

**Reference Section:**

`diag(m)` – returns the diagonal elements of the matrix `m`  
`factorial(n)` – returns `n!`  
`find(m)` – returns the indices of the true elements of `m`  
`image(x)` – display the image from the matrix `x`.  
`imread(filename)` – returns a matrix representation of an image  
`newy = interp1(x,y,newx)` - Interpolates to find `newy`, the values of the underlying function `Y` at the points in `newx`.  
`iscell(a)` – checks if `a` is of class `cell` (a cell array)  
`ischar(a)` – checks if `a` is of class `char` (a string)  
`isempty(here)` – checks if `here` is null (usually represented by `[]`, the empty vector)  
`(x/y/z)label(str)` – labels the plot axes with the given string  
`length(a)` – largest dimension of `a`  
`length(a)` – largest dimension of `a`  
`magic(n)` – builds a `n * n` magic square  
`max(a)` – value and index of the max value in `a`  
`mesh(x, y, z)` – plot the surface defined by the `x`, `y` and `z` arrays with colored lines and white faces  
`[xx, yy] = meshgrid(x, y)` – compute the plaid from the `x` and `y` vectors  
`min(a)` – value and index of the min value in `a`  
`mod(a, b)` – the remainder when `a` is divided by `b`  
`mod(a, b)` – the remainder when `a` is divided by `b`  
`ones(rows, cols)` – generate a matrix filled with 1  
`p = polyfit(x,y,n)` – Finds the coefficients of a polynomial `P(X)` of degree `N` that fits the data  
`y = polyval(p,x)` - Evaluates the polynomial `p`, at all points in `x`  
`prod(v)` – compute the product of all the elements in a vector `v`  
`sin(th)` – sin of the angle in radians  
`size(a)` – all the dimensions of `a`  
`sort(v)` – arranges the vector `v` in ascending numerical order  
`newy = spline(x,y,newx)` - Performs cubic spline interpolation to find `newy`, the values of the underlying function `Y` at the points in `newx`.  
`sum(v)` – total all the elements in the vector `v`  
`surf(x, y, z)` – plot the surface defined by the `x`, `y` and `z` arrays with colored faces and black lines  
`title(str)` – titles the plot with the given string  
`[x, fs] = wavread(file)` – gives the waveform and sampling frequency for a .wav file  
`[x, y, z] = xlsread(filename)` - Returns the numeric, text and raw data respectively from an .xls file  
`xlswrite(filename, array)` - Writes the array to the .xls file  
`zeros(rows, cols)` – generate a matrix filled with 0

**Problem 1 – Sorting [20 Points]**

I. What does the Big-O of any algorithm represent?

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II. Write out the Big-O of the following sorting algorithms:

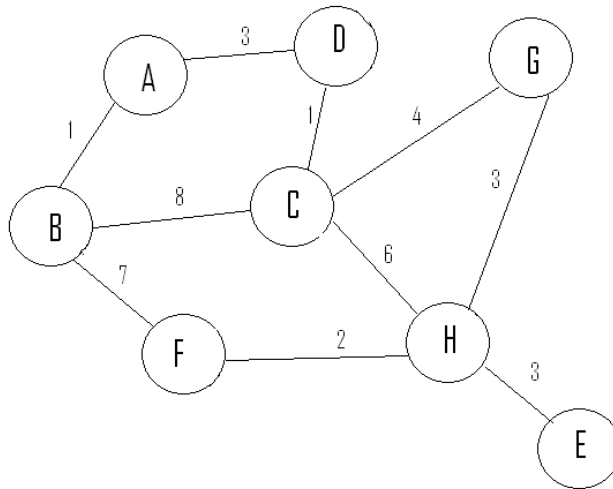
- a. Insertion Sort: \_\_\_\_\_
- b. Merge Sort: \_\_\_\_\_
- c. Quick Sort: \_\_\_\_\_
- d. Bubble Sort: \_\_\_\_\_

III. Sort the following vector using **Insertion Sort**:

[9 1 18 20 5 8 2]

**Problem 2 – Graphs [20 Points]**

I. Point out one node, one edge, and one cycle in the graph below.



II. Use Dijkstra’s algorithm to find the shortest path between **A** and **G** in the tree above. (You must show all your work to receive full credit).

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**Problem 3 – Numerical Methods [20 Points]**

I. Which of the following functions can be used for spline interpolation over a given set of data points? Circle all that apply.

- A. `newY = polyfit(x, y, newX, 'spline')`
- B. `newY = spline(x, y, newX)`
- C. `newY = interp1(x, y, newX, 'spline')`
- D. `newY = splinefit(x, y, newX)`

II. What are the values of `a` and `b` after the following code is run?

```
x = 1:5
```

```
a = diff(x)
```

```
a =
```

---

```
b = cumsum(x)
```

```
b =
```

---

III. You have two vectors, `time` and `distance`, containing X and Y values respectively. Use this data to find the coefficients of a 5<sup>th</sup> order polynomial. Store the coefficients in a variable called `coeffs`. Also, plot the polynomial obtained for X values ranging from 1 to 10 seconds.

IV. When plotting 3-D figures to rotate a curve about an axis, what happens if you use a large increment values in your theta vector?

- A. The built-in plot functions for 3-D figures will produce an error saying there are insufficient points.
- B. MATLAB will automatically add evenly spaced points to your theta vector.
- C. The figure will be angular instead of having a circular shape.
- D. The number of points in the theta vector does not matter, as long as its first and last value are a distance of a multiple of  $2\pi$  apart.

**Problem 4 – Plotting [20 Points]**

I. Circle all of the following functions that can be used to plot a 3-dimensional surface in MATLAB.

- A. `plot3(xx, yy, zz)`
- B. `meshgrid(xx, yy, zz)`
- C. `surf(xx, yy, zz)`
- D. `mesh(xx, yy, zz)`

II. You want to plot a surface of rotation for  $z = f(x)$  around the x and z axes. Given the following commands:

```
v = linspace(1,10,50);
th = linspace(0,2*pi,36);
[vv tth] = meshgrid(v,th);
rr = vv;
xx = rr.*cos(tth);
yy = rr.*sin(tth);
zz = f(x);
surf(xx, yy, zz);
```

III since it does not make sense to rotate it about the y axis, which of the following code blocks rotates  $f(x)$  about the other axis (circle the right answer)?

- |  |  |
|--|--|
| <p>A: <code>xx = vv;</code><br/> <code>rr = f(vv);</code><br/> <code>yy = rr .* cos(tth);</code><br/> <code>zz = rr .* sin(tth);</code><br/> <code>surf(xx, yy, zz)</code></p> | <p>C: <code>xx = vv;</code><br/> <code>rr = f(vv);</code><br/> <code>yy = rr .* cos(tth);</code><br/> <code>zz = rr .* sin(tth);</code><br/> <code>surf(zz, yy, xx)</code></p> |
| <p>B: <code>xx = f(vv);</code><br/> <code>rr = vv;</code><br/> <code>yy = rr .* cos(tth);</code><br/> <code>zz = rr .* sin(tth);</code><br/> <code>surf(zz, yy, xx)</code></p> | <p>D: <code>xx = f(vv);</code><br/> <code>rr = vv;</code><br/> <code>yy = rr .* cos(tth);</code><br/> <code>zz = rr .* sin(tth);</code><br/> <code>surf(xx, yy, zz)</code></p> |

IV. Write the proper commands to make the plot above *smooth* and add appropriate titles and labels.

**Problem 5 – Images/Sounds [20 Points]**

I. Consider the following "image" (assume it is a perfect square), saved under the file 'mysquare.jpg':

1	2
3	4

And the following code:

```
b = imread('mysquare.jpg');
[n,m,l] = size(b);
a = b(1:end, 1:n/2, :);
c = b(1:end, (n/2 + 1):end, :);
b = [c a];
image(b);
```

Which of these will the picture shown on the last line most resemble?

A.            B.            C.            D.

3	4
1	2

2	1
4	3

1
2
3
4

3
4
1
2

II. You are given the following code:

```
[snd, Fst] = wavread('Sound.wav');
```

Which of the following lines of code will play an amplified version of 'Sound.wav'?

- A. `sound(snd, Fst*3);`
- B. `sound(snd(round(1:half^2:end)), Fst)`
- C. `sound(snd*3, Fst);`
- D. `z= fft(Snd)`  
`z(1:floor(length(z)/2)) = 255;`  
`sound(ifft(z), Fst);`

III. “In order to increase the pitch of a sound by  $n$  half steps, you would stretch/shrink the sound vector to have  $1/(2^{(n/12)})$  times the number of original points.”

True or False? If False, Why?

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IV. Given an image file called ‘american\_flag.jpg’ in which the colors are only **pure red, pure white, and pure blue**:

```
af = imread('american_flag.jpg');
[r1,c1] = find(af(:,:,1) == 255 ...
              && af(:,:,2) == 0 ...
              && af(:,:,3) == 0);
[r2,c2] = find(af(:,:,1) == 0 ...
              && af(:,:,2) == 0 ...
              && af(:,:,3) == 255);
[r3,c3] = find(af(:,:,1) == 255 ...
              && af(:,:,2) == 255 ...
              && af(:,:,3) == 255);
af(r1,c1,:) = 255;
af(r2,c2,1) = 255;
af(r2,c2,3) = 0;
af(r3,c3,1:2) = 0;
image(af)
```

What happens in the resulting image?

- A. The white sections become red, the red sections become blue, and the blue sections become white.
- B. The blue sections become red, the red sections become blue, and the white sections become black.
- C. The red sections become white, the blue sections become red, and the white sections become blue.
- D. The blue sections become white, the red sections become black, and the white sections become red.

**Problem 6 – Miscellaneous [20 Points]**

I. You are given the following linear equations:

$$\begin{aligned}x - 3y &= 1 \\ 3x - y &= 2\end{aligned}$$

Now let's say you wanted to solve the equations simultaneously using MATLAB and store the solution vector in the variable named `solution` using the following code:

```
solution = unknown1\unknown2;
```

How must the variables `unknown1` and `unknown2` be defined in order to get the correct solution?

- A. `unknown1 = [1 -3; 3 -1]; unknown2 = [2;1];`
- B. `unknown1 = [2;1]; unknown2 = [1 -3; 3 1];`
- C. `unknown1 = [3 -1; 1 -3]; unknown2 = [2 1];`
- D. `unknown1 = [1;2]; unknown2 = [1 -3; 3 -1];`
- E. `unknown1 = [1 -3; 3 -1]; unknown2 = [1; 2];`

II. The following code is executed in MATLAB:

```
ABCD = 0;
testV = [ 3 -5 6 -8 9 11]

for i=1:length(testV)
    if testV(i) > 0
        ABCD = ABCD - mod(testV(i),2);
    else
        ABCD = ABCD - testV(i);
    end
end
```

What is the final value of the variable `ABCD`?

---

III. Given the following MATLAB command:

```
[x y z] = xlsread(excel_file)
```

What are the data types of  $x$ ,  $y$ , and  $z$ ?

- A.  $x = \text{double}$ ,  $y = \text{double}$ ,  $z = \text{cell array}$
- B.  $x = \text{double}$ ,  $y = \text{character}$ ,  $z = \text{cell array}$
- C.  $x = \text{double}$ ,  $y = \text{cell array}$ ,  $z = \text{cell array}$
- D.  $x = \text{cell array}$ ,  $y = \text{cell array}$ ,  $z = \text{cell array}$
- E. None of the above

IV. Given the following piece of code:

```
a.price = 10;  
b = a.price;
```

What is the data type of the variable  $b$ ?

- A. struct
- B. logical
- C. array
- D. char
- E. double

**Problem 7 – Structure Arrays [20 Points]**

I. Which of the following are valid function headers? (Circle all that apply)

- A. `function ret = myFunction(X)`
- B. `function myFunction (234)`
- C. `function myFunction (X)`
- D. `function = myFunction (X)`
- E. `function ret = myFunction()`

II. Read the code below and answer the questions that follow:

```
value = struct('band', 'nickelback', 'album', {'all the  
right reasons', 'curb'}, 'song', {'animals', 'fly'},  
'genre', 'rock');  
value(3).band = 'U2';  
value(3) = setfield(value(3), 'song', 'sweetest thing');  
value(5) = value(1);  
value = rmfield(value, 'genre');
```

A = `isstruct(value)`

B = `isfield(value(1), 'genre')`

C = `getfield(value(2), 'album')`

D = `value(4).band`

E = `fieldnames(value(5))`

What are the values of the following variables?

A:

---

B:

---

C:

---

D:

---

E:

---

**Problem 8 – Sorting [20 Points]**

III. What does the Big-O of any algorithm represent?

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IV. Write out the Big-O of the following sorting algorithms:

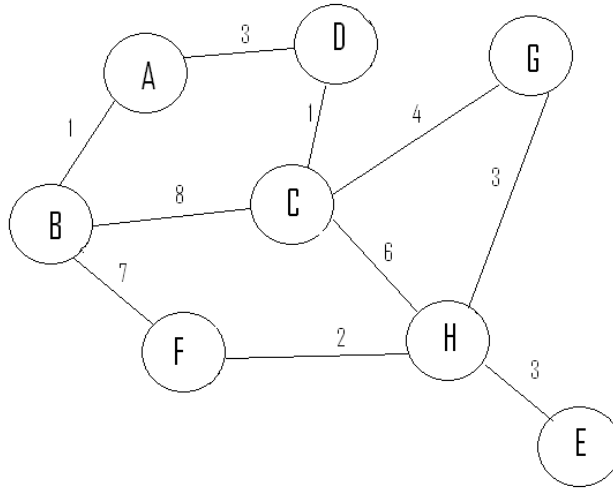
- a. Insertion Sort: \_\_\_\_\_
- b. Merge Sort: \_\_\_\_\_
- c. Quick Sort: \_\_\_\_\_
- d. Bubble Sort: \_\_\_\_\_

III. Sort the following vector using **Merge Sort**:

[9 1 18 20 5 8 2]

**Problem 9 – Graphs [20 Points]**

III. Point out one node, one edge, and one cycle in the graph below.



IV. Use Dijkstra’s algorithm to find the shortest path between **A** and **G** in the tree above. (You must show all your work to receive full credit).

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**Problem 10 – Plotting [20 Points]**

I. Circle all of the following functions that can be used to plot a 3-dimensional surface in MATLAB.

- E. `plot3(xx, yy, zz)`
- F. `meshgrid(xx, yy, zz)`
- G. `surf(xx, yy, zz)`
- H. `mesh(xx, yy, zz)`

II. You want to plot a surface of rotation for  $z = f(x)$  around the x and z axes. Given the following commands:

```
v = linspace(1,10,50);
th = linspace(0,2*pi,36);
[vv tth] = meshgrid(v,th);
xx = vv;
rr = f(x);
yy = rr.*cos(tth);
zz = rr.*sin(tth);
surf(xx,yy,zz);
```

About which axis does this code make a surface of rotation? \_\_\_\_\_

III since it does not make sense to rotate it about the y axis, which of the following code blocks rotates  $f(x)$  about the other axis (circle the right answer)?

- |  |  |
|--|--|
| <p>A: <code>xx = f(vv);</code><br/> <code>rr = vv;</code><br/> <code>yy = rr .* cos(tth);</code><br/> <code>zz = rr .* sin(tth);</code><br/> <code>surf(zz, yy, xx)</code></p> | <p>C: <code>xx = f(vv);</code><br/> <code>rr = vv;</code><br/> <code>yy = rr .* cos(tth);</code><br/> <code>zz = rr .* sin(tth);</code><br/> <code>surf(xx, yy, zz)</code></p> |
| <p>B: <code>xx = vv;</code><br/> <code>rr = f(vv);</code><br/> <code>yy = rr .* cos(tth);</code><br/> <code>zz = rr .* sin(tth);</code><br/> <code>surf(zz, yy, xx)</code></p> | <p>D: <code>xx = vv;</code><br/> <code>rr = f(vv);</code><br/> <code>yy = rr .* cos(tth);</code><br/> <code>zz = rr .* sin(tth);</code><br/> <code>surf(xx, yy, zz)</code></p> |

IV. Write the proper commands to make the plot above *smooth* and add appropriate titles and labels.

**Problem 11 – Images/Sounds[20 Points]**

I. Consider the following "image" (assume it is a perfect square), saved under the file 'mysquare.jpg':

1	2
3	4

And the following code:

```
b = imread('mysquare.jpg');
[n,m,l] = size(b);
a = b(1:end, 1:n/2, :);
c = b(1:end, (n/2 + 1):end, :);
b = [c; a];
image(b);
```

Which of these will the picture shown on the last line most resemble?

A.            B.            C.            D.

3	4
1	2

2	1
4	3

1
2
3
4

2
4
1
3

II. Given the file 'soundtest.wav', the following commands are executed in MATLAB:

```
[x fs] = wavread('soundtest.wav');
L = length(x);
```

The time duration in seconds of 'soundtest.wav' is:

- A.  $fs * L / (L + 1)$
- B.  $fs / L$
- C.  $L / fs$
- D.  $L * fs$
- E.  $fs * L / (fs + 1)$

- V. Given an image file called 'american\_flag.jpg' in which the colors are only red, white, and blue:

```
af = imread('american_flag.jpg');
[r1,c1] = find(af(:,:,1) == 255 ...
              && af(:,:,2) == 0 ...
              && af(:,:,3) == 0);
[r2,c2] = find(af(:,:,1) == 0 ...
              && af(:,:,2) == 0 ...
              && af(:,:,3) == 255);
[r3,c3] = find(af(:,:,1) == 255 ...
              && af(:,:,2) == 255 ...
              && af(:,:,3) == 255);
af(r1,c1,:) = 0;
af(r2,c2,:) = 255;
af(r3,c3,2:3) = 0;
image(af)
```

What happens in the resulting image?

- A. The red sections become white, the blue sections become red, and the white sections become blue.
- B. The white sections become red, the red sections become blue, and the blue sections become white.
- C. The blue sections become red, the red sections become blue, and the white sections become black.
- D. The blue sections become white, the red sections become black, and the white sections become red.

IV. The `fft()` function is used to analyze and convert the signal from:

- A. Frequency domain to time domain
- B. Time domain to frequency domain
- C. Amplitude domain to power domain
- D. Power domain to amplitude domain

**Problem 12 – Vector Manipulations/Functions [20 Points]**

Given the following function:

```
1 function [A B] = blackbox(input)
2 L = length(input)
3 A = []
4 B = 0
5 for ind = 1:L
6     if ischar(input{ind})
7         A = [A input(ind)]
8     elseif isnumeric(input{ind})
9         B = 0 + input{ind}
10    end
11 end
```

The following code is executed in MATLAB:

```
TEST1 = {'ES&T', [98 1 27], 'Woodruff', 'Smith', 1000, [-2]}
[A B] = blackbox(TEST1)
```

I. What is stored in the variable A after the code has been run?

---

II. What data type is A?

---

III. What is stored in B after the code has been run?

---

IV. If line 7 were changed to the following, what now would be stored in A?

```
A = [A input{ind}];
```

---

V. What is the data type of A now (after the change in line 7)?

---

**Problem 13 – Structure Arrays [20 Points]**

I. Which of the following are valid function headers? (Circle all that apply)

- A. `function ret = myFunction(X)`
- B. `function myFunction (X)`
- C. `function = myFunction (X)`
- D. `function myFunction (234)`
- E. `function ret = myFunction()`

III. Read the code below and answer the questions that follow:

```
TA_List(1) = struct( 'Name', 'Shardul', 'Major', 'EcE', ...  
    'Experience', 6)  
TA_List(2) = setfield( TA_List(1), 'Experience', 4)  
TA_List(2).Name = 'Ankit'  
TA_List(3) = TA_List(1)  
setfield( TA_List(3), 'Major', 'ME')  
setfield( TA_List(3), 'Name', 'Tauhira')  
rmfield( TA_List, 'Major')  
TA_List(3).Age = 20  
A = isfield( TA_List(1), 'Age')  
[B, C] = size (getfield (TA_List(2), 'Name'))  
D = TA_List(3).Name  
E = fieldnames(TA_List(1))
```

What are the values of the following variables?

A:

---

B:

---

C:

---

D:

---

E:

---

**Problem 14 – Miscellaneous [20 Points]**

I. You are given the following linear equations:

$$\begin{aligned}x - 3y &= 1 \\ 3x - y &= 2\end{aligned}$$

Now let's say you wanted to solve the equations simultaneously using MATLAB and store the solution vector in the variable named `solution` using the following code:

```
solution = unknown1\unknown2;
```

How must the variables `unknown1` and `unknown2` be defined in order to get the correct solution?

- F. `unknown1 = [1 -3; 3 -1]; unknown2 = [2;1];`
- G. `unknown1 = [2;1]; unknown2 = [1 -3; 3 1];`
- H. `unknown1 = [3 -1; 1 -3]; unknown2 = [2;1];`
- I. `unknown1 = [1;2]; unknown2 = [1 -3; 3 -1];`
- J. `unknown1 = [1 -3; 3 -1]; unknown2 = [1 2];`

II. The following code is executed in MATLAB:

```
ca = {'abcd', 12, true, 37, pi}
x = ca(2)
```

What is the final value of the variable `x`?

- A. `<1x1 struct>`
- B. `12`
- C. `[<1x1 struct>]`
- D. `[12]`
- E. None of the above

III. Given:

```
x = {2, 4, 6, 8, 10};
final = 0
for index = 1:length(x)-1
    <line of code goes here>
end
```

Which of the following lines of code will have final equal to 80 after the code above is executed in MATLAB?

- A. `final = final + (x(index) * x(index+1))`
- B. `final = final + (x{index} * x{index+1})`
- C. `final = x(index) * x(index+1)`
- D. `final = x{index} * x{index+1}`
- E. None of the above

IV. Which of the following correctly define(s) the time domain axis for the following imported sound file?

```
[data fs] = wavread('foo.wav');
n = length(data);
```

- A. `timedomain = 0:1/n:n/fs;`
- B. `timedomain = 0:1/fs:n;`
- C. `timedomain = 1/fs:1/fs:n/fs;`
- D. `timedomain = 0:n*fs;`
- E. `timedomain = 0:n/fs:n;`

**Problem 15 – Sorting [20 Points]**

V. What does the Big-O of any algorithm represent?

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VI. Write out the Big-O of the following sorting algorithms:

- a. Insertion Sort: \_\_\_\_\_
- b. Merge Sort: \_\_\_\_\_
- c. Quick Sort: \_\_\_\_\_
- d. Bubble Sort: \_\_\_\_\_

III. Sort the following vector using **Quick Sort**:

[9 1 18 20 5 8 2]

**Problem 16 – Images/Sounds [20 Points]**

- I. Given an image file called ‘american\_flag.jpg’ in which the colors are only red, white, and blue:

```
af = imread('american_flag.jpg');
[r1,c1] = find(af(:,:,1) == 255 ...
              && af(:,:,2) == 0 ...
              && af(:,:,3) == 0);
[r2,c2] = find(af(:,:,1) == 0 ...
              && af(:,:,2) == 0 ...
              && af(:,:,3) == 255);
[r3,c3] = find(af(:,:,1) == 255 ...
              && af(:,:,2) == 255 ...
              && af(:,:,3) == 255);
af(r1,c1,1) = 0;
af(r2,c2,1) = 255;
af(r1,c1,3) = 255;
af(r2,c2,3) = 0;
af(r3,c3,:) = 0;
image(af)
```

What happens in the resulting image?

- The red sections become white, the blue sections become red, and the white sections become blue.
- The white sections become red, the red sections become blue, and the blue sections become white.
- The blue sections become red, the red sections become blue, and the white sections become black.
- The blue sections become white, the red sections become black, and the white sections become red.

II. You are given the following code:

```
[snd, Fst] = wavread('Sound.wav');
```

Which of the following lines of code will play an amplified version of Sound.wav

- sound(snd, Fst\*3);
- sound(snd(round(1:half^2:end)), Fst)
- sound(snd\*3, Fst);
- z= fft(Snd)
 z(1:floor(length(z)/2)) = 255;
 sound(ifft(z), Fst);

III. Consider the following "image" (assume it is a perfect square), saved under the file 'mysquare.jpg':

1	2
3	4

And the following code:

```
b = imread('mysquare.jpg');
[n,m,l] = size(b);
a = b(1:end, 1:n/2, :);
c = b(1:end, (n/2 + 1):end, :);
b = [c a];
image(b);
```

Which of these will the picture shown on the last line most resemble?

- A.            B.            C.            D.

3	4
1	2

2	1
4	3

1
2
3
4

3
4
1
2

IV. Consider this code that reads in an image saved as 'myimage.jpg':

```
b = imread('myimage.jpg');
[m,n,l] = size(b);
count = 0;
for i = 1:m
    for j = 1:n
        if ( <A> (double(b(i, j, <B>)))) == <C>
            count = count + 1;
        end
    end
end
end
```

Which of the following could you put in the places of <A>, <B> and <C> to give you the number of completely white pixels in the image?

- A.    <A>: any            <B>: j            <C>: 255  
 B.    <A>: all            <B>: :            <C>: 255  
 C.    <A>: sum            <B>: :            <C>: 255  
 D.    <A>: sum            <B>: j            <C>: 765  
 E.    <A>: sum            <B>: :            <C>: 765

**Problem 17 – Plotting [20 Points]**

I. Circle all of the following functions that can be used to plot a 3-dimensional surface in MATLAB.

- I. `plot3(xx, yy, zz)`
- J. `meshgrid(xx, yy, zz)`
- K. `surf(xx, yy, zz)`
- L. `mesh(xx, yy, zz)`

II. You want to plot a surface of rotation for  $z = f(x)$  around the x and z axes. Given the following commands:

```
v = linspace(1,10,50);
th = linspace(0,2*pi,36);
[vv tth] = meshgrid(v,th);
rr = vv;
xx = rr.*cos(tth);
yy = rr.*sin(tth);
zz = f(rr);
surf(xx,yy,zz);
figure
```

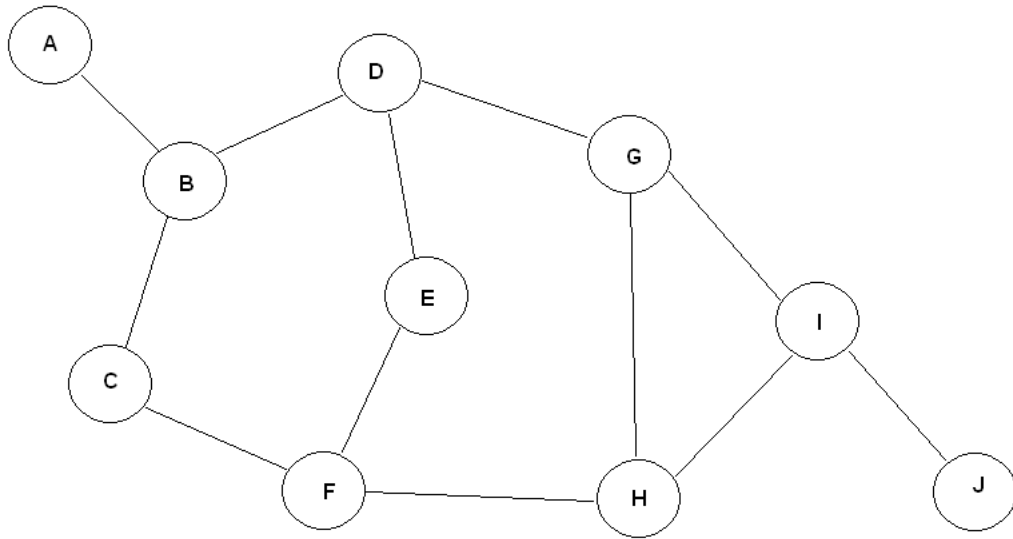
About which axis does this code make a surface of rotation? \_\_\_\_\_

III since it does not make sense to rotate it about the y axis, which of the following code blocks rotates  $f(x)$  about the other axis (circle the right answer)?

- |  |  |
|--|--|
| <p>A: <code>xx = f(vv);</code><br/> <code>rr = vv;</code><br/> <code>yy = rr .* cos(tth);</code><br/> <code>zz = rr .* sin(tth);</code><br/> <code>surf(xx, yy, zz)</code></p> | <p>C: <code>xx = f(vv);</code><br/> <code>rr = vv;</code><br/> <code>yy = rr .* cos(tth);</code><br/> <code>zz = rr .* sin(tth);</code><br/> <code>surf(zz, yy, xx)</code></p> |
| <p>B: <code>xx = vv;</code><br/> <code>rr = f(vv);</code><br/> <code>yy = rr .* cos(tth);</code><br/> <code>zz = rr .* sin(tth);</code><br/> <code>surf(xx, yy, zz)</code></p> | <p>D: <code>xx = vv;</code><br/> <code>rr = f(vv);</code><br/> <code>yy = rr .* cos(tth);</code><br/> <code>zz = rr .* sin(tth);</code><br/> <code>surf(zz, yy, xx)</code></p> |

IV. Write the proper commands to make the plot above *smooth* and add appropriate titles and labels.

**Problem 18 – Graph Traversal [20 Points]**



Starting with node **A** and ending at node **J**, perform a Breadth First Search on the given graph. Visit adjacent nodes in alphabetical order. Show your work in the space below.

Final Path: \_\_\_\_\_

Queue	Dequeued Paths

**Problem 19 – Miscellaneous [20 Points]**

I. The following code is executed in MATLAB:

```

r = 2;
c = r;
img(1:r,1:c,1) = [1 1; 1 46];
img(1:r,1:c,2) = [210 205; 210 76];
img(1:r,1:c,3) = [155 2; 1 16];

for x = 1:r
    for y = 1:c
        for z = 1:3
            if y == c
                if img(x,y,z) <= img(x,y-1,z)
                    newimg(x,y,z) = 255;
                elseif img(x,y,z) > img(x,y-1,z)
                    newimg(x,y,z) = 0;
                end
            else
                if img(x,y,z) <= img(x,y+1,z)
                    newimg(x,y,z) = 0;
                elseif img(x,y,z) > img(x,y+1,z)
                    newimg(x,y,z) = 255;
                end
            end
        end
    end
end

numzero = length(find(newimg(:,:, :) == 0));
nummax = length(find(newimg(:,:, :) == 255));

```

What would be the values stored in the following variables after the script is executed?

numzero = \_\_\_\_\_  
nummax = \_\_\_\_\_

II. Which of the following will solve for  $x$  in the following equation:  $A*x = b$ .

- A.  $\text{inv}(A)*b$
- B.  $A^{-1} \setminus b$
- C.  $A / b$
- D.  $A \setminus b$
- E.  $A*\text{inv}(b)$
- F.  $\text{inv}(A) \setminus b$

III. Which of the following code samples correctly implements the three requirements of recursion?

In the examples below, `x` is a double, `y` is a double, `myvar` is a logical, and `times` is a character array (string).

- A. 

```
function ret = my_recur(x,y)
    if mod(x,y) > x
        ret = 0;
    else
        ret = my_recur(x+1,y);
    end
```
- B. 

```
function my_recur(x,y)
    x = y + x;
    if x < y
        plot(x,y)
    else
        plot(y,x)
        my_recur(x+y,y-x)
    end
```
- C. 

```
function ret = my_recur(times)
    if length(times) <= 2
        ret = times;
    else
        ret = my_recur(times(2:end-1));
    end
```
- D. 

```
function ret = my_recur(myvar)
    if myvar == true
        ret = ~myvar;
    else
        ret = myvar;
    end
```

IV. Given: `A = [3 7 5 2 6 1]`

Circle each of the following choices that **would produce** an error when executed.

- A. `A(A)`
- B. `A(10) = []`
- C. `A([true false true])`
- D. `A(0) = 3`
- E. `A(linspace(2,6,5)) = 0`

**Problem 20 – Miscellaneous [20 Points]**

I. You are given the following information:

A = true

B = false

Evaluate:

i)  $(A \ \&\& \ B) \ || \ (A \ \&\& \ B)$  \_\_\_\_\_

ii)  $(A \ || \ B) \ \&\& \ (A \ || \ B)$  \_\_\_\_\_

iii)  $(\sim(A \ || \ B)) \ || \ (A \ \&\& \ B)$  \_\_\_\_\_

II. Ackermann's Function is "a function to end all functions."

The work done by the function `ack` grows much faster than polynomials or exponentials.

Given the following recursive method:

```
function ret = ack(x,y)
    if (x == 0)
        ans = y + 1;
    elseif (y == 0)
        ans = ack(x - 1, 1);
    else
        ans = ack(x - 1, ack(x, y - 1));
    end
```

What is the result of `ack(1, 4)`?

---

III. Given a vector of coefficients `a`, mark the code fragments below that will evaluate the following function for a single value of `x` (not a vector):

$$y = a(1) + a(2) * x + a(3) * x^2 + \dots a(n) * x^{n-1}.$$

- A. `polyval(x, a)`
- B. `n = 1:length(a)`  
`a(n) * x.^(n-1)'`
- C. `polyval(a, x)`
- D. `polyval(a(end:-1:1), x)`

IV. You have two vectors, `time` and `distance`, containing `X` and `Y` values respectively. Use this data to find the coefficients of a 4<sup>th</sup> order polynomial. Store the coefficients in a variable called `coeffs`. Also, plot the polynomial obtained for `X` values ranging from 1 to 10 seconds.

**Problem 21 – Structures [20 Points]**

I. Which of the following are valid function headers? (Circle all that apply)

- A. `function ret = myFunction(X)`
- B. `function myFunction (X)`
- C. `function = myFunction (X)`
- D. `function myFunction (234)`
- E. `function ret = myFunction()`

II. The following code is executed in MATLAB:

```
car = struct('Make', {'Honda', 'Mazda', 'Ford'}, 'Model', ...
{'Civic', 'Protege', 'Focus'}, 'Year', {2001, 2000, 2006});
car(1).Mileage = 15000;
car(2).Mileage = 200000;
car(3).Mileage = 100000;
```

```
A = rmfield(car(1), 'Mileage');
car(3).Age = 'new';
B = car(2);
C = isfield(car(1), 'Mileage');
D = getfield(A, 'Year');
E = fieldnames(A);
```

What are the values of the following variables?

A:

---

B:

---

C:

---

D:

---

E:

---

**Problem 22 - Computing [10 Points]**

Match the terms described below to the statements further below:

- |                               |                     |                      |                        |
|-------------------------------|---------------------|----------------------|------------------------|
| <b>A. Ethernet connection</b> | <b>B. Processor</b> | <b>C. RAM memory</b> | <b>D. Disk storage</b> |
| <b>E. Printer</b>             | <b>F. Monitor</b>   | <b>G. Keyboard</b>   | <b>H. Sound System</b> |

1. \_\_\_ “I’m the real brain of the computer—the part that does computation and comparisons.”
2. \_\_\_ “I’m the part of the computer that takes in digital data and turns that into voltages that go to the speaker.”
3. \_\_\_ “Plug a cable into me and you can use me for reaching the Internet, other computers, printers, and other resources.”
4. \_\_\_ “I’m where the computer stores short-term data—when the power stops, I forget everything.”
5. \_\_\_ “I’m an input device—users can enter text into the computer through me.”
6. \_\_\_ “I’m your main output device—it’s where graphical information is displayed.”
7. \_\_\_ “I’m a secondary output device—I take digital data and convert it to marks on paper.”
8. \_\_\_ “I’m where the computer stores longer-term data—I’m where data gets stored that’s to last even when the power is turned off.”

**Problem 23 – Sorting [20 Points]**

VII. What does the Big-O of any algorithm represent?

---

---

VIII. Write out the Big-O (algorithm efficiency) of the following sorting algorithms:

- a. Insertion Sort: \_\_\_\_\_
- b. Merge Sort: \_\_\_\_\_
- c. Quick Sort: \_\_\_\_\_
- d. Bubble Sort: \_\_\_\_\_

II. Sort the following vector using Insertion Sort:

[9 1 18 20 5 8 2]

**Problem 24 – Vector Manipulation [20 Points]**

I. Read the code below and answer the questions that follow

```
a = [3:7];  
b = a>5;  
a(3:4) = 0;  
c = find(a > 2);  
d = sum(ones(size(a)));  
e = mod(c, (max(a)-d));
```

What is the value of the following variables when the code above is executed?

b =

---

c =

---

e =

---

II. Which of the following are valid function headers? (Circle all that apply)

F. `function ret = myFunction(X)`

G. `function myFunction (X)`

H. `function ret = myFunction()`

I. `function = myFunction (X)`

J. `function myFunction (234)`

**Problem 25 – Structure Arrays [20 Points]**

I. What will be the value of `x`, when the following line of code is executed?

```
group1 = struct('Name', 'Blue Bombers', 'City', 'Winnipeg')
group2 = struct('Name', 'Raiders', 'City', 'Oakland')
group3 = struct('Name', 'Thrashers', 'City', 'Atlanta')
x = isfield(group1, 'Winnipeg')
```

- B. 'City'
- C. 1
- D. 'Blue Bombers'
- E. 0

II. Read the code below and answer the questions that follow

```
console(1) = struct('Name', 'XBOX360', 'Price', '400');
console(2) = struct('Name', 'PS3', 'Price', '600');
console(3) = struct('Name', 'WII', 'Price', '250');
console(4).Name = 'NES';
console(4).Price = 'Free';

temp1 = rmfield(console(1), 'Price');
console(3) = console(1);
temp2 = console(3);
console4 = setfield(console(2), 'Rating', '10')
temp3 = console(4);
```

What is the value of the following variables when the code above is executed?

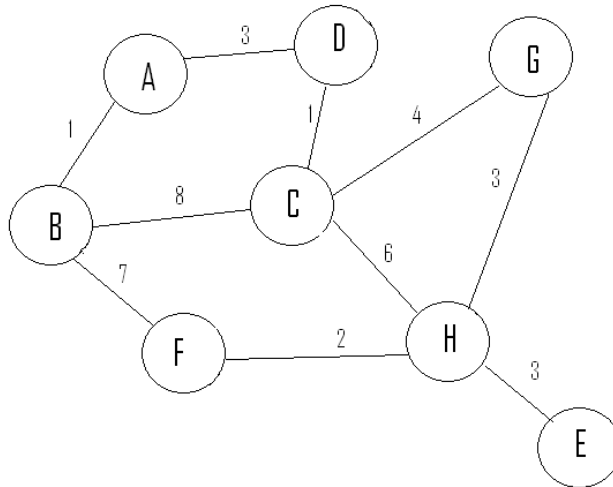
temp1 = \_\_\_\_\_

temp2 = \_\_\_\_\_

temp3 = \_\_\_\_\_

**Problem 26 – Graphs [20 Points]**

VI. Point out one node, one edge, and one cycle in the graph below.



VII. Use Dijkstra’s algorithm to find the quickest path between A and G in the tree above.

Priority Queue	Dequeued Paths

**Problem 27 – Numerical Methods [20 Points]**

1. Which of the following functions can be used for spline interpolation over a given set of data points? Circle all that apply.

- A. `newY = polyfit(x, y, newX, 'spline')`
- B. `newY = spline(x, y, newX)`
- C. `newY = interp1(x, y, newX, 'spline')`
- D. `newY = splinefit(x, y, newX)`

2. What are the values of `a` and `b` after the following code is run?

```
x = 1:5
```

```
a = diff(x)
```

```
a =
```

---

```
b = cumsum(x)
```

```
b =
```

---

3. You have a vector `coeffs` that contains the coefficients of an  $n$ -th order polynomial.

Using NOT more than 2 lines of code, find the vector `coeffs2` that contains the coefficients of the polynomial `coeffs` when it is differentiated.

4. You now have a vector that contains the coefficients of some polynomial. You also have a few  $x$ -data points for which you would like the  $y$ -data when the  $x$ -data is substituted into the polynomial. What built-in MATLAB function can you use for this purpose?

- A. `polyval()`
- B. `polyfit()`
- C. `substitute()`
- D. `evalPoly()`

**Problem 28 – Plotting [20 Points]**

1. Circle all of the following functions that can be used to plot a 3-dimensional surface in MATLAB.

- A. `plot3(xx, yy, zz)`
- B. `meshgrid(xx, yy, zz)`
- C. `surf(xx, yy, zz)`
- D. `mesh(xx, yy, zz)`

2. You want to plot a surface of rotation for  $y = -5x^4 + 2x^2 - 9x + 13$  around the x and z axes. Given the following commands:

```
v = linspace(1, 10, 50);  
th = linspace(0, 2*pi, 36);  
[vv tth] = meshgrid(v, th);
```

About which axis does the following code make a surface of rotation? \_\_\_\_\_

```
rr = vv;  
xx = rr.*cos(tth);  
yy = rr.*sin(tth);  
zz = -5rr.^4 + 2*rr.^2 - 9*rr + 13;  
surf(xx, yy, zz);
```

3. Write the commands that will make a rotational surface of this function around the other axis.

4. Write the proper commands to make the plot above *smooth* and add appropriate titles and labels.

**Problem 29 – Images/Sounds [20 Points]**

1. Consider the following "image" (assume it is a perfect square), saved under the file 'mysquare.jpg':

1	2
3	4

And the following code:

```
b = imread('mysquare.jpg');
[n,m,l] = size(b);
a = b(1:end, 1:n/2, :);
c = b(1:end, (n/2 + 1):end, :);
b = [c a];
image(b);
```

Which of these will the picture shown on the last line most resemble?

A.            B.            C.            D.

3	4
1	2

2	1
4	3

1
2
3
4

3
4
1
2

2. You are given the following code:

```
[snd, Fst] = wavread('Sound.wav');
```

Which of the following lines of code will play an amplified version of Sound.wav

- A. `sound(snd, Fst*3);`
- B. `sound(snd(round(1:half^2:end)), Fst)`
- C. `sound(snd*3, Fst);`
- D. `z= fft(Snd)`  
`z(1:floor(length(z)/2)) = 255;`  
`sound(ifft(z), Fst);`

3. “In order to increase the pitch of a sound by  $n$  half steps, you would stretch the sound vector to have  $2^{(n/12)}$  times the number of original points.”

True or False? If False, Why?

---

---

4. Given an image file called ‘american\_flag.jpg’ in which the colors are only pure red, pure white, and pure blue:

```
af = imread('american_flag.jpg');
[r1,c1] = find(af(:,:,1) == 255 ...
              && af(:,:,2) == 0 ...
              && af(:,:,3) == 0);
[r2,c2] = find(af(:,:,1) == 0 ...
              && af(:,:,2) == 0 ...
              && af(:,:,3) == 255);
[r3,c3] = find(af(:,:,1) == 255 ...
              && af(:,:,2) == 255 ...
              && af(:,:,3) == 255);
af(r1,c1,:) = 255;
af(r2,c2,1) = 255;
af(r2,c2,3) = 0;
af(r3,c3,1:2) = 0;
image(af)
```

What happens in the resulting image?

- e) The red sections become white, the blue sections become red, and the white sections become blue.
- f) The white sections become red, the red sections become blue, and the blue sections become white.
- g) The blue sections become red, the red sections become blue, and the white sections become black.
- h) The blue sections become white, the red sections become black, and the white sections become red.

**Problem 30 – Images/Sounds [20 Points]**

1. For a given 2-dimensional matrix, `mat`, the effect of `x = rot90(mat)` is replicated by which of the following code:

- A. `mat = mat'`  
`mat = mat(end:-1:1, :)`
- B. `mat = mat(end:-1:1, :)`  
`mat = mat'`
- C. `mat = mat(end:-1:1, :)`
- D. `mat = mat(:, end:-1:1)`

a. Given an image file called 'american\_flag.jpg' in which the colors are only red, white, and blue:

```
af = imread('american_flag.jpg');
[r1,c1] = find(af(:,:,1) == 255 ...
              && af(:,:,2) == 0 ...
              && af(:,:,3) == 0);

[r2,c2] = find(af(:,:,1) == 0 ...
              && af(:,:,2) == 0 ...
              && af(:,:,3) == 255);

[r3,c3] = find(af(:,:,1) == 255 ...
              && af(:,:,2) == 255 ...
              && af(:,:,3) == 255);

af(r1,c1,1) = 0;
af(r2,c2,:) = 255;
af(r1,c1,3) = 255;
af(r3,c3,2:3) = 0;
image(af)
```

What happens in the resulting image?

- A. The red sections become white, the blue sections become red, and the white sections become blue.
- B. The white sections become red, the red sections become blue, and the blue sections become white.
- C. The blue sections become red, the red sections become blue, and the white sections become black.
- D. The blue sections become white, the red sections become black, and the white sections become red.

3. Consider the following "image" (assume it is a perfect square), saved under the file 'mysquare.jpg':

1	2
3	4

And the following code:

```
b = imread('mysquare.jpg');
[n,m,l] = size(b);
a = b(1:n/2, 1:end, :);
c = b((n/2 + 1):end, 1:end, :);
b = [c a];
image(b);
```

Which of these will the picture shown on the last line most resemble?

A.            B.            C.            D.

3	4
1	2

2	1
4	3

1
2
3
4

3
4
1
2

4. Given the file *soundtest.wav*, the following commands are executed:

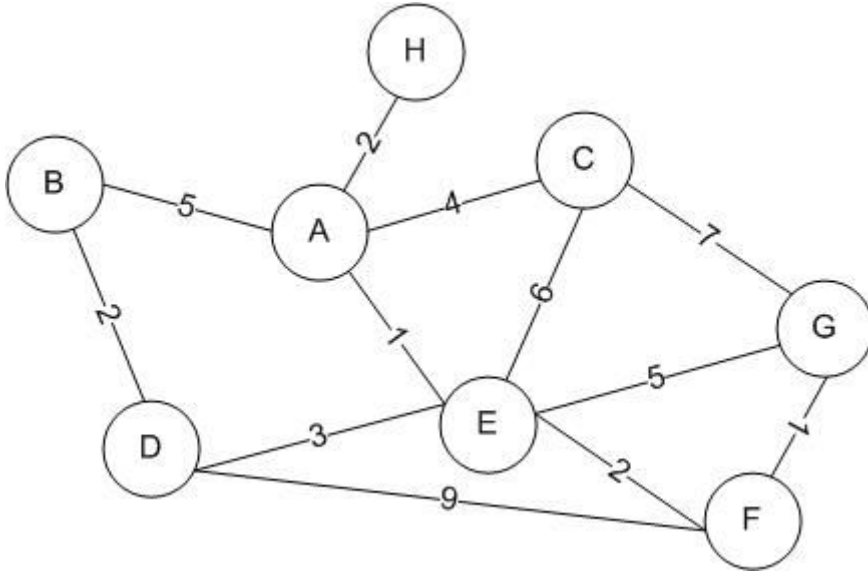
```
[x fs] = wavread('soundtest.wav');
L = length(x);
```

The time duration in seconds of *soundtest.wav* is:

- F.  $fs \cdot L / (L+1)$
- G.  $fs / L$
- H.  $L / fs$
- I.  $L \cdot fs$
- J.  $fs \cdot L / (fs+1)$

**Problem 31 – Graph Traversal [20 Points]**

The graph below represents a map where nodes are cities and edges are labeled with the distances between each city. Find the FINAL PATH given by performing a Breadth First Search on the given graph starting at city B and ending at city G.



Final Path using Depth First Search; show your work in the space below:

---

**Problem 32 – Plotting [20 Points]**

1. Circle all of the following functions that can be used to plot a 3-dimensional surface in MATLAB.

- E. `plot3(xx, yy, zz)`
- F. `meshgrid(xx, yy, zz)`
- G. `surf(xx, yy, zz)`
- H. `mesh(xx, yy, zz)`

2. You want to plot a surface of rotation for  $y = -x^3 + 5x^2 - 21x + 43$  around the x and z axes. Given the following commands:

```
v = linspace(1,10,50);  
th = linspace(0,2*pi,36);  
[vv tth] = meshgrid(v,th);
```

About which axis does the following code make a surface of rotation? \_\_\_\_\_

```
xx = vv;  
rr = -xx.^3 + 5*xx.^2 - 21*xx + 43;  
yy = rr.*cos(tth);  
zz = rr.*sin(tth);  
surf(xx,yy,zz);
```

3. Write the commands that will make a rotational surface of this function around the other axis.

4. Write the proper commands to make the plot above *smooth* and add appropriate titles and labels.

**Problem 33 – Miscellaneous [20 Points]**

1. Read the following code and answer the question that follows:

```
ch = 'Ann';  
ch = ch + 'a';  
ch = [ch 'na'];  
len = length(ch);
```

What is the value of `len` at the end?

- A. 3
- B. 4
- C. 5
- D. 6

2. Read the following code and answer the question that follows:

```
A = {'cat', [7 6 9], {'dog'}}  
a = A{3}  
b = A{1}(1)  
c = A{2}  
d = A(2)
```

After the code above is executed, what is the data type of the following variables:

A = \_\_\_\_\_

a = \_\_\_\_\_

b = \_\_\_\_\_

c = \_\_\_\_\_

d = \_\_\_\_\_

3. Read the following code and answer the question that follows:

```
x = [9 3 0 6 3]
y = mod((sqrt(length((x+5).*[1 2 3 4 5]))*5)),3)
```

What is the value of y?

- A. 0
- B. 3
- C. 2
- D. 5

b. You are given the following equations:

$$\begin{aligned}3x + 2y - z &= 5 \\6x + z &= 7 \\5x - 2y + z &= 12\end{aligned}$$

Write a script in MATLAB to solve the values of x, y, and z.

**Problem 34 – Recursion [20 Points]**

1. Which of the following are essential for a recursive function?

- A. Modifying the input so that it moves towards termination
- B. Wrapper function
- C. A call to the function itself
- D. Terminating condition
- E. All of the above

2. Read the following code and answer the question that follows:

```
function ret = myFunc(str)
if length(str) == 0
    ret = 1;
elseif length(str) == 1
    ret = 1;
else
    if strcmp(string(1), string(end))
        ret = myFunc(str(2:end-1));
    else
        ret = 0;
    end
end
```

A. In the code above, circle the terminating condition(s).

B. Assume that this function has a wrapper function that will remove all spaces, punctuation, etc. from the input string. Given the following:

```
A = 'was it an ant i saw'
B = 'never odd or even'
```

i.) What would myFunc(A) return? \_\_\_\_\_

ii.) What would myFunc(B) return? \_\_\_\_\_

iii.) Ignoring the user's call to the function, how many times is the function called recursively when myFunc(A) is run? \_\_\_\_\_

C. Finally, write a wrapper function which removes all of the spaces from the input. Call this function pwrap.

**Problem 35 – Structures [20 Points]**

The following code is run in Matlab:

```
Player1 = struct('name','Henry','age',25,'Captain','Yes');
Player1.Jersey = 14;
Player2 = struct('name','Lampard','age',26,'Jersey',8);
Player2 = setfield(Player2,'Position','Midfield');
Player1 = rmfield(Player1,'Captain');
Player1.Team = 'Arsenal';
Player2 = rmfield(Player2,'Position');
Player2 = setfield(Player2,'Team','Chelsea');
Player3 = Player1;
```

```
A = isstruct(Player2)
```

```
B = Player1.age
```

```
C = isfield(Player2,'Position')
```

```
D = isfield(Player3, 'Captain')
```

```
E = getfield(Player2, 'Team')
```

What are the values of A,B,C, D, and E?

A = \_\_\_\_\_

B = \_\_\_\_\_

C = \_\_\_\_\_

D = \_\_\_\_\_

E = \_\_\_\_\_

**Problem 36 – Images/Sounds [20 Points]**

- II. Given an image file called 'american\_flag.jpg' in which the colors are only red, white, and blue:

```
af = imread('american_flag.jpg');
[r1,c1] = find(af(:,:,1) == 255 ...
              && af(:,:,2) == 0 ...
              && af(:,:,3) == 0);
[r2,c2] = find(af(:,:,1) == 0 ...
              && af(:,:,2) == 0 ...
              && af(:,:,3) == 255);
[r3,c3] = find(af(:,:,1) == 255 ...
              && af(:,:,2) == 255 ...
              && af(:,:,3) == 255);
af(r1,c1,1) = 0;
af(r2,c2,1) = 255;
af(r1,c1,3) = 255;
af(r2,c2,3) = 0;
af(r3,c3,:) = 0;
image(af)
```

What happens in the resulting image?

- The red sections become white, the blue sections become red, and the white sections become blue.
- The white sections become red, the red sections become blue, and the blue sections become white.
- The blue sections become red, the red sections become blue, and the white sections become black.
- The blue sections become white, the red sections become black, and the white sections become red.

2. You are given the following code:

```
[snd, Fst] = wavread('Sound.wav');
```

Which of the following lines of code will play an amplified version of Sound.wav

- sound(snd, Fst\*3);
- sound(snd(round(1:half^2:end)), Fst)
- sound(snd\*3, Fst);
- z= fft(Snd)
 z(1:floor(length(z)/2)) = 255;
 sound(ifft(z), Fst);

3. Consider the following "image" (assume it is a perfect square), saved under the file 'mysquare.jpg':

1	2
3	4

And the following code:

```

b = imread('mysquare.jpg');
[n,m,l] = size(b);
a = b(1:end, 1:n/2, :);
c = b(1:end, (n/2 + 1):end, :);
b = [c a];
image(b);
    
```

Which of these will the picture shown on the last line most resemble?

- A.            B.            C.            D.

3	4
1	2

2	1
4	3

1
2
3
4

3
4
1
2

4. Consider this code that reads in an image saved as 'myimage.jpg':

```

b = imread('myimage.jpg');
[m,n,l] = size(b);
count = 0;
for i = 1:m
    for j = 1:n
        if ( <A> (double(b(i, j, <B>)))) == <C>
            count = count + 1;
        end
    end
end
    
```

Which of the following could you put in the places of <A>, <B> and <C> to give you the number of completely white pixels in the image?

- |    |          |        |          |
|----|----------|--------|----------|
| A. | <A>: any | <B>: j | <C>: 255 |
| B. | <A>: all | <B>: : | <C>: 255 |
| C. | <A>: sum | <B>: : | <C>: 255 |
| D. | <A>: sum | <B>: j | <C>: 765 |
| E. | <A>: sum | <B>: : | <C>: 765 |

**Problem 37 – Vector Manipulations [20 Points]**

Answer the following questions with regard to vector manipulations:

1. Which of the two commands produces an error (if any)? If so, explain why.

```
a)  cat = [1 2 3 4 5 6];  
    dog = [1 2 3 4 5];  
    cat(dog > 3)
```

```
b)  cat = [1 2 3 4 5 6];  
    dog = [1 2 3 4 5];  
    cat(find(dog < 3))
```

ANSWER: \_\_\_\_\_

```
2.  pie = [1 2 3 4 5]  
    z = pie(pie < 4);  
    y = pie([1 1 1 0 0])
```

“z and y produce the same result”  
Is this statement true or false? If false, why?

ANSWER: \_\_\_\_\_

```
3.  salt = [1 9 2 8 3 7 4 6];  
    pepper = find(salt < 7);  
    curry = pepper(end:-1:1);  
    teehee = salt(curry)
```

What are the contents of `teehee`?

ANSWER: \_\_\_\_\_

```
4.  chocolate = [9 8 7 6 5 4 3 2 1 0];  
    vanilla = [1 2 3 4 5 6 7 8];  
    ice_cream = chocolate(mod(chocolate,2) == 0);  
    ice_cream = [ice_cream, vanilla(2:2:end)];
```

What are the contents of `ice_cream`?

ANSWER: \_\_\_\_\_

**Problem 38 – Plotting [20 Points]**

1. Circle all of the following functions that can be used to plot a 3-dimensional surface in MATLAB.

- A. `plot3(xx, yy, zz)`
- B. `meshgrid(xx, yy, zz)`
- C. `surf(xx, yy, zz)`
- D. `mesh(xx, yy, zz)`

2. You want to plot a surface of rotation for  $y = -5x^4 + 2x^2 - 9x + 13$  around the x and z axes. Given the following commands:

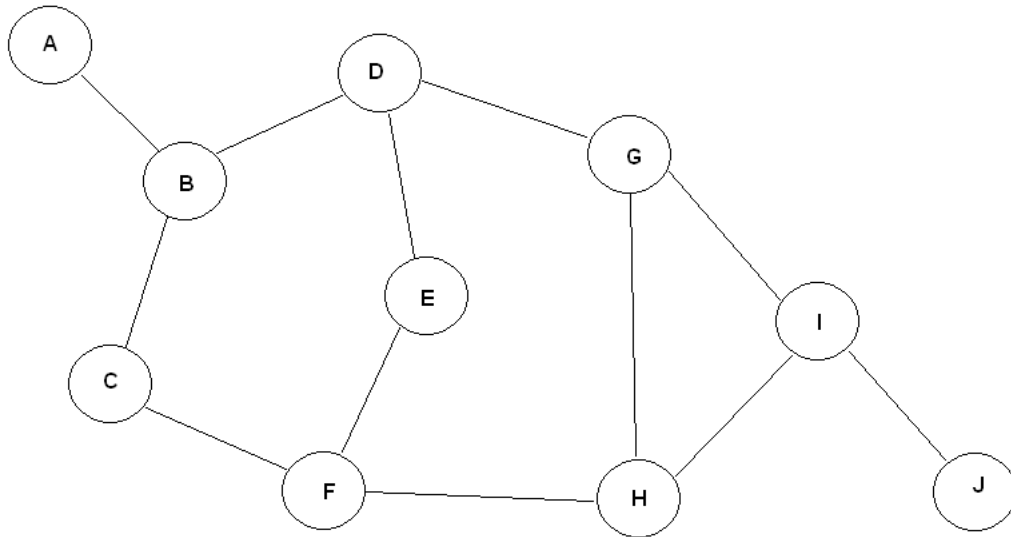
```
v = linspace(1, 10, 50);  
th = linspace(0, 2*pi, 36);  
[vv tth] = meshgrid(v, th);
```

About which axis does the following code make a surface of rotation? \_\_\_\_\_

```
rr = vv;  
xx = rr.*cos(tth);  
yy = rr.*sin(tth);  
zz = -5rr.^4 + 2*rr.^2 - 9*rr + 13;  
surf(xx, yy, zz);
```

3. Write the commands that will make a rotational surface of this function around the other axis.

4. Write the proper commands to make the plot above *smooth* and add appropriate titles and labels.

**Problem 39 – Graph Traversal [20 Points]**

Starting with node A and ending at node J, perform a Breadth First Search on the given graph. Visit adjacent nodes in alphabetical order. Show your work in the space below.

Final Path: \_\_\_\_\_

**Problem 40 – Miscellaneous [20 Points]**

1. You are given the following information:

A = true

B = false

Evaluate:

i)  $(A \ \&\& \ B) \ || \ (A \ \&\& \ B)$  \_\_\_\_\_

ii)  $(A \ || \ B) \ \&\& \ (A \ || \ B)$  \_\_\_\_\_

iii)  $(\sim(A \ || \ B)) \ || \ (A \ \&\& \ B)$  \_\_\_\_\_

2. Ackermann's Function is "a function to end all functions."

The work done by the function `ack` grows much faster than polynomials or exponentials.

Given the following recursive method:

```
function ret = ack(x,y)
    if (x == 0)
        ans = y + 1;
    elseif (y == 0)
        ans = ack(x - 1, 1);
    else
        ans = ack(x - 1, ack(x, y - 1));
    end
```

What is the result of `ack(1, 4)`?

---

3. Given a vector of coefficients  $a$ , mark the code fragments below that will evaluate the following function for a single value of  $x$  (not a vector):

$$y = a(1) + a(2) * x + a(3) * x^2 + \dots a(n) * x^{n-1}.$$

- E. `polyval(x, a)`
- F. `n = 1:length(a)`  
`a(n) * x.^(n-1)'`
- G. `polyval(a, x)`
- H. `polyval(a(end:-1:1), x)`

4. Which of the following correctly solves for  $X$  in the equation  $AX = B$ , knowing that  $A$  is a  $4 \times 4$  matrix of known values,  $B$  is a  $4 \times 1$  column vector of known values, and  $X$  is a  $4 \times 1$  column vector of unknown values?

- A. `X = inv(B) * A`
- B. `X = B \ A`
- C. `X = inv(A) * B`
- D. `X = A / B`

**Problem 41 – Structures [20 Points]**

The following code is run in Matlab:

```
honda1 = ...  
struct('model','S2000','exterior','silver','spoiler','wing');  
honda1.interior = 'red';  
honda2 = ...  
struct('model','Accord','exterior','grey','spoiler','none');  
honda2 = setfield(honda2, 'interior', 'tan');  
honda1.exterior = 'white';  
honda3 = setfield(honda1, 'interior', 'tan');  
honda3 = rmfield(honda3, 'spoiler');  
honda4 = honda2;
```

**A = isstruct(honda3)**

**B = honda1.exterior**

**C = isfield(honda4, 'spoiler')**

**D = honda2.model**

**E = getfield(honda1, 'spoiler')**

What are the values of A, B, C, D, and E?

**A = \_\_\_\_\_**

**B = \_\_\_\_\_**

**C = \_\_\_\_\_**

**D = \_\_\_\_\_**

**E = \_\_\_\_\_**