University of Nevada, Las Vegas Computer Science 477/677 Spring 2026

Assignment 6: Due Saturday May 2, 2026 11:59:59 PM

Name:_____

1. Evaluate each of these expressions.

   (i) $\log_2 4$

   (ii) $\log_5 \left(4\left(\frac{2}{5}\right)^2 + \left(\frac{3}{5}\right)^2 \right)$

   (iii) $3^{log_9(49)}$ (Hint: it's an integer.)

2. (i) What is the asymptotic complexity of $george(n)$, computed by the recursive code below?

   (ii) What is the asymptotic time complexity of the computation of $george(n)$ using the code below?

   (iii) Asymptotically, how many memos are needed if $george(n)$ is computed using memoization?

```
int george(int n)
 {
  if(n < 3) return 1;
  return george(n/2) + george(n/3) + george(n/6) + n;
 }
```

3. Fill in the blanks.

   (i) We say that graph is _____ if there is a path between any two vertices.

   (ii) A _____ is a graph where there is an edge connecting any two vertices. (One word!)

   (iii) A binary tree of height h has at least _____ nodes, and has no more than _____ nodes. (Exact answers, which are algebraic expressions, please.)

   (iv) A graph G is _____ if it can be embedded in a plane with no crossings. In that case, if G has n vertices, where $n \geq 3$, then G has no more than _____ edges. (Exact answer, which is an algebraic expression.)

4. Use Graham Scan to find the convex hull of the set of points in the Euclidean plane listed below.

$A = (0, 4)$	$G = (5, 4)$
$B = (1, 3)$	$H = (5, 8)$
$C = (3, 3)$	$I = (5, 8)$
$D = (4, 1)$	$J = (6, 2)$
$E = (4, 2)$	$K = (6, 5)$
$F = (4, 1)$	$L = (7, 8)$

5. The array $A[10][5][8]$ is stored in row major order in RAM. $A[0][0][0]$ is stored in RAM[1024] and each entry requires two addresses in RAM. What is the RAM address of $A[8][3][2]$?

6. $R[][]$ is an virtual array of 8 rows, where the first row has length 1i and each subsequent row is twice the length of the previous row. That is, $R[i, j]$ is an entry if $0 \leq i < 8$ and $0 \leq j < 2^i$.
   How many entries does R have? _____
   How many predecessors does $R[7][45]$ have? _____

7. Find a longest monotone subsequence of the sequence:
   $YDRCTNWQZFMGPHSK$.

8. Let $G = (V, E)$ be a graph, where $|V| = n$ and $|E| = m$. Describe an algorithm which computes the components of G quickly. Hint: there is more than one good answer.

9. Find the asymptotic time complexity of each code fragment, in terms of n. You have plenty of time; get them right!

(i)
```
for(int i = 1; i < n; i++)
    for(int j = 1; j < i; j = 2*j)
```

(ii)
```
for(int i = 1; i < n; i++)
    for(int j = i; j < n; j = 2*j)
```

(iii)
```
for(int i = 1; i < n; i++)
    for(int j = n; j > i; j = j/2)
```

(iv)
```
for(int i = 1; i < n; i++)
    for(int j = i; j > 1; j = j/2)
```

(v)
```
for(int i = 2; i < n; i = i*i)
```

(vi)
```
for(int i = 1; sqrt(i) < n; i++)
```

10. The following table lists the out-neighbors of each vertex of a directed graph G. Write the table of in-neighbor lists of G.

a	b
b	a,e
c	b
d	a,e
e	h,f
f	g
g	i
h	d
i	j
j	

11. Compute the strong components of the graph given in problem 10.

12. Huffman's algorithm creates a code which satisfies the *prefix condition.* What is the purpose of that condition?

13. (i) _____ What is the name of the algorithm given by the following code?

```
for(int i = 0; i < n; i++)
  for(int j = i+1; j < n; j++);
    if(A[j] < A[i]) swap(A[i],A[j]);
```

(ii) The code has two loops. Give the loop invariant of each loop.

You can replace the for loops with while loops, if that helps:

```
int i = 0;
while(i < n)
 {
  j = i+1;
  while(j < n)
   {
    if(A[j] < A[i]) swap(A[i],A[j]);
    j = j+1;
   }
  i = i+1;
 }
```

14. A C++ program uses a binary search tree (bst) of characters.. Here is the definition of the binary search tree. Note that two types are defined: a struct, "bstnode," and "bst," a pointer to "bstnode."[1]

```
struct bstnode;
typedef bstnode*bst;
struct bstnode
 {
  char item;
  bst lft;
  bst rgt;
 };
```

Complete the C++ code below, for the recursive function which computes the height of a binary search tree.

```
int hite(bst t) // height
  // empty tree has height -1
 {









 }
```

[1] I guarantee that the code given below compiles and runs when the missing parts are included; I ran it myself.

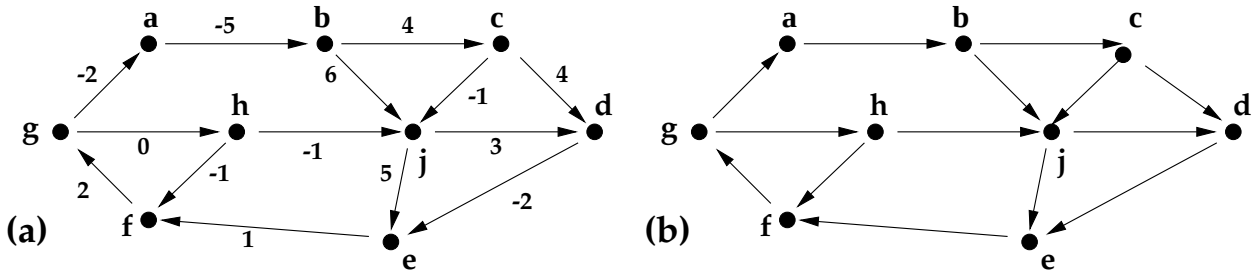
Complete the C++ code below for the recursive function which traverses a binary search tree, printing the characters in alphabetic order, also known as "inorder."

```
void inorder(bst t)
 {









}
```

Complete the C++ code below, for the function which inserts a new character into a bst.

```
void insert(bst&t,char newitem)
 {
  // duplicates not inserted









}
```

15. Work the first part of Johnson's algorithm on the weighted directed graph shown in (a) below. In (b) show the adjusted weight of each arc Do not finish Johnson's algorithm.



16. All the sorting algorithm we've studied this semester use the comparison model of computation, but *radix sort* does not. Describe radix sort, where the list being sorted consists of binary strings of length n.

17. Give the *information theory* proof that the time complexity of any sequential algorithm for sorting a list of n items which uses the comparison model of computation, is $\Omega(n \log n)$.

18. Write pseudocode for an algorithm which finds the greatest sum of a contiguous subsequence of a sequence $\sigma = x_1, x_2, \ldots x_n$ of numbers. The σ may contain negative as well as positive numbers. For example, if σ is 3, -4, 2, 6, -3, 2, -8, 4, 7, -2, 6, -1, 8, -5, the maximum weight contiguous subsequence, of weight 22, is 4, 7, -2, 6, -1, 8. Your algorithm should take $\Theta(n)$ time.