



# School District of Marshfield Course Syllabus

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**Course Name: EM Digital Electronics PS (PLTW-DE)**

**Length of Course: Year**

**Credit: 1 Credit**

## **Program Goal:**

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, 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.

## Wisconsin Standards for Technology and Engineering (TE)

### Broad-Based (BB)

**BB1:** Students will analyze the core concepts of technology.

**Analyze and use technological systems**  
BB1.a

1.a.5.h: Describe how systems can fail because of design flaws, defective parts, poorly matched parts, or they were used beyond their design capabilities.  
1.a.6.h: Describe how the outputs of one subsystem are the inputs of another subsystem given a prominent energy, power, and transportation system.

**Analyze and use tools and materials**  
BB1.b

1.b.5.h: Select appropriate resources and explain how trade-offs between competing values, such as availability, cost, desirability, and waste influenced their decision.

**Analyze and use electricity and electronic systems**  
BB1.d

1.d.6.h: Perform a voltage drop test and describe the relationship between voltage, current, and resistance with a multimeter.  
1.d.7.h: Inspect and test components such as switches, connectors, relays, and solid-state devices and conductors and take appropriate action.

**Analyze, explain, and use control systems**  
BB1.e

1.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.

### Electronics (EL)

**EL1:** Students will develop, use, and apply basic electronics and electricity concepts.

**Apply electronic theory to practice**  
EL1.a

1.a.12.h: Explain electronic physics terminology of work and energy.  
1.a.13.h: Calculate current, voltage, or resistance using Ohm's Law and Kirchoff's Voltage Law.  
1.a.14.h: Describes Watts Law.  
1.a.16.h: Demonstrate standard metric conversions.  
1.a.17.h: Convert fixed numbers to scientific notation.  
1.a.18.h: Explain the difference between conventional current theory and electron current theory.

**EL2:** Students will develop the ability to use symbols, measurements, and schematics to build, test, and troubleshoot electronic circuits and systems.

**Construct and measure a basic circuit using electronic components**  
EL2.a

2.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.  
2.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.  
2.a.10.h: Demonstrate multimeter and usage.  
2.a.11.h: Explain the reasons for flux usage and describe it's interaction between metals.  
2.a.12.h: List types of solder and reasons for choosing each.

	<p>2.a.13.h: Describe and demonstrate the differences between good and bad mechanical and electrical solder connections.</p> <p>2.a.14.h: Analyze the process of manufacturing a printed circuit board and construct a soldered circuit.</p>
<p><b>Demonstrate electronic measurement to series, parallel, and combination circuits</b> EL2.b</p>	<p>2.b.5.h: Explain how a series circuit is used in DC electronic equipment.</p> <p>2.b.6.h: Calculate an unknown current, voltage, or resistance in a series circuit using Ohm’s Law.</p> <p>2.b.7.h: Explain how a parallel circuit is used in DC electronic equipment.</p> <p>2.b.8.h: Calculate an unknown current, voltage, or resistance in a parallel circuit using Ohm’s Law.</p> <p>2.b.9.h: Apply Kirchoff’s Current Law to a construction circuit.</p> <p>2.b.10.h: Explain multimeter construction, components, and usage, and distinguish between digital and analog meters.</p>
<p><b>EL3: Students will analyze and use digital electronics.</b></p>	
<p><b>Analyze, develop, use, and apply digital electronics</b> EL3.a</p>	<p>3.a.5.h: Identify and describe the operation of common electronic components.</p> <p>3.a.6.h: Perform basic soldering techniques and printed circuit board construction.</p> <p>3.a.7.h: Analyze simple analog and digital circuits using common electronic test equipment and tools.</p> <p>3.a.8.h: Determine the characteristics of analog and digital signals.</p> <p>3.a.9.h: Translate data specifications into truth tables and extract logical expressions.</p> <p>3.a.10.h: Use Boolean algebra and DeMorgan’s Theorem to simplify logic expressions.</p> <p>3.a.11.h: Convert binary, hexadecimal and octo numbers to base 10.</p> <p>3.a.12.h: Add, subtract, multiply, and divide binary, hexadecimal and octo numbers.</p>
<p><b>EL4: Students will analyze and use combinational logic analysis and design.</b></p>	
<p><b>Design and build a combinational logic circuit that satisfies a need, to design constraints</b> EL4.a</p>	<p>4.a.6.h: Describe the operation of basic logic components, including gates, inverters, and flip-flops.</p> <p>4.a.7.h: Design a combinational logic circuit using basic logic gates.</p> <p>4.a.8.h: Simulate and prototype a logic circuit.</p> <p>4.a.9.h: Design a combinational logic circuit incorporating negative logic.</p> <p>4.a.10.h: Simulate and prototype a logic circuit employing negative logic.</p> <p>4.a.11.h: Design half-adder, full-adder and binary adder logic circuits using exclusive logic.</p> <p>4.a.12.h: Design a combinational logic circuit using a programmable logic device.</p>

	4.a.13.h: Simulate and prototype a combinational logic circuit employing a programmable logic device.
<b>EL5:</b> Students will analyze and use sequential logic analysis and design.	
<b>Design and build a sequential logic circuit that satisfies a need to design constraints</b> EL5.a	5.a.3.h: Design, simulate and prototype a basic flip-flop application. 5.a.4.h: Design, simulate, asynchronous counters and prototype SSI and MSI. 5.a.5.h: Describe the components of a state machine. 5.a.6.h: Design, simulate and prototype state machines using discrete or programmable logic. 5.a.7.h: Analyze and design basic flip-flop applications, including event detection circuits, data synchronizers, shift registers and frequency dividers.
<b>EL7:</b> Demonstrate safe and appropriate use of tools, machines, and materials in electronics technology.	
<b>Demonstrate, apply, and measure electronic safety concepts applied to circuits</b> EL7.a	7.a.6.h: Demonstrate the safe usage of appropriate tools, procedures, and operation of equipment. 7.a.7.h: Describe personal safety precautions for working with electric and electronic devices electrical shock. 7.a.8.h: List various degrees of current the human body can tolerate. 7.a.9.h: Explain the concept of First Aid and its particular importance to workers in electric and electronic fields. 7.a.10.h: List applicable governing fire safety regulations NEC (National Electrical Code) and NFPA 70 (National Fire Protection Association). 7.a.11.h: Explain the cause of solder fumes and the effects of lead poisoning. 7.a.12.h: List causes and precautions to prevent or reduce solder splatter.
<b>Wisconsin Common Career Technical Standards (WCCTS)</b>	
<b>Creativity, Critical Thinking, Communication and Collaboration (4C)</b>	
<b>4C1:</b> Students will think and work creatively to develop innovative solutions to problems and opportunities.	
<b>Develop original solutions, products, and services to meet a given need</b> 4C1.a	1.a.7.h: Develop original ways to solve a given problem. 1.a.8.h: Design a product or service that could fulfill a human need or desire. 1.a.9.h: Apply past experiences to current problems in developing innovative solutions.
<b>Work creatively with others to develop solutions, products, and services</b> 4C1.b	1.b.7.h: Incorporate the skills and experiences of others to develop a new solution to a problem. 1.b.8.h: Work as part of a team to design a product or service that could fulfill a human need or desire. 1.b.9.h: Work as part of a team to improve an existing product or process.
<b>4C2:</b> Students will formulate and defend judgments and decisions by employing critical thinking skills.	

<p><b>Develop effective resolutions for a given problem, decision or opportunity using available information</b> 4C2.a</p>	<p>2.a.11.h: Determine the information needed to address an identified problem. 2.a.12.h: Contrast the benefits and drawbacks of various proposed resolutions to a given situation. 2.a.13.h: Predict how an action could result in unintended consequences, both positive and negative. 2.a.14.h: Analyze the impact of a decision using a systems thinking model. 2.a.15.h: Determine the best resolution for a problem, decision or opportunity based on given criteria. 2.a.16.h: Defend an action taken or a decision implemented.</p>
<p><b>Develop and implement a resolution for a new situation using personal knowledge and experience</b> 4C2.b</p>	<p>2.b.5.h: Apply past experience to develop a course of action for a new situation. 2.b.6.h: Use existing knowledge to develop a resolution for a new situation, problem, or opportunity.</p>
<p><b>4C3:</b> Students will communicate and collaborate with others to accomplish tasks and develop solutions to problems and opportunities.</p>	
<p><b>Communicate thoughts and feelings with others using verbal and non-verbal language</b> 4C3.a</p>	<p>3.a.9.h: Develop a mutually acceptable response to a question or problem. 3.a.11.h: Communicate effectively in the presence of a language barrier. 3.a.12.h: Utilize effective listening skills in creating consensus in a group.</p>
<p><b>Work collaboratively with others</b> 4C3.b</p>	<p>3.b.7.h: Participate in group processes to generate consensus. 3.b.8.h: Lead group processes to generate consensus.</p>
<p><b>Use interpersonal skills to resolve conflicts with others in an ethical manner</b> 4C3.c</p>	<p>3.c.7.h: Resolve conflicts productively with individuals as they arise. 3.c.8.h: Lead a team or group through a conflict resolution process to reach a productive outcome.</p>
<p><b>Career Development (CD)</b></p>	
<p><b>CD1:</b> Students will consider, analyze, and apply an awareness of self, identity, and culture to identify skills and talents.</p>	
<p><b>Identify person strengths, aptitudes, and passions</b> CD1.a</p>	<p>1.a.3.h: Evaluate various occupations and career pathways to identify personal, academic and career goals based on personal strengths, aptitudes, and passions.</p>
<p><b>Demonstrate effective decision-making, problem solving and goal setting</b> CD1.b</p>	<p>1.b.5.h: Use a decision-making and problem-solving model. 1.b.6.h: Develop an action plan to set and achieve realistic goals.</p>
<p><b>Interact effectively with others in similar and diverse teams</b> CD1.c</p>	<p>1.c.11.h: Evaluate how the personal strengths and assets of others contribute to a cooperative group atmosphere. 1.c.12.h: Assess how respect and appreciation for individual and cultural differences impacts group processes.</p>
<p><b>Apply a range of relevant decision-making strategies</b></p>	<p>1.d.5.h: Predict the outcome of various decisions on personal, social and career success.</p>

CD1.d	1.d.6.h: Evaluate the impact of personal decision-making strategies on specific outcomes.
<b>CD2:</b> Students will identify the connection between educational achievement and work opportunities in order to reach personal and career goals.	
<b>Apply academic experiences to the world of work, inter-relationships and the community</b> CD2.a	2.a.3.h: Evaluate how performance and connections within the learning community enhance future opportunities. 2.a.4.h: Determine those opportunities that best support attainment of a specific career goal.
<b>Assess attitudes and skills that contribute to successful learning in school and across the life span</b> CD2.b	2.b.7.h: Interpret and analyze the impact of current education, training and work trends on life, learning and career plans. 2.b.8.h: Assess education and training opportunities to acquire new skills necessary for career advancement. 2.b.9.h: Analyze local and regional labor market and job growth information to select a career pathway for potential advancement.
<b>CD3:</b> Students will create and manage a flexible and responsive individualized learning plan to meet their career goals.	
<b>Investigate the world of work in order to gain knowledge of self in order to make informed career decisions</b> CD3.a	3.a.10.h: Analyze how career plans may be affected by personal growth, external events and changes in motivations and aspirations. 3.a.11.h: Apply academic and employment readiness skills in work-based learning situations such as internships, shadowing and/or mentoring experiences. 3.a.12.h: Evaluate changes in local, national and global employment trends, societal needs and economic conditions related to career planning. 3.a.14.h: Implement an individual learning plan to maximize academic ability and achievement.
<b>Examine and evaluate opportunities that could enhance life and career plans and articulate plans to guide decisions and actions</b> CD3.b	3.b.4.h: Implement strategies for responding to transition and change with flexibility and adaptability. 3.b.5.h: Evaluate the relationship between educational achievement and career development.
<b>Employ career management strategies to achieve future career success and satisfaction</b> CD3.c	3.c.5.h: Determine how principles of equal opportunity, equity, respect, inclusiveness, and fairness, affect career planning and management. 3.c.6.h: Discuss how adaptability and flexibility, especially when initiating or responding to change, contributes to career success.
<b>CD4:</b> Students will identify and apply employability skills.	
<b>Identify and demonstrate positive work behaviors and personal qualities needed to be employable</b> CD4.a	4.a.6.h: Evaluate how self-discipline, self-worth, positive attitude and integrity displayed in a work situation affect employment status. 4.a.7.h: Assess how flexibility and willingness to learn new knowledge and skills affect employment status. 4.a.8.h: Apply communication strategies when adapting to a culturally diverse environment.

	<p>4.a.9.h: Use positive work-qualities typically desired in each of the career cluster’s pathways.</p> <p>4.a.10.h: Manage work roles and responsibilities to balance them with other life roles and responsibilities.</p>
<p><b>Demonstrate skills related to seeking and applying for employment to find and obtain a desired job</b> CD4.b</p>	<p>4.b.5.h: Use multiple resources to locate job opportunities.</p> <p>4.b.6.h: Prepare a resume, cover letter, employment application.</p> <p>4.b.7.h: Employ critical thinking and decision-making skills to exhibit qualifications to a potential employer in an interview.</p>
<p><b>Identify and exhibit traits for retaining employment</b> CD4.c</p>	<p>4.c.4.h: Model behaviors that demonstrate reliability and dependability.</p> <p>4.c.5.h: Maintain appropriate dress and behavior for the job to contribute to a safe and effective workplace/jobsite.</p> <p>4.c.6.h: Complete required employment forms and documentation.</p> <p>4.c.7.h: Summarize key activities necessary to retain a job in an industry.</p>
<p><b>Develop positive relationships with others</b> CD4.d</p>	<p>4.d.5.h: Participate in co-curricular and community activities to enhance the school experience.</p> <p>4.d.6.h: Evaluate the best method to assist co-workers in accomplishing goals and tasks.</p> <p>4.d.7.h: Examine the skills required to enable students to successfully transition to post-secondary opportunities.</p> <p>4.d.8.h: Use a systematic approach to academic and career planning for students to achieve their learning, socio-cultural and work goals.</p>
<p><b>Environment, Health, and Safety (EHS)</b></p>	
<p><b>EHS1:</b> 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.</p>	
<p><b>Implement personal and jobsite safety rules and regulations to maintain and improve safe and healthful working conditions and environments</b> EHS1.d</p>	<p>1.d.7.h: Assess workplace conditions with regard to personal and environmental health and safety.</p> <p>1.d.8.h: Identify different workplace systems that protect and enhance personal and environmental health and safety.</p> <p>1.d.9.h: Describe employee rights and responsibilities to maintain workplace health and safety, including compliance with rules and laws.</p>

Key Vocabulary:			
AND Gate	555 Timer	Flip-Flop	Analog
Combinational Logic	Edge-Sensitive	NOT Gate	Boolean Expression

DeMorgan's Theorems	Synchronous Counter	Transistor-Transistor (TTL)	Dual In-Line Package (DIP)
Duty Cycle (DC)	Logic Gate	Level-Sensitive	Karnaugh Map
Exclusive-OR (XOR) Circuit	Integrated Circuit (IC)	Seven-Segment Display	Small-Scale Integration (SSI)
NAND Gate	NOR Gate	Up/Down Counter	Oscilloscope
Truth Table	Rising Edge	State Machines	Sequential Logic
Falling Edge	OR Gate		

## 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