

Digital Electronics

COURSE SYLLABUS

INSTRUCTOR: Mr. Baker

CLASS LOCATION: Room 118

OFFICE HOURS: 8:30 - 5:00 Mon. & Wed., 08:30 – 4:00 Fri.

OFFICE PHONE: 753-7377 Ext. 4300 HOME PHONE: 563-6689

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COURSE WEB PAGE: <http://www.intechengineering.org>

A. COURSE DESCRIPTION

Digital Electronics™ 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 a continuously varying voltage, digital signals are represented by two discrete voltages or logic levels. This distinction allows for greater signal speed and storage capabilities and has revolutionized the world electronics. Digital electronics is the foundation of all modern electronic devices such as cellular phones, MP3 players, laptop computers, digital cameras, high definition televisions, etc.

The major focus of the DE course is to expose students to the design process of combinational and sequential logic design, teamwork, communication methods, engineering standards, and technical documentation.

Utilizing the activity-project-problem-based (APPB) teaching and learning pedagogy, students will analyze, design and build digital electronic circuits. While implementing these designs students will continually hone their interpersonal skills, creative abilities and understanding of the design process.

Digital Electronics™ (DE) is a high school level course that is appropriate for 10th or 11th grade students interested in electronics. Other than their concurrent enrollment in college preparatory mathematics and science courses, this course assumes no previous knowledge.

Digital Electronics™ is one of three foundation courses in the Project Lead The Way® high school pre-engineering program. The course applies and concurrently develops secondary level knowledge and skills in mathematics, science, and technology.

The course of study includes:

Foundations of Digital Electronics

- Scientific and Engineering Notations
- Electronic Component Identification
- Basic Soldering and PCB Construction
- Electron Theory & Circuit Theory Laws
- Circuit Simulation
- Breadboard Prototyping
- Component Datasheets & Troubleshooting

Combinational Logic Analysis and Design

- Binary, Octal and Hexadecimal Number Systems
- Boolean Algebra and DeMorgan's Theorems
- AND-OR-INVERT, NAND Only, and NOR Only Logic Design.
- Binary Adders and Two's Complement Arithmetic
- Combinational Logic Design with Field Programmable Gate Arrays

Sequential Logic Analysis and Design

- Flip-Flops, Latches and Their Applications.
- Asynchronous Counter Design with Small and Medium Scale Integrated Circuits.
- Synchronous Counter Design with Small and Medium Scale Integrated Circuits.
- Sequential Logic Design with Field Programmable Gate Arrays
- Introduction to State Machines.

Introduction to Microcontrollers

- Software Development for an Introductory Microcontroller
- Real-World Interface: Introduction to Hardware Controls
- Process Control with a Microcontroller

B. METHOD OF INSTRUCTION

This is a lecture-lab course in which topics are presented by the instructor. Projects are explained and assigned, and are to be completed during lab periods and outside of class as needed. Students are required to maintain an Engineer's Notebook and Portfolio throughout the course with periodic checks. There is a comprehensive final exam given at the end of the school year in May.

C. COURSE UNITS

Unit 1: Fundamentals of Analog and Digital Electronics

(32 Total Days)

Lesson 1.1: Foundations and the Board Game Counter (9 days)

- Lab Safety
- Scientific, Engineering, and Systems International (SI) Notation
- Resistor Values
- Capacitors Values
- Soldering

Lesson 1.2: Introduction to Analog (11 days)

- Analog and Digital Signals
- Atomic Structure
- Conductors, Insulators, and Semiconductors
- Voltage, Current, and Resistance
- Circuit Design Software

Lesson 1.3: Introduction to Digital (12 days)

- Integrated Circuits
- Logic Gate
- Datasheets
- Circuitry
- Scale of Integration
- Packaging
- Schematic Symbols
- Truth Tables
- Transistor-Transistor Logic (TTL)
- Combinational Logic using AND, OR, and INVERTER (AOI) gates
- Flip-Flops

Unit 2: Combinational Logic (60 Total Days)

Lesson 2.1: Introduction to AOI Logic (20 days)

- Binary Number System
- Creating Truth Tables
- Sum-of-Products (SOP) and Products-of-Sum (POS) Expressions

Lesson 2.2: Introduction to NAND and NOR Logic (14 days)

- Karnaugh Mapping
- Don't Care Conditions
- NAND and NOR Gate Design

Lesson 2.3: Date of Birth Design (9 days)

- Seven-Segment Displays
- Common Cathode
- Common Anode

Lesson 2.4: Specific Comb Logic Circuits & Miscellaneous Topics (8 days)

- Hexadecimal and Octal number Systems
- Binary Adder Circuits using XOR and XNOR Gates
- Half and Full Adders
- Multiplexer and De-multiplexer Pairs
- Two's-Complement Arithmetic

Lesson 2.5: Programmable Logic: Combinational (9 days)

- Programmable Logic Devices

Unit 3: Sequential Logic (54 Total Days)

Lesson 3.1: Latches & Flip-Flops (6 days)

- Using Flip-Flop and Transparent Latches to Store Data
- Synchronous and Asynchronous Inputs
- Flip-Flop Uses
- Single Event Detection Circuits
- Data Synchronizers
- Shift Registers
- Frequency Dividers

Lesson 3.2: Asynchronous Counter (14 days)

- Asynchronous Counters
- Small Scale Integrated (SSI) Implementation
- Medium Scale Integrates (MSI) Implementation
- D and J/K Flip-Flops
- Up, Down, and Modulus Counters

Lesson 3.3: Synchronous Counters (14 days)

- Synchronous Counters
- Small Scale Integrated (SSI) Implementation
- Medium Scale Integrates (MSI) Implementation
- D and J/K Flip-Flops
- Up, Down, and Modulus Counters

Lesson 3.4: Introduction to State-Machine Design (20 days)

- State Machines
- Everyday Uses
- Mealy and Moore Implementation
- Small, Medium Scale Integrated Gates
- Programmable Logic Devices

Unit 4: Microcontrollers (29 Total Days)

Lesson 4.1: Introduction to Microcontrollers (9 days)

- Flowcharting
- Basic Programming
- Variable Declaration
- Loops
- Debugging
- Syntax
- Microcontrollers

Lesson 4.2: Microcontroller: Hardware (11 days)

- Microcontroller Everyday Uses
- Servo Motors
- Programming Microcontrollers

Lesson 4.3: Microcontroller: Process Control (9 days)

- Digital Control Devices for Mechanical Systems
- Linking Analog Inputs and Outputs to Digital Devices

D. REQUIRED SUPPLIES

- One (1) 1 1/2 Three Ring Binder for handouts and portfolio if you don't have one already from a previous PLTW course.
- Blue or Black regular ball point pens (No felt-tip or gel pens)
- 3X5 notecards for tests

E. GRADING PLAN

- Homework = 20%
- Engineering Notebook = 15%
- Projects = 35%
- Tests = 30%

The grading scheme will be as follows:

A	A-	B+	B	B-	C+	C	C-	D+	D	F
93%	90%	87%	83%	80%	77%	73%	70%	67%	63%	<63%

F. COURSE SPECIFICS

- For all papers to be written, the following formatting standards apply:
 - 12 point Arial or Times New Roman font only. Arial is preferred.
 - Double space only. No other spacing will be accepted.
 - Top and bottom margins are to be 1" (one inch) only.
 - Left and Right margins are to be 1" to 1.25" only.
 - Students may use a 8.5" x 11" sheet of notes (handwritten, single-sided) for use on the final exam. Notes will be turned in with the test. If a student misses a test because of an exempt or excused absence, the test may be made up the next day.

G. CLASSROOM RULES OF CONDUCT

- SAFETY -- Students will **ALWAYS** follow all safety rules. Violation of any safety rule will result in a three page safety report to be submitted and presented to the class.
- RESPECT -- Students will respect one another, themselves and the teacher by their actions, words and expressions. Students will respect others when they are teaching or sharing by giving them their attention.
- HONOR -- Students will honor other people's ideas and feelings. Students will honor the rules of the school.

H. ATTENDANCE POLICY

- LATE – Students not in their seat at the time of the late bell will be considered tardy which will be recorded in the school records.
- ABSENT – Students who have an unexcused absence will have any assignments, tests, or labs considered late under the assignment policy. Excused absences have two (2) class days to make up missing work.

I. RESOURCES INFORMATION

- All assignments, hand-outs and presentations are available on my school website including a copy of this syllabus. Course webpages are password protected. Students will receive login information the first day of class.

J. AFFIDAVIT

- See following page

Digital Electronics Syllabus Affidavit

My signature below indicates that I have read and understand this syllabus and have been given instructions on where to locate additional copies online.

Student Printed Name

Student Signature

Parent Printed Name

Parent Signature

Please sign and return to the instructor.