ME 120 – midterm study guide Fall 2018

This document lists the important concepts from ME 120. You should be able to use or answer questions about each of these items on the final exam. The midterm exam will cover all items that are not crossed out.

Engineering Analysis

- Correct use of algebra
- Neat, organized and clearly documented analysis on standard engineering paper
- Evaluation of mathematical functions: e^x, $\log_{10}(x)$, $\ln(x)$, $\sin(x)$, $\cos(x)$, x^2, x^3, sqrt(x), etc.
- Assign units and cancel units during analysis.
- ~~Hand sketches of parts and systems used in the class~~
- ~~Manual calculation of a linear least squares fit (I don't think we covered this)~~
- ~~Interpretation and use of a linear least squares fit, and polynomial least squares fit from Excel~~

DC Circuits

- Ohm's law
- Power consumption of a resistor
- Equivalent resistance of resistors in series and parallel
- Kirchoff's voltage and current laws
  - > Voltage is the same across parallel components
  - > Voltage around a loop adds to zero
  - > Current is the same through serial components
  - > Current *into* a node adds to zero
- Simplify a resistor network to get the equivalent resistance, total current, total power consumption, as well as voltage drops, current flows and power consumption of individual components
- Voltage dividers, potentiometers
- Read and draw schematics: recognize and use standard symbols
- Use of a multimeter to measure resistance, voltage and current
- Building the following circuits on a breadboard given a schematic
  - > LED circuits
  - > Servo motor
  - ~~> Transistor used as a switch~~
  - ~~> DC motor with fly-back diode and transistor to control speed with PWM~~
  - ~~> Button with a pull-down or pull-up resistor~~

Arduino Programming

- Basic program structure and required elements
- Variable types: **`int`**, **`long`**, **`float`**, **`unsigned int`**, **`unsigned long`**
- Programming equivalents of mathematical functions like e^x, $\log_{10}(x)$, $\ln(x)$, $\sin(x)$, $\cos(x)$, x^2, x^3, sqrt(x), etc.
- Step through code manually to evaluate expressions and logic

- Communication to host computer (i.e. laptop) with the Serial Monitor
  - > Initialize the **`Serial`** object
  - > Use of **`Serial.print`** and **`Serial.println`**, and knowing the difference
- Functions
  - > Specification of return types
  - > Use of input arguments
  - > Calling from your code
  - > Writing your own functions – proper use of input arguments, brackets, return values, etc.
- Loops
  - > syntax of **`for`** ~~and **`while`**~~ loops
  - > designing loops to achieve a specific objective
- Conditional execution (a.k.a. branching):
  - > **`if`** and **`if … else`** constructs
  - > logical expressions and logical operators
  - > design and evaluate logical tests
- Mathematical expressions and built-in functions
- Analog input
- Digital input and output
- PWM control (simulated analog output)

Arduino Applications

- Reading sensors:
  - > Building the appropriate circuits so that voltage can be measured by an Arduino
  - > Using analog input and scaling to convert an A/D reading to a physical value like voltage
- Turning things on and off: blinking LEDs, DC motor circuits,
- Controlling power levels: PWM for LEDs, ~~motors~~
- Using sensor input to make decisions
  - > Use potentiometer input to specify a control parameter (blink rate for an LED, motor speed, servo angle, …)
  - > Turn an LED ~~or motor~~ on or off depending on a sensor values

Excel

- Entering formulas in cells
- Evaluating formulas to create a table of $y_1 = f_1(x)$, $y_2 = f_2(x)$, etc.
- Creating scatter plots
  - > Plots from a table of data
  - > Plots with multiple y values on the same axes with different symbol and line types
  - > Labeling axis and adding a legend
- ~~Creating curve fits by evaluating least squares formulas and by using the TRENDLINE function.~~

- ~~Extracting curve fit coefficients using graphical display is OK, but know how to control the number of digits displayed.~~

Project work (review how these were done)

- Breathing LED
  - > PWM control of brightness of an LED
  - > Use system clock to set time base for evaluating a mathematical function
  - > Evaluate formulas involving e^x and $\ln(x)$
- Desktop fan
  - > ~~PWM control of motor speed~~
  - > Use of servo library
  - > **`for`** loops to control servo sweep
  - > ~~Use a potentiometer to control fan/DC motor speed~~
- ~~Pump~~
  - ~~> Knowledge of all fabrication steps~~
  - ~~> Distinguish features and fabrication steps that must be precise in order to have good pump function, from those features and fabrication steps that need not be precise~~
  - ~~> Describe the purpose of all components, fasteners, and seals~~
  - ~~> Correct orientation and rotation direction of the impeller~~
  - ~~> Pump testing procedure~~
  - ~~> Data reduction~~

How to succeed checklist

Of course, doing things on the list below is not a guarantee of success in ME 120. The list does not address the core learning objectives in the class. It simply describes a set of behaviors that will help you achieve the core learning objectives.

- ☐ Install the Arduino IDE while carefully observing all of the instructions in the manual for the Sparkfun Inventor's Kit
- ☐ Thoroughly test the Arduino IDE with your Arduino board. Make sure *your* Arduino board works correctly and reliably with *your* computer.
- ☐ Aggressively track down solutions to any problems with serial communication over to your laptop.
- ☐ Install Excel on your computer. If you use an alternative (Libre Office, Open Office, Pages, whatever), make sure it works without an internet connect. Note that Google Spreadsheet will not work because internet connectivity during exams will not be allowed.
- ☐ Regularly practice using Excel to enter formulas and make plots. Be able to evaluate any mathematical expression involving e^x, ln(x), sin(x), x^2, x^3, $\sqrt{x}$
- ☐ Buy all of the tools in the required equipment list.
- ☐ Buy a multimeter.
- ☐ Bring *all* of the following items to the exam:
  - › laptop computer
  - › Arduino
  - › Sparkfun Inventor's kit
  - › multimeter
  - › USB cable to connect your laptop to your Arduino board
  - › calculator.
- ☐ Learn how to use your multimeter to measure voltage and resistance.
- ☐ Figure out a way to use hands-free measurement of voltage with your multimeter. The recommended procedure is to buy the $4 test clips for your multimeter.