Murrieta Valley Unified School District **Board Submission: May 2018**
HIGH SCHOOL COURSE OUTLINE

Course Title: Digital Electronics (DE) -
Project Lead the Way (PLTW)

Department: Career Technical Education

Course #: 2448

Grade Level/s: 11-12

Length of Course: Year

Prerequisite/s: PLTW Foundation Courses: Introduction to Design-Engineering (IED) and Principles of Engineering (POE)

UC/CSU (A-G) Req: G (Pending)

Brief Course Description: Digital Electronics (DE) is a capstone course of the engineering pathway. This course is the study of electronic circuits that are used to process and control digital signals. In contrast to analog electronics, where information is represented by continuously varying voltage, digital signals are represented by two discrete voltages or logic levels. This distinction allows for a greater signal speed and storage capabilities and has revolutionized the world of electronics. Students will learn about electronic circuits used to process and control digital signals.

I. GOALS

The students will:

A. Translate circuit designs, truth tables and design requirements into logic expressions
B. Simplify circuits using Boolean algebra theorems and DeMorgan's theorems
C. Simplify a logic expression graphically using the Karnaugh Mapping process
D. Design a circuit to meet voltage, current, or resistance design requirements
E. Select design components in a design to produce a desired waveform
F. Implement the best combinational logic circuit design
G. Apply knowledge of logic gates to select an appropriate gate for the circuit design
H. Troubleshoot the design of a circuit by analysis and comparison to the truth table
I. Implement a circuit design based on logic expressions
J. Troubleshoot existing circuits based on logic expressions
K. Determine when NAND only or NOR only implementations are the most efficient
L. Implement a seven segment display into a circuit design
M. Determine when a common cathode or common anode seven segment display may perform better in a particular circuit design
N. Design a sequential circuit
O. Describe the function of XOR/XNOR gates in a circuit design
P. Design an adder/subtractor circuit related to the carry out and use on XOR gates
Q. Design a desired frequency of a clock signal in a 555 timer design

R. Design a sequential logic circuit to produce a desired output
S. Design synchronous/asynchronous counter circuits based on design requirements
T. Design a state machine based on specific design requirements
U. Design a circuit with motors as outputs that operate at different voltage levels
V. Select and apply the most appropriate design method for circuit implementation
W. Solder and de-solder components to printed circuit boards
X. Validate circuit design through measurement using a probe/oscilloscope and analysis of timing diagram
Y. Select and apply the most appropriate technology for circuit implementation
Z. Implement designs on an FPGA
AA. Create a program to manage inputs and outputs of a microcontroller

CTE Model Standards:

The students will:

1. Apply appropriate technical skills and academic knowledge.
2. Communicate clearly, effectively, and with reason.
3. Develop an education and career plan aligned with personal goals.
4. Apply technology to enhance productivity.
5. Utilize critical thinking to make sense of problems and persevere in solving them.
6. Act as a responsible citizen in the workplace and the community.
7. Model integrity, ethical leadership and effective management.
8. Work productively in teams while integrating cultural and global competence.
9. Demonstrate creativity and innovation.
10. Employ valid and reliable research strategies.
11. Understand the environmental, social, and economic impacts of decisions.
12. Demonstrate sketching process used in concept development.
13. Employ the design process to solve analysis and design problems.
14. Understand industrial engineering processes, including the use of tools and equipment, methods of measurement, and quality assurance.
15. Understand fundamental control system design and develop systems that complete preprogrammed tasks.
16. Understand the fundamentals of systems and market influences on products as they are developed and released to production.
17. Design and construct a culminating project effectively using engineering technology.

II. OUTLINE OF CONTENT FOR MAJOR AREAS OF STUDY

Semester 1

A. Unit 1: Foundations in Electronics
   1. Lesson 1.1 Introduction to Electronics
   2. Lesson 1.2 Introduction to Circuit Design

B. Unit 2: Combinational Logic
   1. Lesson 2.1 AOI Combinational Logic Circuit Design
   2. Lesson 2.2 Alternative Design: Universal Gates and K-Mapping
   3. Lesson 2.3 Specific Combinational Logic Designs
   4. Lesson 2.4 Introduction to Programmable Logic Devices (PLDs)

Course Title: Digital Electronics (DE) - Project Lead the Way (PLTW)

Semester 2

A. Unit 3: Sequential Logic
   1. Lesson 3.1 Sequential Logic Circuit Design
   2. Lesson 3.2 Asynchronous Counters
   3. Lesson 3.3 Synchronous Counters

B. Unit 4: Controlling Real World Systems
   1. Lesson 4.1 Introduction to State Machines
   2. Lesson 4.2 Introduction to Microcontrollers

III. ACCOUNTABILITY DETERMINANTS

A. Key Assignments
   1. Unit 1 Foundations in Electronics: Create circuits with discrete components and simplify these circuits to implement efficient designs.

   2. Unit 2 Combinational Logic:
      a. Use a design process to transform design specifications into functional AOI, NAND and NOR combinational logic circuits.
      b. Apply the combinational logic design process to develop a Fireplace Control Circuit.
      c. Students will design, simulate, and breadboard a circuit that displays their unique birthdate. Circuit implementation is demonstrated by utilizing a programmable logic device called a Field Programmable Gate Array (FPGA).

   3. Unit 3: Sequential Logic
      a. After completing a series of activities on the process for designing Small Scale Integration (SSI) and Medium Scale Integration (MSI) asynchronous counters, students will design, simulate and create a Now Serving display circuit.
      b. After completing a series of activities on the process for designing SSI and MSI synchronous counters, students will design and simulate a Sixty Second Timer circuit.

   4. Unit 4: Controlling Real World Systems
      a. Students will learn and apply the state machine design process utilizing both discrete logic gates and programmable logic.
      b. After completing a foundational activity on state machine design, students will design and implement a state machine that controls the operation of a fixture using programmable logic.
      c. Students will create programs (Sketches) to control systems with unique sensors, human input controls, motors and servos. The ATmega328 microcontroller found on the Arduino™ Uno Microcontroller Board will be used to explore these controls and inputs.

B. Assessment Methods
   1. Skill mastery and quality of work
   2. Engineers notebook
   3. Portfolio
   4. Tests and quizzes

5. Projects
6. Presentations
7. Research and project development
8. Performance tasks
9. Unit exams
10. Semester final exam/s
11. Presentation of design projects

IV. INSTRUCTIONAL MATERIALS AND METHODOLOGIES

A. Required Textbook(s)
Title: Project Lead the Way's Learning Management System
ISBN: N/A
Format: Online program
Author(s): N/A
Publisher: Project Lead the Way
Year: N/A
Additional Info: https://www.pltw.org/

B. Supplementary Materials
1. Oscilloscope
2. DMM
3. FPGA
4. Digital Mini System
5. Digital Logic Board

C. Instructional Methodologies
1. Guided Inquiry
2. Direct Instruction
3. Cooperative Learning
4. Discourse
5. Problem-based Learning
6. Visual Representations and Concrete Models
7. Field Trips/Research
8. Professional Interviews