ME 1020 Engineering Programming with MATLAB

Problem 3.13:

13. A fenced enclosure consists of a rectangle of length L and width $2R$ and a semicircle of radius R, as shown in Figure P13. The enclosure is to be built to have an area A of 2000 ft^2. The cost of the fence is \$50 per foot for the curved portion and \$40 per foot for the straight sides. Use the `fminbnd` function to determine with a resolution of 0.01 ft the values of R and L required to minimize the total cost of the fence. Also compute the minimum cost.

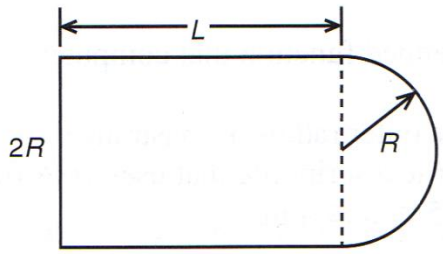

Figure P13

Problem setup:

$$L_{\text{curv}} = \pi R;\ L_{\text{str}} = 2L + 2R;\ A_{\text{curv}} = \frac{\pi}{2}R^2;\ A_{\text{str}} = 2RL$$

$$A = A_{\text{curv}} + A_{\text{str}} = \frac{\pi}{2}R^2 + 2RL = 2000\ \text{ft}^2$$

$$L = \frac{1}{2R}\left(2000 - \frac{\pi}{2}R^2\right)$$

$$\text{Cost} = \left(50\ \frac{\$}{\text{ft}}\right)L_{\text{curv}} + \left(40\ \frac{\$}{\text{ft}}\right)L_{\text{str}} = [50(\pi R) + 40(2L + 2R)]\ \$$$

Create the following **Function File**:

```
% Problem 3.13
function [fence_cost] = fence_cost(fence_radius)

fence_area = 2000; %ft^2
cost_ft_curv = 50; %$/ft
cost_ft_str = 40; %$/ft

%Side Length L (ft)
L = (fence_area-pi/2*fence_radius^2)/2/fence_radius;
```

```
%Curved Length L_curv (ft)
L_curv = pi*fence_radius;

%Straight Length L_str (ft)
L_str = 2*L + 2*fence_radius;

%Fence Cost ($)
fence_cost = cost_ft_curv*L_curv + cost_ft_str*L_str;
```

Check the function using a calculator by setting the fence radius to R = 1 ft:

```
>> fence_cost(1)

fence_area =

        2000


cost_ft_curv =

    50


cost_ft_str =

    40


L =

  999.2146


L_curv =

    3.1416


L_str =

   2.0004e+03


ans =

   8.0174e+04

fx >>
```

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 3.13
clear
clc
disp('Problem 3.13: Scott Thomas')

fence_radius = fminbnd('fence_cost',1,100)

fence_area = 2000; %ft^2
cost_ft_curv = 50; %$/ft
cost_ft_str = 40; %$/ft

%Side Length L (ft)
L = (fence_area-pi/2*fence_radius^2)/2/fence_radius

%Curved Length L_curv (ft)
L_curv = pi*fence_radius

%Straight Length L_str (ft)
L_str = 2*L + 2*fence_radius

%Fence Cost ($)
fence_cost = cost_ft_curv*L_curv + cost_ft_str*L_str

r_plot = 15:0.01:25;
L_plot = (fence_area-pi/2*r_plot.^2)/2./r_plot;
L_curv_plot = pi*r_plot;
L_str_plot = 2*L_plot + 2*r_plot;
fence_cost_plot = cost_ft_curv*L_curv_plot + cost_ft_str*L_str_plot;

subplot(2,1,1)
plot(r_plot,fence_cost_plot),xlabel('Radius (ft)'),ylabel('Cost ($)'), grid on
subplot(2,1,2)
plot(r_plot,L_plot),ylabel('Length (ft)'),xlabel('Radius (ft)'),grid on
```

```
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fence_radius =

   21.4270


L =

   29.8414


L_curv =

   67.3149


L_str =

  102.5367
```

```
fence_cost =

   7.4672e+03
```