table for shift registers.

Learning Objectives

7.a. Explain the operational characteristics of various flip-flops.
7.b. Explain the operation of a shift counter.
7.c. Explain the operation of asynchronous and synchronous counters.
7.d. Construct up-down counters.
7.e. Construct divide-by-N counters.

8. Ascertain functions of memory devices.

Assessment Strategies

8.1. Written Objective Test

Criteria

You will know you are successful when

8.1. You identify the different types of memory.
8.2. You observe the memory function characteristics.
8.3. You verify the function table of memory devices.

Learning Objectives

8.a. Explain the characteristics of semiconductor memory devices.
8.b. Construct a simple circuit using a memory device.

9. Interface digital circuits to real world devices.

Assessment Strategies

9.1. Performance

Criteria

You will know you are successful when:

9.1. You control an output device using a digital circuit.
9.2. You connect an input device to drive a digital circuit.
9.3. You connect an opto-isolator or relay to control a device.

Learning Objectives

9.a. Explain the characteristics of opto-isolator devices.
9.b. Use a digital circuit to control an output device.
9.c. Connect an input device to drive a digital circuit.

10. Apply Boolean tools and other simplification techniques.

Assessment Strategies

10.1. Written Objective Test

Criteria

You will know you are successful when

10.1. You convert minterm to maxterm and maxterm to minterm using Demorgan's theorem.
10.2. You verify the conversion produces the same output for a given input
10.3. You implement a logic circuit from the maxterm and minterm Boolean expression.
10.4. You verify the implementation produces the sam output for the given input.
10.5. You reduce a logic circuit or a minterm Boolean expression using Karnaugh mapping.
10.6. You verify the reduction produces the same output for a given input.

Learning Objectives

10.a. Use Demorgan's theorem to convert between minterm and maxterm formats.
10.b. Verify that minterm and maxterm equations produce the same out.
10.c. Use Karnaugh mapping to simplify Boolean expressions.
10.d. Use Multisim software to reduce Boolean expressions.

11. Differentiate specifications among logic families.

Assessment Strategies

11.1. Written Objective Test

Criteria

You will know you are successful when

11.1. You extract pertinent information from the data sheet.
11.2. You extract physical characteristics.
11.3. You extract electrical characteristics
11.4. You select appropriate components for interfacing between logic families.

Learning Objectives

11.a. Identify TTL and CMOS parameters using a specification book or online resource.
11.b. Describe the difference between totem-pole and open-collector outputs.
11.c. Interface between the different logic families.
11.d. Describe the differences between IC packages.

12. Perform digital arithmetic.

Assessment Strategies

12.1. Written Objective Test

Criteria

12.1. You verify the truth table for a half adder.
12.2. You verify the truth table for a full adder.
12.3. You verify the truth table for an ALU.

Learning Objectives

12.a. Define half-adder.
12.b. Define full-adder.
12.c. Add binary numbers.
12.d. Subtract binary numbers using 2's complement.
12.e. Describe the function of the ALU.

13. Build encoders, decoders, and multiplexers into a system.

Assessment Strategies

13.1. Performance

Criteria

You will know you are successful when

13.1. You build a bcd encoder.
13.2. You build a bcd decoder.
13.3. You build a seven segment encoder.
13.4. You troubleshoot the system using proper test equipment.

Learning Objectives

13.a. Explain the function/operations of encoders.
13.b. Explain the functions/operation of decoders.
13.c. Explain the function/operations of multiplexers.
13.d. Explain the operation of LED's.
13.e. Explain the operation of LCD's.
13.f. Explain the operation of seven-segment displays.
13.g. Construct a circuit utilizing a decoder and a seven-segment display.

14. Generate pulses and timing signals.

Assessment Strategies

14.1. Performance

Criteria

You will know you are successful when

14.1. You build a 555 timer to be a one-shot.
14.2. You build a 555 timer to creat a pulse train.
14.3. You build a 555 timer to create asymmetrical pulses.
14.4. You investigate alternatives to the 55 timer.
14.5. You discover hysteresis using a Schmidt trigger.

Learning Objectives

14.a. Describe how to use the 555 timer as a one-sot.
14.b. Describe how to use the 555 timer generate clock signal.
14.c. Explain the effect of hysteresis when using a Schmidt trigger.

15. Build clocked logic to drive encoders, decoders, and multiplexer systems with asynchronous and or synchronous logic.

Assessment Strategies

15.1. Performance

Criteria

You will know you are successful when

15.1. You construct a four-bit asynchronous counter using flip flops.
15.2. You troubleshoot a four-bit asynchronous counter.
15.3. You determine a test procedure for several types of logic circuits.
15.4. You follow the test procedure to trouble shoot several types of log circuits.

Learning Objectives

15.a. Build a four-bit asynchronous counter.
15.b. Develop test procedures for various types of logic circuits.

16. Implement a design using CPLDs and or FPGAs.

Assessment Strategies

16.1. Performance
16.2. Written Objective Test

Criteria

You will know you are successful when

16.1. You use schematic capture or VHDL to modify or design a logic function.
16.2. You develop a stimulus model.
16.3. You simulate your design.

Learning Objectives

16.a. Be able to implement various CPLD circuit designs using the Quartus 2 software.
16.b. Develop a stimulus model to test the CPLD design.

17. Analyze digital design considerations.

Assessment Strategies

17.1. Written Objective Test

Criteria

You will know you are successful when

17.1. You analyze low-voltage/battery operation.
17.2. You analyze debounce circuits.
17.3. You analyze power-up/power-down sequencing.
17.4. You analyze input and output coupling/driving circuits.
17.5. You analyze interface considerations.
17.6. You analyze noise considerations.
17.7. You analyze transmission of digital signals.

Learning Objectives

17.a. Describe supply voltage considerations.
17.b. Describe the need for debouncing mechanical switches.
17.c. Describe limitations in digital transmissions systems.
17.d. Define power-up/power-down sequencing.
17.e. Explain the use of coupling/driving circuits.

18. Build an analog and digital system.

Assessment Strategies

18.1. Performance

Criteria

You will know you are successful when:

18.1. You test the function of a D/A.
18.2. You test the function of a A/D.
18.3. You construct an analog to digital system.
18.4. You construct a digital to analog system.

Learning Objectives

18.a. Construct an analog to digital conversion circuit.
18.b. Construct a digital to analog conversion circuit.
18.c. Describe two methods used for analog to digital conversion.
18.d. Describe two methods for digital to analog conversion.