Syllabus: Digital Electronics (DE)
(Project Lead The Way)

Course Overview:

Digital electronics and micro-computers. This is a course in applied logic that encompasses the application of electronic circuits and devices. Computer simulation software is used to design and test digital circuitry prior to the actual construction of circuits and devices.
(Dual/transcripted credit is offered by Milwaukee School of Engineering [MSOE] with transfer possibilities to other colleges and universities.)

Department: Technology and Engineering	**Department/Course Website (if applicable):** CTE
Course Number: TEC1030	**Instructor:** Ignacio Retana
Credits Earned/Length of Course: 1 credit/Year long course	**Office Hours:** NA
Prerequisites: Algebra Trig	**Instructor Contact Info:** Phone: 608-204-3697 Email: retana@madison.k12.wi.us
Required Materials: Insert here	**Other:** College credit possible if grade of A or B and score 7 or above on End Of course Exam
	Pathway(s): STEM: Engineering

Course Standards:
- Common Core State Standards for Literacy in All Subjects
- Common Core State Standards for Mathematics -- Standards for Mathematical Practice
- Wisconsin Common Career Technical Core Standards
- Wisconsin Standards for Technology and Engineering

Course Assessment(s):
- Summative assessments for units
- EOC assessments PLTW online exam

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Course Outline (including Unit(s) of Time and Essential Questions):

Unit 1: Foundations in Electronics

Lesson 1.1 Introduction to Electronics (10 Days)

Essential Questions - *Students will keep considering*

- Why are the safety considerations and best practices associated with working in electronics important?
- How are calculations and measurement used to design and verify circuit characteristics?
- What are the functions of the most common analog and digital components used in electronics?
- What are the technical skills and processes that are utilized throughout electronics?

Established Goals - *It is expected that students will*

- Work safely with electronics.
- Express numbers in scientific notation, engineering notation, and System International (SI) notation.
- Use Ohm's Law, Kirchhoff's Voltage Law, and Kirchhoff's Current Law to solve for simple series and parallel circuits.
- Identify many of the common components used in electronics.
- Measure voltage, current, and resistance using a Digital Multimeter (DMM).
- Determine a resistor's nominal value by reading its color code.
- Determine a capacitor's nominal value by reading its labeled nomenclature.
- Demonstrate proper soldering/desoldering techniques to solder and desolder components on printed circuit boards.
- Understand the significance of the base 2 number system in digital electronics.

Lesson 1.2 Introduction to Circuit Design (10 days)

Essential Questions - *Students will keep considering*

- How are the characteristics of digital circuits different than analog circuits?
- Why is the understanding of binary and decimal number systems essential to your ability to design combinational logic circuits?
- What might a design process look like for creating an analog or digital circuit?
- How are calculations, computer software design (CDS) tools, and measurement tools used in electronics to guide development and troubleshoot a circuit?

- Why is the 555 timer design such an important and commonly used design in electronics?

Established Goals - *It is expected that students will*

- Recognize and contrast the characteristics of analog and digital circuits.
- Understand how analog and digital circuit designs work by altering the characteristics of existing circuits.
- Use a design process to design and create a circuit.
- Use calculations and measurement tools to troubleshoot circuits.

Unit 2: Combinational Logic

Lesson 2.1 AOI Combinational Logic Circuit Design

Established Goals (6 days) - *It is expected that students will*

- Translate a set of design specifications into a functional AOI combinational logic circuit following a formal design process.
- Understand the relationships between truth tables, logic gates, and logic expressions.
- Recognize and apply simplification strategies to create the most efficient AOI combinational logic circuit design.

Essential Questions - *Students will keep considering*

- How would you use a design process to convert a set of design specifications into a functional combinational logic circuit?
- What is the relationship between a combinational logic circuit truth table, logic expression, and circuit implementation? Can I describe the process of obtaining either of the first two design items given the third?
- When you simplify logic expressions using Boolean algebra, how do you know that you have the simplest solution and that the solution is correct?
- In terms of circuit implementation, what is the advantage of representing all logic expressions in either the SOP or POS form?
- Defend the following statement: “All logic expressions, regardless of complexity, can be implemented with AND, OR, and INVERTER gates.”

Lesson 2.2 Alternative Design: Universal Gates and K-Mapping (7 days)

Established Goals - *It is expected that students will*

- Utilize alternative design strategies to AOI design to create circuits using universal gates.
- Be able to determine when using a universal gate design might be beneficial.
- Simplify logic expressions utilizing Karnaugh maps.

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Essential Questions - *Students will keep considering*

- Why are NAND gates and NOR gates considered universal gates?
- What are the advantages of implementing a combinational logic design with universal gates?
- What are the advantages of using K-mapping over Boolean algebra to simplify logic expressions?

Lesson 2.3 Specific Combinational Logic Designs (5 days)
Established Goals - *It is expected that students will*

- Convert numbers between hexadecimal, octal, and decimal number systems.
- Recognize common types of seven-segment displays and implement them into a design effectively.
- Add and subtract numbers in binary.
- Correlate binary addition/subtraction to the function of a binary adder.
- Recognize and implement multiplexed and demultiplexed designs.

Essential Questions - *Students will keep considering*

- Why is the understanding of number systems and conversion between number systems such as binary, octal, decimal, hexadecimal, and Binary Coded Decimal (BCD) essential to your ability to design combinational logic circuits?
- Why are binary adders such an important design in digital electronics and how do they work?
- How can different types of seven-segment displays be integrated into your designs?
- How would you use a design process to convert a set of design specifications that you have defined into a functional combinational logic circuit containing multiple outputs?
- What is the basic operation of digital multiplexers and demultiplexers and how can they improve a circuit's design?

Lesson 2.4 Introduction to Programmable Logic Devices (PLDs) (4 days)
Established Goals - *It is expected that students will*

- Describe how Programmable Logic Devices (PLDs) represent the next progression in technological develop for circuit design.
- Use Programmable Logic Devices (PLDs) to design circuits and describe the advantage PLDs provide.

Essential Questions - *Students will keep considering*

- How is the design process impacted by use of Circuit Design Software (CDS) and Programmable Logic Devices (PLDs)?

- How are programmable logic devices used to implement combinational logic circuits?
- Describe the advantages and disadvantages of using a programmable logic device over discrete logic gates.

Unit 3: Sequential Logic

Lesson 3.1 Sequential Logic Circuit Design (3 days)

Established Goals - ***It is expected that students will***

- Understand and describe how sequential logic designs hold or store bits of data.
- Distinguish between different logic devices used in sequential logic circuits. Describe the advantages and disadvantages of each when utilizing in a digital design.
- Implement commonly used sequential circuit designs to execute tasks used regularly in electronics.

Transfer - ***Students will be able to independently use their learning to***

- Understand and describe how sequential logic designs hold or store bits of data.
- Distinguish between different logic devices used in sequential logic circuits. Describe the advantages and disadvantages of each when utilizing in a digital design.
- Implement commonly used sequential circuit designs to execute tasks used regularly in electronics.

Essential Questions - ***Students will keep considering***

- What are flip-flops and transparent latches and how do they function to store data?
- What are some of the differences between synchronous and asynchronous inputs on flip-flops?
- What are some of the ways a flip-flop can be triggered?
- What are some of the common applications of flip-flops?

Lesson 3.2 Asynchronous Counters (12 days)

Established Goals - ***It is expected that students will***

- Identify the characteristics of asynchronous counters.
- Implement asynchronous counters to count up or down over identified number ranges.
- Implement small scale integrated (SSI) and medium scale integrated (MSI) circuits.

Essential Questions - ***Students will keep considering***

- How can D flip-flops or J/K flip-flops be arranged in order to create a desired asynchronous clock signal?
- How would you use a design process to create asynchronous counters using small scale integration (SSI) and medium scale integration (MSI)?
- Why is it important to have a counter/start at specific values?
- How can an asynchronous counter be designed to start and stop/repeat a count at the desired values?

Lesson 3.3 Synchronous Counters (13 days)
Established Goals - ***It is expected that students will***

- Design and implement common types of synchronous counters used in electronics and recognize where these types of counters might be applied in a digital circuit.
- Implement synchronous counters to count up or down over identified number ranges.
- Implement small scale integrated (SSI) and medium scale integrated (MSI) circuits.

Essential Questions - ***Students will keep considering***

- How can D flip-flops or J/K flip-flops be arranged in order to create a desired synchronous clock signal?
- How would you use a design process to create synchronous counters using small scale integration (SSI) and medium scale integration (MSI)?
- Why is it important to have a counter/start at specific values?
- How can a synchronous counter be designed to start and stop/repeat a count at the desired values?

Unit 4: Controlling Real World Systems
Lesson 4.1 Introduction to State Machines (10 days)
Established Goals - ***It is expected that students will***

- Use the design process associated with state machines to create a state machine design and implement the circuit.
- Translate a state graph into a state transition table.

Essential Questions - ***Students will keep considering***

- Why are state machine designs used in electronics?
- What are the common components of a state machine and how are they arranged to make state transitions based on inputs?
- What are some common everyday devices that are controlled by state machines?

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Lesson 4.2 Introduction to Microcontrollers (5 days)
Established Goals - *it is expected that students will*

- Recognize and relate how microcontrollers represent the next evolution in circuit design to control real world systems.
- Design and implement circuit designs using a microcontroller.

Essential Questions - *Students will keep considering*

- Why are microcontrollers such a valuable tool today in electronics?
- What are the components and processes associated with programming microcontrollers to control real world systems?

Unit 5: Career Development/21st Century Skills
Ongoing
Essential Questions

- How do the skills and knowledge I am learning in this class get applied within a job setting?
- How can I work with a team to develop an answer to a question or solution to problem?
- How I apply the skills that my future employers will value?

Texts, Technology, and Resources:
PLTW LMS
Multisim computer program

Autodesk Inventor, Revit

Behavior/Attendance Policy:
Students are expected to behave and attend as if at a place of employment. This includes use of cell phone, teamwork and completion of assignments. Students are responsible for completing missed work. Students will have 5 school days from date of absence to make up missed work. It is the responsibility of the student to come during office hours to make up missing assignments, projects or tests

Grading Policy:

100-90	A
89-80	B
79-70	C
69-60	D

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As a student I agree to not use my cell phone for personal use and only use it in class for assistance in completing my work with permission of the classroom teacher/adult. If I use it without permission, I will hand over my cell phone immediately when asked by the teacher/adult. I also agree to complete all assignments and make up any work due to absences or tardies. If my grade falls below a "C" I will come in at lunch and or after school until my grade has improved to a "C" or better.

____ date:__________________

As a parent/guardian I agree to supporting the teacher by encouraging my student to finish all assignments by seeking support during lunch or after school when necessary.

____ date:__________________

Is there anything that you as a parent/guardian or student would like me to know that may help the student have greater success in my class? If so, please write below.

What is the best way to make contact with parent/guardian, Phone, email, other? Please write down the information.

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Thank you
Mr. Retana