

## Engineering Models I Homework Assignment #2

### Instructions:

1. **Show your work! Make sure you include MATLAB commands.**
2. It is fine to work with other students, but what you turn in must be your own work - not something copied from someone else.

### Problem 1: Plotting Functions (Suggestion: Create a script file for this)

Use the subplot command to break the MATLAB figure window into a 2x2 grid of sub-windows. Then plot the following functions using MATLAB commands (**not Plot Tools**) for the formatting. Be sure to make good choices for the values on the x-axis. In all four plots, don't mark the individual data points.

(a) Top Left Sub-window:  $y = t^2 - 4t + 3$  (solid red line - grid)

**MATLAB Commands:**

(b) Top Right Sub-window:  $y = \cos(4t)$  (dashed black line)

**MATLAB Commands:**

(c) Bottom Left Sub-window:  $y = e^{-12t}$  (dashed magenta line – grid)

**MATLAB Commands:**

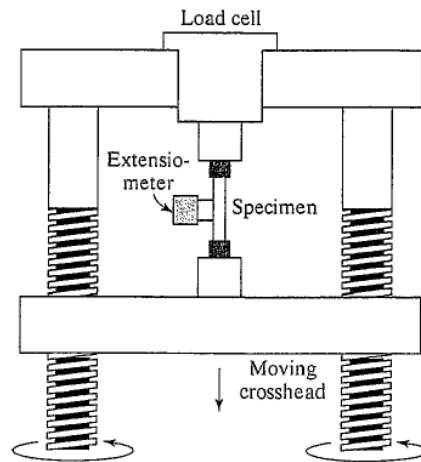
(d) Bottom Right Sub-window:  $y = \sin(2\pi t) \sin(2\pi(20t))$  (solid blue line – use  $t = 0$  to 2 secs)

**MATLAB Commands:**

**Final Plot:**

**Problem 2: Tensile Testing (Suggestion: Create a script file for this)**

(Modified from William Callister, Materials Science and Engineering, An Introduction, 5<sup>th</sup> ed.)



A tensile testing machine, like the one shown in the diagram above, is used to apply an increasing force to a material and measure the resulting strain in order to characterize how the material behaves as it deforms.

Applied Force (lbf)	Length after force is applied (in)	Applied Stress, $\sigma$ (lbf/in <sup>2</sup> )	Resulting Strain, $\epsilon$ (in/in)
0	2		
1650	2.003		
3400	2.006		
5200	2.009		
6850	2.012		
7750	2.015		
8150	2.03		
8500	2.06		
8750	2.09		
9000	2.12		

- Calculate the *Applied Stress*:  $\sigma = F/A$  and enter the results into the table.  $F$  is the applied force (lbf) and  $A$  is the cross-sectional area of the material (in<sup>2</sup>). Assume the material is a cylindrical rod with a diameter of 0.4 in.
- Calculate the resulting *Strain*:  $\epsilon = (\text{Length} - \text{OriginalLength})/\text{OriginalLength}$ . The original length of the rod is 2 inches (i.e., the length with no applied force). Enter the results in the table.
- In MATLAB, plot strain on the x-axis and stress on the y-axis. Connect the data points with a solid black line and mark the data points as circles. Label the x and y axis appropriately making sure to include units. Paste all of your MATLAB commands to create the plot in the space below. Leave your plot open for the next part of the problem.

### **MATLAB Commands:**

- (d) The point at which the curve begins to flatten is called the yield point or yield stress. If the applied stress is below the yield point, the material will return to its original length when the force is removed. If the applied stress exceeds the yield point, the material has been deformed and will not return to the original shape. Add a text arrow to mark the yield point. To do this, choose Insert in your figure window and select Text Arrow. Place the arrow then type the text (yield point).

### **Plot:**

#### **Problem 3: Projectile Motion (Suggestion: Create a script file for this)**

The x and y position (in meters) of a projectile fired at an initial speed of  $V_0$  (m/s), at an angle of  $\theta$ , and at an initial height above the ground of  $y_0$  (m) are a function of time (s):

$$x_{position} = [V_0 \cos(\theta)]t$$
$$y_{position} = -\frac{1}{2}gt^2 + [V_0 \sin(\theta)]t + y_0 \quad \text{Note: } g = 9.81 \text{ m/s}^2$$

- (a) Assume the projectile is fired at 90 m/s and the initial height is 0. On a single graph, plot the y-position of the projectile on the y-axis and time, t, on the x-axis using five different launch angles: 10°, 25°, 45°, 65°, and 85°. Your time, t, should range from 0 to 20 seconds in increments of 0.01 seconds. ***Remember: In MATLAB use sind not sin when the angle is in degrees.***

Using MATLAB commands or plot tools or a combination of both, do the following:

- Label the x-axis as Time (s) and the y-axis as Projectile Height (m).
- Adjust the y-axis so the Projectile Height is non-negative.
- Add a legend to show the various launch angles.

### **MATLAB Commands:**

### **Plot:**

- (b) Use the Data Cursor Tool to determine the maximum height for each launch angle and the time when the projectile hits the ground for each launch angle. Put these values in the table below. Then calculate the range (final x-position at the time of impact) and add these values to the table.

<b>Launch Angle (deg)</b>	<b>Maximum Height (m)</b>	<b>Time of Impact (s)</b>	<b>Range (m)</b>
10°			
25°			
45°			
65°			
85°			

- (c) How does the launch angle affect maximum height of the projectile?
- (d) How does the launch angle affect the time to impact?
- (e) How does the launch angle affect the range of the projectile?