Name:	ID:

COMPUTER APPLICATIONS IN IME – MEE212	**QUIZ 1 - MATLAB** 119 MINUTES	LAU الجامعة اللبنانية الأميركية Lebanese American University

PROBLEM 1 (25 PTS)	PROBLEM 2 (50 PTS)	PROBLEM 3 (25 PTS)	TOTAL (100 PTS)

READ BEFORE YOU START:

- No questions are allowed.
- Write your name and ID before you start. You are not allowed to take the exam handout with you.
- The quiz handouts will be collected on 12:55 PM.
- Before you start create a folder on the Desktop using you FIRST_LAST name.
- SAVE ALL YOUR FILES IN THAT FOLDER BEFORE 12:59 PM.
- It is your responsibility to save your work before the test ends. No files will be collected afterwards what so ever.
- Attempt all problems to get partial grades.
- UNLESS SPECIFIED, values should NOT be displayed in MATLAB's command window.
- Log in to the workstations using the following credentials (Case sensitive): **User=** mee.exam | **Pass=** GLuckHf

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Problem 1 – matrix manipulation (25 points)

Perform the following matrix manipulations in a single script file (add *%comments* to separate problem parts).

a. Create the two matrices ***A*** and ***B***

$$A=\begin{bmatrix}25 & 58\\ 13 & 31\\ 5 & 62\\ 6 & 2\\ 8 & 12\end{bmatrix} \quad B=\begin{bmatrix}1 & 4 & 5 & 3 & 2\\ 5 & 7 & 2 & 9 & 6\\ 8 & 10 & 15 & 22 & 6\end{bmatrix}$$

b. Concatenate ***A*** and ***B*** into one 5x5 matrix ***C*** by taking the transpose of ***B*** and inserting it to the right of ***A***.

$$\textit{i.e. } C=\begin{bmatrix}25 & 58 & 1 & 5 & 8\\ 13 & 31 & 4 & 7 & 10\\ 5 & 62 & 5 & 2 & 15\\ 6 & 2 & 3 & 9 & 22\\ 8 & 12 & 2 & 6 & 6\end{bmatrix}$$

c. Calculate the determinant of ***C*** and save it in a variable called ***C_det***. Disply ***C_det*** in the workspace.

d. Find the inverse of ***C*** and save it in a variable called ***D***.

e. Extract the ***C*** the elements highlighted below and save it in a variable called ***E***.

$$C = \begin{bmatrix} 25 & 58 & 1 & 5 & 8 \\ 13 & 31 & 4 & 7 & 10 \\ 5 & 62 & 5 & 2 & 15 \\ 6 & 2 & 3 & 9 & 22 \\ 8 & 12 & 2 & 6 & 6 \end{bmatrix}$$

Problem 2 – functions and applications (50 points)

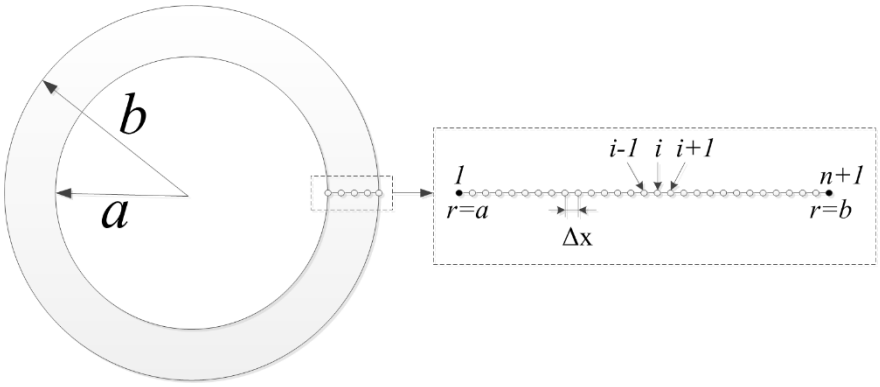
It is required to find the radial deflection across the wall of a pressure vessel subject to internal pressure. For a thick pressure vessel of inner radius ***a*** and outer radius ***b***, the differential equation for the radial deflection of a point along the thickness is given by:

$$\frac{d^2u}{dr^2} + \frac{1}{r}\frac{du}{dr} - \frac{u}{r^2} = 0$$

The deflection ***u*** (in inch) at the boundaries is related to the pressure ***P*** (in psi) inside the vessel by:

$$u\big|_{r=a} = 5.2\times10^{-5}P - 1.45\times10^{-7}$$
$$u\big|_{r=b} = -3\times10^{-11}P^2 + 2.1\times10^{-5}P - 14.5\times10^{-5}$$

Given the symmetry of the pressure vessel, the problem can be simplified into a 1D domain as shown in the figure



You are required to use the finite difference method to discretize the 1D domain and find the deflection distribution across the wall of a vessel that has an inside diameter of *10"* and a wall thickness of *1.5"* by doing the following:

a. Create a function called *"PressureVessel"* that will find the deflection across the wall thickness. The function inputs should be: ***N*** (the number of discretization elements) and ***P*** (the pressure inside the vessel). The function should return 2 arrays: the radial coordinates of the nodes ***r*** and the deflection magnitude at these coordinates ***d*** (Both should be ***N+1*** in size).

   The finite difference approximations of the differential equation terms are given by:

$$\frac{d^2u}{dr^2} \approx \frac{u_{i+1} - 2u_i + u_{i-1}}{(\Delta r)^2}$$

$$\frac{du}{dr} \approx \frac{u_{i+1} - u_i}{\Delta r}$$

b. Create a MATLAB script that will first prompt the user to input the number of discretization points (***N***) and then use the *"PressureVessel"* function to solve the deflection distribution problem for the following pressure values: [***P*** =25 psi], [***P*** =50 psi], [***P*** =100 psi], and [***P*** =200 psi] (Enter a value of 10 for ***N***). The script file should plot the deflection distribution of the 4 cases on a single figure with:
   - Each curve should have a different color and a different marker.
   - A legend showing the pressure of each curve (e.g. '*P=25 psi*', '*P=50 psi*', …)
   - The title of the figure should be: "*Problem 2 Solution*"
   - The x-label of the figure should be: "*Radial distance, inch*"
   - The y-label of the figure should be: "*Deflection, inch*"

   NOTE: the figure coloring and labeling should be done programmatically (i.e. in the script file not manually with the figure editor).

Problem 3 – plotting (25 points)

Solve this problem using a single script file (add *%comments* to separate problem parts).

You should first generate the data that you are going to use in your plots using the following command:

```
L=membrane;
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This will generate a 31x31 array that will be used in all the plots.

On a single figure containing 2x2 plots generate the following programatically:

a. Plot the data using the **mesh** plot; the x-axis label should be *"x"*, the y-axis label should be *"y"*, the z-axis label should be *"Height"*, and the plot title should be *"3D Mesh plot"*. Grid should be off. Plot should be on the *upper left* side of the figure.
b. Plot the data using the **surf** plot; the x-axis label should be *"x"*, the y-axis label should be *"y"*, the z-axis label should be *"Height"*, and the plot title should be *"3D Surface plot"*. Grid should be off. Shading should be interp (refer to MATLAB *help* on how to use the *shading* function). Plot should be on the *upper right* side of the figure.
c. Plot the data using the **contour3** plot with 30 lines; the x-axis label should be *"x"*, the y-axis label should be *"y"*, the z-axis label should be *"Height"*, and the plot title should be *"3D Contour plot"*. Grid should be off. Plot should be on the *lower left* side of the figure.
d. Plot the data using the **contourf** plot with 10 lines; x-axis label should be *"x"*, the y-axis label should be *"y,* and the plot title should be *"2D Contour plot"*. Grid should be off. Plot should be on the *lower right* side of the figure.

The axis limits for the 3D plots should be [0 30] for the x-axis, [0 30] for the y-axis, and [min(L) max(L)] for the z-axis.