2025 Spring MATH 9, MIDTERM 1

Sample Midterm

Note: this is neither an official nor a complete version of the Midterm 1.

Name: _____

Student ID: _____

Instructions: This is an in-class, 50-minute, written exam. Notes/computers/mobile phones/communication/etc., are not allowed. Your work will be graded on clarity as well as correctness. Clearly indicate your final answers and cross out incorrect work. Do work in the space provided. Good luck.

1. Answer the following questions (short answers).

(1). Determine the output of the following MATLAB function when $v = [2, 2]$ and $w = [-3, 0]$. Clearly indicate your answer.

```
function [A] = myfn(v,w)
for i = 1:2
   for j = 1:2
      A(i,j) = v(i) + w(j) + i + j;
   end
end
end
```

(2). Write MATLAB code that generates a length 64 vector $[1, -1, 1, -1, ..., 1, -1]$.

(3). What vector v is produced by the following code? Justify your answer.

```
clear;
v = [];
while length(v) < 4
  v = [v, abs(v(end)-3)];
end
```

(4). What vector d is produced by the following code? Justify your answer.

```
clear;
m = linspace(-3,3,7);
d = ones(1, length(m));
for i = 1:length(m)
    d(i) = any(m(1:i)>1);
end
```

2. The function new_function is defined below.

```
function [x] = new_function(v, w)
% You can assume that v and w are sorted vectors
while v(1)~=(w(2)+1)
    if v(1)<(w(2)+1)
        v(1) = [ ];
    elseif v(1)>(w(2)+1)
        w(2) = [ ];
    end
end
x = v(1);
end
```

(1). What is the output if $v = [1, 2, 3, 4]$ and $w = [4, 3, 2, 1]$? Briefly show your work.

(2). Continue to assume $v = [1, 2, 3, 4]$ and $w = [4, 3, 2, 1]$, and each time the line

```
1 while v(1)~=(w(2)+1)
```

is executed, list the values of v and w. List them in the same order they are executed (no justification is needed). The values at the first time have been given:
First time: $v = [1, 2, 3, 4]$ and $w = [4, 3, 2, 1]$

3. Consider the following function, which should remind you in some ways of our code for the bisection method.

```
function [xb] = fn1(y, err)
% y and err should be positive real numbers.
x0 = 1;
x1 = 2*y;
xb = (x0+x1)/2;
while abs(xb-y)>err
    if xb<y
        x0 = xb;
    elseif xb>y
        x1 = xb;
    end
    xb = (x0+x1)/2;
end
end
```

(1). What are the first three values that xb takes when we input $y = 3$ and $err = 0.01$? Show your work.

4. (1). Write a MATLAB function rw_test which takes as input a positive integer n and as output returns a random walk that starts at 0 and continues for n total steps. For example, if you evaluate rw_test(3), you might get the output $[0, 1, 0, -1]$ or $[0, 1, 2, 3]$. (It's fine to use an additional "helper" function if you want. This question is asking for an "unweighted" random walk, where the steps -1 and 1 are both equally likely.)

(2). Suppose v is a 1-by-10 row vector that all the elements are random numbers between 1 and 5.

Write a one-line MATLAB code in each question to:

(i) select the elements of v that are equal to 2, save them as a new vector $v2$, and suppress the output.

(ii) add the first and the last elements of v, suppress the output.

(iii) calculate the mean of all the elements in v, save it as a new variable m, and suppress the output.