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- Failure to cooperate with or follow directions given by a proctor.
- Failure to stop writing when the allotted time is up (as reported by a proctor).
- Communication with anyone other than a proctor for ANY reason in ANY language in ANY manner.
- Sharing of ANYTHING (e.g. pencils, erasers, paper).
- Writing on paper that is not given to you by a proctor.
- Using cell phones, beepers, personal radios or music players, etc. during the exam.
- Using calculators (unless explicitly permitted) or hand-held computers during the exam.
- Using books or other reference material during the exam.
- Disruption of the exam setting.

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 - Computing [10 Points]

Match the terms described below to the statements further below:

A. Ethernet connection

B. Processor

C. RAM memory

D. Disk storage

E. Printer

F. Monitor

G. Keyboard

H. Sound System

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 2 – Sorting [20 Points]

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

II. 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 Bubble Sort showing only the results after each pass across the vector:

[9 1 18 20 5 8 2]

Problem 3 – 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)`

2. 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:

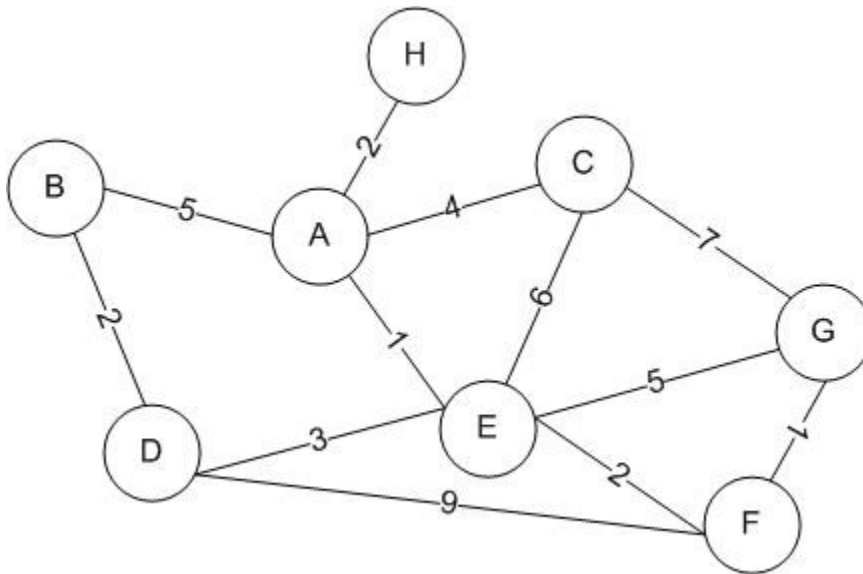
```
[x fs] = wavread('soundtest.wav');
L = length(x);
```

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

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

Problem 4 – 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 5 – 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 $y = -x^3 + 5x^2 - 21x + 43$ 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 6 – 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

3. 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 7 – 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 8 – 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 = _____

