

EXAM 2 – WRITTEN PORTION

NAME _____

SECTION NUMBER _____

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Written Portion	/ 44
Computer Portion	/ 56
Total	/ 100

USE MATLAB SYNTAX FOR ALL PROGRAMS AND COMMANDS YOU WRITE

Problem 1: (4 points) The code below is supposed to print the current value of `number` until it is greater than 20, so that the output looks like the “correct” version of the output shown below. It should not print any values of `number` greater than 20, but it does (see “incorrect” output below). Fix the code so that it does not print numbers greater than 20. Do **not** change the condition in the while loop; it must check for the condition `number <= 20`.

```
i = 1;
number = 3;

while number <= 20

    number = number + number*i;

    i = i+1;

    fprintf('The number is %2.0f \n', number);

end
```

Here is the current, **incorrect** output:

```
The number is 6
The number is 18
The number is 72
```

Here is the **correct** output:

```
The number is 3
The number is 6
The number is 18
```

Problem 2: (8 points) The code below is supposed to print the squares of integers 1, 2, 3, etc., until the square of the integer exceeds 100. When you run it, it runs without errors, but it seems to be taking a long time and it never prints “It is finished!” to the command window as it should. Fix the code so that it works correctly. You may **only** change the code **inside** the while loop (in other words, do *not* change the while loop condition, and do *not* change the code outside the loop).

```
clc
clear variables

x = 1;
square = x^2;
file = fopen('squares.txt','wt');

while square <= 100

    square = x^2;

    fprintf(file, 'The square of %2.0f is %3.0f \n', x, square);

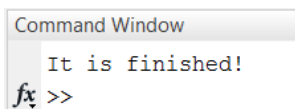
end

fprintf('It is finished! \n');
fclose(file);
```

The text file should look like this after the code is fixed:

```
The square of 1 is 1
The square of 2 is 4
The square of 3 is 9
The square of 4 is 16
The square of 5 is 25
The square of 6 is 36
The square of 7 is 49
The square of 8 is 64
The square of 9 is 81
The square of 10 is 100
```

And the command window should look like this after the code is fixed:



```
Command Window
It is finished!
fx >>
```

Problem 3: (4 points) What is the value of N after the following code is executed?

```
M = [1 2 3 4; 5 6 7 8];
```

```
N = M(1,2:3);
```

Problem 4: (4 points) The vectors height and width contain the height and width of 5 different rectangles. The code below is supposed to create a vector that contains the areas of these 5 rectangles, but it doesn't run correctly; it gives the error shown below instead. Fix to the code so that it runs correctly.

```
height = [1 6 4 5 2];  
width = [2 8 5 6 3];  
area = height*width;
```

Command Window

```
Error using *  
Inner matrix dimensions must agree.
```

Problem 5: (4 points) Consider the main routine and function shown below. What is the value of `d` after the main routine runs?

```
a = 2;  
b = 4;  
c = 8;
```

```
d = new_function(a,b,c);
```

```
function [answer] = new_function(c,b,a)
```

```
answer = b*c + a;
```

Problem 6: (4 points) Complete the single line of code below so that it creates a vector named `neat_vector`, whose components start at 100 and decrease by -2 until reaching -100:

```
neat_vector = _____
```

Problem 7: (4 points) You have loaded a matrix called `elec_use` and wish to copy the 19th and 20th rows of the matrix from the 1st to the 48th column into a new matrix called `use_day_10`. You want to be clever and not use a loop. Complete the single line of code below to accomplish this task.

```
use_day_10 = elec_use ( _____ );
```

Problem 8: (4 points) What is the value of R upon executing the following code?

```
clear variables
R(2:3,3) = 1;
```

Problem 9: (4 points) You have a vector, t , that is one column by 3285 rows. You want to cleverly create a vector z according to $z = 5 * (t^2) * \exp(-t/0.2) * \cos(12*t+0.5)$. Select the best option (that is, the one with the fewest required dot-operators) from the list below.

- A) $z = 5.*(t.^2).*\exp(-t./0.2).*\cos(12.*t+0.5)$
- B) $z = 5*(t.^2).*\exp(-t/0.2).*\cos(12*t+0.5)$
- C) $z = 5.*(t^2)*\exp(-t./0.2)*\cos(12.*t+0.5)$
- D) $z = 5.*(t.^2).*\exp(-t./0.2).*\cos(12.*t.+0.5)$
- E) $z = 5*(t^2).*\exp(-t/0.2).*\cos(12*t+0.5)$
- F) $z = 5*(t.^2).*\exp(-t/0.2)*\cos(12*t+0.5)$

Problem 10: (4 points) Suppose you have written this scrap of code:

```
1 -   clc
2 -   clear variables
3 -   close all
4 -   a = 5;
5 -   while( a <= 20 )
6 -       if ( a < 10 )
7 -           a = a + 10;
8 -       elseif ( a < 15 )
9 -           a = a + 5;
10 -      else
11 -          a = a * 1;
12 -      end
13 -   end
14 -   fprintf('The result is %3.0f.\n',a)
```

The intended output is:

The result is 20.

But instead you get nothing. In fact, you have to go to the command window and press Ctrl+C to stop the program. Select the single answer from the options below that corrects the problem(s).

- A) Line 5: while (a < 20) and Line 7: a = a * 10;
- B) Line 6: if (a <= 10)
- C) Line 6: if (a <= 10) and Line 8: elseif (a <= 15)
- D) Line 7: a = a * 10; and Line 9: a = a * 5;
- E) Line 5: while (a < 20) and Line 11: a = a + 1;
- F) Line 10: elseif (a < 20)
- G) Line 9: a = a*5; and Line 11: a = a + 1;

EXAM 2 – COMPUTER PORTION

For this exam, you will create **THREE** m-files: a main script called `lastname_firstname_exam_2.m` (all lower case), a function called `lastname_find_I.m`, and a function called `lastname_find_volume.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 (10 pts)

In your main script, add code to plot an exponential curve

$$y = e^x$$

for x values starting at zero and going until y just exceeds 100. Use increments of 0.001 for the x values. You must use a while loop to accomplish this task and x and y must be stored as vectors in your code. Do not worry if the last value of y is a little bit bigger than 100. Give your plot good axis labels and a good title (there are no units to worry about here). (Hint: recall that e^x is `exp(x)` in Matlab.)

Problem 2 (10 pts)

(a) Create a function named `lastname_find_I.m` that finds the second moment of area of a rectangle (I). Recall that

$$I = \frac{bh^3}{12}$$

The inputs to your function should be b and h, and the output should be I.

(b) Add code to your main script that calls the function with b=1.5 and h=3.5, and prints the answer to the *command window* in this format:

```
I for a 2x4 oriented vertically is 5.36 in^4
```

(Note: This is the correct answer. A 2x4 stud is actually 1.5" by 3.5".)

Problem 3 (36 pts)

In Dr. Olson's breast cancer research, she needs to create a 3D finite element model of a breast tissue replica. The model is made of a large number of tetrahedrons, as shown in Figure 1. Recall that a tetrahedron is a 3D geometrical shape somewhat like a pyramid, but it has triangles for every face (see Figure 2). As part of the research we need to check that the model was created correctly by checking the total volume against the volume of the physical tissue replica.

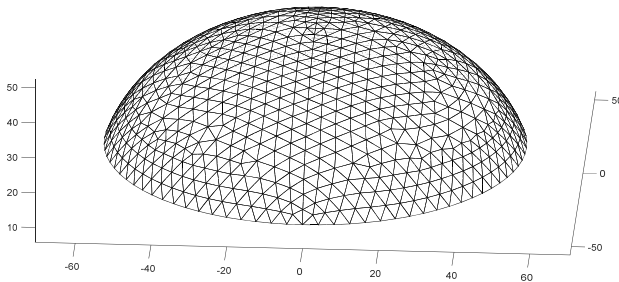


Figure 1. Finite element model of a breast tissue replica
(all dimensions in mm)

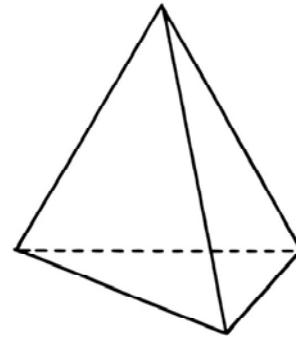


Figure 2. A tetrahedron
(www.kidsmathgamesonline.com)

a) (10 pts) Write a function to compute the volume of a single tetrahedron from vectors of the x , y , and z coordinates of the corners (vertices). Each tetrahedron in the model has four corners. Your function header should look like this:

```
function this_volume=lastname_find_volume(x,y,z)
```

Here x , y , and z are vectors containing the coordinates of the corners for this tetrahedron, for example,

$$x = [x_1 \ x_2 \ x_3 \ x_4]$$

and $this_volume$ is the volume of this tetrahedron. The volume of a tetrahedron based on its corners is calculated by first creating the matrix

$$A = \begin{bmatrix} x_1 & y_1 & z_1 & 1 \\ x_2 & y_2 & z_2 & 1 \\ x_3 & y_3 & z_3 & 1 \\ x_4 & y_4 & z_4 & 1 \end{bmatrix}$$

Then, you find the volume by issuing the Matlab command

```
this_volume=abs(det(A)/6);
```

which takes the determinant of A , divides it by 6, and takes the absolute value.

b) (12 pts) Now, in your main script, you will add code to find the volume of the first tetrahedron in the model. Read in the spreadsheets

x_coords.xlsx
y_coords.xlsx
z_coords.xlsx

which contain the coordinates for all of the tetrahedrons in the model. Each spreadsheet has 4 columns (one for each corner) and N rows, where N is the total number of tetrahedrons. Extract the first row of each spreadsheet and call your function. Print the volume to the *command window* using the following format:

The volume of the first tetrahedron is 43 mm³.

(Note that this is the correct answer.)

c) (14 pts) Finally, add code to your main script to find the volume of each tetrahedron in the model and sum it up to find the total volume. DO NOT HARD CODE THE TOTAL NUMBER OF TETRAHEDRONS. Divide your total volume by 1000 to get the answer in cubic centimeters. Print the total volume to the command window with an appropriate message. (The total volume of material used to create the physical breast tissue replica that we are modeling is 180 cm³ and your answer for the model should be within 10% of that.)

When you are finished, put your main program (lastname_firstname_exam_2.m) and your two functions (lastname_find_I.m and lastname_find_volume.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.