



School District of Marshfield Course Syllabus

Course Name: Digital Electronics

Length of Course: 1 Year

Credit: 1

Program Goal(s):

Empower learners to be college and career ready through standards-based experiences in the classroom and career-based learning experiences with business and industry partners. Learners will engage through technology in design, building, problem-solving, repair or service, in a collaborative environment through theory and hands-on experiences.

Course Description:

The major focus of this course is to open doors to understanding electronics and foundations in circuit design. Digital electronics is the foundation of all modern electronic devices such as cellular phones, MP3 players, laptop computers, digital cameras, high definition televisions, etc. Students learn the digital circuit design process to create circuits and present solutions that can improve people's lives. Learn how advancements in foundational electronic components and digital circuit design processes have transformed the world around you.

Standards:

Wisconsin Technology & Engineering Broad Based (BB)		
Standard	Learning Priority	Performance Indicators
BB1: Students will analyze the core concepts of technology	BB1.a: Analyze and use technological systems.	BB1.a.3.m: Identify inputs, processes, outputs and, at times, feedback components for technological systems.

		BB1.a.5.h: Describe how systems can fail because of design flaws, defect parts, poorly matched parts or they were used beyond their design capabilities. BB1.a.6.h: Describe how the outputs of one subsystem are the inputs of another subsystem given a prominent energy, power and transportation system.
	BB1.b: Analyze and use tools and materials.	BB1.b.3.m: Students will describe how resources are the things needed to complete a task (e.g., tools, machines, materials, information, energy, people, capital and time). BB1.b.5.h: Select appropriate resources and explain how trade-offs between competing values, such as availability, cost, desirability and waste influenced their decision.
	BB1.d: Analyze and use electricity and electronic systems.	BB1.d.2.m: Define basic electrical concepts (i.e., voltage, direct and alternating current, resistance, power, polarity, conductor, insulator, series circuit, parallel circuit, series-parallel circuit, inductance, capacitance, continuity, digital, analog). BB1.d.3.m: Measure current, voltage and resistance in series, parallel and series-parallel circuits and components. BB1.d.4.m: Locate and identify shorts to power & ground, opens and high resistance problems in circuits and components. BB1.d.6.h: Perform a voltage drop test and describe the relationship between voltage, current and resistance with a multimeter. BB1.d.7.h: Inspect and test components such as switches, connectors, relays, solid state devices and conductors and take appropriate action.
	BB1.e: Analyze, explain and use control systems.	BB1.e.3.m: Explain how control systems sense what is happening in a system, compare it to what people want to happen within the system and trigger subsystems that will make needed adjustments. BB1.e.5.h: Identify the multiple controls that sense information from a number of areas, evaluate

		the system and act accordingly given a flawed complex system.
Wisconsin Technology & Engineering- Electronics (EL)		
Standard	Learning Priority	Performance Indicators
Standard: EL1: Students will develop, use and apply basic electronics and electricity concepts.	EL1.a: Apply electronic theory to practice.	EL1.a.5.m: Describe atomic structure, the components of the atom, their charges and importance to electronics technology. EL1.a.6.m: Construct electrical systems and explain material's tendency toward being a conductor or insulator. EL1.a.7.m: Identify the fundamental and supplementary units that are the bases of the International System of Units (SI). EL1.a.8.m: Describe current, voltage, resistance, power and their application to DC electronics. EL1.a.9.m: Summarize Ohms law. EL1.a.10.m: Identify the scientific symbols used in DC electronics. EL1.a.11.m: Explain Peta, Tera, Giga, Mega, kilo, milli, micro, nano, pico and their SI symbols. EL1.a.12.h: Explain electronic physics terminology of work and energy. EL1.a.13.h: Calculate current, voltage or resistance using Ohms Law and Kirchoff's Voltage Law. EL1.a.14.h: Describe Watts Law. EL1.a.16.h: Demonstrate standard metric conversions. EL1.a.17.h: Convert fixed numbers to scientific notation. EL1.a.18.h: Explain the difference between conventional current theory and electron current theory.
Standard: EL2: Students will develop the ability to use symbols, measurements and schematics to build, test and troubleshoot electronic circuits and systems.	EL2.a: Construct and measure a basic circuit using electronic components.	EL2.a.4.m: Identify the following electronic components and their usages: source, load, insulator conductor and control device. EL2.a.7.m: Construct a basic circuit using a solder-less breadboard to demonstrate a source, load, connector, safety device and control device. EL2.a.8.h: Explain the basic operation of the following electronic components: Capacitors, Resistors, Diodes, Transistors, Insulators, Conductors, Switches, Fuses, Circuit Breakers, Batteries and Power Supplies.

		EL2.a.9.h: Recognize the following electronic components by constructing simple circuits: Capacitors, Resistors, Diodes, Transistors, Insulators, Conductors, Switches, Fuses, Circuit Breakers, Batteries and Power Supplies. EL2.a.10.h: Demonstrate multimeter and usage. EL2.a.11.h: Explain the reasons for flux usage and describe it's interaction between metals. EL2.a.12.h: List types of solder and reasons for choosing each. EL2.a.13.h: Describe and demonstrate the differences between good and bad mechanical and electrical solder connections. EL2.a.14.h: Analyze the process of manufacturing a printed circuit board and construct a soldered circuit.
	EL2.b: Demonstrate electronic measurement to series, parallel and combination circuits.	EL2.b.3.m: Construct a series circuit and explain its basic concepts. EL2.b.4.m: Construct a parallel circuit, explain its basic concepts and be able to calculate resistance total. EL2.b.5.h: Explain how a series circuit is used in DC electronic equipment. EL2.b.6.h: Calculate an unknown current, voltage or resistance in a series circuit, using Ohms law. EL2.b.7.h: Explain how a parallel circuit is used in DC electronic equipment. EL2.b.8.h: Calculate an unknown current, voltage or resistance in a parallel circuit, using Ohms law. EL2.b.9.h: Apply Kirchoff's Current Law to a constructed circuit. EL2.b.10.h: Explain multimeter construction, components and usage and distinguish between digital and analog meters.
Standard: EL3: Students will analyze and use digital electronics.	EL3.a: Analyze, develop, use and apply digital electronics.	EL3.a.2.m: Demonstrate basic logic decision making using switches. EL3.a.3.m: Identify different numbering systems including binary and hexadecimal. EL3.a.4.m: Interpret a flowchart based on a decision making logic

		sequence and write a basic program. EL3.a.5.h: Identify and describe the operation of common electronic components. EL3.a.6.h: Perform basic soldering techniques and printed circuit board construction. EL3.a.7.h: Analyze simple analog and digital circuits using common electronic test equipment and tools. EL3.a.8.h: Determine the characteristics of analog and digital signals. EL3.a.9.h: Translate data specifications into truth tables and extract logical expressions. EL3.a.10.h: Use Boolean algebra and DeMorgan's Theorem to simplify logic expressions. EL3.a.11.h: Convert binary, hexadecimal and octo numbers to base 10. EL3.a.12.h: Add, subtract, multiply and divide binary, hexadecimal and octo numbers.
Standard: EL4: Students will analyze and use combinational logic analysis and design.	EL4.a: Design and build a combinational logic circuit that satisfies a need, to design constraints.	EL4.a.2.m: Distinguish between the functions of Inverter and OR gates. EL4.a.3.m: Create a truth table that controls the decision making for a basic decision. EL4.a.4.m: Use switches to create circuits that function as AND and OR gates. EL4.a.5.m: Determine the logic, sensors, gates, outputs and other components needed to emulate existing electronic devices that utilize logic. EL4.a.6.h: Describe the operation of basic logic components, including gates, inverters and flip-flops. EL4.a.7.h: Design a combinational logic circuit using basic logic gates. EL4.a.8.h: Simulate and prototype a logic circuit. EL4.a.9.h: Design a combinational logic circuit incorporating negative logic. EL4.a.10.h: Simulate and prototype a logic circuit employing negative logic. EL4.a.11.h: Design half-adder, full-adder and binary adder logic circuits using exclusive logic.

		EL4.a.12.h: Design a combinational logic circuit using a programmable logic device. EL4.a.13.h: Simulate and prototype a combinational logic circuit employing a programmable logic device.
Standard: EL5: Students will analyze and use sequential logic analysis and design.	EL5.a: Design and build a sequential logic circuit that satisfies a need to design constraints.	EL5.a.2.m: Design, construct and test device solutions for emulating common electronic devices that utilize data acquisition. EL5.a.3.h: Design, simulate and prototype a basic flip-flop application. EL5.a.4.h: Design, simulate, asynchronous counters and prototype SSI and MSI. EL5.a.5.h: Describe the components of a state machine. EL5.a.6.h: Design, simulate and prototype state machines using discrete or programmable logic. EL5.a.7.h: Analyze and design basic flip-flop applications, including event detection circuits, data synchronizers, shift registers and frequency dividers.
Standard: EL6: Students will explain the role of microcontrollers in process control and demonstrate use.	EL6.a: Program and construct a microcontroller that satisfies a need to design constraints.	EL5.b.1.e: Explain where energy comes from and how to reduce energy consumption at home. EL6.a.2.m: Communicate using electronic circuit diagrams.
Standard: EL7: Demonstrate safe and appropriate use of tools, machines and materials in electronics technology.	EL7.a: Demonstrate, apply and measure electronic safety concepts applied to circuits.	EL7.a.2.m: Select appropriate tools, procedures and/or equipment. EL7.a.3.m: Demonstrate good organization at workstation within total laboratory. EL7.a.4.m: Explain precautions needed in the area of electronic safety. EL7.a.5.m: Describe solder safety as it pertains to burns and potential fires or damage to facilities or customer products. EL7.a.6.h: Demonstrate the safe usage of appropriate tools, procedures and operation of equipment. EL7.a.7.h: Describe personal safety precautions for working with electric and electronic devices electrical shock. EL7.a.8.h: List various degrees of current the human body can tolerate.

		EL7.a.9.h: Explain the concept of First Aid and its particular importance to workers in electric and electronic fields. EL7.a.10.h: List applicable governing fire safety regulations NEC (National Electrical Code) and NFPA 70 (National Fire Protection Association). EL7.a.11.h: Explain the cause of solder fumes and the effects of lead poisoning. EL7.a.12.h: List causes and precautions to prevent or reduce solder splatter.
Wisconsin Common Career Technical Standards (WCCTS)-Creativity, Critical Thinking, Communication and Collaboration (C)		
Standard	Learning Priority	Performance Indicators
Standard: 4C1: Students will think and work creatively to develop innovative solutions to problems and opportunities.	4C1.a: Develop original solutions, products and services to meet a given need.	4C1.a.4.m: Analyze elements of a problem to develop creative solutions. 4C1.a.6.m: Describe how past experiences can inform current problem solving. 4C1.a.7.h: Develop original ways to solve a given problem. 4C1.a.8.h: Design a product or service that could fulfill a human need or desire. 4C1.a.9.h: Apply past experiences to current problems in developing innovative solutions.
	4C1.b: Work creatively with others to develop solutions, products and services.	4C1.b.4.m: Explain how multiple people can develop better solutions than an individual. 4C1.b.5.m: Explain how multiple people and perspectives can develop better ideas than an individual. 4C1.b.6.m: Explain how multiple people and perspectives can improve an existing product or process better than an individual. 4C1.b.7.h: Incorporate the skills and experiences of others to develop a new solution to a problem. 4C1.b.8.h: Work as part of a team to design a product or service that could fulfill a human need or desire. 4C1.b.9.h: Work as part of a team to improve an existing product or process.

Standard: 4C2: Students will formulate and defend judgments and decisions by employing critical thinking skills.	4C2.a: Develop effective resolutions for a given problem, decision or opportunity using available information.	4C2.a.5.m: Analyze symptoms to identify the root cause of a problem. 4C2.a.6.m: Develop multiple resolutions for a given problem, decision or opportunity. 4C2.a.7.m: Identify problems that became worse due to poorly thought out or poorly informed solutions. 4C2.a.8.m: Explain how implementation of a solution or action may affect one or more corresponding systems. 4C2.a.9.m: Explain how different resolutions may be appropriate under different circumstances. 4C2.a.10.m: Explain the process for choosing an action or making a decision. 4C2.a.11.h: Determine the information needed to address an identified problem. 4C2.a.12.h: Contrast the benefits and drawbacks of various proposed resolutions to a given situation. 4C2.a.13.h: Predict how an action could result in unintended consequences, both positive and negative. 4C2.a.14.h: Analyze the impact of a decision using a systems thinking model. 4C2.a.15.h: Determine the best resolution for a problem, decision or opportunity based on given criteria. 4C2.a.16.h: Defend an action taken or a decision implemented.
	4C2.b: Develop and implement a resolution for a new situation using personal knowledge and experience.	4C2.b.3.m: Analyze problems to determine what past experiences might be related and relevant. 4C2.b.4.m: Analyze a problem to determine how it relates to existing knowledge. 4C2.b.5.h: Apply past experience to develop a course of action for a new situation. 4C2.b.6.h: Use existing knowledge to develop a resolution for a new situation, problem or opportunity.
Standard: 4C3: Students will communicate and collaborate with others to accomplish tasks and develop solutions to problems and opportunities.	4C3.a: Communicate thoughts and feelings with others using verbal and non-verbal language.	4C3.a.8.m: Implement effective listening skills in resolving a situation.

		4C3.a.9.h: Develop a mutually acceptable response to a question or problem. 4C3.a.11.h: Communicate effectively in the presence of a language barrier. 4C3.a.12.h: Utilize effective listening skills in creating consensus in a group.
	4C3.b: Work collaboratively with others.	4C3.b.4.m: Use idea generating practices as part of a group. 4C3.b.5.m: Describe ways to facilitate group collaboration. 4C3.b.6.m: Demonstrate the use of various tools to communicate effectively with an individual or a group. 4C3.b.7.h: Participate in group processes to generate consensus. 4C3.b.8.h: Lead group processes to generate consensus.
	4C3.c: Use interpersonal skills to resolve conflicts with others in an ethical manner.	4C3.c.5.m: Contribute to resolving conflicts that occur within a team or group. 4C3.c.6.m: Explore the ethical considerations of a current or historical action or decision. 4C3.c.7.h: Resolve conflicts productively with individuals as they arise. 4C3.c.8.h: Lead a team or group through a conflict resolution process to reach a productive outcome.
Wisconsin Common Career Technical Standards (WCCTS)-Career Development (CD)		
Standard	Learning Priority	Performance Indicators
Standard: CD1: Students will consider, analyze and apply an awareness of self, identity and culture to identify skills and talents.	CD1.a: Identify person strengths, aptitudes and passions.	CD1.a.2.m: Assess personal strengths, aptitudes and passions related to potential future careers CD1.a.3.h: Evaluate various occupations and career pathways to identify personal, academic and career goals based on personal strengths, aptitudes and passions.
	CD1.b: Demonstrate effective decision-making, problem solving and goal setting.	CD1.b.4.m: Identify long and short-term goals. CD1.b.5.h: Use a decision-making and problem-solving model.
	CD1.c: Interact effectively with others in similar and diverse teams.	CD1.c.7.m: Display cooperative behavior and identify personal strengths and assets in groups. CD1.c.11.h: Evaluate how the personal strengths and assets of others contribute to a cooperative group atmosphere.

		CD1.c.12.h: Assess how respect and appreciation for individual and cultural differences impacts group processes.
	CD1.d: Apply a range of relevant decision-making strategies.	CD1.d.4.m: Apply decision-making strategies to personal and team interactions. CD1.d.5.h: Predict the outcome of various decisions on personal, social and career success. CD1.d.6.h: Evaluate the impact of personal decision-making strategies on specific outcomes.
Standard: CD2: Students will identify the connection between educational achievement and work opportunities in order to reach personal and career goals.	CD2.a: Apply academic experiences to the world of work, inter-relationships and the community.	CD2.a.2.m: Describe a diverse range of opportunities available beyond high school. CD2.a.3.h: Evaluate how performance and connections within the learning community enhance future opportunities. CD2.a.4.h: Determine those opportunities that best support attainment of a specific career goal.
	CD2.b: Assess attitudes and skills that contribute to successful learning in school and across the life span.	CD2.b.5.m: Apply academic information from a variety of sources to enhance career preparedness and lifelong learning. CD2.b.6.m: Research local and regional labor market and job growth information to analyze career opportunities. CD2.b.7.h: Interpret and analyze the impact of current education, training and work trends on life, learning and career plans. CD2.b.8.h: Assess education and training opportunities to acquire new skills necessary for career advancement. CD2.b.9.h: Analyze local and regional labor market and job growth information to select a career pathway for potential advancement.
Standard: CD3: Students will create and manage a flexible and responsive individualized learning plan to meet their career goals.	CD3.a: Investigate the world of work in order to gain knowledge of self in order to make informed career decisions.	CD3.a.5.m: Demonstrate the ability to use technology to retrieve and manage career information that inspires educational achievement. CD3.a.6.m: Build an ongoing awareness of personal abilities, skills, interests and motivation and determine how these fit with chosen career pathway. CD3.a.7.m: Develop an individual learning plan to enhance

		educational achievement and attain career goals based on a career pathway. CD3.a.9.m: Use assessment results in educational planning including career awareness. CD3.a.10.h: Analyze how career plans may be affected by personal growth, external events and changes in motivations and aspirations. CD3.a.11.h: Apply academic and employment readiness skills in work-based learning situations such as internships, shadowing and/or mentoring experiences. CD3.a.12.h: Evaluate changes in local, national and global employment trends, societal needs and economic conditions related to career planning. CD3.a.14.h: Implement an individual learning plan to maximize academic ability and achievement.
	CD3.b: Examine and evaluate opportunities that could enhance life and career plans and articulate plan to guide decisions and actions.	CD3.b.2.m: Describe educational levels (e.g., work-based learning, certificate, two-year, four-year and professional degrees) and performance skills needed to attain personal and career goals. CD3.b.3.m: Demonstrate openness to exploring a wide range of occupations and career pathways. CD3.b.4.h: Implement strategies for responding to transition and change with flexibility and adaptability. CD3.b.5.h: Evaluate the relationship between educational achievement and career development.
	CD3.c: Employ career management strategies to achieve future career success and satisfaction.	CD3.c.3.m: Identify work values and needs. CD3.c.4.m: Define adaptability and flexibility in the world of work. CD3.c.5.h: Determine how principles of equal opportunity, equity, respect, inclusiveness and fairness, affect career planning and management. CD3.c.6.h: Discuss how adaptability and flexibility, especially when initiating or responding to change, contributes to career success.

Standard: CD4: Students will identify and apply employability skills.	CD4.a: Identify and demonstrate positive work behaviors and personal qualities needed to be employable.	CD4.a.4.m: Demonstrate flexibility and willingness to learn new knowledge and skills. CD4.a.5.m: Identify positive work-qualities typically desired in each of the career cluster's pathways. CD4.a.6.h: Evaluate how self-discipline, self-worth, positive attitude and integrity displayed in a work situation affect employment status. CD4.a.7.h: Assess how flexibility and willingness to learn new knowledge and skills affect employment status. CD4.a.8.h: Apply communication strategies when adapting to a culturally diverse environment. CD4.a.9.h: Use positive work-qualities typically desired in each of the career cluster's pathways. CD4.a.10.h: Manage work roles and responsibilities to balance them with other life roles and responsibilities.
	CD4.b: Demonstrate skills related to seeking and applying for employment to find and obtain a desired job.	CD4.b.3.m: Use technology to assist in career exploration and job-seeking activities. CD4.b.4.m: Compare and contrast personal attributes with employment needs and trends. CD4.b.5.h: Use multiple resources to locate job opportunities. CD4.b.6.h: Prepare a resume, cover letter, employment application. CD4.b.7.h: Employ critical thinking and decision-making skills to exhibit qualifications to a potential employer in an interview.
	CD4.c: Identify and exhibit traits for retaining employment.	CD4.c.3.m: Distinguish between appropriate behaviors in a social vs. professional setting. CD4.c.4.h: Model behaviors that demonstrate reliability and dependability. CD4.c.5.h: Maintain appropriate dress and behavior for the job to contribute to a safe and effective workplace/jobsite. CD4.c.6.h: Complete required employment forms and documentation. CD4.c.7.h: Summarize key activities necessary to retain a job in an industry.

	CD4.d: Develop positive relationships with others.	CD4.d.4.m: Use cooperative behavior in helping peers accomplish goals and tasks. CD4.d.5.h: Participate in co-curricular and community activities to enhance the school experience. CD4.d.6.h: Evaluate the best method to assist co-workers in accomplishing goals and tasks. CD4.d.7.h: Examine the skills required to enable students to successfully transition to post-secondary opportunities. CD4.d.8.h: Use a systematic approach to academic and career planning for students to achieve their learning, socio-cultural and work goals.
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Wisconsin Common Career Technical Standards (WCCTS)-Environmental Health and Safety (EHS)

Standard	Learning Priority	Performance Indicators
Standard: EHS1: Students will identify the importance and interrelationships of health, safety and environmental systems and evaluate the impacts of these systems on organizational performance for continuous improvement.	EHS1.d: Implement personal and jobsite safety rules and regulations to maintain and improve safe and healthful working conditions and environments.	EHS1.d.5.m: Recognize and use systems in school and in the community that protect and enhance personal, environmental health and safety. EHS1.d.6.m: Discuss employee rights and responsibilities and how to apply them in a workplace setting. EHS1.d.7.h: Assess workplace conditions with regard to personal and environmental health and safety. EHS1.d.8.h: Identify different workplace systems that protect and enhance personal and environmental health and safety. EHS1.d.9.h: Describe employee rights and responsibilities to maintain workplace health and safety, including compliance with rules and laws.

Key Vocabulary:

2's Complement	555 Timer	Amplitude	Analog
AND Gate	Asynchronous Counter	Binary Counter	Boolean Expression
Breadboard	Capacitor	Central Processing Unit	Clock
Combinational Logic	Current	Cycle	Datasheet

DeMorgan's Theorems	Digital	Digital Multi-Meter(DMM)	Dual In-Line Package (DIP)
Duty Cycle (DC)	Edge-Sensitive	Engineering Notation	Exclusive-NOR (XNOR) Circuit
Exclusive-OR (XOR) Circuit	Falling Edge	Flip-Flop	Frequency
Hertz (Hz)	Integrated Circuit (IC)	Inverter	Karnaugh Map
Kirchhoff's Current Law (KCL)	Kirchhoff's Voltage Law (KVL)	LED	Level-Sensitive
Logic Diagram	Logic Gate	Logic HIGH	Logic LOW
Maxterm	Minterm	Modulus	Multiplexer
NAND Gate	NOR Gate	NOT Gate	Octal Number System
Ohm	Ohm's Law	OR Gate	Oscilloscope
Parallel Circuit	Period	Printed Circuit Board	Product Term
Product-of-Sums (POS)	Programmable Logic Device (PLD)	Programming	Resistance
Resistor Color Code	Rising Edge	Scientific Notation	Sequential Logic
Series Circuit	Seven-Segment Display	Shift Register	SI Notation
Simulation	Sine Wave	Small-Scale Integration (SSI)	Solder
Solder Bridge	Soldering	Square Wave	State Machines
Sum-of-Products (SOP)	Synchronous Counter	Transistor	Transistor-Transistor (TTL)
Truth Table	Up/Down Counter	Variables	

Topics/Content Outline- Units and Themes:

Quarter 1:

Unit 1: Foundations in Electronics

- Lesson 1.1 Introduction to Electronics

Quarter 2:

- Lesson 1.2 Introduction to Circuit Design

Unit 2: Combinational Logic

- Lesson 2.1 AOI Combinational Logic Circuit Design

Quarter 3:

- Lesson 2.2 Alternative Design: Universal Gates and K-Mapping
- Lesson 2.3 Specific Combinational Logic Designs
- Lesson 2.4 Introduction to Programmable Logic Devices (PLDs)

Quarter 4:

Unit 3: Sequential Logic

- Lesson 3.1 Sequential Logic Circuit Design
- Lesson 3.2 Asynchronous Counters
- Lesson 3.3 Synchronous Counters

Unit 4: Controlling Real World Systems

- Lesson 4.1 Introduction to State Machines
- Lesson 4.2 Introduction to Microcontrollers

Primary Resource(s):
• Project Lead the Way: Digital Electronics Curriculum

