Indiana Department of Education
Indiana Academic Standards Course Framework

Digital Electronics

Digital Electronics explores the design, building and implementation of modern day digital electronics circuits. Throughout the course, students will be using engineering principles to evaluate electrical requirements for a circuit, computer simulation software to design and test circuits within a virtual environment, and build and test circuits using physical wiring and protoboards. Topics covered in the class include, but not limited to, characteristics of basic analog and digital circuits, combinational logic, logic simplification (i,e, Boolean Algebra, Karnaugh Mapping), programmable logic devices, sequential logic and introductions to microprocessors.

- PLTW DOE Codes: 4826
- Non-PLTW DOE Code: 5538
- Recommended Grade Level: 11-12
- Recommended Prerequisites: Introduction to Engineering Design and Principles of Engineering
- Credits: 2 semester course, 2 semesters required, 1 credit per semester, maximum of 2 credits
- Fulfills a Directed Elective or Elective requirement for all diploma types
- Qualifies as a quantitative reasoning course

Dual Credit
This course provides the opportunity for dual credit for students who meet postsecondary requirements for earning dual credit and successfully complete the dual credit requirements of this course. The Dual Credit crosswalk can be accessed here.

Application of Content and Multiple Hour Offerings
Intensive laboratory applications are a component of this course and may be either school based or work based or a combination of the two. Work-based learning experiences should be in a closely related industry setting. Instructors shall have a standards-based training plan for students participating in work-based learning experiences.

Implementation Guidance
Domain Zero (0) was created much like a process standard to be implemented throughout the length of the course. These standards should be taught in conjunction with Content Area Standards in

Career and Technical Student Organizations (CTSOs)
Career and Technical Student Organizations are considered a powerful instructional tool when integrated into Career and Technical Education programs. They enhance the knowledge and skills students learn in a course by allowing a student to participate in a unique program of career and leadership development. Students should be encouraged to participate in a Career and Technical Student Organization, such as the Technology Student Association (TSA)

Domain 0 – Project Management

Core Standard 1 **Students will exhibit appropriate safety practices while working with tools and equipment.**

DE – 0.1.1 Demonstrate relevant safety practices when using tools and equipment as determined by task, materials, environment, and protective attire.

DE – 0.1.2 Apply corrective action(s) to eliminate hazards.
Understand the format and content of industry based Material Safety Data Sheets (MSDS).

Core Standard 2 **Students will investigate various careers within the fields of engineering and technology.**

DE – 0.2.1 Identify engineering and technology occupations and the roles and responsibilities of each.

DE – 0.2.2 Report job outlook, demand, and projected wages for engineering and technology careers.

DE – 0.2.3 Explore job opportunities that are available in engineering and technology.

DE – 0.2.4 Investigate post-secondary training opportunities and industry certifications that are available.

DE – 0.2.5 Explore professional organizations related to engineering and technology.

Core Standard 3 **Students will communicate the design process.**

DE - 0.3.1 Explain the importance of documentation.

DE - 0.3.2 Apply sketching and annotation skills to document work.

DE - 0.3.3 Produce working drawings using appropriate drawing styles and techniques.

DE - 0.3.4 Construct design models or finish models to display concepts of design or theory investigated.

DE - 0.3.5 Document project components into an engineering notebook (digital or paper).

DE - 0.3.6 Communicate technical knowledge in a variety of formats.

DE - 0.3.7 Utilize presentation software to create a presentation that outlines team or individual priorities for design and share with peers.

DE - 0.3.8 Document best work in a portfolio (digital or paper).

Core Standard 4 **Students will apply appropriate research techniques.**

DE - 0.4.1 Formulate unbiased research questions to collect information/data.

DE - 0.4.2 Apply appropriate investigative strategies.

DE - 0.4.3 Evaluate sources appropriate for academic research.

DE - 0.4.4 Select resources relevant to the identified problem.

DE - 0.4.5 Synthesize information collected during the research process.

DE - 0.4.6 Generate a list of sources used to gather information using APA or MLA format.

Content Standards
Domain – Lab and Electrical Wiring Safety

Core Standard 5 **Students apply concepts of lab and electrical wiring safety to ensure a safe work environment.**

DE – 5.1 Demonstrate wearing safety attire and following all classroom procedures related to safety.

DE – 5.2 Demonstrate methods to avoid electric shock by identifying the causes.

DE – 5.3 Utilizing environmentally sustainable design principles, design electronic circuits that reduce the negative impact on the environment while maintaining functions and safety.

Domain – Soldering, Equipment, and Supplies

Core Standard 6 Students will establish a working and functional knowledge of the software and equipment used in designing and troubleshooting circuits.

DE – 6.1 Create and test circuits using circuit design software.
DE – 6.2 Determine values associated with resistance, voltage, current and continuity using a digital multi-meter.
DE – 6.3 Demonstrate successful soldering and desoldering techniques.
DE – 6.4 Demonstrate breadboarding techniques to build a working circuit.

Domain – Basic Laws of Electricity

Core Standard 7 Distinguish the parts of the atomic structure and how it plays a part in determining what elements are good conductors, insulators, and semi-conductors.

DE – 7.1 Define and explain Alternating Current (AC) and Direct Current (DC).
DE – 7.2 Distinguish between conventional current flow versus electron current flow and how they apply to engineering and scientific disciplines.
DE – 7.3 Distinguish between conventional current flow versus electron current flow and how they apply to engineering and scientific disciplines.
DE – 7.4 Design circuit boards that demonstrate the theory and principles associated with that of a complex circuit.
DE – 7.5 Calculate resistance, current and voltage in simple series, parallel and complex circuits using Ohm's Law.
DE – 7.6 Demonstrate the use of Kirchhoff's Voltage Law applied to simple series and complex circuits.
DE – 7.7 Demonstrate the use of Kirchhoff's Current Law for simple parallel and complex series-parallel circuits.

Domain – Electrical Components

Core Standard 8 Students apply concepts of the basic electrical components to design and create circuits.

DE – 8.1 Identify resistors by determining their nominal value.
DE – 8.2 Describe the material makeup of resistors and their application to circuit design.
DE – 8.3 Recognize industry standard symbols associated with resistors and their operation in schematic design.
DE – 8.4 Compare and contrast the measured value of a resistor to the calculated tolerance.
DE – 8.5 Identify the component parts of a capacitor, the types of capacitors available, ability to capture and contain static charge and voltage polarity requirements.
DE – 8.6 Identify and describe the unit of measure for capacitors.
DE – 8.7 Calculate the nominal values of different capacitors and their voltage polarity requirements.
DE – 8.8 Investigate types, functions, and power requirements of integrated circuits (logic gates).

DE – 8.9 Demonstrate the differences between an analog and cathode seven segment display.

Domain 5 – Combinational Logic

Core Standard 9 Students apply the laws of motion as they apply to principles of engineering.

DE – 9.1 Demonstrate the calculation of projectile motion given parameters.
DE – 9.2 Examine the propulsion of an object.
DE – 9.3 Explain how gravity impacts motion.
DE – 9.4 Apply the laws of motion to solutions.
DE – 9.5 Analyze the forces acting on an object while in motion.
DE – 9.6 Describe the relationships among force, mass, and direction.

Domain – Simple Machines

Core Standard 10 Students create, analyze and simplify digital logic circuits utilizing combinational logic.

DE – 10.1 Create truth tables and Boolean expressions for basic logic gates.
DE – 10.2 Demonstrate the relationship between the Boolean expression, logic diagram, and the truth table.
DE – 10.3 Design Boolean expressions, logic circuit diagrams or truth tables from information provided in a design problem.
DE – 10.4 Select the Sum-of-Products (SOP) or the Products-of-Sums (POS) form of a Boolean expression to use in the solution of a design problem.
DE – 10.5 Apply the rules of Boolean algebra to logic diagrams and truth tables to minimize the circuit size necessary to solve a design problem.
DE – 10.6 Apply DeMorgan's theory to simplify a negated expression to reduce resources used in the design and production of circuits.
DE – 10.7 Formulate and employ a Karnaugh Map to reduce Boolean expressions and logic circuits to their simplest forms.
DE – 10.8 Create circuits to solve a problem using NAND or NOR gates to replicate all combinational logic functions.
DE – 10.9 Generate simplified schematics to design problems using logic gates and symbolic algebra.

Domain – AC/DC Current Waveforms

Core Standard 11 Students analyze the characteristics of waveforms and voltage generation associated with AC and DC current.

DE – 11.1 Identify the anatomy of the waveform associated with AC and DC current.
DE – 11.2 Analyze both analog and digital waveforms
DE – 11.3 Differentiate between digital and analog signals when given a waveform.
DE – 11.4 Design, create and test circuits to calculate the output frequency of circuits using observations and the oscilloscope.
DE – 11.5 Calculate the duty cycle associated with a digital waveform using observations and the oscilloscope.

Domain – Sequential Logic (Flip-Flops)

Core Standard 12 **Students create, analyze and simplify digital logic circuits utilizing combinational and sequential logic.**

- DE – 12.1 Examine how to operate a circuit using sequential logic.
- DE – 12.2 Compare and contrast between the different kinds of flip-flops.
- DE – 12.3 Construct circuits and evaluate information about the various applications of flip-flops.
- DE – 12.4 Demonstrate the differences associated with asynchronous and synchronous circuits.
- DE – 12.5 Compare and evaluate how sequential logic determines the operation of a circuit waveform and how a truth table can be used to predict an outcome.
- DE – 12.6 Use of flip-flops or latches to store data, act as a memory device or transfer data through a shift register.
- DE – 12.7 Determine the proper selection and use of a small scale integrated circuit (SSI) and medium scale integrated circuit (MSI).

Domain – Number Systems, Simplifying

Core Standard 13 **Students convert and calculate number systems and sequences to simplify problems.**

- DE – 13.1 Convert numbers between the binary, hexadecimal, octal and decimal number systems.
- DE – 13.2 Translate design specifications into truth tables using binary numbering system language.
- DE – 13.3 Construct truth tables from logic expressions and vice versa.
- DE – 13.4 Understand least significant bit and most significant bit numerical place value within a numbering system.
- DE – 13.5 Use mathematical symbols to represent bases and communicate concepts using different number systems.
- DE – 13.6 Demonstrate the relationship of binary and hexadecimal to bits and bytes of information used in computers.
- DE – 13.7 Design, construct and test adder circuits using both discrete and MSI gates to perform basic addition and subtraction using a binary numbering system.
- DE – 13.8 Convert any number using appropriate SI unit prefixes.

Domain – Programmable Logic Devices, State Machines, and Microprocessors

Core Standard 14 **Students design and create a microprocessor to understand the impact of design, creation and implementation of a processor.**

- DE – 14.1 Understand how programmable logic devices (PLDs) are used to build and execute the operation of a circuit.
- DE – 14.2 Develop an understanding of a state bubble and state diagram.
- DE – 14.3 Construct a state transition table and derive equations for outputs at each state.
- DE – 14.4 Construct a state machine circuit using multiple inputs and outputs.
- DE – 14.5 Formulate a flowchart/pseudocode to correctly apply basic programming concepts in the planning of a project.
- DE – 14.6 Execute a program using a microprocessor.