

Digital Electronics

Knowledge and skills. DIGELC

- 1 The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to: DIGELC.1**
 - A** apply mathematics to problems arising in everyday life, society, and the workplace; DIGELC.1A
 - B** use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution; DIGELC.1B
 - C** select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems; DIGELC.1C
 - D** communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate; DIGELC.1D
 - E** create and use representations to organize, record, and communicate mathematical ideas; DIGELC.1E
 - F** analyze mathematical relationships to connect and communicate mathematical ideas; and DIGELC.1F
 - G** display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication. DIGELC.1G

- 2 The student demonstrates the skills necessary for success in a technical career. The student is expected to: DIGELC.2**
 - A** distinguish the differences between an engineering technician, engineering technologist, and engineer; DIGELC.2A
 - B** identify employment and career opportunities; DIGELC.2B
 - C** identify industry certifications; DIGELC.2C
 - D** discuss ethical issues related to engineering and technology and incorporate proper ethics in submitted projects; DIGELC.2D
 - E** identify and demonstrate respect for diversity in the workplace; DIGELC.2E
 - F** identify and demonstrate appropriate actions and identify consequences relating to discrimination, harassment, and inequality; DIGELC.2F
 - G** explore electronics engineering careers and preparation programs; DIGELC.2G

- H explore career preparation learning experiences, including job shadowing, mentoring, and apprenticeship training; and DIGELC.2H
 - I discuss Accreditation Board for Engineering and Technology (ABET) accreditation and implications. DIGELC.2I
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3 The student participates in team projects in various roles. The student is expected to: DIGELC.3

- A explain the importance of teamwork in the field of electronics; DIGELC.3A
 - B apply principles of effective problem solving in teams to practice collaboration and conflict resolution; and DIGELC.3B
 - C demonstrate proper attitudes as a team leader and team member. DIGELC.3C
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4 The student develops skills for managing a project. The student is expected to: DIGELC.4

- A implement project management methodologies, including initiating, planning, executing, monitoring and controlling, and closing a project; DIGELC.4A
 - B develop a project schedule and complete work according to established criteria; DIGELC.4B
 - C participate in the organization and operation of a real or simulated engineering project; and DIGELC.4C
 - D develop a plan for production of an individual product. DIGELC.4D
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5 The student practices safe and proper work habits. The student is expected to: DIGELC.5

- A master relevant safety tests; DIGELC.5A
 - B comply with safety guidelines as described in various manuals, instructions, and regulations; DIGELC.5B
 - C identify governmental and organizational regulations for health and safety in the workplace related to electronics; DIGELC.5C
 - D identify and classify hazardous materials and wastes according to Occupational Safety and Health Administration (OSHA) regulations; DIGELC.5D
 - E dispose of hazardous materials and wastes appropriately; DIGELC.5E
 - F perform maintenance on selected tools, equipment, and machines; DIGELC.5F
 - G handle and store tools and materials correctly; and DIGELC.5G
 - H describe the results of improper maintenance of material, tools, and equipment. DIGELC.5H
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6 The student explores the fundamentals of analog and digital electronics. The student uses appropriate notation and understands the logic of circuit design and logic gates. The student is expected to: DIGELC.6

- A use scientific notation, engineering notation, and Systems International (SI) notation to conveniently write very large or very small numbers frequently encountered when working with electronics; DIGELC.6A
 - B describe the process of soldering and how it is used in the assembly of electronic components; DIGELC.6B
 - C explain the different waveforms and distinctive characteristics of analog and digital signals; DIGELC.6C
 - D identify the voltage levels of analog and digital signals; DIGELC.6D
 - E determine whether a material is a conductor, an insulator, or a semiconductor based on its atomic structure; DIGELC.6E
 - F analyze the three fundamental concepts of voltage, current, and resistance; DIGELC.6F
 - G define circuit design software and explain its purpose; DIGELC.6G
 - H identify the fundamental building block of sequential logic; DIGELC.6H
 - I identify the components of a manufacturer's datasheet, including a logic gate's general description, connection diagram, and function table; DIGELC.6I
 - J categorize integrated circuits by their underlying circuitry, scale of integration, and packaging style; DIGELC.6J
 - K describe the advantages and disadvantages of the various sub-families of transistor-transistor logic (TTL) gates; DIGELC.6K
 - L explain that a logic gate is depicted by its schematic symbol, logic expression, and truth table; DIGELC.6L
 - M evaluate the different functions of input and output values of combinational and sequential logic; DIGELC.6M
 - N explain combinational logic designs implemented with AND gates, OR gates, and INVERTER gates; and DIGELC.6N
 - O identify the fundamental building block of sequential logic. DIGELC.6O
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7 The student understands and uses multiple forms of AND-OR-Invert (AOI) logic.

The student is expected to: DIGELC.7

- A develop an understanding of the binary number system and its relationship to the decimal number system as an essential component in the combinational logic design process; DIGELC.7A
- B translate a set of design specifications into a truth table to describe the behavior of a combinational logic design by listing all possible input combinations and the desired output for each; DIGELC.7B
- C derive logic expressions from a given truth table; DIGELC.7C
- D demonstrate logic expressions in sum-of-products (SOP) form and products-of-sum (POS) form; DIGELC.7D

- E explain how all logic expressions, whether simplified or not, can be implemented using AND gates and INVERTER gates or OR gates and INVERTER gates; and DIGELC.7E
 - F apply a formal design process to translate a set of design specifications into a functional combinational logic circuit. DIGELC.7F
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8 The student understands, explains, and applies NAND and NOR Logic and understands the benefits of using universal gates. The student is expected to: DIGELC.8

- A apply the Karnaugh Mapping graphical technique to simplify logic expressions containing two, three, and four variables; DIGELC.8A
 - B define a "don't care" condition and explain its significance; DIGELC.8B
 - C explain why NAND and NOR gates are considered universal gates; DIGELC.8C
 - D demonstrate implementation of a combinational logic expression using only NAND gates or only NOR gates; DIGELC.8D
 - E discuss the formal design process used for translating a set of design specifications into a functional combinational logic circuit implemented with NAND or NOR gates; and DIGELC.8E
 - F explain why combinational logic designs implemented with NAND gates or NOR gates will typically require fewer integrated circuits (IC) than AOI equivalent implementations. DIGELC.8F
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9 The student understands combinational logic systems, including seven-segment displays, Exclusive OR and Exclusive NOR gates, and multiplexer/de-multiplexer pairs. The student understands the relative value of various logic approaches. The student is expected to: DIGELC.9

- A use seven-segment displays used to display the digits 0-9 as well as some alpha characters; DIGELC.9A
- B identify the two varieties of seven-segment displays; DIGELC.9B
- C describe the formal design process used for translating a set of design specifications into a functional combinational logic circuit; DIGELC.9C
- D develop an understanding of the hexadecimal and octal number systems and their relationships to the decimal number system; DIGELC.9D
- E explain the primary intended purpose of Exclusive OR (XOR) and Exclusive NOR (XNOR) gates; DIGELC.9E
- F describe how to accomplish the addition of two binary numbers of any bit length; DIGELC.9F
- G explain when multiplexer/de-multiplexer pairs are most frequently used; DIGELC.9G
- H explain the purpose of using de-multiplexers in electronic displays that use multiple seven-segment displays; DIGELC.9H
- I identify the most commonly used method for handling negative numbers in digital electronics; DIGELC.9I

- J discuss the use of programmable logic devices and explain designs for which they are best suited; and DIGELC.9J
 - K compare and contrast circuits implemented with programmable logic devices with circuits implemented with discrete logic. DIGELC.9K
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10 The student understands and describes multiple types of sequential logic and various uses of sequential logic. The student is expected to: DIGELC.10

- A explain the capabilities of flip-flop and transparent latch logic devices; DIGELC.10A
 - B discuss synchronous and asynchronous inputs of flip-flops and transparent latches; DIGELC.10B
 - C explore the use of flip-flops, including designing single event detection circuits, data synchronizers, shift registers, and frequency dividers; DIGELC.10C
 - D explain how asynchronous counters are characterized and how they can be implemented; DIGELC.10D
 - E explore the use of the asynchronous counter method to implement up counters, down counters, and modulus counters; DIGELC.10E
 - F explain how synchronous counters are characterized and how they can be implemented; DIGELC.10F
 - G explore the use of the synchronous counter method to implement up counters, down counters, and modulus counters; DIGELC.10G
 - H describe a state machine; DIGELC.10H
 - I identify common everyday devices that machines are used to control such as elevator doors, traffic lights, and combinational or electronic locks; and DIGELC.10I
 - J discuss various ways state machines can be implemented. DIGELC.10J
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11 The student explores microcontrollers, specifically their usefulness in real-world applications. The student is expected to: DIGELC.11

- A demonstrate an understanding of the use of flowcharts as graphical organizers by technicians, computer programmers, engineers, and other professionals and the benefits of various flowcharting techniques; DIGELC.11A
- B develop an understanding of basic programming skills, including variable declaration, loops, and debugging; DIGELC.11B
- C identify everyday products that use microcontrollers such as robots, garage door openers, traffic lights, and home thermostats; DIGELC.11C
- D describe a servo motor; DIGELC.11D
- E explore the way microcontrollers sense and respond to outside stimuli; DIGELC.11E
- F explain why digital devices are only relevant if they can interact with the real world; DIGELC.11F
- G explain the importance of digital control devices, including microcontrollers in controlling mechanical systems; and DIGELC.11G

- H demonstrate an understanding that realistic problem solving with a control system requires the ability to interface analog inputs and outputs with a digital device. DIGELC.11H