ME 1020 Engineering Programming with MATLAB

Chapter 3 In-Class Assignment: 3.1, 3.3, 3.9, 3.11, 3.19, 3.23

Topic Covered:

- Addition, multiplication and division of complex numbers
- Creation of user-defined functions
- Importing data into MATLAB from text files

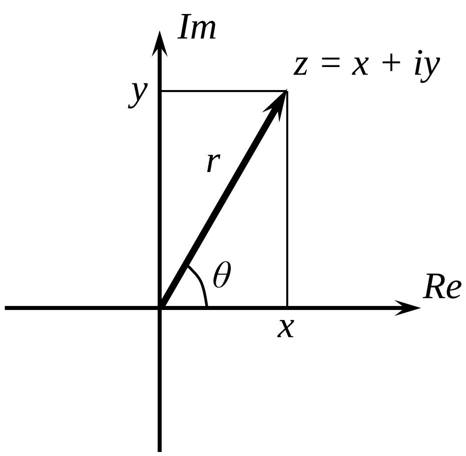
Open a new **Script File** for Problem 3.1:

1.* Suppose that $y = -3 + ix$. For $x = 0$, 1, and 2, use MATLAB to compute the following expressions. Hand-check the answers.

a. $|y|$ *b.* $y + y$

c. $(-5 - 7i)y$ *d.* $\frac{y}{6 - 3i}$

Complex number computations:



Absolute value:

$$\text{abs}(-3 + i) = \sqrt{3^2 + 1^2} = \sqrt{10} = 3.162$$

Addition:

$$(-3 + i) + (-3 + i) = [(-3) + (-3)] + [(1) + (1)]i = -6 + 2i$$

Multiplication:

$$(-5 - 7i)(-3 + i) = (-5)(-3) + (-5)(i) + (-7i)(-3) + (-7i)(i) = 15 - 5i + 21i - 7(i)(i)$$

$$(i)(i) = \sqrt{-1} \times \sqrt{-1} = -1$$

$$(-5 - 7i)(-3 + i) = 22 + 16i$$

Division:

Multiply the top and the bottom by the complex conjugate of the denominator.

$$\frac{(-3+i)}{(6-3i)} \cdot \frac{(6+3i)}{(6+3i)} = \frac{-18-9i+6i+3i^2}{36-9i^2} = \frac{-21-3i}{36+9} = -0.4667-0.0667i$$

```
% Problem 3.1
clear
clc
disp('Problem 3.1: Scott Thomas')

x=0:2
y = -3 +i*x

disp('Part (a)')
abs(y)

disp('Part (b)')
y + y

disp('Part (c)')
(-5 - 7i)*y

disp('Part (d)')
y/(6 - 3i)
```

```
Problem 3.1: Scott Thomas
x =

     0     1     2

y =

  -3.0000            -3.0000 + 1.0000i  -3.0000 + 2.0000i

Part (a)
ans =

    3.0000    3.1623    3.6056

Part (b)
ans =

  -6.0000            -6.0000 + 2.0000i  -6.0000 + 4.0000i

Part (c)
ans =

  15.0000 +21.0000i  22.0000 +16.0000i  29.0000 +11.0000i

Part (d)
ans =

  -0.4000 - 0.2000i  -0.4667 - 0.0667i  -0.5333 + 0.0667i
```

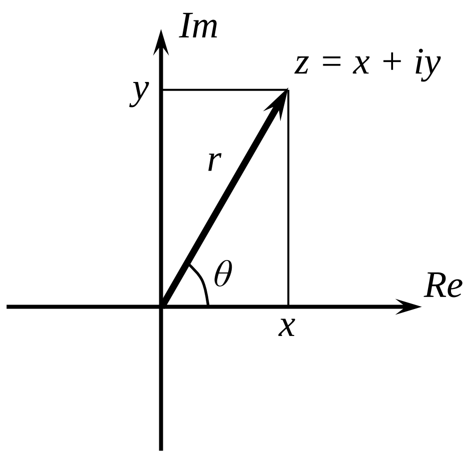
Open a new **Script File** for Problem 3.3:

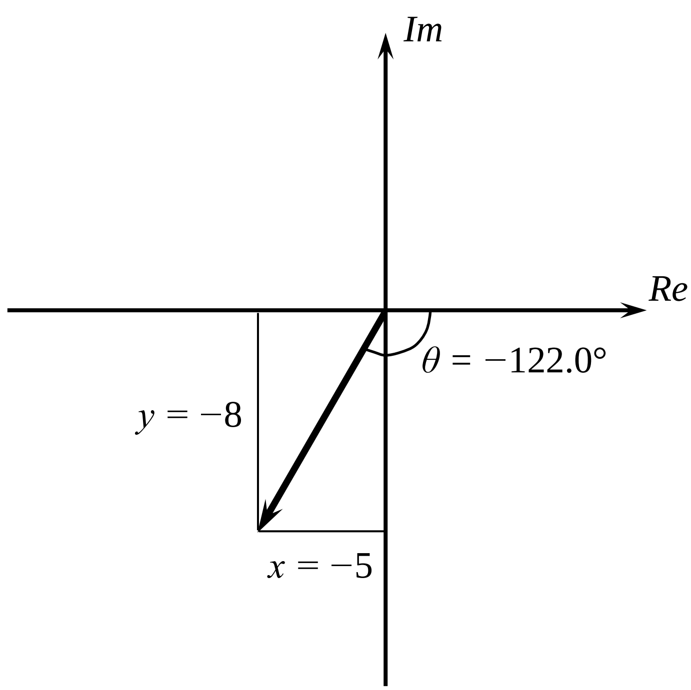
3.* Use MATLAB to find the angles corresponding to the following coordinates. Hand-check the answers.

a. $(x, y) = (5, 8)$ *b.* $(x, y) = (-5, 8)$

c. $(x, y) = (5, -8)$ *d.* $(x, y) = (-5, -8)$

Complex number computations, continued:





```
% Problem 3.3
clear
clc
disp('Problem 3.3: Scott Thomas')

disp('Part (a)')
xa = 5 + 8i
theta_a_radians = angle(xa)
theta_a_degrees = theta_a_radians*180/pi

disp('Part (b)')
xb = -5 + 8i
theta_b_radians = angle(xb)
theta_b_degrees = theta_b_radians*180/pi

disp('Part (c)')
xc = 5 - 8i
theta_c_radians = angle(xc)
theta_c_degrees = theta_c_radians*180/pi

disp('Part (d)')
xd = -5 - 8i
theta_d_radians = angle(xd)
theta_d_degrees = theta_d_radians*180/pi
```

```
Problem 3.3: Scott Thomas
Part (a)

xa =

   5.0000 + 8.0000i


theta_a_radians =

    1.0122


theta_a_degrees =

   57.9946

Part (b)

xb =

  -5.0000 + 8.0000i


theta_b_radians =

    2.1294


theta_b_degrees =

  122.0054
```

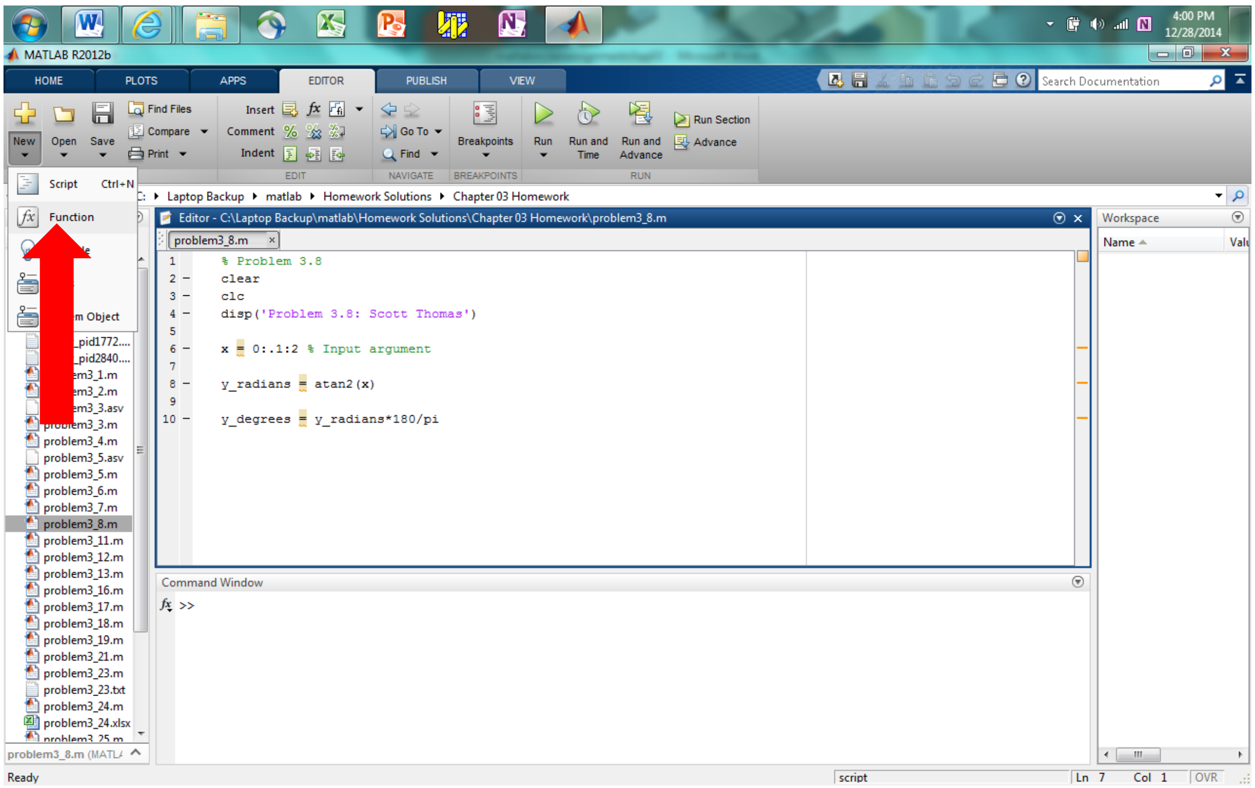
```
Part (c)

xc =

   5.0000 - 8.0000i


theta_c_radians =

   -1.0122


theta_c_degrees =

  -57.9946

Part (d)

xd =

  -5.0000 - 8.0000i


theta_d_radians =

   -2.1294


theta_d_degrees =

 -122.0054
```

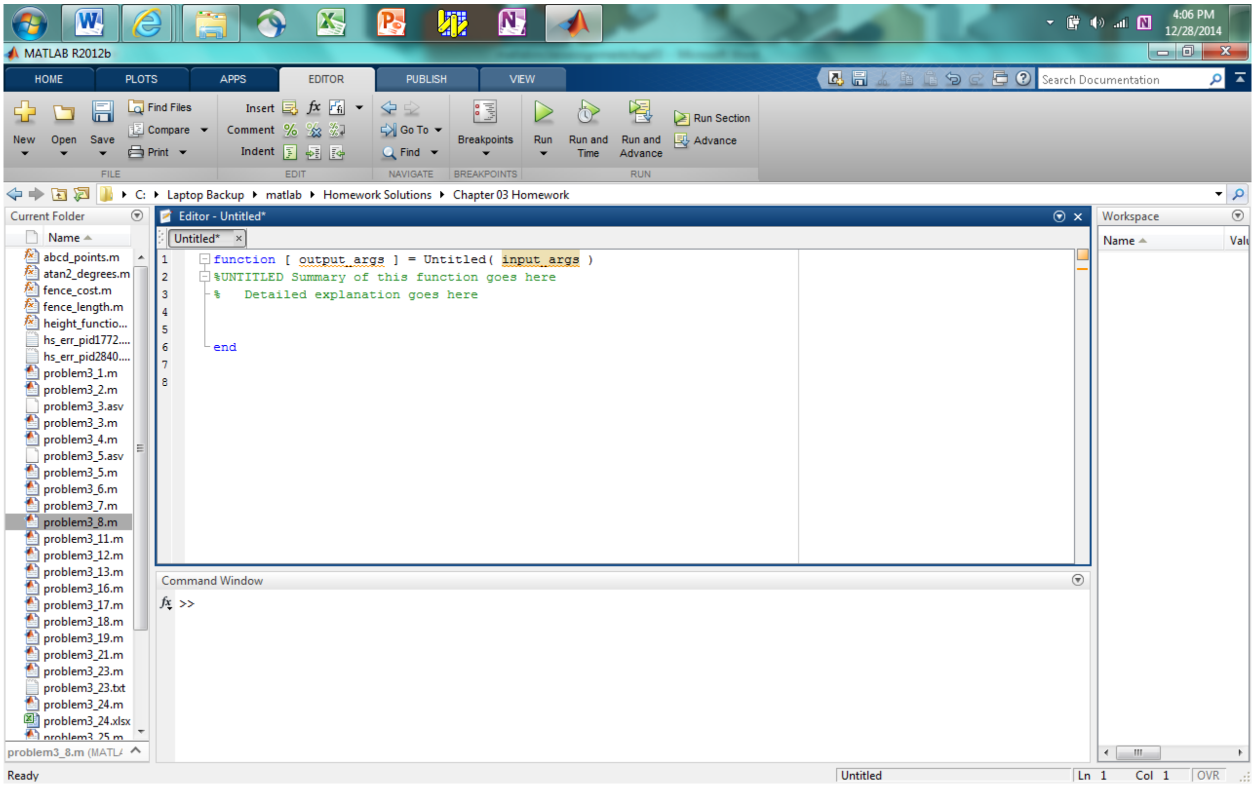
Open a new **Function File** for Problem 3.9:

9. Write a function that accepts temperature in degrees Fahrenheit (°F) and computes the corresponding value in degrees Celsius (°C). The relation between the two is

$$T\,°\mathrm{C} = \frac{5}{9}(T\,°\mathrm{F} - 32)$$

Be sure to test your function.






```
% Problem 3.9
function [Temperature_degrees_C] = temp_converter(Temperature_degrees_F)
Temperature_degrees_C = 5/9*(Temperature_degrees_F - 32);
```

```
% Problem 3.9
clear
clc
disp('Problem 3.9: Scott Thomas')

Temperature_degrees_F = 212

T_degrees_Celsius = temp_converter(Temperature_degrees_F)
```

```
Problem 3.9: Scott Thomas

Temperature_degrees_F =

   212


T_degrees_Celsius =

   100
```

Open a new **Function File** for Problem 3.11:

11. A water tank consists of a cylindrical part of radius r and height h and a hemispherical top. The tank is to be constructed to hold 600 m^3 when filled. The surface area of the cylindrical part is $2\pi rh$, and its volume is $\pi r^2 h$. The surface area of the hemispherical top is given by $2\pi r^2$, and its volume is given by $2\pi r^3/3$. The cost to construct the cylindrical part of the tank is $400 per square meter of surface area; the hemispherical part costs $600 per square meter. Use the `fminbnd` function to compute the radius that results in the least cost. Compute the corresponding height h.

Problem setup:

$$A_{\text{cyl}} = 2\pi rh;\ A_{\text{hemi}} = 2\pi r^2;\ V_{\text{cyl}} = \pi r^2 h;\ V_{\text{hemi}} = \frac{2\pi}{3}r^3$$

$$V = V_{\text{cyl}} + V_{\text{hemi}} = \pi r^2 h + \frac{2\pi}{3}r^3 = 600\ \text{m}^3$$

$$h = \frac{1}{\pi r^2}\left(600 - \frac{2\pi}{3}r^3\right)$$

$$\text{Cost} = \left(400\ \frac{\$}{\text{m}^2}\right)A_{\text{cyl}} + \left(600\ \frac{\$}{\text{m}^2}\right)A_{\text{hemi}} = [400(2\pi rh) + 600(2\pi r^2)]\ \$$$

fminbnd

Find minimum of single-variable function on fixed interval

Syntax

```
x = fminbnd(fun,x1,x2)
x = fminbnd(fun,x1,x2,options)
[x,fval] = fminbnd(...)
[x,fval,exitflag] = fminbnd(...)
[x,fval,exitflag,output] = fminbnd(...)
```

Description

`fminbnd` finds the minimum of a function of one variable within a fixed interval.

`x = fminbnd(fun,x1,x2)` returns a value `x` that is a local minimizer of the function that is described in `fun` in the interval `x1 < x < x2`. `fun` is a function handle.

Parameterizing Functions in the MATLAB Mathematics documentation, explains how to pass additional parameters to your objective function `fun`.

`x = fminbnd(fun,x1,x2,options)` minimizes with the optimization parameters specified in the structure `options`. You can define these parameters using the `optimset` function. `fminbnd` uses these `options` structure fields:

`Display`	Level of display. `'off'` displays no output; `'iter'` displays output at each iteration; `'final'` displays just the final output; `'notify'` (default) displays output only if the function does not converge. See Iterative Display in MATLAB Mathematics for more information.
`FunValCheck`	Check whether objective function values are valid. `'on'` displays an error when the objective function returns a value that is `complex` or `NaN`. `'off'` displays no error.
`MaxFunEvals`	Maximum number of function evaluations allowed.

Create the following **Function** file:

```
% Problem 3.11
function [wh_cost] = wh_cost(wh_radius)

wh_volume = 600; %m^3
cost_area_cyl = 400; %$/m^2
cost_area_hemi = 600; %$/m^2

%Water Heater Height (m)
wh_height = (wh_volume-2*pi/3*wh_radius^3)/pi/wh_radius^2;

%Cylinder Area (m^2)
area_cyl = 2*pi*wh_radius*wh_height;

%Hemisphere Area (m^2)
area_hemi = 2*pi*wh_radius^2;

%Water Heater Cost ($)
wh_cost = cost_area_cyl*area_cyl + cost_area_hemi*area_hemi;
```

Check the function using a calculator by setting the water heater radius to 1 m:

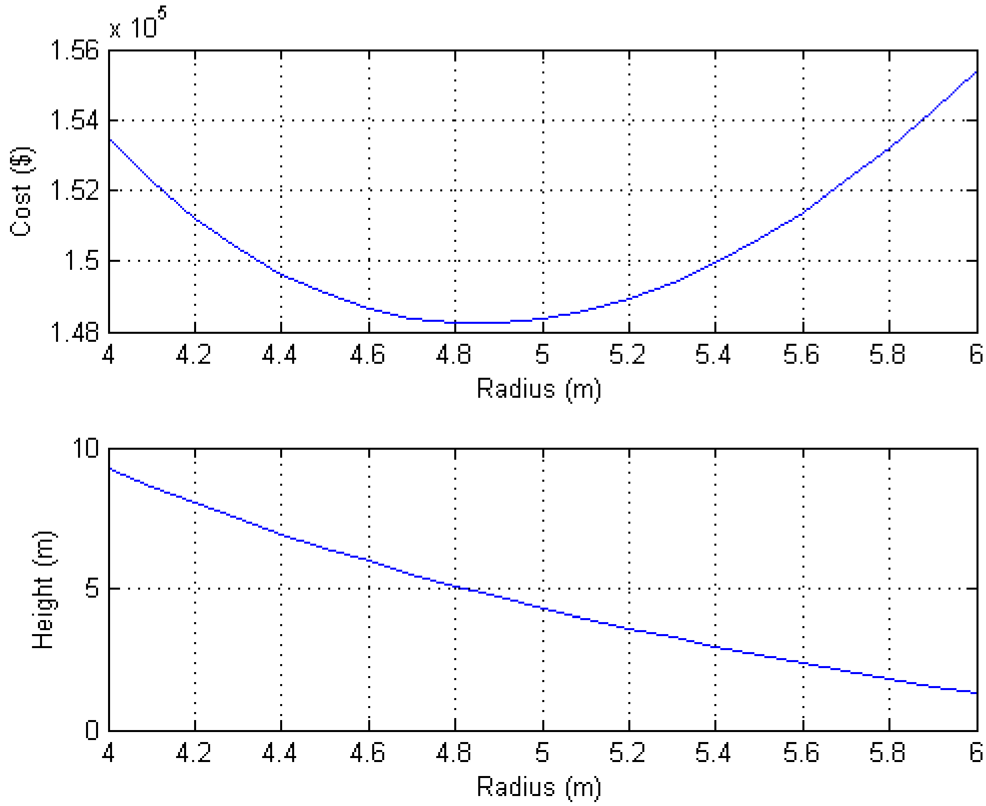
```
>> water_tank(1)

wh_volume =

   600


cost_area_cyl =

   400


cost_area_hemi =

   600


wh_height =

  190.3193


area_cyl =

   1.1958e+03


area_hemi =

    6.2832


wh_cost =

   4.8209e+05


ans =

   4.8209e+05

>>
```

Now create the following **Script File** to use the **fminbnd** function to find the radius that minimizes the cost. Make sure that the **Script File** and the **Function File** are in the same computer folder.

```
% Problem 3.11
clear
clc
disp('Problem 3.11: Scott Thomas')

wh_radius = fminbnd('wh_cost',1,10)

wh_volume = 600; %m^3
```

```
cost_area_cyl = 400; %$/m^2
cost_area_hemi = 600; %$/m^2

%Water Heater Height (m)
wh_height = (wh_volume-2*pi/3*wh_radius^3)/pi/wh_radius^2

%Cylinder Area (m^2)
area_cyl = 2*pi*wh_radius*wh_height;

%Hemisphere Area (m^2)
area_hemi = 2*pi*wh_radius^2;

%Water Heater Cost ($)
wh_cost = cost_area_cyl*area_cyl + cost_area_hemi*area_hemi

r_plot = 4:0.1:6;
h_plot = (600-2*pi/3*r_plot.^3)./(pi*r_plot.^2);
cost_plot = 800*pi.*r_plot.*h_plot + 1200*pi*r_plot.^2;

subplot(2,1,1)
plot(r_plot,cost_plot),xlabel('Radius (m)'),ylabel('Cost ($)'), grid on
subplot(2,1,2)
plot(r_plot,h_plot),ylabel('Height (m)'),xlabel('Radius (m)'),grid on
```

```
Problem 3.11: Scott Thomas

wh_radius =

    4.8572


wh_height =

    4.8572


wh_cost =

   1.4823e+05
```



x 10^5
1.56
1.54
1.52
1.5
1.48
Cost ($)
4
4.2
4.4
4.6
4.8
5
5.2
5.4
5.6
5.8
6
Radius (m)
10
5
0
Height (m)
4
4.2
4.4
4.6
4.8
5
5.2
5.4
5.6
5.8
6
Radius (m)

Open a new **Script File** for Problem 3.19:

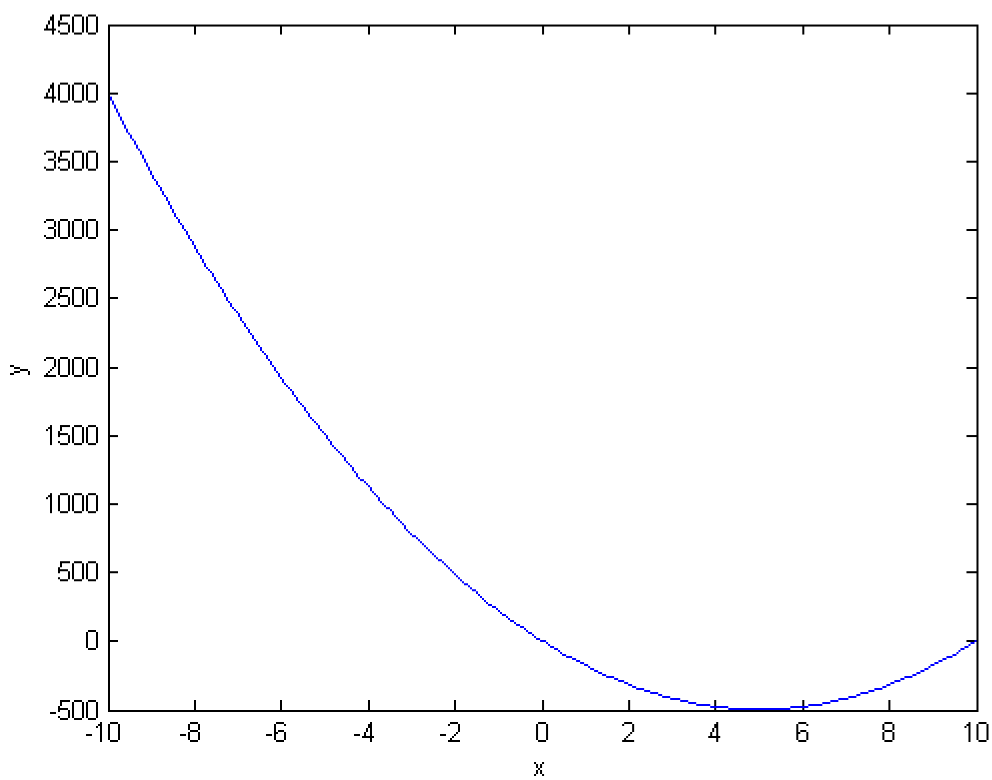
19. Create an anonymous function for $20x^2 - 200x + 3$ and use it

a. To plot the function to determine the approximate location of its minimum

b. With the `fminbnd` function to precisely determine the location of the minimum

```
% Problem 3.19
clear
clc
disp('Problem 3.19: Scott Thomas')

anonfun = @(x) 20*x.^2 - 200*x + 3;

a = -10:0.1:10;

y1 = anonfun(a);

plot(a,y1), xlabel('x'), ylabel('y')

y = fminbnd(anonfun,-10,10)
```

```
Problem 3.19: Scott Thomas

y =

    5.0000
```



Problem 3.23:

23. Use a text editor to create a file containing the following data. Then use the `load` function to load the file into MATLAB, and use the `mean` function to compute the mean value of each column.

55	42	98
49	39	95
63	51	92
58	45	90

```
% Problem 3.23
clear
clc
disp('Problem 3.23: Scott Thomas')

%load problem3_23.txt

S = load('problem3_23.txt', '-ascii')

col_mean_1 = mean(S(:,1))
col_mean_2 = mean(S(:,2))
col_mean_3 = mean(S(:,3))
```

Problem 3.23: Scott Thomas

S =

```
   55   42   98
   49   39   95
   63   51   92
   58   45   90
```

col_mean_1 =

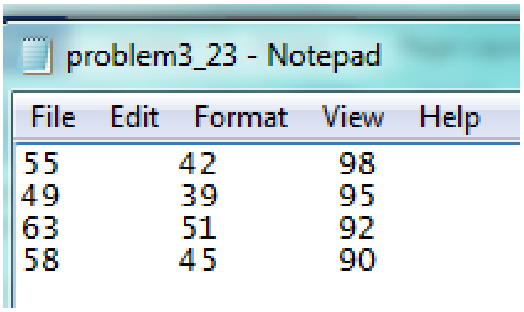
  56.2500

col_mean_2 =

  44.2500

col_mean_3 =

  93.7500


problem3_23 - Notepad

File Edit Format View Help

55	42	98
49	39	95
63	51	92
58	45	90