Computer Science 302 Fall 2018 Practice Examination for the Second Examination, October 17, 2018

Name:_____

No books, notes, or scratch paper. Use pen or pencil, any color. Use the rest of this page and the backs of the pages for scratch paper. If you need more scratch paper, it will be provided.

The entire examination is 335 points.

1. True or False. [5 points each]

   (a) _____ Binary tree sort takes $O(n \log n)$ time to sort n items.

   (b) _____ Polyphase mergesort takes $O(n \log n)$ time to sort n items.

   (c) _____ Heapsort takes $O(n \log n)$ time to sort n items.

   (d) _____ Mergesort takes $O(n \log n)$ time to sort n items.

   (e) _____ Bubblesort takes $O(n \log n)$ time to sort n items.

   (f) _____ If a directed graph is acyclic, there can be at most one path from a vertex x to another vertex y.

   (g) _____ Planar graphs are sparse.

   (h) _____ In open hashing, the size of the hash table may not exceed the number of data items stored in the table.

   (i) _____ In closed hashing, the size of the hash table may not exceed the number of data items stored in the table.

2. Fill in the blanks.

   (a) [10 points] The height of a binary tree with 20 nodes is at least _____

   (b) [10 points] A planar graph with 20 edges must have a least _____ vertices.

   (c) [15 points] Name three kinds of priority queue. _____ _____ _____

   (d) [10 points] What are the two standard ways that a stack is implemented?

   _____ _____

   (e) [5 points] In _____ hashing, there are no collisions between data items.

   (f) [5 points] A directed graph is _____ if and only if its vertices have a topological order.

(g) [15 points] The three standard ways to handle the false overflow problem in an array implementation of a queue are

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(h) [15 points] Three properties that a good hash function should have are

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(i) [10 points]The answer to each of these two questions is either *preorder, postorder, inorder,* or *level order*.

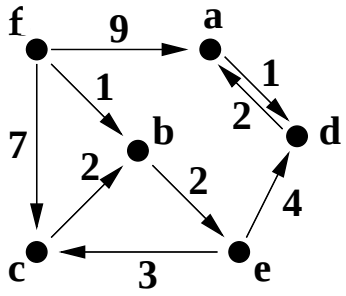
i. A _____ visitation of the nodes of a binary tree visits the nodes in depth-first-search order.

ii. A _____ visitation of the nodes of a binary tree visits the nodes in breadth-first-search order.

3. [20 points] Build a binary search tree, starting from an empty tree, inserting the following items one at a time: **Moe Abe Joe Nan Ted Kim Sam Ron Dan Sue Zed**. Once an item is inserted into the tree, it is not moved.

4. [15 points] The items of a binary tree are characters. The preorder list of items is ABDGKEHICFLJ, while the inorder list of items is GKDBHEIAFCJL. Write the postorder list of items.

5. [10 points] Write the matrix (array) implementation of the weighted directed graph illustrated below.



6. Give the asymptotic complexity of each code fragment in terms of n, using Θ notation.

   (a) [5 points]

```
for(int i = 1;i < n; i=i+2}
 for(int j = i; j > 0; j = j-3)
```

   (b) [5 points]

```
for(int i = n; i > 0; i = i/4);
```

   (c) [5 points]

```
for(int i=0; i < n; i++);
 for(int j = 1; j < i; j = 2*j)
```

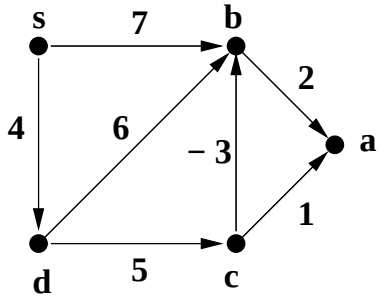
   (d) [5 points]

```
for(int i = 0; i < n; i++);
 for(int j = i; j < n; j = 2*j)
```

   (e) [5 points]

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

7. [20 points] Fill in the arrays shown for the single source minimum path problem for the weighted directed graph illustrated below, where the start vertex is **s**.



	s	a	b	c	d
V					
back					

8. [10 points] The vertices of a directed graph G are the integers i such that $0 \leq i < N$, where N is a constant. The back pointers of a solution to a single source path problem, where the start vertex is 0, is given as an array `int back[N];`. Write C++ code for a recursive function which prints in forward (not backward) order the path from 0 to a given vertex i. You only need two lines of code.

```
void writepath(int i)
 {
\\ You only need 2 lines


 }
```

9. [30 points] Consider the array implementation of a heap of 12 elements illustrated below.

B	**M**	**K**	**Q**	**N**	**S**	**L**	**Z**	**W**	**P**	**R**	**U**	**X**	**B**	**V**	**W**	**K**	**A**

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Illustrate the implementation after insertion of the letter **E**.

10. [10 points]Three data items are stored in a cuckoo hash table of size 4. The first and second hash values of each item are shown below. The items are inserted in order A,B,C. Show the hash table at each step.

A	0	1
B	1	3
C	0	2

11. [15 points] Use polyphase mergesort to sort the array SQIBEWMCYRXOLHTZ. Show each phase.

12. [20 points] Suppose that the items of a queue are A, H, K, B, T in that order, where A is the front item.

    (a) Sketch the appearance of a circular linked list implementation of that queue.

    (b) Insert the item L into that queue. Show the steps. (You should draw at least two additional figures.)

13. [20 points] Fill in the code for the member functions `bool find(node*x,int y)` and `int length(node*x)` of the class `set` defined below. To save space, many lines have been deleted.

```
class set
 {
  public:
   bool empty();
   bool find(int);
   int cardinality();
  private:
   struct node
    {
     int item;
     node*next;
    };
   node*head;
   bool find(node*x,int y) // name of function overloaded
    {
//    only four lines here if you write short statements
//                on the same line as if or else




    }
   int length(node*x)
    {
//    only two lines here if you write short statements
//                on the same line as if or else


    }
 }; // end of definition of class set

bool set::find(int n)
 {
  return find(head,n); // overload: this is not the same function "find"
 }

int set::cardinality()
 {
  return length(head);
 }
```