Engineering Analysis I, Fall 2022

Midterm 1

Name _____

Section number _____

Section number	Discussion time	Instructor
23	9:00 a.m.	Prem Kumar
24	10:00 a.m.	Michael Honig
25	11:00 a.m.	Prem Kumar
26	8:00 a.m.	Randy Freeman
27	12:00 p.m.	Michael Honig

This exam is closed-book and closed-notes. Calculators, computers, phones, or other computing/communication devices are not allowed.

Students should skip this page—it is only for graders.

Question	Points	Score
1	30	
2	25	
3	25	
4	20	
Total:	100	

Answer each question in the space provided. There are 4 questions for a total of 100 points.

1. Put a check mark ✓ in the box next to **EACH** correct answer. Note that there may be more than one correct answer for each question!

   (a) [6 points] Which of the following six MATLAB statements will create (or overwrite) a variable `A` and assign it the matrix $\begin{bmatrix} 2 & 5 & 8 \\ 9 & 5 & 1 \end{bmatrix}$?

   ☐ `A = [2 5 8];[9 5 1]`   ☐ `A = [2 5 8; 9 5 1]`

   ☐ `A = [2 9; 5 5; 8 1]'`   ☐ `[[2;9] [5;5] [8;1]]`

   ☐ `A = [2 5 8; 9 5 1] = A`   ☐ `A = [2:3:8; 9:-4:1]`

   (b) [4 points] Which of the following four MATLAB statements will replace the second column of an existing matrix variable `A` with the sum of its first and fourth rows? Assume that `A` is a 4 by 4 square matrix.

   ☐ `A(2) = A(1)+A(4)`   ☐ `A(2,:) = A(:,1) + A(:,4)`

   ☐ `A(:,2) = A(1,:) + A(4,:)`   ☐ `A(1:size(A,2),2) = ...`
                                                  `A(1,1:end) + A(4,1:end)`

   (c) [4 points] Which of the following four MATLAB statements will *not* generate an error message?

   ☐ `x = 2 == [2 3]`   ☐ `y = rand(5,1);`
                                          `x = y(y<.1 & y>.9)`

   ☐ `x = [2 3].*[3 1]`   ☐ `x = sqrt(10:1)`

(d) [4 points] Which of the following four MATLAB logical expressions will return a value of logical 1 (meaning "true")?

☐ `(1>=1) || (x==4)`   ☐ `~(5~=5) & ~(3<=2)`

☐ `(1>2) & (3>2)`   ☐ `(3>1) && (3=3)`

(e) [6 points] Which of the following six MATLAB statements is a valid first line of a loop? Assume that the variable `k` already exists in the workspace and contains the row vector `[3 2 1]`.

☐ `while k = 1:3`   ☐ `for k = 2:6`

☐ `for jj = k+2`   ☐ `while 0 < k < 4`

☐ `while k < 5`   ☐ `for ii = k`

(f) [6 points] Which of the following six blocks of code will square each element of an existing (and possibly non-square) matrix `A`? Note that the squared values should be accessible after the calculations are performed.

☐
```
for ii=1:size(A,1)*size(A,2)
    A(ii) = A(ii)*A(ii);
end
```

☐ `A = (zeros(size(A))+A).*A`

☐ `A = A*A;`

☐
```
for ii = 1:size(A,1)
    jj = 1;
    while jj <= size(A,2)
        A(ii,jj) = A(ii,jj)^2;
        jj = jj + 1;
    end
end
```

☐ `A = A^2;`

☐ `A = A.*ones(size(A)).*A;`

2. Suppose each section of code below is run in MATLAB. If MATLAB generates an error message for the given code section, write "error" on the associated line, and otherwise write the value the variable x will have after the code section is run.

(a) [5 points]
```
clear;
x = 0;
for k = 100:-10:1
    if (k <= 20)
    x = x + k;
    end
end
```
(a) ―――――――

(b) [5 points]
```
clear; x = 3;
if ((x>1) || (x>6)) && x < 5
    x = 17;
end
```
(b) ―――――――

(c) [5 points]
```
clear; x = 0;
while y <= 20
    x = x + 4;
    y = y + 5;
end
```
(c) ―――――――

(d) [5 points]
```
clear; x = 0;
for k = 1:3:14
    if k == 10
        x = 4;
    else
        x = x + 1;
    end
end
```
(d) ―――――――

(e) [5 points]
```
clear; x = 0;
for x <= 6
    while k = 5:-1:1
        x = x + 1;
    end
end
```
(e) ―――――――

3. [25 points] The following code simulates a series of random walks (trials), each starting at position 0. Each step is randomly chosen from the set $\{-1, 0, 1\}$. For each random walk it counts the number of steps it takes to reach a particular location L, which can be any integer value. Each random walk terminates when either the location reaches L or the number of steps reaches a maximum number, specified by the user. The program then computes the average of the number of steps taken over the trials and the fraction of trials for which the number of steps reaches the maximum number.

Fill in the blanks in the code to complete the program. Each answer should complete a single statement (one line of code).

```
1    % set the number of random walks, or trials
2    trials = 10000;
3
4    % prompt the user to input the final location L (an integer)
5    % and the maximum number of steps
6    L =    _____
7    max_steps =    _____
8
9    % initialize array containing the number of steps
10   % reached by each trial
11   num_steps = zeros(1,trials);
12
13   % loop over all of the trials
14      _____
15
16   % fill in the missing statement
17      _____
18       % start the loop to update the position variable "pos" until
19       % it reaches L or the number of steps reaches the maximum
20          _____
21
22             % generate a random step, either -1, 0, or 1
23             step =    _____
24             % update the position
25             pos =    _____
26          % update the number of steps
27          _____
28       end
29   end
30
31   % Compute the average of the number of steps taken over all trials.
32   avg_steps =    _____
33
34   % PROGRAM CONTINUES TO NEXT PAGE
35
```

```
36   % Compute the fraction of trials for which the number of steps
37   % reached the maximum number.
38   frac_max =   _____

39

40   % Print the results using two fprintf statements as follows:
41   % Avg steps to reach __ is __.
42   % Fraction of trials where num_steps = max_steps is __.

43

44   % Each statement should fill in the blanks.
45   % Print L as an integer and the other values as real numbers.
46       _____
47       _____
48
```

4. [20 points] For this question, we will first generate a random matrix of integers (between 2 and 20), with random dimensions (between 1 and 20). Our goal is to find, for each element, the highest power it can be raised to that keeps it under 1e6. For example, if an element is 11, the highest power it can be raised to is 5, since $11^5 = 161051$, while $11^6 = 1771561 > 1e6$. The output should be a matrix of the same size as the original, where each element is this highest power. For example, consider the following input matrix A and output B.

$$A = \begin{bmatrix} 11 & 6 \\ 13 & 18 \\ 4 & 3 \end{bmatrix} \qquad\qquad B = \begin{bmatrix} 5 & 7 \\ 5 & 4 \\ 9 & 12 \end{bmatrix}$$

Fill in the blanks below to complete this task.

In this problem, you may use any of the following MATLAB functions:
`abs, factorial, min, max, mean, rand, randi, sqrt, sum, zeros.`

```
% Create the input random matrix.
A = randi([2 20],randi(20),randi(20));

% Find dimensions of A
m =    _____

n =    _____

% Create an output matrix B filled with zeros
B =    _____

for ii = 1:m
    for jj =   _____
        my_exp =   _____

        % Iterate as stated in the introduction.
        while   _____
            my_exp = my_exp + 1;
        end

        % Fill in the corresponding value in the B matrix.
        B(ii,jj) =   _____
    end
end
```