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ETCS 105 Career Discovery

MatLab Project 4

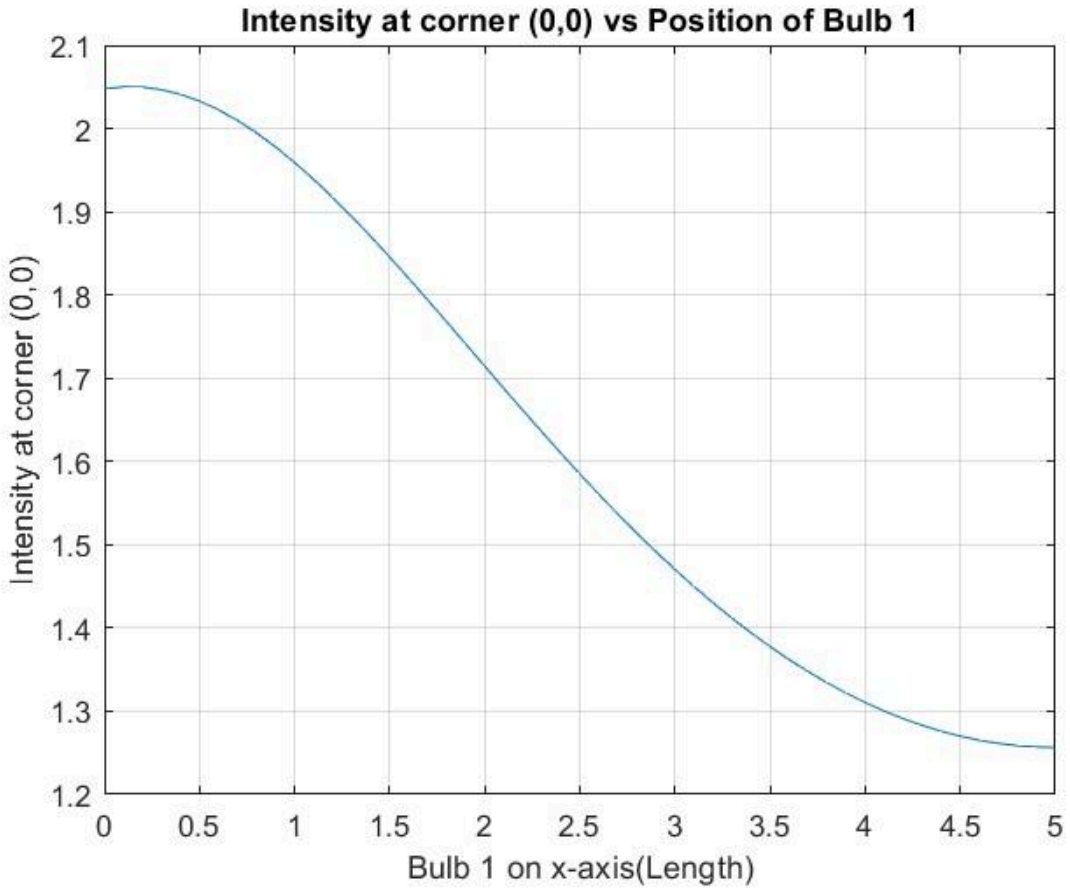
Two 150-Watt Bulbs

Looking along the long walls, the room is now darker toward the middle than at the corners. This indicates that we have spread the lights too far apart. We could proceed with further contour plots, but instead, let's be systematic about finding the best position for the lights. In general, we can put one light at x=d and the other symmetrically at x=10-d for d between 0 and 5. Judging from the examples above, the darkest spots will be either at the corners or at the midpoints of the two long walls. By symmetry, the intensity will be the same at all four corners, so let's graph the intensity at one of the corners (0, 0) as a function of d.

Answer:

```
% room dimensions
l=10; % length
w=4; % width

% bulb 1 on the x-axis
d1=0:0.1:5;

% positions and powers of the bulbs
bulb_pos=[d1;          % x-coordinates of the first bulb
    10-d1;           % symmetric x-coordinates of the second bulb
    ones(size(d1))*2;  % constant y-coordinate for all bulbs
    ones(size(d1))*3]; % constant z-coordinate for all bulbs
bulb_pow=ones(size(d1)) * 150;

% function to calculate intensity from a single bulb
intensity_single=@(X, Y, bulb_x, bulb_y, bulb_z, p)
p./(4*pi*((X-bulb_x).^2 + (Y-bulb_y).^2 + bulb_z.^2));

% function to calculate the total intensity from all bulbs
intensity=@(X, Y, d1) intensity_single(X, Y, bulb_pos(1, :), bulb_pos(3,
:), bulb_pos(4, :), bulb_pow) + ...
                      intensity_single(X, Y, bulb_pos(2, :), bulb_pos(3,
:), bulb_pos(4, :), bulb_pow);

% plot intensity at corner (0,0) as a function of d1
figure;
plot(d1, intensity(0, 0, d1) + intensity(0, 0, 10 - d1));
```

```
xlabel('Bulb 1 on x-axis(Length)');
ylabel('Intensity at corner (0,0)');
title('Intensity at corner (0,0) vs Position of Bulb 1');
grid on;
```



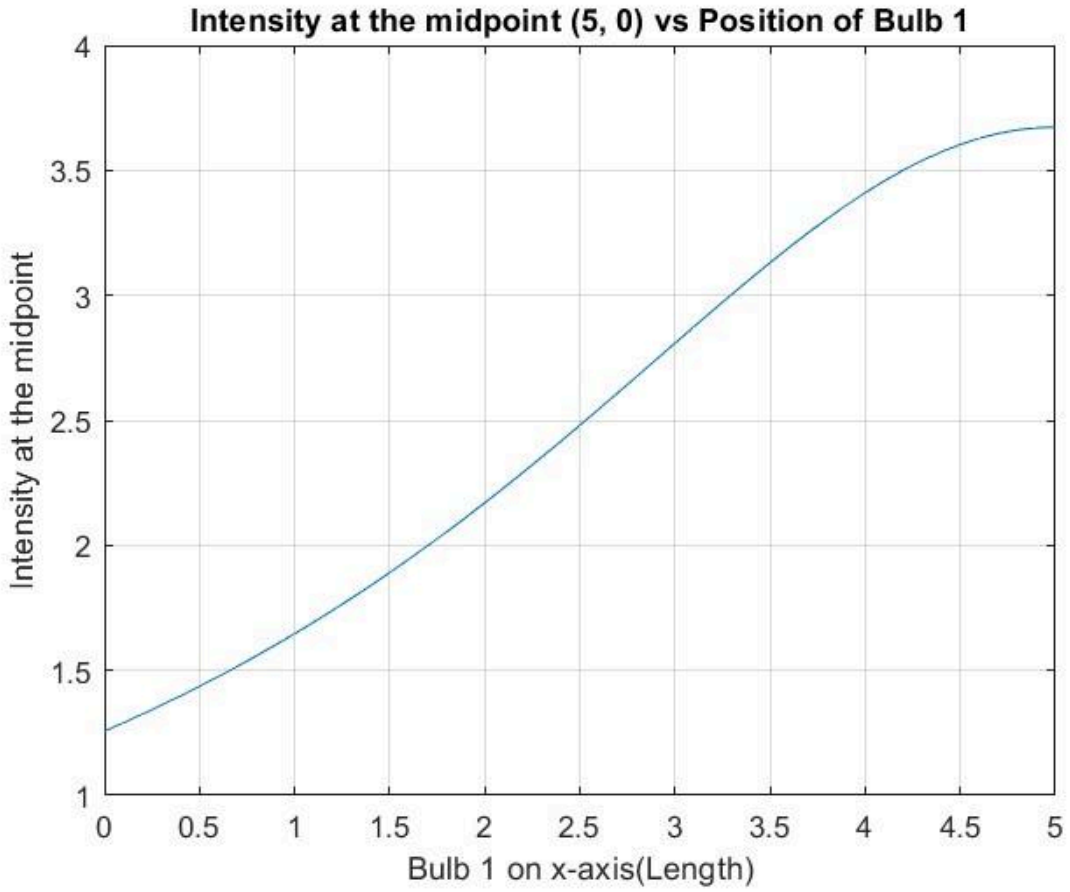
As expected, the smaller the d is, the brighter the corners are. In contrast, the graph for the intensity at the midpoint (5, 0) of a long wall (again by symmetry it does not matter which of the two long walls we choose) should grow as d increases toward 5.

Answer:

Let's edit the plotting part of the code above to the graph of the **intensity at the midpoint (5, 0)**.
Just change the first two inputs for the ***intensity*** function in the plotting part from **0, 0 to 5, 0** and adjust the title, and y-label names:

```
% plot intensity at the midpoint (0,5) as a function of d1
figure;
```

```
plot(d1, intensity(5, 0, d1) + intensity(5, 0, 10 - d1));
xlabel('Bulb 1 on x-axis(Length)');
ylabel('Intensity at the midpoint');
title('Intensity at the midpoint (5, 0) vs Position of Bulb 1');
grid on;
```



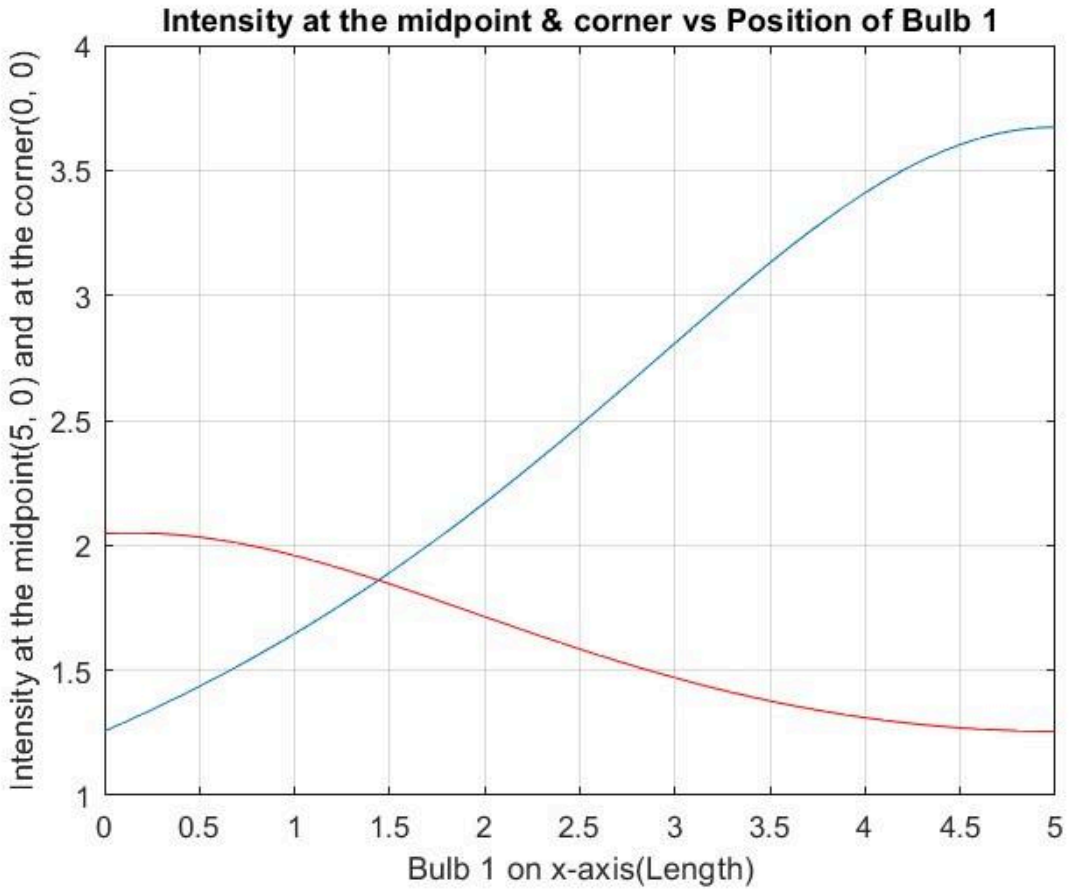
We are after the value of d for which the lower of the two numbers on the above graphs (corresponding to the darkest spot in the room) is as high as possible. We can find this value by showing both curves on one graph.

Answer:

Use *hold on* on the previous code block to add the curve of intensity on the corner (0,0). Add colors to identify curves: red for corner intensity and blue for midpoint intensity. Adjust the label and title names:

```
% plot intensity at midpoint(0,5) and corner(0, 0) as a function of d1
figure;
plot(d1, intensity(5, 0, d1) + intensity(5, 0, 10 - d1));
hold on
plot(d1, intensity(0, 0, d1) + intensity(0, 0, 10 - d1), 'r');
```

```
xlabel('Bulb 1 on x-axis(Length)');
ylabel('Intensity at the midpoint(5, 0) and at the corner(0, 0)');
title('Intensity at the midpoint & corner vs Position of Bulb 1');
grid on;
hold off
```



The optimal value of d is at the point of intersection, near 1.4, minimum intensity a little under 1. To get the optimum value d, we find exactly where the two curves intersect.

Answer:

Create an equation to find an intersection point of two plots:

```
syms d1;
eqn=inline(char(intensity(0, 0, d1) + intensity(0, 0, 10 - d1) - intensity(5, 0,
d1) - intensity(5, 0, 10 - d1)));
disp(fzero(eqn, [0, 5]))
```

```
>> proj4
   1.441000000000000
```

So, the lights should be placed about 1.44m from the short walls. For this configuration, the approximate intensity at the darkest spots on the floor is as follows.

Answer:

```
disp(intensity(0, 0, 1.441) + intensity(0, 0, 10 - 1.441))
```

```
ans =

    0.930100000000000
```