# Scope & Sequence

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| Course Name: Digital Electronics **TSDS PEIMS Code:** 13037600 | | | **Course Credit:** 1.0  **Course Requirements:** Recommended for students in Grades 10-12.  **Prerequisites:** Algebra I and Geometry. |
| **Course Description:** Digital Electronics is the study of electronic circuits that are used to process and control digital signals. In contrast to analog electronics, where a continuously varying voltage represents information, two discreet voltages or logic levels represent digital signals. This distinction allows for greater signal speed and storage capabilities and has revolutionized the world of electronics. Digital electronics is the foundation of modern electronic devices such as cellular phones, digital audio players, laptop computers, digital cameras, and high-definition televisions. The primary focus of Digital Electronics is to expose students to the design process of combinational and sequential logic design, teamwork, communication methods, engineering standards, and technical documentation. This course satisfies a high school mathematics graduation requirement. Students shall be awarded one credit for successful completion of this course. | | | |
| **NOTE:** This is a suggested scope and sequence for the course content. This content will work with any textbook or instructional materials. If locally adapted, make sure all TEKS are covered. | | | |
| **Total Number of Periods**  **Total Number of Minutes**  **Total Number of Hours** | 175 Periods  7875 Minutes  131.25 Hours | \*Schedule calculations based on 175/180 calendar days. For 0.5 credit courses, schedule is calculated out of 88/90 days. Scope and sequence allows additional time for guest speakers, student presentations, field trips, remediation, extended learning activities, etc. | |
| **Unit Number, Title, and Brief Description** | **# of Class Periods\***  (assumes 45-minute periods)  Total minutes per unit | **TEKS Covered**  **130.407. Knowledge and skills** | |
| **Unit 1: Exploration of the STEM Field of Digital Electronics**  In this unit, students will further their knowledge of the digital electronics field. Students will explore and distinguish the varying roles in the field and experience necessary for each.The unit culminates with an activity in which students present on field preparation necessary and opportunities to job shadow or get needed experience to assure it is the right field for them. | 15 Periods  675 Minutes | (3) The student demonstrates the skills necessary for success in a technical career. The student is expected to:  (A) distinguish the differences between an engineering technician, engineering technologist, and engineer;  (B) identify employment and career opportunities;  (C) identify industry certifications;  (D) discuss ethical issues related to engineering and technology and incorporate proper ethics in submitted projects;  (E) identify and demonstrate respect for diversity in the workplace;  (F) identify and demonstrate appropriate actions and identify consequences relating to discrimination, harassment, and inequality;  (G) explore electronics engineering careers and preparation programs;  (H) explore career preparation learning experiences, including job shadowing, mentoring, and apprenticeship training; and  (I) discuss Accreditation Board for Engineering and Technology (ABET) accreditation and implications. | |
| **Unit 2: Mathematics in Electronics**  Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions. In this unit, the student will use mathematical processes and models to solve real-world problems. The culminating activity for this unit will have students analyze mathematical relationships and create representations to organize, record, and communicate mathematical ideas. | 15 Periods  675 Minutes | (2) The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:  (A) apply mathematics to problems arising in everyday life, society, and the workplace;  (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;  (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;  (D) communicate mathematical ideas, reasoning, and their implications using multiple representations, including symbols, diagrams, graphs, and language as appropriate;  (E) create and use representations to organize, record, and communicate mathematical ideas;  (F) analyze mathematical relationships to connect and communicate mathematical ideas; and  (G) display, explain, and justify mathematical ideas and arguments using precise mathematical language in written or oral communication. | |
| **Unit 3: Safety Precautions**  In this unit, students will comply with federal and state safety regulations as specified by Occupational Safety and Health Administration (OSHA) and other regulatory agencies. Students will master relevant safety tests, dispose of hazardous materials and wastes appropriately and handle tools and materials correctly. The culminating activity will have students describe improper maintenance and consequences of handling and storing tools and materials poorly. | 10 Periods  450 Minutes | (6) The student practices safe and proper work habits. The student is expected to:  (A) master relevant safety tests;  (B) comply with safety guidelines as described in various manuals, instructions, and regulations;  (C) identify governmental and organizational regulations for health and safety in the workplace related to electronics;  (D) identify and classify hazardous materials and wastes according to Occupational Safety and Health Administration (OSHA) regulations;  (E) dispose of hazardous materials and wastes appropriately;  (F) perform maintenance on selected tools, equipment, and machines;  (G) handle and store tools and materials correctly; and  (H) describe the results of improper maintenance of material, tools, and equipment. | |
| **Unit 4: Fundamentals of Analog and Digital Electronics**  The Science, Technology, Engineering, and Mathematics (STEM) Career Cluster focuses on planning, managing, and providing scientific research and professional and technical services, including laboratory and testing services, and research and development services. This unit explores the fundamentals of analog and digital electronics. Students will perform such activities such as identifying the voltage levels of analog and digital signals and identifying the fundamental building blocks of sequential logic. The culminating activity for this unit will be to evaluate different functions of input and output logic and explain combinational logic designs implemented with our without various gates. | 15 Periods  675 Minutes | (7) 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:  (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;  (B) describe the process of soldering and how it is used in the assembly of electronic components;  (C) explain the different waveforms and distinctive characteristics of analog and digital signals;  (D) identify the voltage levels of analog and digital signals;  (E) determine whether a material is a conductor, an insulator, or a semiconductor based on its atomic structure;  (F) analyze the three fundamental concepts of voltage, current, and resistance;  (G) define circuit design software and explain its purpose;  (H) identify the fundamental building block of sequential logic;  (I) identify the components of a manufacturer's datasheet, including a logic gate's general description, connection diagram, and function table;  (J) categorize integrated circuits by their underlying circuitry, scale of integration, and packaging style;  (K) describe the advantages and disadvantages of the various sub-families of transistor-transistor logic (TTL) gates;  (L) explain that a logic gate is depicted by its schematic symbol, logic expression, and truth table;  (M) evaluate the different functions of input and output values of combinational and sequential logic;  (N) explain combinational logic designs implemented with AND gates, OR gates, and INVERTER gates; and  (O) identify the fundamental building block of sequential logic. | |
| **Unit 5: AND-OR-Invert (AOI) Logic**  The mathematical process standards describe ways in which students are expected to engage in the content. The process standards weave the other knowledge and skills together so that students may be successful problem solvers and use mathematics efficiently and effectively in daily life. This unit reflects that the process standards are integrated at every grade level and course. When possible, students will apply mathematics to problems arising in everyday life, society, and the workplace. Students will 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. | 15 Periods  675 Minutes | (8) The student understands and uses multiple forms of AND-OR-Invert (AOI) logic. The student is expected to:  (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;  (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;  (C) derive logic expressions from a given truth table;  (D) demonstrate logic expressions in sum-of-products (SOP) form and products-of-sum (POS) form;  (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  (F) apply a formal design process to translate a set of design specifications into a functional combinational logic circuit. | |
| **Unit 6: NAND and NOR Logic**  In this unit, students will select appropriate tools such as real objects, manipulatives, paper and pencil, and technology and techniques such as mental math, estimation, and number sense to solve problems. Students will effectively communicate mathematical ideas, reasoning, and their implications using multiple representations such as symbols, diagrams, graphs, and language. | 15 Periods  675 Minutes | (9) The student understands, explains, and applies NAND and NOR Logic and understands the benefits of using universal gates. The student is expected to:  (A) apply the Karnaugh Mapping graphical technique to simplify logic expressions containing two, three, and four variables;  (B) define a "don't care" condition and explain its significance;  (C) explain why NAND and NOR gates are considered universal gates;  (D) demonstrate implementation of a combinational logic expression using only NAND gates or only NOR gates;  (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  (F) explain why combinational logic designs implemented with NAND gates or NOR gates will typically require fewer integrated circuits (IC) than AOI equivalent implementations. | |
| **Unit 7: Combinational Logic Systems, Including Seven-Segment Displays, Exclusive OR and Exclusive NOR Gates, and Multiplexer/De-Multiplexer Pairs**  Students will use mathematical relationships to generate solutions and make connections and predictions. In this unit, students will analyze mathematical relationships to connect and communicate mathematical ideas. | 15 Periods  675 Minutes | (10) 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:  (A) use seven-segment displays used to display the digits 0-9 as well as some alpha characters;  (B) identify the two varieties of seven-segment displays;  (C) describe the formal design process used for translating a set of design specifications into a functional combinational logic circuit;  (D) develop an understanding of the hexadecimal and octal number systems and their relationships to the decimal number system;  (E) explain the primary intended purpose of Exclusive OR (XOR) and Exclusive NOR (XNOR) gates;  (F) describe how to accomplish the addition of two binary numbers of any bit length;  (G) explain when multiplexer/de-multiplexer pairs are most frequently used;  (H) explain the purpose of using de-multiplexers in electronic displays that use multiple seven-segment displays;  (I) identify the most commonly used method for handling negative numbers in digital electronics;  (J) discuss the use of programmable logic devices and explain designs for which they are best suited; and  (K) compare and contrast circuits implemented with programmable logic devices with circuits implemented with discrete logic. | |
| **Unit 8: Sequential Logic**  In this unit, students will display, explain, or justify mathematical ideas and arguments using precise mathematical language in written or oral communication. | 15 Periods  675 Minutes | (11) The student understands and describes multiple types of sequential logic and various uses of sequential logic. The student is expected to:  (A) explain the capabilities of flip-flop and transparent latch logic devices;  (B) discuss synchronous and asynchronous inputs of flip-flops and transparent latches;  (C) explore the use of flip-flops, including designing single event detection circuits, data synchronizers, shift registers, and frequency dividers;  (D) explain how asynchronous counters are characterized and how they can be implemented;  (E) explore the use of the asynchronous counter method to implement up counters, down counters, and modulus counters;  (F) explain how synchronous counters are characterized and how they can be implemented;  (G) explore the use of the synchronous counter method to implement up counters, down counters, and modulus counters;  (H) describe a state machine;  (I) identify common everyday devices that machines are used to control such as elevator doors, traffic lights, and combinational or electronic locks; and  (J) discuss various ways state machines can be implemented. | |
| **Unit 9: Teamwork in STEM**  In this unit students will demonstrate teamwork processes that promote team building, consensus, continuous improvement, respect for the opinions of others, cooperation, adaptability, and conflict resolution. Students will collaborate to work together efficiently, using positive interpersonal skills to establish and maintain effective working relationships in order to accomplish objectives and tasks. The culminating activity will require students to explain the importance of teamwork in the field of electronics. | 15 Periods  675 Minutes | (4) The student participates in team projects in various roles. The student is expected to:  (A) explain the importance of teamwork in the field of electronics;  (B) apply principles of effective problem solving in teams to practice collaboration and conflict resolution; and  (C) demonstrate proper attitudes as a team leader and team member. | |
| **Unit 10: Real-World Applications of Microcontrollers**  In this unit, students will explore flowcharts and basic programming. Students will identify everyday products that use microcontrollers. The culminating activity will have students explain the importance of digital control devices. | 15 Periods  675 Minutes | (12) The student explores microcontrollers, specifically their usefulness in real-world applications. The student is expected to:  (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;  (B) develop an understanding of basic programming skills, including variable declaration, loops, and debugging;  (C) identify everyday products that use microcontrollers such as robots, garage door openers, traffic lights, and home thermostats;  (D) describe a servo motor;  (E) explore the way microcontrollers sense and respond to outside stimuli;  (F) explain why digital devices are only relevant if they can interact with the real world;  (G) explain the importance of digital control devices, including microcontrollers in controlling mechanical systems; and  (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. | |
| **Unit 11: Employability Skills**  This unit offers students basic technical skills necessary to fulfill careers in the workforce. Through group activities, students will demonstrate interpersonal skills, such as: communication, professionalism, decision-making, leadership, and conflict resolution. The unit culminates with a peer review evaluation and reflection upon skills needed for success in the workforce. | 15 Periods  675 Minutes | (1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:  (A) demonstrate knowledge of how to dress appropriately, speak politely, and conduct oneself in a manner appropriate for the profession;  (B) show the ability to cooperate, contribute, and collaborate as a member of a group in an effort to achieve a positive collective outcome;  (C) present written and oral communication in a clear, concise, and effective manner, including explaining and justifying actions;  (D) demonstrate time-management skills in prioritizing tasks, following schedules, and performing goal-relevant activities in a way that produces efficient results; and  (E) demonstrate punctuality, dependability, reliability, and responsibility in performing assigned tasks as directed. | |
| **Unit 12: Extended Learning Experience**  In this unit, students are encouraged to expand their learning experiences through avenues such as STEM organizations and other leadership or extracurricular organizations. By connecting with these networks and/or their peers in the previous unit, students will be able to participate in a real or simulated engineering project. The culminate project will have students develop a plan of an individual product. | 15 Periods  675 Minutes | (5) The student develops skills for managing a project. The student is expected to:  (A) implement project management methodologies, including initiating, planning, executing, monitoring and controlling, and closing a project;  (B) develop a project schedule and complete work according to established criteria;  (C) participate in the organization and operation of a real or simulated engineering project; and  (D) develop a plan for production of an individual product. | |