EG1311 – Design and Make
AY24/25, Y2S2
Notes

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Contents

1 Week 1: Course Introduction & Safety

1.1 Course Overview

- Team (45%)
  - Obstacle Checkoff (10%)
  - Report Body (10%)
  - Report Appendix (10%)
  - Video (External Review) (10%)
  - Video (Tutor) (5%)
- Individual (55%)
  - Arduino Quiz (15%)
  - CAD Quiz (15%)
  - Lecture Viewing (10%)
  - Midterm Peer Review (5%)
  - Final Peer Review (10%)

1.2 Lab Safety Guidelines

Sit according to your tables. Wear covered shoes and long pants. Do not touch anything that looks like it will hurt.

1.3 Project Materials and Resources

Refer to Project Material and Resources PDFs.

1.4 Introduction to Project Templates

Refer to slides.

2 Week 2: Fundamentals of Electricity & Computing

2.1 Basics of Electricity

2.1.1 Energy

Newton's Second Law: $F = ma$
Work Energy = $W = Fs$
Power = $P = Fv = VI = \frac{W}{Q}\frac{Q}{t}$
Ohm's Law = $V = IR$

Multimeter Measures:

- Voltage
  - AC on right, DC on left
  - Measure in parallel
- Resistance
  - The motor has 6 ohms
  - A short has 0 ohms
  - A break has infinite ohms
  - Measure in isolation
- Current
  - Motor Start: 0.1A
  - Motor Stall: 0.6A
  - Measure in series

2.1.2 Alternating Current

In Singapore, is AC at 230V 50Hz. In US, is AC at 130V 60Hz

2.1.3 Direct Current

Arduino has 5V, AA has 1.5V, 9V Battery has 9V

2.2 Motor Physics & Applications

2.2.1 DC Motor

Made up of a motor and gearbox with 120:1 ratio. Gear box changes angular velocity for torque. DC Motor generates motion using magnets and loops of wires through Lorentz Force. Determine the direction of force using Flemings right hand rule. Faraday's law shows that voltage generated is proportional to rate of change of magnetic flux.

The maximum power out of a motor is in the middle of no load and stall, and the maximum efficiency is slightly below that. Angular speed decreases as load increases, and torque increases as load increases.

2.3 Introduction to Digital Computers

Computer needs memory and a CPU

2.3.1 Binary

Assembly needs read, write, modify, jump.

2.3.2 Types

- Char: 8 Bits
- Int: 16 Bits
- Unsigned Long: 32 Bits
- Float: 32 Bits

3 Week 3: Embedded Systems & Control

3.1 Getting Started with Arduino

Components:

- PWR IN: 7-12V, 1A
- USB to Computer: 5V, 1A
- Reset
- Power: 5V (800mA), 3,3V, GND
- Analog Inputs
- I2C Bus
- Pin 0-1: Serial COM
- Pin 13: LED Pin
- Digital I/O: 5V, 40mA

3.1.1 Required

void setup and void loop.

3.1.2 Constants

true, false. HIGH, LOW for Voltage. Used with digitalWrite(pin, voltage). INPUT, OUTPUT for Pin Mode. int digitalRead will output HIGH or LOW, pinMode(pin, mode) will set.

3.1.3 Other functions

void delay(millisecs);
void delayMicroseconds(microsecs);
unsigned long millis() and unsigned long micros return how long the board has been alive for. The maximum is 50 days and 1 hour respectively.

3.2 Serial Communication Protocols

Baudrate for Arduino is 9600 or 115200. void Serial.begin(baudrate);
void Serial.print(string);

3.3 Sensors and Driver Circuits

The motor driver is an electronic switch. Refer to Datasheet

The sensor has Vcc, Trig, Echo, and Gnd. Sound and echo to get distance.

- digitalWrite(trig, HIGH);
- delayMicroseconds(10);
- digitalWrite(trig, LOW);
- int microsecs = pulseIn(echo, HIGH);
- float cms = microsecs * 0.0345 div 2

3.4 PWM and Servo Motor Control

Use on PWM pins 3,5,6,9,10,11. 3, 11 are tgt, so are 5,6 and 9, 10 for 3 arduino clocks. They are marked with tilde.
void analogWrite(pin, val). Val is from 0 to 255.

3.4.1 Servo

Do not use PWM on 9, 10 if using servo.

- include ¡Servo.h¿
- Servo servo;
- servo.attach(pin, 0deg, 180deg). Do not put pulse width values smaller than 500 or larger than 2500
- servo,write*deg)

4 Week 4: Computer-Aided Design (CAD)

4.1 Introduction to CAD

4.2 Part Modeling - Basics

4.3 Part Modeling - Advanced

4.4 Laser Cutting & DXF File Preparation

5 Week 5: Advanced Design & Measurement

5.1 3D Assemblies in CAD

5.2 Animation & Appearance in CAD

5.3 Measurement & Precision in Design