

Answers to Quick Questions

1. Evaluate the expression $\delta = 23.45 \sin\left(360 \frac{284 + n}{365}\right)$ for $n = 1, 74, 2004, 355$
- ```
>> n = [1, 74, 2004, 355]
n =
 1 74 2004 355

>> delta = 23.45*sin(360*(284 + n)/365)
delta =
 -23.3811 22.1596 19.6562 21.9694
```

### Comprehensive Questions

2. Analysis of tensile test data:

The assignment involved modifying a partially complete \MATLAB\ function so that it performed a number of tasks. The function is called `tensileTest` and its final form is listed on the next page.

The complete `tensileTest` function performs the following steps.

- Read the data from `\texttt{AltensileTest.dat}`. The code for this step was included in the template. No change is necessary.
- Compute the stress at each point during the test from the measured `F` values. Stress is force per unit area. If `d` is the diameter of the circular cross section of the sample, then vector of stress values is computed with

```
d = 0.252;
area = 0.25*pi*d^2;
stress = Force/area;
```

The `d` and `area` variables are scalars. The `stress` variable is a vector having the same shape (same number of rows and columns) as the `Force` vector.

- Plot stress versus strain using small dots for each data point. This is obtained with the single line.

```
plot(strain, stress, '.')
```
- Add the yield stress point for Aluminum 2024-T4 to the curve as a single, red, square. The key to this step is to find the point that represents the yield stress. The yield stress is  $\sigma_y = 47 \times 10^3$  psi which corresponds to a horizontal line on the stress versus strain plot.
- What is the “strain” coordinate for this point? Let’s call the coordinates of the red square  $(\epsilon^*, \sigma^*)$  where  $\epsilon$  is the strain and  $\sigma$  is the stress. The plot showing the solution (provided with the assignment) has the red square on the line corresponding to Young's modulus. Since  $\sigma = E \epsilon$  on this line, and since  $\sigma^* = \sigma_y$  we solve have  $\epsilon^* = \sigma_y / E$ .

(Discussion of the solution is continued after the listing)

List of tensileTest.m:

```
function [sigmaMax,tmax] = tensileTest
% tensileTest Load and plot tensile test data
% ME 352, Problem Set #1, 7 October 2003

% --- Load data from file
D = load('AltensileTest.dat');
t = D(:,1); % time (s)
strain = D(:,2); % strain (in/in)
Force = D(:,3); % load (lbf)

% --- Compute stress
d = 0.252; % sample diameter (in)
area = 0.25*pi*d^2; % sample cross section
stress = Force/area;

% --- Known material properties
E = 10.6e6; % Young's modulus for 2024-T4 Aluminum
yield = 47e3; % Yield strength for 2024-T4 Aluminum

% --- Find intersection of horizontal line at stress = yield with line
% having slope E (Young's modulus) that passes through zero
epsStar = yield/E;
sigStar = epsStar*E;

% --- Plot curves and label axes
plot(strain, stress, '.', epsStar, sigStar, 'rs', [0 epsStar], [0 sigStar], '--')
xlabel('Strain (in/in)');
ylabel('Stress (psi)');

% --- Find the maximum stress and the time of the last recorded measurement
sigmaMax = max(stress);
tmax = t(end);
```

- f. The red square is added to the plot with these statements

```
epsStar = yield/E;
sigStar = epsStar*E;
plot(strain, stress, '.', epsStar, sigStar, 'rs')
```

- g. Draw a dashed line indicating the Young's Modulus for Aluminum 2024-T4. This is easy when the coordinates of the red square are known. We can define two element vectors with the coordinates of this line and then add it to the plot

```
xline = [0 epsStar];
yline = [0 sigStar];
plot(strain, stress, '.', epsStar, sigStar, 'rs', xline, yline, '--')
```

or we can put the vectors directly in the input argument to the plot statement like this

```
plot(strain, stress, '.', epsStar, sigStar, 'rs', [0 epsStar], [0 sigStar], '--')
```

- h. Label the  $x$  axis "Strain (in/in)" and the  $y$  axis "Stress (psi)".

```
xlabel('Strain (in/in)');
ylabel('Stress (psi)');
```

- i. Find `sigmaMax` the maximum stress for the data set, and `tmax` the time of the last recorded measurement. Return both from `sigmaMax` and `tmax` from the function. *Do not* print `sigmaMax` and `tmax` from within the function.

```
sigmaMax = max(sigma);
tmax = t(end);
```

Running `tensileTest` produces the following text output and the plot in Figure 1.

```
>> [smax, tmax] = tensileTest
smax =
 5.9902e+004
tmax =
 231.7500
```

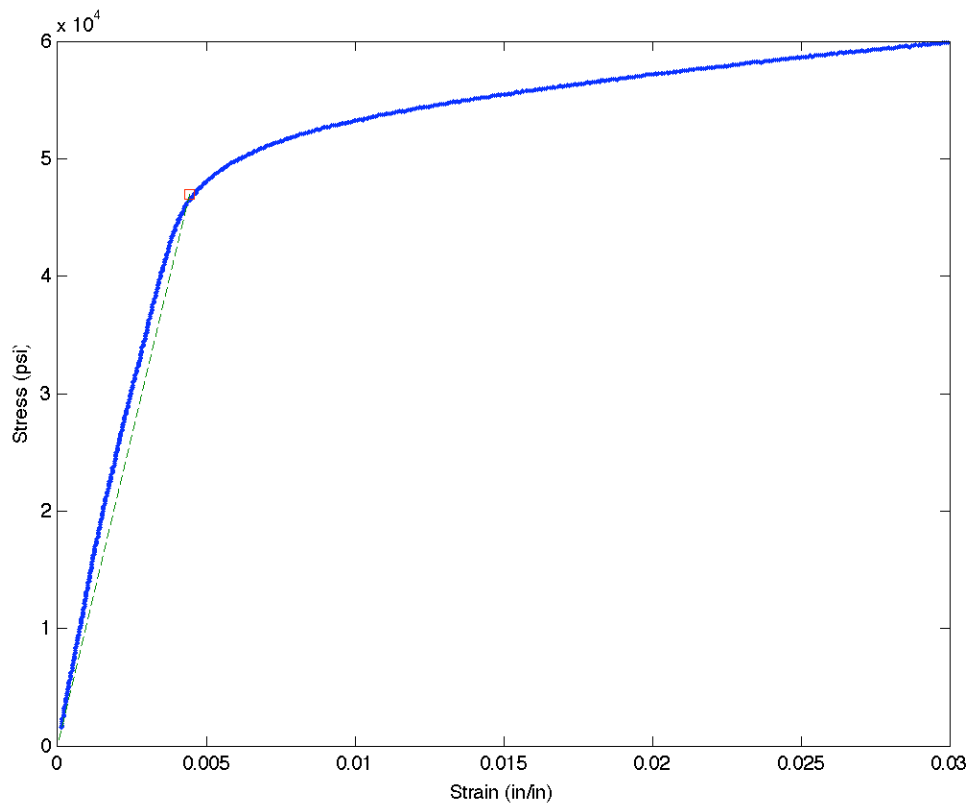


Figure 1 Plot of stress versus strain created by the tensileTest function.