Digital Electronics

Level 2: Assumes student had pathway introduction
Pathway(s): Engineering & Technology; Mechatronics

Description

Digital Electronics is intended to provide students with an introduction to the basic components of digital electronic systems and equip them with the ability to use these components to design more complex digital systems. Proficient students will be able to (1) describe basic functions of digital components (including gates, flip flops, counters, and other devices upon which larger systems are designed), (2) use these devices as building blocks to design larger, more complex circuits, (3) implement these circuits using programmable devices, and (4) effectively communicate designs and systems. Students develop additional skill in technical documentation when operating and troubleshooting circuits. Upon completion of the Digital Electronics course, students will be able to design a complex digital system and communicate their designs.

NOTE: This course is still in draft form. While no additional competencies will be added, some may be removed.

Student Learning Outcomes

Safety

1) Perform safe practices within the classroom
    a. Accurately read and interpret safety rules adopted by the school/district as they relate to the spaces and equipment used in this
    b. Identify and explain the intended use of safety equipment available in the classroom.
    c. Demonstrate how to properly inspect and use safe operating procedures with tools and equipment
    d. Incorporate safety procedures

Citizenship and Career Exploration

2) Investigate the role of electrical and/or computer engineers
3) Identify postsecondary institutions in Colorado that offer pathways to and/or through electrical engineering, electrical, and/or computer engineering technology

Analog vs. Digital

4) Classify variables as continuous (analog) or discrete (digital)
5) State advantages of analog systems
6) State advantages of digital systems

Transistor-Transistor Logic (TTL) Gates

7) Identify each type of logic gate including the valid number of input(s) and output(s) for each gate

    a. AND
    b. OR
    c. NOT
    d. NAND
    e. NOR
8) Locate important specifications, such as electrostatic discharge (ESD), in TTL chip data sheets
9) Build TTL logic circuits on a breadboard
10) Troubleshoot TTL logic circuits

Complementary metal-oxide-semiconductor (CMOS) Gates

11) Identify each type of logic gate including the valid number of input(s) and output(s) for each gate
    a. AND
    b. OR
    c. NOT
    d. NAND
    e. NOR
12) Locate important specifications, such as electrostatic discharge (ESD), in CMOS chip data sheets

Special Purpose Gates

13) Explain the operation of the XOR logic function
14) Explain the operation of the XNOR logic function
15) Implement logic circuits using AND-OR-Invert chips
16) Explain the purpose of Schmitt trigger circuits

Binary Numbers

17) Explain numbers in unsigned and signed binary format
18) Convert numbers between decimal, binary, binary, octal, hexadecimal, and Binary-Coded Decimal (BCD)
19) Represent negative binary numbers in two's-complement form
20) Add, subtract, multiple, and divide signed and unsigned numbers in binary format
21) Add numbers in BCD format
22) Build a half-adder circuit using TTL gates
23) Build a full-adder circuit using TTL gates
24) Build a 4-bit adder using a TTL adder chip
25) Build a 4-bit BCD adder using a TTL adder chip

Boolean Algebra

26) Write Boolean expressions for basic logic gates (AND, OR, NOT, NAND, and NOR)
27) Write Boolean expressions for combinational logic circuits
28) Write Boolean expressions from logic function in truth table format
29) Simplify Boolean expressions

Logic Diagrams

30) Translate between logic function in circuit, truth table, and Boolean form
31) Apply DeMorgan's Theorem to simply logic circuits

Troubleshooting

32) Use a logic probe to find open pins or traces
33) Use a logic probe to find shortened pins or traces
34) Develop a troubleshooting methodology for a digital circuit that could be used by a new technician

Flip-Flops

35) Explain the operation of a set/reset (SR) latch
36) Explain the operations of a gated SR latch
37) Explain the operations of a master-slave latch
38) Use a state table to explain the operations of a D flip-flop
39) Use a state table to explain the operations of a T flip-flop
40) Use a state table to explain the operations of a JK flip-flop
41) Implement a frequency divider circuit using JK flip-flops

Counters

42) Explain the operation of synchronous counters
43) Construct modulus(X) synchronous counters using JK flip-flops
44) Explain the operations of asynchronous counters
45) Construct asynchronous up and down counters using JK flip-flops
46) Explain the advantages and disadvantages of synchronous and asynchronous counters

Shift Registers

47) Explain the operations of a Johnson counter
48) Explain the operations of a ring counter
49) Explain the advantages and disadvantages of serial data transmission
50) Explain the advantages and disadvantages of parallel data transmission

Encoders-Decoders

51) Explain the operations of an 8-3 octal encoder
52) Explain the operations of a 3-8 decoder
53) Explain Gray coding
54) Build a display circuit using a 7-segment decoder

LED Displays

55) Use a logic probe to map the pins of a 7-segment LED Display
56) Build a two-digit 7-segment display on a breadboard

Technical Documentation

57) Identify a problem requiring a digital circuit
    a. Follow an identified design process to solve the problem using digital electronics
    b. Produce drawings and schematics
    c. Predict results from the design