SCARSDALE HIGH SCHOOL

PRINCIPLES OF ELECTRICAL ENGINEERING COURSE CURRICULUM

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1. Overview

The Electrical Engineering[1] course is designed to introduce students to basic principles in electronics and electrical engineering, and lay a foundation for subsequent study in engineering, applied physics and design. A main objective of the course is to introduce students to programming with a specific emphasis on using coding to interface/interact with physical devices and hardware. Students will be introduced to the basic theory of electricity and circuits and will apply this knowledge in the form of hands-on projects through the use of the Arduino platform. The projects are intended to make the connection for students between theory and application, as well as to teach them important tangible skills they will be using in subsequent courses in the department (and potentially in college or at a job). The course covers three main units: 1) Theory of Electricity and Circuits; 2) Programming and the Arduino Microcontroller; 3) Sensors and APIs. The course will culminate with a final capstone project in which students apply what they have learned in units (1)-(3) in an integrated way.

2. Electricity and Circuits

Topic	**Notes**
Vectors and Newton's Laws	
Coulomb's Force Law, Electric Fields	
Current, Voltage and Ohm's Law	On first day, focus on theory and working with the mathematical equations. On second day, discuss breadboarding and physical components.
Energy and Power	
Kirchoff's Laws	Emphasize conservation of energy and charge
Series and Parallel Circuits	Derive formulas from Kirchoff's Laws
Voltage Divider	
Solving Circuits	Set up system of equations using Kirchoff's Laws
(Optional): Solving Circuits with Matrices	Show how systems of equations can be solved using Gaussian Elimination
	Time: 15 Days

[1] Submitted by M. Kumaresan

3. Programming

Topic	Notes
The Arduino Microcontroller	Discuss hardware components: ATMega328, pins, CPU
C Data Types and Variable assignment	
C programming control flow	
Functions and Arrays	
Displaying Data and the Serial Monitor	
Project: Let There be Light	Controlling LEDs using Arduino
Project: Pulse-Width Modulation	
Project: Morse Code Flasher	4-stage project, emphasizing more complex tasks and more efficient and cleaner code
Project: Digital Inputs	Interacting with push buttons
Project: Model Traffic Light	
Project: Traffic Control	Build on previous project to have two-directional flow
Project: Battery Tester	
Project: LED Dice	
	Time: 15 Days

4. Sensors and APIs

Topic	Notes
The idea of a sensor	Example we will use: TMP36 Temperature Sensor
Other Components: Piezo Buzzer, Servo Motor	
Advanced components: Shift registers, 7-Segment and LCD	
Project: Piezo Buzzer	
Project: Quick-Read Thermometer	Use both LEDs and Buzzers as means of displaying temperatures. Then move to display in the Serial Monitor
Project: Analog Thermometer	Use servo to display temperature based on angle of rotation
Project: Binary Quiz Game	Introduce shift register and binary numbers
Project: Digital Thermometer	Use the 7-segment display to show temperature
Project: Temp History Monitor	Use LCD display to show temperature
	Time: 30 Days

5. Final Project

The final capstone project will be assigned by the teacher at the end of the course. The goal of the project is to give students the opportunity to apply the knowledge they have acquired in the course. Ideally, the project will require students to experiment with a sensor they have never seen before. Students will be given some constraints; however, the project will allow some freedom for students to make their own design choices and apply design thinking to their final product. Some suggested final projects include:

(1) Temperature History Monitor (Graphic LCD Module)
(2) M&M Sorter Machine (Color sensor)
(3) Safe/Lock Mechanism (Keypad sensor)
(4) BOT Navigation (IR Sensor)
(5) GPS Position and Time (GPS Shield)
(6) Project of choice