1/30/2012

El Monte Union High School District

Course Outline

High School District

Title: Digital Electronics (PLTW) Transitional*_______(Eng. Dept. Only) Sheltered (SDAIE)*____Bilingual*___ AP**________Honors**___________ Department: Industrial Technology Grade Level (s): 9-12 Semester___________Year X Year of State Framework Adoption_____	This course meets graduation requirements: ( ) English ( ) Fine Arts ( ) Foreign Language ( ) Health & Safety ( ) Math ( ) Physical Education ( ) Science ( ) Social Science (X) Elective (Math)	Department/Cluster Approval Date _________________ ___________ _________________ ___________ _________________ ___________ _________________ ___________ _________________ ___________ _________________ ___________ _________________ ___________

*Instructional materials appropriate for English Language Learners are required.

**For AP/Honors course attach a page describing how this course is above and beyond a regular course. Also, explain why this course is the equivalent of a college level class.

1. **Prerequisite(s):** Algebra I, Geometry and POE (Principles of Engineering) and/or IED (Introduction to Engineering Design)
   Co-requisites: Algebra II, Precalculus or Calculus I

2. **Short description of course which may also be used in the registration manual:**
   Students are introduced to the process of combinational and sequential logic design, engineering standards and technical documentation. Students learn programming and build electrical circuits including robotics. The course uses extensive math and is project/hands on based. This course is designed for 10th or 11th grade students.

3. **Describe how this course integrates the schools ESLRs (Expected School-wide Learning Results):**
This course integrates El Monte High School's ESLRs by combining elements of hands on career technical education in various areas of material working with the fundamental skills of reading, writing and mathematics. Furthermore, concepts from the physical sciences will be used during on-going instruction to facilitate student observation and learning of fundamental common practices in product design, engineering problem solving and production processes. A high degree of computer-based programming technology will be used along with cutting edge robotics and other digital electronics. Assessment methods will be based on project evaluations specifically involving a measurement of the degree to which

students follow written instructions in the execution of the operations involved in designing and constructing projects. Additionally, student designs (blueprints) will be assessed based on how well they conform to a grading rubric based on industry standards. Project or activity-based assessments will also be utilized to grade students.

4. Describe the additional efforts/teaching techniques/methodology to be used to meet the needs of English Language Learners:

Additional efforts, techniques and methodologies used to meet the needs of ELL students include the pairing or partnering of ELL students with bilingual advanced students open to assisting struggling or challenged students. Additionally, when available, ELL students will be provided with learning materials in their native language. Furthermore, if available, instructional aides will be provided to translate and assist ELL students with coursework. Lastly, since the course is already has day by day objectives in place, SIOP model practices will be implemented, such as posting daily learning objectives in written form for the entire class to see.

5. Describe the interdepartmental articulation process for this course:

Students who successfully complete the introductory portion of this course will have laid a firm foundation in the most fundamental skills used in all areas of design, engineering and production. The skills that will be used are: measurement, estimating, testing, design evaluation, prototyping, one-off production, programming, re-engineering, reverse engineering, repair, design improvement, computer-aided design, computer-aided manufacturing, production planning, manufacturing engineering process design, shop management, inventory management, materials management, workplace management and workforce management.

There are math worksheets that contain math relevant questions containing academic language relevant to digital electronics and other Engineering and Science classes. These will be collaborated at different parts of the year with the math department. In addition, reports will be written and in industry standard formats containing relevant academic language. Collaboration will take place between the Engineering department and English department to discuss the timing and rubrics of such assignments. Student will also build from the computer/technical skills they attain from the business tech core department, thus collaboration will occur to transition students from basic skills to the more advance skills required in the field of engineering.

6. Describe how this course will integrate academic and vocational concepts, possibly through connecting activities. Describe how this course will address work-based learning/school to career concepts:

Engineering is one of the fastest growing, highest paying professions in California. This course prepares students for engineering fields and gives them a head start over other students majoring in college in the same field. The class has real world applications of robotics and electronics which allow students to design miniature manufacturing processes. The Digital Electronics class is highly project and computer based and gives students the skills they need to succeed in college and their future careers.

7. Materials of Instruction (Note: Materials of instruction for English Language Learners are required and should be listed below.)

A. Textbook(s) and Core Reading(s):
As required by the PLTW materials guide (32 page material guide is updated yearly)

B. Supplemental Materials and Resources:
As required by the PLTW materials guide (32 page material guide is updated yearly)

C. Tools, Equipment, Technology, Manipulatives, Audio-Visual:
As required by the PLTW materials guide (32 page material guide is updated yearly)

8. Objectives of Course

1. Fundamentals

Students will

- Be able to identify hazards in the lab and know locations of the safety equipment and how to use it.
- Explain the relationship of quantum energy required to strip away electrons from atoms to being classified as an insulator or conductor.
- Be able to re-write any number using conventional prefix definitions. Understand the material makeup of resistors and how they are used in circuit design.
- Correctly select and utilize electrical meters to determine voltage, resistance and current in simple circuits.
- Be able to draw and label the parts of a simple circuit.
- Be familiar with different types of capacitors and their voltage polarity requirements.
- Become familiar with the information contained on a data sheet.

2. Number systems

Students will

- Students use mathematical symbols to represent different bases and will communicate concepts using different number systems.
- Students will demonstrate the relationship of binary and hexadecimal to bits and bytes of information used in computers.
- Students will convert values from one number system to another.

3. Gates

Students will

- Use schematics and symbolic Algebra to represent digital gates in the creation of solutions to design problems.
- Identify the name, symbol, and function and create the truth table, and Boolean Expression for the basic logic gates through research and experimentation.
- Apply logic to design and create, using gates, solutions to a problem.

4. Boolean Algebra

Students will

- Students will be able to create Boolean Expressions, logic circuit diagrams or truth tables from information provided in the solution of design problems.
- 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.
- Students will formulate and employ a Karnaugh Map to reduce Boolean expressions and logic circuits to their simplest forms.
- Create circuits to solve a problem using NAND or NOR gates to replicate all logic functions.

5. Combinational circuit design

Students will

- Design, construct, build, troubleshoot, and evaluate a solution to a design problem.
- Design a circuit to control a seven segment display with a decimal to BCD encoder and a display driver.
- Be able to design and implement combinational logic circuits using reprogrammable logic devices.
- Create PLD logic files that define combinational circuit designs using Boolean Expressions.

6. Adding

Students will

- Demonstrate understanding of binary addition and subtraction by designing circuits to produce correct answers.
- Create and prove the truth table for both half and full adders.

7. Flip-Flops

Students will

- Construct and test simple latches and flip-flops from discrete gates.
- Interpret, design, draw, and evaluate circuits using the logic symbols for latches and flip-flops.
- Understand the different types of triggers used by latches and flip-flops and select the appropriate one for the circuits they design.
- Conduct experiments with clock pulse width to determine the effect on the accuracy of data transmission.
- Assemble circuits and compile information about the various applications of flipflops.

8. Shift Registers and Counters

Students will

- Evaluate the use of shift registers in product design and the speeds at which those products run.
- Create a circuit using discrete flip-flops to discover the operation and characteristics of asynchronous counters.

9. Families and Specifications

Students will

- Interpret the graphs, charts, and written materials contained in a data sheet and apply it to a design problem.
- Define, calculate, and measure noise margin, drive capabilities, fan-out and propagation delay.

10. Microprocessors

Student will

- Students will be able to formulate a flow chart to correctly apply basic programming concepts in the planning of a project .
- 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.
- Create an interface to allow them to inspect, evaluate and manage program parameters in the microprocessor during the operation of a program.
- 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.

- **Unit detail including projects and activities including duration of units (pacing plan)**

FALL Semester

Unit 1: Fundamentals

Lesson 1.1 Safety
1.1.1. Electrical
1.1.2. Equipment
1.1.3. Hand Tools
1.1.4. Clothing
1.1.5. Procedures
1.1.6. Material Safety Data
Lesson 1.2 Basic Electron Theory
1.2.1. Current Flow
1.2.1.1. Conventional vs. Electron Flow
1.2.1.2. DC

1.6.2. Reading the value
1.6.3. Units
1.6.3.1. Farads
1.6.3.2. Voltage
1.6.4.1. Ceramic
1.6.4.2. Electrolytic
1.6.5. Polarity
1.6.6. Measuring
1.6.6.1. Scope
1.6.6.1.1. Time
1.6.6.1.2. Voltage
1.6.6.2. Capacity Checker
Lesson 1.7 Analog and Digital Waveforms
1.7.1. Reading Waveforms
1.7.1.1. Signal Generator
1.7.1.2. Wave types
1.7.1.2.1. Square
1.7.1.2.2. Sine
1.7.1.2.3. Sawtooth
1.7.1.3. Period/Wavelength
1.7.1.4. Amplitude
1.7.1.5. Rise and Fall time
1.7.1.6. Offset
1.7.1.7. Pulse Width
1.7.1.8. Duty Cycle
1.7.1.9. Calculating Frequency
1.7.2. Logic Conditions
1.7.2.1. High
1.7.2.2. Low
1.7.3. Multivibrators
Lesson 1.8 Obtaining Data Sheets
1.8.1 Internet Search
1.8.2 Information included

Unit 2: Number Systems

Lesson 2.1 Conversions
2.1.1. Binary to Decimal
2.1.2. Decimal to Binary
2.1.3. Hexadecimal to Binary
2.1.4. Binary to Hexadecimal
2.1.5. Hexadecimal to Decimal
2.1.6. Decimal to Hexadecimal

Unit 3: Gates

Lesson 3.1 Logic Gates
3.1.1. The Logic Symbols for the AND, OR, NOT, NAND, NOR Gates
3.1.2. Reading Pin-out Diagram
3.1.3. Truth Tables
3.1.4. Boolean Expression
3.1.5. Creating Multiple Input Gates

Unit 4: Boolean Algebra

Lesson 4.1 Boolean Expressions
4.1.1. Boolean Expressions and Truth Tables
4.1.2. Minterm Expressions, Sum of Products
4.1.3. Maxterm Expressions, Product of Sums
4.1.4. Unsimplified Boolean Expression and Schematic Circuits
Lesson 4.2 Logic Simplifications
4.2.1. Boolean Simplification

4.2.2. DeMorgan’s Theorems
4.2.3. Karnaugh Mapping
4.2.4. Electronic Simplification Tools
Lesson 4.3 Duality of Logic Functions
4.3.1. Using NOR Gates to Emulate All Logic Functions
4.3.2. Using NAND Gates to Emulate All Logic Functions

Spring Semester

Unit 5: Combinational Circuit Design
Lesson 5.1 Paradigm for Combinational Logic Problems
5.1.1. Word Problem
5.1.2. Construct Truth Table
5.1.3. Create a Logic Equation from a Truth Table
5.1.4. Simplify the Logic Equation
5.1.5. Simulate the Circuit
5.1.6. Construct the Circuit
5.1.7. Troubleshoot
Lesson 5.2 Specific Application MSI Gates
5.2.1. Levels of Integration (SSI, MSI, LSI)
5.2.2. Display Drivers
5.2.3. Code Converters
5.2.3.1. Binary Coded Decimal (BCD)
5.2.3.1.1. BCD to Decimal
5.2.3.1.2. Decimal to BCD
5.2.3.1.3. Binary to Hexadecimal
Lesson 5.3 Programmable Logic Devices (PLD)
5.3.1. Introduction to PLD
5.3.2. PLD Programming Software
5.3.3. PLD Programming Hardware

Unit 6: Adding
Lesson 6.1 Binary Addition
6.1.1. 2’s Complement Notation, Addition and Subtraction
6.1.2. The Exclusive OR and Exclusive NOR Functions
6.1.3. Half Adder Design
6.1.4. Full Adder Design
6.1.5. N Bit Adder Design

Unit 7: Flip-Flops
Lesson 7.1 Introduction to Sequential Logic
7.1.1. Latches
7.1.2. Flip-Flop
7.1.3. Timing Diagrams
Lesson 7.2 The J-K Flip-Flop
7.2.1. Operation of J-K Flip-Flop
7.2.2. Asynchronous Inputs
7.2.3. Synchronous Inputs
Lesson 7.3 Triggers
7.3.1. Positive-Edge Trigger
7.3.2. Negative-Edge Trigger
7.3.3. Positive-Level Trigger (Latch)
7.3.4. Negative-Level Trigger (Latch)
Lesson 7.4 Flip-Flop Timing Considerations
7.4.1. Setup and Hold Times
7.4.2. Propagation Delays
7.4.3. Timing Limitations (fmax, Minimum Pulse Width)
Lesson 7.5 Elementary Applications of Flip-Flops
7.5.1. Data Storage
7.5.2. Logic Synchronizing

Indicate references to state framework(s)/standards (If state standard is not applicable then national standard should be used)

Physics

5a. Students know how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.

5b. Students know how to solve problems involving Ohm's law.

5c. Students know any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula Power = IR (potential difference) × I (current) = I^2R.

5d.Students know the properties of transistors and the role of transistors in electric circuits.

5f. Students know magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources.

Math

Most basic Algebra standards will be practiced

Student performance standards

1.0 Academics

Students understand the academic content required for entry into postsecondary education and employment in the Arts, Media, and
Entertainment sector.

2.0 Communications

Students understand the principles of effective oral, written, and multimedia communication in a variety of formats and contexts.

3.0 Career Planning and Management

Students understand how to make effective decisions, use career information, and manage personal career plans.

4.0 Technology

Students know how to use contemporary and emerging technological resources in diverse and changing personal, community, and
workplace environments.

5.0 Problem Solving and Critical Thinking

Students understand how to create alternative solutions by using critical and creative thinking skills, such as logical reasoning, analytical
thinking, and problem-solving techniques.

6.0 Health and Safety

Students understand health and safety policies, procedures, regulations, and practices, including the use of equipment and handling of
hazardous materials.

7.0 Responsibility and Flexibility

Students know the behaviors associated with the demonstration of responsibility and flexibility in personal, workplace, and community
settings.

8.0 Ethics and Legal Responsibilities

Students understand professional, ethical, and legal behavior consistent with applicable laws, regulations, and organizational norms.

Evaluation/assessment/rubrics

Assessment opportunities that enable continuous evaluation of student progress will be embedded in all areas of the course thus evaluation will be part of the learning process. Strategies for assessment will include:

- Daily/weekly work assignments.
- Performance-based assessment such as experiments, demonstrations, discussions-brainstorming and simulations.
- Writing assignments including research, investigation, justification for solutions, technical and project reports.
- Project grades.
- Cumulative portfolio exhibiting investigative processes to reaching solutions to design problems.
- Objective and performance based tests.
- Teacher and peer evaluation.
- National PLTW Exam

Include minimal attainment for student to pass course

PLTW Certification Students must meet the following requirements to receive PLTW certification:
Completed Portfolio
Completed Engineering Notebook
Minimum of 70% on class work and exams
Minimum of 70% on national final exam