University of Cyprus
Department of Civil and Environmental Engineering

CEE325: Computed-Aided Structural Analysis
Matlab Lab

Exercise - 1:

Use the commands that are necessary to request and get from the user (i.e., you) the width, b, and height, h, of a beam with a bxh rectangular cross-section, and compute the area (A=b*h) and the moment of inertia ($I=b*h^3/12$) of the specific cross-section.

Print the computed area and moment of inertia with all 3 different ways (while being computed, using the function *disp()* and using the function *fprintf()* with certain number of digits overall and after the decimal point.

Exercise - 2:

Define a row vector and then multiply it with a scalar.

Define a column vector and then multiply it with a scalar.

Define vectors using the colon (:) operator with various steps.

Access certain elements of the vectors you have defined.

Open the Workspace and see the representation of the defined variables and the various options provided by the Workspace window.

Define several matrices (arrays), using both the semicolon and a new line to define their rows and access certain elements of the matrices you have defined.

Define a few matrices with ones (containing elements with values of 1), with sevens (values 7), with different sizes.

Define identity matrices of various sizes.

Define diagonal matrices.

Use the function *rand()* to define arrays of certain dimensions with random numbers.

Determine the transposes of some of your matrices.

Define a 4x4 matrix with random numbers between 5 and 8 and then compute its transpose, its determinant, its inverse, and its rank. Subsequently, multiply that matrix with its inverse to check whether the result is an identity matrix.

Define some matrices with proper dimensions (sizes) and perform matrix multiplications and element-wise multiplication, division and raising to a power.

Use the functions *length()* and *size()* to obtain the dimensions of vectors and arrays.

Define some arrays and concatenate them.

Exercise - 3:

Define the proper arrays (matrices) and solve the following system of algebraic equations to determine the unknown x, y, and z, using both the \ operator and the inversion of the matrix of coefficients.

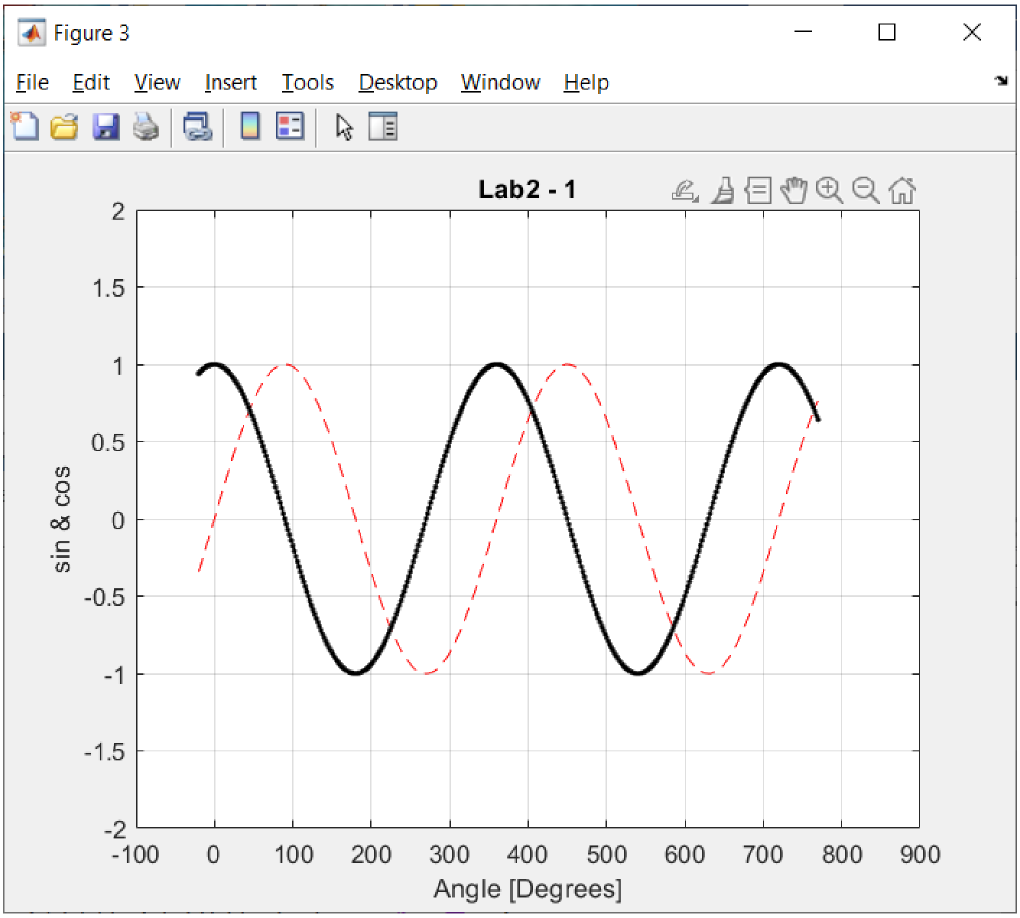
$$13x + 2y - 0.5z = 24.5$$

$$-2.5x - 3.5y + 5.7z = 5.6$$

$$7.5x + 9.1y - 12.5z = 6.1$$

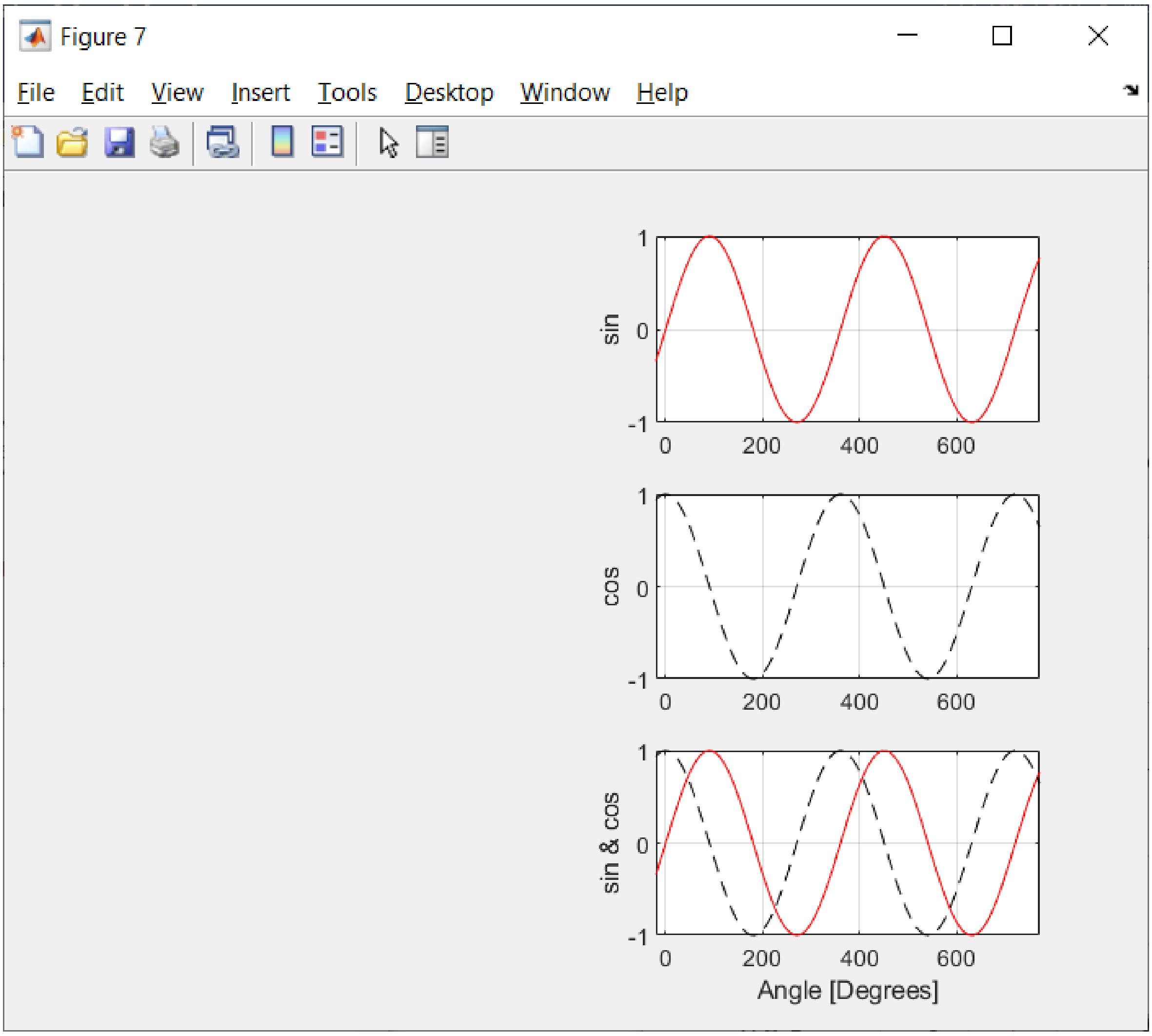
Exercise - 4:

- Provide the necessary Matlab commands to draw in Figure 3, the sine(θ) with red dashed line '- -', and the cos(θ) with black '.-' line, with the angle θ, varying between -20 and 770 degrees with a step equal to 2.
- Add the title *'Lab2 - 1'* to the figure and titles are the axes, specifically *'Angle [Degrees]'* on the horizontal axis and *'sin & cos'* on the vertical axis.
- Add a grid in the figure and set the horizontal axis to vary between -100 and 900 degrees and between -2 and 2 the vertical axis, as shown in the following figure.



Exercise - 5:

- Create a new figure, Figure 7, which should be subdivided into 3 rows and 2 columns of subplots.
- Draw the ***sine***, as computed in the previous exercise, with a red continuous line, in the top right subplot, as shown below, and add the world *sin* on the vertical axis.
- Draw the cosine, as computed in the previous exercise, with a black dashed (- -) line in the center-right subplot, as shown below, and add the world *cos* on the vertical axis.
- Finally, draw in the center bottom subplot, as shown below, both the sine, with a red continuous line, and the cosine, with a black dashed (- -) line, as computed in the previous exercise, and add the string '*Angle [Degrees]*' on the horizontal axis and the string '*sin & cos*' on the vertical axis.
- Save Figure 7 both as a Matlab figure and as a *jpg* image, using the name *ex5F*.



Exercise - 6:

- Redo Exercise - 5, using a script, with the name *ex6.m*, where you should provide all Matlab commands that have been used in the previous exercise
- Execute the script *ex6.m*

Exercise - 7:

- Write a function, named *celciusToFahrenheit()*, with one parameter named *tempC*, which will be used to provide the temperature in Celsius and compute and return the corresponding temperature in Fahrenheit.
- Note that to compute the temperature in Fahrenheit, the temperature in Celsius should be multiplied by 1.8, and 32 should be added.
- Write a script, in a file named *ex7.m*, to test the *celciusToFahrenheit*() function, by asking the user for a temperature in Celsius, calling the function to get the corresponding value in Fahrenheit, and printing it.

Sample execution:

```
>> celciusToFahrenheit(0)
ans =
    32
>> celciusToFahrenheit(20)
ans =
    68
>> celciusToFahrenheit(30)
ans =
    86
>> celciusToFahrenheit(100)
ans =
   212
```

Exercise - 8:

- Write a function, named *km2Miles()*, which will accept in one parameter a distance in kilometers (km) and convert and return it in miles (1 km = 0.621371192 miles).
- Write a script, in a file named *ex8.m*, to test the *km2Miles()* function, by asking the user for a distance in km, calling the function to get the corresponding value in miles, and printing it.

Sample execution:

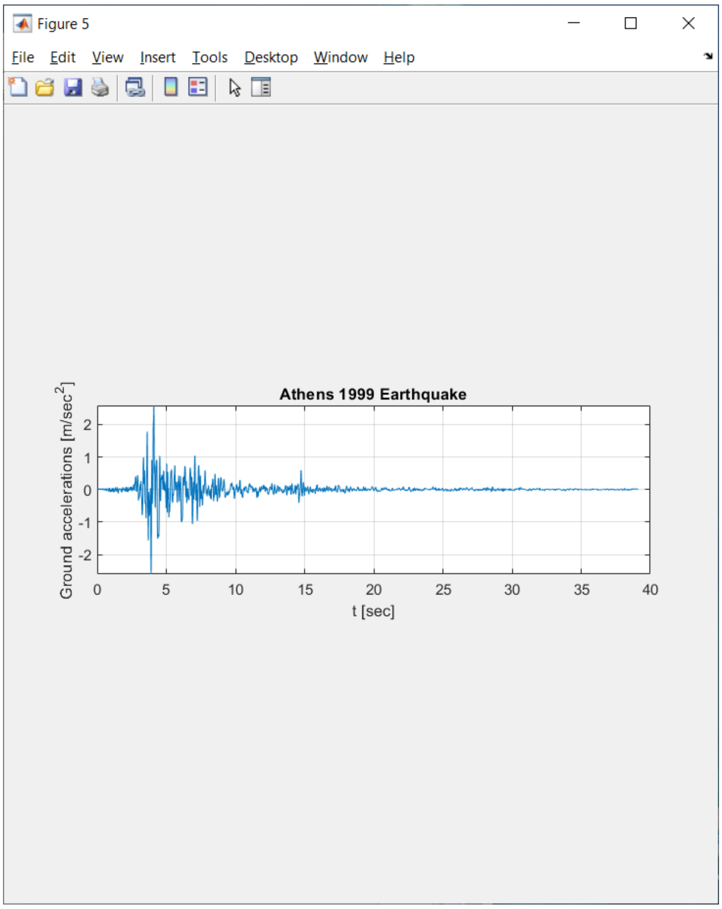
```
>> test_km2Miles
Distance [km] = 100
100.0 km equals 62.137 m
>> test_km2Miles
Distance [km] = 60
60.0 km equals 37.282 m
```

Exercise - 9:

- An accelerogram (*επιταχυνσιογράφημα*) is a graph (plot) of the ground accelerations (εδαφικές επιταχύνσεις) in terms of the recorded time instances, as recorded by an accelerograph (*επιταχυνσιογράφος*) with a very small time-step (0.01 s or smaller).
- From the following URL (Uniform Resource Locator), you can download and save to your folder the file with the recorder ground accelerations along a specific direction, at the Kallithea District during the 9/11/1999 Athen's earthquake.

  https://www.eng.ucy.ac.cy/petros/Earthquakes/Athens_3_KallitheaN46_Accel

- The recorder ground accelerations are stored in the aforementioned file as 2 columns, the 1st one providing the times of recording and the 2nd one providing the recorded ground accelerations.
- After downloading and saving the file (*Athens_3_KallitheaN46_Accel.txt*) with the ground accelerations (directory) in a folder, which should be your active (current) Matlab folder (directory), write a Matlab script, named ***plotAccelogram.m***, to load the values and store the times (1st column) in a vector named *recordingTimes* and the ground accelerations (2nd column) in a vector named *recorderAcc*.
- Plot the accelerogram (i.e., ground accelerations vs. time instances) in the middle subplot of Figure 5, which should be subdivided into 3 rows, as shown below, giving a proper title (e.g., "*Athens 1999 Earthquake*"), and axes titles (e.g., *'t [sec]'* and *'Ground accelerations [m/sec^2]'*, respectively, as follows:



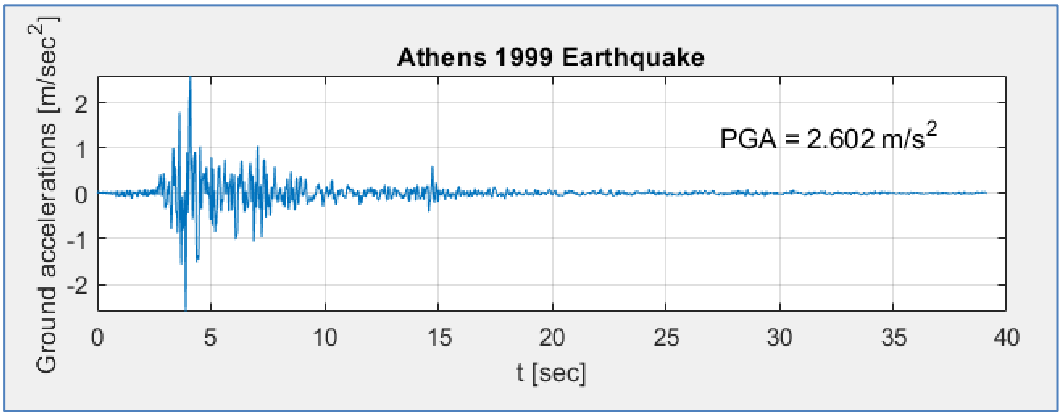
- Print the number of points (number of recorded instances) you have read and the time step between the points, as shown below.
- Print the maximum value, in absolute values, of the recorded ground accelerations, which is called Peak Ground Acceleration (PGA) expressed both in m/s^2 and g (where g=9.81 m/s^2), as well as the time at which the PGA has been recorded, as shown below.

```
>> plotAccelogram

 3913 pairs of values have been read
 With time step = 0.010 seconds

 PGA = 2.602400 m/s^2 = 0.265280 g at time 3.900
```

- Using the function *text()*, add a string providing the PGA at the coordinates corresponding to the 70% of the time range and the 50% of the PGA, as shown below.


Athens 1999 Earthquake
PGA = 2.602 m/s2
Ground accelerations [m/sec2]
t [sec]
0
5
10
15
20
25
30
35
40
2
1
0
-1
-2