ME 120 in a Nutshell

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.

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, $\text{sqrt}(x)$, 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
- Interpretation and use of a linear least squares fit, and polynomial least squares fit from Excel

DC Circuits

- Ohm's law
- Power consumption
- Resistors in series and parallel
- Kirchoff's voltage and current laws
- 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
- Building circuits on a breadboard given a schematic
  - > Wiring of LED circuits
  - > Transistor used as a switch
  - > DC motor
  - > Button with a pull-down or pull-up resistor
- Use of a multimeter to measure resistance, voltage and current

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, $\text{sqrt}(x)$, 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

ME 120 in a Nutshell

  - Calling from your code
  - Writing your own – proper definition of input arguments, use of brackets, etc.
- Loops
  - syntax of "for" and "while" loops
  - designing loops to achieve a specific objective
- conditional execution (a.k.a. branching):
  - "if", "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
  - using analog input and scaling to convert input 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
  - Create a plot from a table of data
  - multiple y values on the same axes with different symbol and line types
  - Labeling axis and adding a legend
- Creating a curve fit
- Extracting curve fit coefficients (using graphical display is OK, but know how to control the number of digits displayed

Solidworks

- Use the template file to make 2D drawings for laser cutters
- 3D parts
- Basic operations
  - Manipulating the interface: pan, zoom, selection of on-screen entitites

ME 120 in a Nutshell

  - > Changing the units, making dimensions invisible
  - > Defining entities in a 2D sketch
  - > Adding dimension to and changing dimensions of features
  - > Extrusion and whole cutting to make 3D parts
  - > Modify a 2D sketch to change the features of an existing 3D part
- Draw components of the pump

Fabrication

- Safety practices and common sense
- Use of hand tools and hand-held power tools (drills)
- Use of a caliper to measure part dimensions
- Use of milling machines in the classroom
  - > Controlling motion along three axes
  - > Reading and zeroing the display
  - > Locking motion of the quill
- Drilling holes for screws: through-holes and pilot holes
- Using zip ties
- Use of spade/crimp connectors

Project work

- Breathing LED
- Desktop fan
  - > PWM control of motor speed
  - > Use of servo library
  - > 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, seals
  - > Correct orientation and rotation direction of the impeller
  - > Pump testing procedure
  - > Data reduction