Due Monday May 3, 2021

1. Based on the attached Excel spreadsheet containing US and world oil production rate figures for the last hundred years or so, fit the distribution

$$q(t) = \frac{Q_\infty}{\sigma\sqrt{2\pi}}\exp\left(-\frac{1}{2}\left(\frac{t-\mu}{\sigma}\right)^2\right)$$

to the oil production rate data. In the expression, Q_∞ is the total amount of oil produced, μ is date of the maximum rate of oil production, and σ is the characteristic width of the distribution.

   (a) Using US oil production figures, determine the values of Q_∞, μ and σ. Based on your calculations, when will we stop producing oil in the US? To quantify this, look for the date when we fall below 5% of our maximum production.

   (b) Using world oil production figures, determine the values of Q_∞, μ and σ. Based on your calculations, when will we stop producing oil in the world? To quantify this, look for the date when we fall below 5% of the maximum production.

   (c) Using world oil production figures, determine the values of μ and σ assuming

   - a modest estimate of $Q_\infty = 2$ trillion barrels
   - $Q_\infty = 3$ trillion barrels
   - a generous estimate of $Q_\infty = 4$ trillion barrels

   For each of these cases, when will the world oil production rate peak, and when will we run "out of oil?"

For each of the above calculations, plot your results on an appropriate graph and indicate key events (you may do this by hand if you need to), such as the date of maximum production and the date when we essentially stop producing oil. Be sure to include labels on your plots.

Please observe the following general guidelines for homework submission. Your homework should:

- have all MatLab files placed in a directory (folder) called YourNameHW11 which is zipped into a file called YourNameHW11.zip and emailed to adam@colorado.edu by 11:59 PM on the due date.
- all m-files should contain the following lines at the beginning, (with the appropriate information filled in):

```
%   Your Name
%   HW 11
%   APPM 3050
%   Date: today's date
```

- all m-files should contain comments to clearly explain what is being done at various points in the program.
- all m-files should clearly list and explain the input and output from any function files.
- any hard-copy should contain a clear statement of the problem, in your own words.
- any hard-copy should contain a clear discussion of the results of the problem. (Do the results make sense? Are they reasonable? Why, or why not? Do you *trust* the results of your program?)

Here is some sample code for the illumination problem simililar to that from the previous lab. Note the use of the `meshgrid`, `zeros`, and `size` functions.

```
%-------------------------------------------------------
% Adam Norris
% HW 11
% APPM 3050
% Spring 2010
%-------------------------------------------------------
% This program calculates the light intensity on a floor
% due to overhead lightbulbs.
%-------------------------------------------------------

clear                  % clear workspace
close all              % close all graphics windows

% Create x as a 2D array of x-coordinates at each floor point
% Create y as a 2D array of y-coordinates at each floor point
% Create z as a 2D array of z-coordinates at each floor point
[x y] = meshgrid( 0:1:100, 0:1:40 );
z = zeros( size(x) );

% Calculate 2D arrays of light intensity at each floor point
% for two bulbs
amount1 = illum2(x, y, z, 15, 20, 30, 150);
amount2 = illum2(x, y, z, 85, 20, 30, 150);

amount = amount1 + amount2;      % Calculate the total amount

contourf( x, y, amount, 20 )     % Make 20 filled-contour lines
   colormap('gray'),
   xlabel('X'),
   ylabel('Y'),
   title('Illumination')

% Calculate maximum variation in illumination level
difference = max(max(amount)) - min(min(amount))
```

Here is the associated function m–file. Notice that this function file has been modified to handle computations using vectors and arrays rather than scalars.

```
function amount = illum2(x, y, z, xl, yl, zl, wattage)
%-------------------------------------------------------
% Adam Norris
% HW 11
% APPM 3050
% Spring 2010
%---------------------------------------------------------------
% This function calculates the light intensity at each floor point
% accounting for the fact that intensity decreases as 1/distance^2.
%---------------------------------------------------------------
% Input:
% x, y, z are 2D arrays containing the coordinates of floor points.
% xl, yl, zl are 1x1 (scalar) values for the bulb coordinates.
% Wattage of the bulb
% Output:
% amount is a 2-D array of the illumination level at floor points.
%---------------------------------------------------------------

amount = wattage ./ ( 4*pi * ( (x-xl).^2 + (y-yl).^2 + (z-zl).^2 ) );
```