ROSE-HULMAN INSTITUTE OF TECHNOLOGY

Department of Mechanical Engineering

ME 123 Comp Apps I

EXAM 2 – WRITTEN PORTION

NAME ____

SECTION NUMBER ________________________________

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Written Portion	/ 50
Computer Portion	/ 50
Total	/ 100

ROSE-HULMAN INSTITUTE OF TECHNOLOGY

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ME 123 Comp Apps I

USE MATLAB SYNTAX FOR ALL PROGRAMS AND COMMANDS YOU WRITE

Problem 1 (3 points): You are given a matrix *A*:

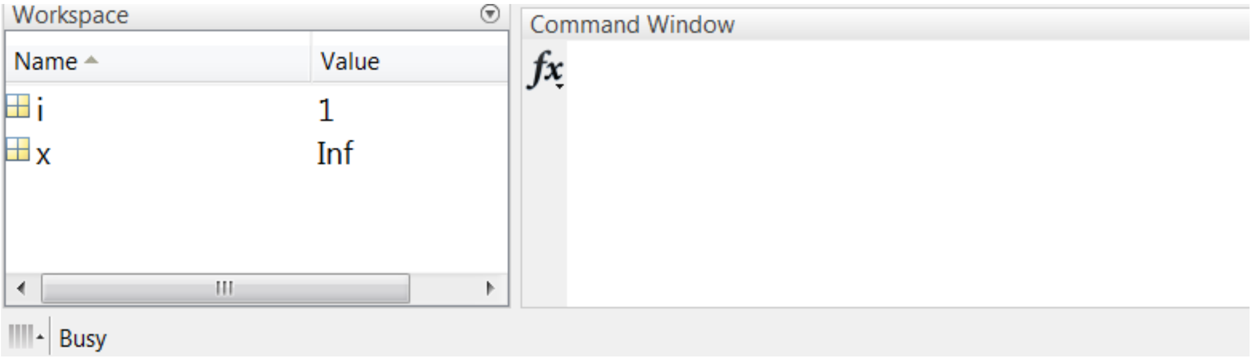
$$A = \begin{bmatrix} 1 & 9 & 3 & 6 \\ 2 & 4 & 1 & 9 \\ 7 & 6 & 2 & 2 \\ 5 & 3 & 1 & 7 \end{bmatrix}$$

Write one line of code that will replace the fourth row of *A* with the numbers 1, 2, 3, 4.

Problem 2 (3 points): Consider the following script:

```
i=1;
x=3;
while i < 10
    x=x*x;
end
```

When we run the code, we just see this:



Name	Value
i	1
x	Inf

There appears to be something wrong, because it just lays there doing this. What is happening with the code? (You don't need to fix it, just tell what is happening.)

Problem 3:

a) **(4 points)** Consider the function shown below used to calculate the instantaneous position of a projectile for some given launch criteria. Based on the function comments and code, write the first line of this function (i.e., the function definition) in the box provided.

```
% projectile_function.m
% This function computes the instantaneous position of a
% projectile given specified input criteria.
%
% Inputs:
%    V     - launch velocity [m/s]
%    angle - launch angle [degs]
%    t     - instantaneous time [s]
% Outputs:
%    x     - instantaneous x location [m]
%    y     - instantaneous y location [m]

g = 9.81         % m/s^2

x = V*sind(angle)*t;
y = V*cosd(angle)*t - 0.5*g*t*t;
```

b) **(4 points)** Now consider the following main code below. Based on this main code, call the function from part (a) and store the displacements using variables named `x_inst` and `y_inst`. Write the necessary line of code to call the function in the box provided.

```
clear all
clc

V_launch = 50;   % launch velocity [m/s]
theta = 30;      % launch angle [degs]
time = 5;        % instantaneous time [s]
```

Problem 4 (3 points): You are given a matrix A:

$$A = \begin{bmatrix} 1 & 9 & 3 & 6 \\ 2 & 4 & 1 & 9 \\ 7 & 6 & 2 & 2 \\ 5 & 3 & 1 & 7 \end{bmatrix}$$

What is A after running the snippet of code shown below?

```
A(3:4,1:2) = A(2:3,2:3)
```

a) $A = \begin{bmatrix} 1 & 9 & 3 & 6 \\ 1 & 9 & 1 & 9 \\ 2 & 4 & 2 & 2 \\ 7 & 6 & 1 & 7 \end{bmatrix}$ b) $A = \begin{bmatrix} 1 & 1 & 9 & 3 \\ 2 & 2 & 4 & 1 \\ 7 & 6 & 2 & 2 \\ 5 & 3 & 1 & 7 \end{bmatrix}$ c) $A = \begin{bmatrix} 1 & 9 & 3 & 6 \\ 2 & 4 & 1 & 9 \\ 4 & 1 & 2 & 2 \\ 6 & 2 & 1 & 7 \end{bmatrix}$ d) $A = \begin{bmatrix} 1 & 9 & 3 & 6 \\ 2 & 7 & 6 & 9 \\ 7 & 5 & 3 & 2 \\ 5 & 3 & 1 & 7 \end{bmatrix}$

e) None of the above. Explain:

Problem 5 (3 points): Below is a main code followed by a simple function:

```
% Main Code
x = 2;
y = 4;
z = 6;
[outVar] = simplefunction(x,y,z)

% Function Code
function [outVar] = simplefunction(y,z,x)
outVar = x/y + z;
```

After running the main code, what is `outVar` in the main workspace?

a) `outVar = 2`

b) `outVar = 4.25`

c) `outVar = 6.5`

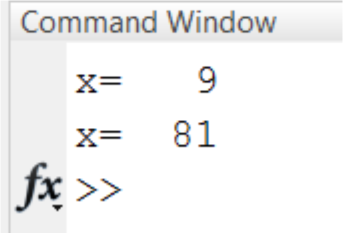
d) `outVar = 7`

e) An error occurs; explain what caused the error:

Problem 6 (3 points): Consider the following script:

```
clc
x=3;
while x > 10
     x=x*x;
     fprintf('x=%4.0f \n',x)
end
```

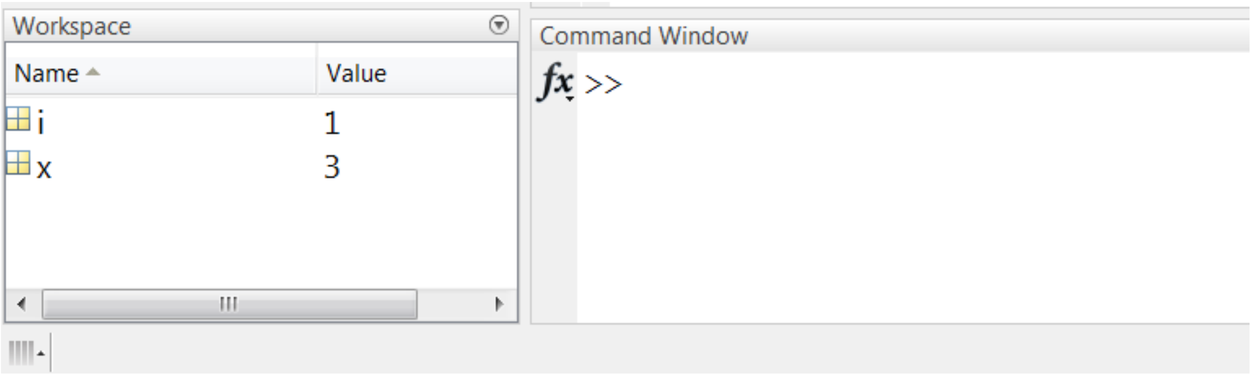
The code is supposed to print this to the Command Window:



Command Window

```
x=    9
x=   81
>>
```

However, when we run the code, we see this:



Workspace

Name	Value
i	1
x	3

Command Window

```
>>
```

Fix the code so that it works properly.

Problem 7 (3 points):

You are given the matrix *A* shown below:

$$A = \begin{bmatrix} 1 & 5 & 2 \\ 3 & 2 & 6 \\ 4 & 3 & 9 \end{bmatrix}$$

What is `B` if `B = A(:,1)'.*A(2,:)`?

a) `B = [3 6 24]`

b) `B = [1 15 8]`

c) `B = [5 10 6]`

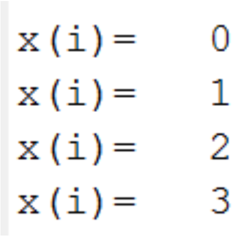
d) `B = [15 4 18]`

e) `B = [1 3]`

Problem 8 (3 points): Consider the following script:

```
clc
i=1;
x=[0:1:5];
while x < 4
    fprintf('x(i)=%4.0f \n',x(i))
    i=i+1;
end
```

We were expecting it to print



```
x(i)=    0
x(i)=    1
x(i)=    2
x(i)=    3
```

But nothing prints at all. Fix the code so that it works properly.

Problem 9 (3 points): Below is a main code followed by a simple function:

```
% Main Code
a = 2;
b = 4;
c = 6;
[d] = simplefunction(a,b,c)

% Function Code
function [d] = simplefunction(a,b,c)
outVar = a + 2*b + 3*c;
```

After we run the main code, what is `d` in the main workspace?

a) `d = 28`

b) `d = 24`

c) `d = 12`

d) `d = 6`

e) An error occurs; explain what caused the error:

Problem 10 (3 points):

The following snippet of code produces the result `a = 1.7143` when you were expecting a vector with three elements for `a`. This equation for `a` is supposed to perform the calculation element by element.

```
x = [4 0 2]

y = [3 2 0]

z = [2 3 1]

a = x.*y/z
```

Fix the code such that `a` is a vector with three elements.

Problem 11 (3 points): What is `x` after running the code snippet below?

```
x = [2:4:6]
```

Problem 12 (3 points): Below is a main code followed by a simple function:

```
% Main Code
i = 2;
j = 4;
k = 6;
[z] = simplefunction(i,j,k)

% Function Code
function [u] = simplefunction(r,s,t)
u = i +k/j;
```

After we run the main code, what is `z` in the main workspace?

a) `z = 2`

b) `z = 2.33333`

c) `z = 3.5`

d) `z = 5`

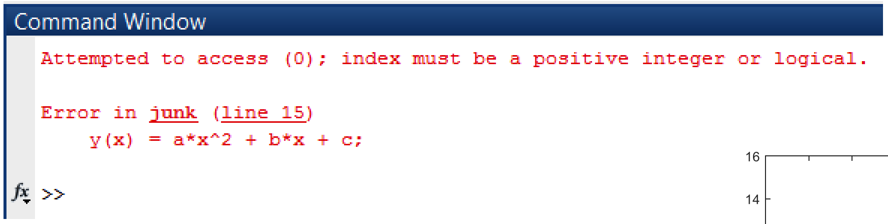
e) An error occurs; explain what caused the error:

Problem 13 (6 points):

The following code should produce a graph with the vector x on the horizontal axis and the vector y on the vertical axis.

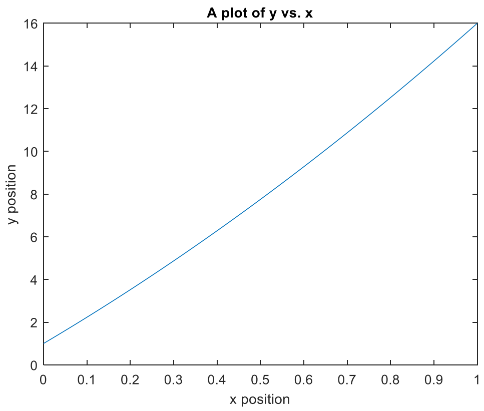
```
clear variables
clc

% Define some parameters:

a = 3;
b = 12;
c = 1;

% Create two vectors to be used in a graph:

for x = 0:0.01:1

    y(x) = a*x^2 + b*x + c;

end

% Graph the two vectors x and y:

plot(x,y)
xlabel('x position')
ylabel('y position')
title('A plot of y vs. x')
```

When you run the code, you get the following error message:



```
Attempted to access (0); index must be a positive integer or logical.

Error in junk (line 15)
    y(x) = a*x^2 + b*x + c;

>>
```

Fix the code such that it produces the following figure:



Problem 14 (3 points): Below is a main code followed by a simple function:

```
% Main Code
I = 2;
J = 4;
K = 6;
[X] = simplefunction(I,J,K)

% Function Code
function [x] = simplefunction(i,j,k)
x = 3*i + j - k;
```

After we run the main code, what is `X` in the main workspace?

a) `X = 2`

b) `X = 4`

c) `X = 8`

d) `X = 16`

e) An error occurs; explain what caused the error:

EXAM 2 – COMPUTER PORTION

For this exam, you will create **TWO** m-files: a main program called `lastname_firstname_exam_2.m` (all lower case) and a function called `lastname_function.m` (all lower case).

The header section of your code should include your name, section number, and CM number; you do not need to do any other commenting. **There should be no output other than what is requested.**

Problem 1 (20 pts)

a) (10 points) Write a function with 3 inputs and 2 outputs. The 3 inputs include 2 radial parameters, R and r, and an angle θ (in radians, rad), while the 2 outputs are the x-y values of a curve. The first line of the function must have the form

```
function [x, y] = lastname_function(R, r, theta)
```

where `x`, `y`, `R`, `r`, and `theta` are x, y, R, r, and θ, respectively. The curve's x-y values are calculated according to the following equations:

$$x = (R - r)\cos\theta + r\cos\left(\left(\frac{R}{r} - 1\right)\theta\right)$$

$$y = (R - r)\sin\theta - r\sin\left(\left(\frac{R}{r} - 1\right)\theta\right)$$

The function input θ and the outputs x and y may be scalars or vectors, whichever you prefer.

b) (10 points) Using your function created in a), generate vectors of the curve's x-y values for $R = 2.5$, $r = 1$, and θ values ranging from 0 rad to 20 rad in steps of 0.01 rad. Plot the curve as a **solid black line**. Label the horizontal axis "x value" and the vertical axis "y value". Give your figure the title "A star is born". Also include the `axis equal` command.

Complete the next problem in your main program file, `lastname_firstname_exam_2.m`, *started for Problem 1.* ***Do not create a new file.***

Problem 2 (30 pts)

Displacement data for a tracked particle are provided in an Excel file named `displacement.xls`. Time (measured in milliseconds, ms) is stored in the first column, and the displacement x (in centimeters, cm) is in the second column.

a) (5 points) Download the Excel file from the course website. Load the contents of the file into MATLAB. **Do not** hard-code the dimensions of the loaded array. Create vectors of the time and displacement data.

(over)

b) (10 points) Download the function file `exam_2_function.m` from the course website. This function computes the particle's displacement based on a model of its behavior. The first line of the function is as follows:

```
function [xmodel] = exam_2_function(time)
```

where `xmodel` is the particle's model displacement(s) x_{model} at the time(s) specified by `time`, which may either be a scalar or a vector. You are welcome to inspect the function file, but **do not modify the function in any way.**

Using this function, generate a vector of the particle's model displacement values at the measured times. Create a **new** figure (i.e., **do not** overwrite your graph from Problem 1). In this figure, plot the model displacement of the particle over time as a **solid black line** and the displacement data over time as a **solid red line** on the same axes. Set the axes so that the plot displays time ranging from 0 ms to 10 ms and displacement ranging from 0 cm to 50 cm. Make sure you include good axis labels, a title, and a legend.

c) (15 points) Unfortunately, the accuracy of the particle model deteriorates as time progresses; the model begins to consistently underestimate the particle's actual displacement. Suppose the model is considered valid up until the model displacement differs from the measured displacement by 1 cm. Have your program create **new** vectors of the model displacement and time so long as the error, $x_{\mathrm{data}} - x_{\mathrm{model}}$, is below 1 cm. **Do not generate any further values.** In a **new** figure, plot **only** the valid model displacement over time as a **solid black line**. Use the same axes scaling as your plot in b). Remember to include axis labels and a title.

When you are finished, put your main program (`lastname_firstname_exam_2.m`) and your function (`lastname_function.m`) in the Moodle assignment dropbox.

NOTE: All programming must stop 5 minutes before the end of the period. You will have 5 minutes after that to upload your files to Moodle if you need that time.