

[illegible]

0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	1	1
2	2	2	2	2	2	2	2	2
3	3	3	3	3	3	3	3	3
4	4	4	4	4	4	4	4	4
5	5	5	5	5	5	5	5	5
6	6	6	6	6	6	6	6	6
7	7	7	7	7	7	7	7	7
8	8	8	8	8	8	8	8	8
9	9	9	9	9	9	9	9	9
A	A	A	A	A	A	A	A	A
B	B	B	B	B	B	B	B	B
C	C	C	C	C	C	C	C	C
D	D	D	D	D	D	D	D	D
E	E	E	E	E	E	E	E	E
F	F	F	F	F	F	F	F	F
G	G	G	G	G	G	G	G	G
H	H	H	H	H	H	H	H	H
I	I	I	I	I	I	I	I	I
J	J	J	J	J	J	J	J	J
K	K	K	K	K	K	K	K	K
L	L	L	L	L	L	L	L	L
M	M	M	M	M	M	M	M	M
N	N	N	N	N	N	N	N	N
O	O	O	O	O	O	O	O	O
P	P	P	P	P	P	P	P	P
Q	Q	Q	Q	Q	Q	Q	Q	Q
R	R	R	R	R	R	R	R	R
S	S	S	S	S	S	S	S	S
T	T	T	T	T	T	T	T	T
U	U	U	U	U	U	U	U	U
V	V	V	V	V	V	V	V	V
W	W	W	W	W	W	W	W	W
X	X	X	X	X	X	X	X	X
Y	Y	Y	Y	Y	Y	Y	Y	Y
Z	Z	Z	Z	Z	Z	Z	Z	Z

I hereby signify that this examination paper contains my own work exclusively, and I have neither given nor received inappropriate help during the taking of this examination, in compliance with the letter and spirit of the Academic Honor Code of Georgia Tech.

Name (print): _____

Signature: _____

TA / Section: _____

Prob.	Poss. Pts	Earned Pts	Lost Pts	Grader
(cover)	-	-		
1	20			
2	20			
3	20			
4	20			
5	20			
6	20			
7	20			
TOTAL	140			

Please Note: Failure to complete this front sheet correctly will cost you 5% of your grade.

Please turn off (or silence) and put away any cell phones, beepers/pagers, personal radios or music players that you have in your possession

Good Luck!

Academic misconduct (including - but not limited to - examples on the list below) could result in a zero score on this examination, an "F" final grade in the course, and/or other disciplinary action:

- 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 – Sorting [20 Points]

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

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 **Bubble Sort** showing only the results after each pass across the vector. Show *not more* than the seven vectors that result from each minor loop:

[9 1 18 20 5 8 2]

Problem 2 – Images/Sounds [20 Points]

I. For a given 2-dimensional matrix, `mat`, which of the following rotates the matrix by 90 degrees counterclockwise?

- 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)`

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,:) = 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.

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: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

IV. Given the file 'soundtest.wav', the following commands are executed:

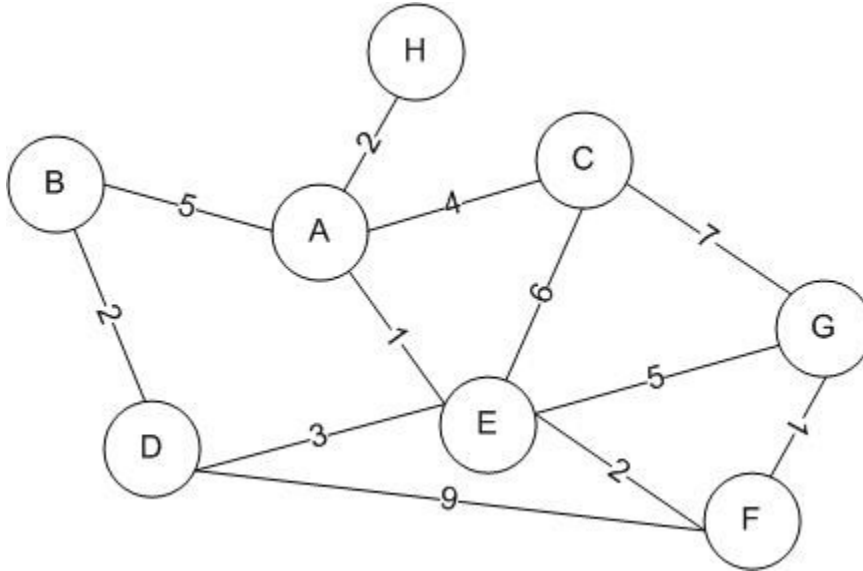
```
[x fs] = wavread('soundtest.wav');
L = length(x);
```

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 3 – 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 Breadth First Search; show your work in the space below:

Queue	Dequeued Paths

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);  
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)?

A: `xx = vv;
rr = f(vv);
yy = rr .* cos(tth);
zz = rr .* sin(tth);
surf(zz, yy, xx)`

C: `xx = vv;
rr = f(vv);
yy = rr .* cos(tth);
zz = rr .* sin(tth);
surf(xx, yy, zz)`

B: `xx = f(vv);
rr = vv;
yy = rr .* cos(tth);
zz = rr .* sin(tth);
surf(xx, yy, zz)`

D: `xx = f(vv);
rr = vv;
yy = rr .* cos(tth);
zz = rr .* sin(tth);
surf(zz, yy, xx)`

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

Problem 5 – Miscellaneous [20 Points]

I. You are given the following three equations. Write the MATLAB code to solve for x , y , and z .

Note: You may not use any built in MATLAB functions including `inv()`

$$\begin{aligned}2x + 3y + z &= 10 \\ 2y + 6z &= -2 \\ 4x + y &= 1\end{aligned}$$

II. The following code is executed in MATLAB:

```
[data fs] = wavread('sweetchild.wav');  
n = length(data);  
A = data(floor(linspace(1,n,n/2)));  
B = data(floor(linspace(1,n,n*2)));  
C = data;  
D = data(end:-1:1);  
E = data(1:2:end);  
F = data./2;
```

Circle all of the following sounds that will play `sweetchild.wav` **one octave higher?**
Ignore any change in volume or intensity (if any).

- A. `sound(A, fs)`
- B. `sound(B, fs)`
- C. `sound(C, fs/2)`
- D. `sound(C, fs*2)`
- E. `sound(D, fs)`
- F. `sound(E, fs)`
- G. `sound(F, fs*2)`
- H. `sound(F, fs)`

III. Given the following code:

```
a = {[4 8 20 -3] 'CS1371' 29}
b = 'Finals'
```

- i. a = [a {b}]
- ii. a = {a b}
- iii. a{4} = b

Which of the above would correctly concatenate a and b to yield:

```
a = {[4 8 20 -3] 'CS1371' 29 'Finals'}
```

- A. i. only
- B. ii. Only
- C. i. and iii.
- D. ii. and iii.
- E. i., ii, and iii

Problem 6 – 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 7 – 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 ret = myFunction()`
- E. `function myFunction (234)`

II. The following code is executed in MATLAB:

```
PartyGuest = struct('name',  
{ 'Joe', 'Bob', 'Jane', 'Sarah' }, ...  
'age', {21, 34, 17, 25}, 'job', { 'bartender', 'banker', 'dancer', ..  
    . 'clown' }, 'drink', { 'beer', 'juice', 'martini', 'milk' })  
PartyGuest(5).name = 'Bill'  
Party = rmfield(PartyGuest, 'drink')  
for index = 1:length(PartyGuest)  
    if PartyGuest(index).age >=21  
        PartyGuest(index).legal = 'yes';  
    else  
        PartyGuest(index).legal = 'no';  
    end  
end  
Party(3).music = 'rock'  
A = isfield(PartyGuest, 'drink')  
PartyGuest(1).age = PartyGuest(1).age + 10;  
B = length(PartyGuest)  
C = PartyGuest(1)  
D = fieldnames(Party)  
E = isfield(PartyGuest, 'legal')
```

What are the values of the following variables?

A:

B:

C:

D:

E:

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