Project Lead The Way® "Digital Electronics"
Technology Education – Applied Technology Education
Utah State Office of Education
CIP Code 210121

COURSE DESCRIPTION: This course introduces students to applied digital logic, a key element of careers in engineering and engineering technology. This course explores the smart circuits found in watches, calculators, video games, and computers. Students use industry-standards computer software in testing and analyzing digital circuitry. They design circuits to solve problems, export their designs to a printed circuit auto-routing program that generates printed circuit boards, and use appropriate components to build their designs. Students use mathematics and science in solving real-world engineering problems. This course covers several topics, including:

- Analog and digital fundamentals
- Number systems and binary addition
- Logic gates and functions
- Boolean algebra and circuit design
- Decoders, multiplexers and de-multiplexers

STANDARD & OBJECTIVES

210121.01 FUNDAMENTALS

210121.0101 Students will be able to identify hazards in the lab and know locations of the safety equipment and how to use it. (Safety)
210121.0102 Students will understand the causes of and the dangers from electric shock and explain methods to prevent it. (Safety)
210121.0103 Students will understand that the process of designing an electronic circuit takes into account many factors, including environment concerns, and will be familiar with precautionary measures. (Safety)
210121.0104 Students will be able to label the parts of the atom. (Basic Electron Theory)
210121.0105 Students will explain the relationship of quantum energy required to strip away electrons from atoms to being classified as an insulator or conductor. (Basic Electron Theory)
210121.0106 Students will learn how to apply Kirchhoff's voltage and current laws to closed loops. (Basic Electron Theory)
210121.0107 Students will be able to define and explain the difference between direct and alternating currents. (Basic Electron Theory)
210121.0108 Students will be able to re-write any number using conventional prefix definitions. (Scientific Prefixes)
210121.0109 Students will understand the material makeup of resistors and how they are used in circuit design. (Resistors)
210121.0110 Students will understand the symbols associated with resistors. (Resistors)
210121.0111 Students will be able to correctly setup lab equipment to measure resistor values in order to compare measured and rated values. (Resistors)
210121.0112 Students will calculate the tolerance levels of various resistors to determine if the measured value is within specifications. (Resistors)

210121.0103 Students will be able to draw and label the parts of a simple circuit. (Laws)
210121.0104 Students will build and test a variety of series and parallel circuits, using simulation software and proto-boards, to prove the accuracy of Ohm's and Kirchhoff's laws. (Laws)
210121.0105 Students will correctly select and utilize electrical meters to determine voltage, resistance and current in simple circuits. (Laws)
210121.0106 Students will calculate the resistance, current and voltage in a circuit using Ohm's Law. (Laws)
210121.0107 Students will describe the component parts of a capacitor and describe how a capacitor holds a static charge. (Capacitance)
210121.0108 Students will use and understand the units of measurement for capacitors. (Capacitance)
210121.0109 Students will be able to calculate the value of capacitors mathematically and through the use of instrumentation. (Capacitance)
210121.0110 Students will be familiar with different types of capacitors and their voltage polarity requirements. (Capacitance)
210121.0111 Students will be able to draw a digital waveform and identify the anatomy of the waveform. (Analog and Digital Waveforms)
210121.0112 Students will differentiate between digital and analog signals when given the waveforms. (Analog and Digital Waveforms)
210121.0113 Students will wire and test a free-running clock circuits using a 555 timer. (Analog and Digital Waveforms)
210121.0114 Students will calculate the output frequency of a clock circuits using observations and the oscilloscope. (Analog and Digital Waveforms)

210121.02 NUMBER SYSTEMS

210121.0201 Students will understand numerical place value. (Conversions)
210121.0202 Students use mathematical symbols to represent different bases and will communicate concepts using different number systems. (Conversions)
210121.0203 Students will demonstrate the relationship of binary and hexadecimal to bits and bytes of information used in computers. (Conversions)
210121.0204 Students will convert values from one number system to another. (Conversions)

210121.03 GATES

210121.0301 Students will use schematics and symbolic Algebra to represent digital gates in the creation of solutions to design problems. (Logic Gates)
210121.0302 Students will identify the name, symbol, and function and create the truth table, and Boolean Expression for the basic logic gates through research and experimentation. (Logic Gates)
210121.0303 Students will apply logic to design and create, using gates, solutions to a problem. (Logic Gates)

210121.04 BOOLEAN ALGEBRA

210121.0401 Students will recognize the relationship between the Boolean expression, logic diagram, and truth table. (Boolean Expressions)
210121.0402 Students will be able to create Boolean Expressions, logic circuit diagrams or truth tables from information provided in the solution of design problems. (Boolean Expressions)
210121.0403 Students will appropriately select the Sum-of-Products or the Product-of-Sums form of a Boolean Expression to use in the solution of a problem. (Boolean Expressions)
210121.0404 Students will apply the rules of Boolean algebra to logic diagrams and truth tables to minimize the circuit size necessary to solve a design problem. (Logic Simplifications)
210121.0405 Students will use DeMorgan's Theorem to simplify a negated expression and to convert a SOP to a POS and visa versa in order to save resources in the production of circuits. (Logic Simplifications)
210121.0406 Students will formulate and employ a Karnaugh Map to reduce Boolean expressions and logic circuits to their simplest forms. (Logic Simplifications)
210121.0407 The students will create circuits to solve a problem using NAND or NOR gates to replicate all logic functions. (Duality of Logic Functions)
210121.0408 The students will apply their understanding of the workings of NOR and NAND gates to make comparisons with standard combinational logic solutions to determine amount of resource reduction. (Duality of Logic Functions)

210121.05 BOOLEAN ALGEBRA AND CIRCUIT DESIGN

210121.0501 Students will restate and simplify a digital design problem as part of the systematic approach to solving a problem. (Paradigm for Combinational Logic Problems)
210121.0502 Students will design, construct, build, troubleshoot, and evaluate a solution to a design problem. (Paradigm for Combinational Logic Problems)
210121.0503 Students will present an oral report presenting a solution and evaluation of a design problem of their choice. (Paradigm for Combinational Logic Problems)
210121.0504 Students will discover the code to create numbers on a seven segment display by experimentation. (Specific Application MSI Gates)
210121.0505 Students will design a circuit to control a seven segment display with a decimal to BCD encoder and a display driver. (Specific Application MSI Gates)
210121.0506 Students will control the flow of data by utilizing Multiplexers and De-multiplexers. (Specific Application MSI Gates)
210121.0507 Students will be able to design and implement combinational logic circuits using reprogrammable logic devices. (Programmable Logic Devices (PLD))
210121.0508 Students will create PLD logic files that define combinational circuit designs using Boolean Expressions. (Programmable Logic Devices (PLD))
210121.0509 Students will understand and use logic compiler software to create JEDEC files for programming PLDs. (Programmable Logic Devices (PLD))

210121.06 ADDING

210121.0601 Students will demonstrate understanding of binary addition and subtraction by designing circuits to produce correct answers. (Binary Addition)
210121.0602 Students will create and prove the truth table for both half and full adders. (Binary Addition)

210121.0603 Students will design, construct and test adder circuits using both discrete gates and MSI gates. (Binary Addition)

210121.07 FLIP-FLOPS

210121.0701 Students will construct and test simple latches and flip-flops from discrete gates. (Introduction to Sequential Logic)
210121.0702 Students will interpret, design, draw, and evaluate circuits using the logic symbols for latches and flip-flops. (Introduction to Sequential Logic)
210121.0703 Students will be able to interpret waveform diagrams from circuits they construct and compare them with combinational waveforms. (Introduction to Sequential Logic)
210121.0704 Students will compare and contrast operation of synchronous with asynchronous flip-flop circuits they construct. (The J-K Flip-Flop)
210121.0705 Students will be able to create and interpret timing diagrams and truth tables for J-K Flip-Flops. (The J-K Flip-Flop)
210121.0706 Students will understand the different types of triggers used by latches and flip-flops and select the appropriate one for the circuits they design. (Triggers)
210121.0707 Students will analyze timing diagrams that reflect triggering to identify distinguishing characteristics. (Triggers)
210121.0708 Students will conduct experiments with clock pulse width to determine the effect on the accuracy of data transmission. (Flip-Flop Timing Considerations)
210121.0709 Students will assemble circuits and compile information about the various applications of flip-flops. (Elementary Applications of Flip-Flops)

210121.08 SHIFT REGISTERS AND COUNTERS

210121.0801 Students will conduct experiments to determine the basic principles of how shift registers work. (Shift Registers)
210121.0802 Students will evaluate the use of shift registers in product design and the speeds at which those products run. (Shift Registers)
210121.0803 Students will create a circuit using discrete flip-flops to discover the operation and characteristics of asynchronous counters. (Asynchronous Counters)
210121.0804 Students will design, simulate, build and test Mod counters using discrete gates in the solution to a design problem. (Asynchronous Counters)
210121.0805 Students will design, simulate, build and test asynchronous Mod counters using an integrated counter chip (MSI). (Asynchronous Counters)
210121.0806 Students will design, simulate, build and test synchronous Mod counters using discrete gates to solve a problem. (Synchronous Counters)
210121.0807 Students will design, simulate, build and test synchronous Mod counters using an integrated counter chip in the solution to a design problem. (Synchronous Counters)

210121.09 FAMILIES AND SPECIFICATIONS

210121.0901 Students will be able to interpret the graphs, charts and written materials contained in a data sheet and apply it to a design problem. (Logic Families)

210121.0902 Students will be able to correctly setup and use an oscilloscope to observe and measure propagation delay in a digital circuit. (Logic Families)
210121.0903 Students will be able to define, calculate, and measure noise margin, drive capabilities, fan-out and propagation delay. (Logic Families)
210121.0904 Students will be able to list safety precautions for handling CMOS chips. (Logic Families)

210121.10 MICROPROCESSORS

210121.1001 Students will be able to formulate a flow chart to correctly apply basic programming concepts in the planning of a project . (Microcontrollers)
210121.1002 Students will be able to design and create a program, using correct syntax, to evaluate data and make decisions based on information gathered from the environment using external digital and analog sensors. (Microcontrollers)
210121.1003 Students will create an interface to allow them to inspect, evaluate and manage program parameters in the microprocessor during the operation of a program. (Microcontrollers)
210121.1004 Students will be able to design and create a program in correct syntax allowing a microprocessor to evaluate external data in order to operate motors and other devices to control the external environment. (Interfacing with Motors)
210121.1005 Students will appropriately select, size, and implement interface devices to control external devices. (Interfacing with Motors)
210121.1006 Students will design and create programming to control the position of stepper motors. (Interfacing with Motors)