Name: _____

CMSC132 Summer 2015 Final Exam

True/False (10 points, 2 points each)
Indicate whether the statement is true or false.

____ 1. (2 points) In a weighted graph, assume that the shortest path from a source 's' to a destination 't' is correctly calculated using a shortest path algorithm. Is the following statement true?
If we increase weight of every edge of the graph by 1, the shortest path always remains same.

____ 2. (2 points) Variabes of type Integer and int are both references.

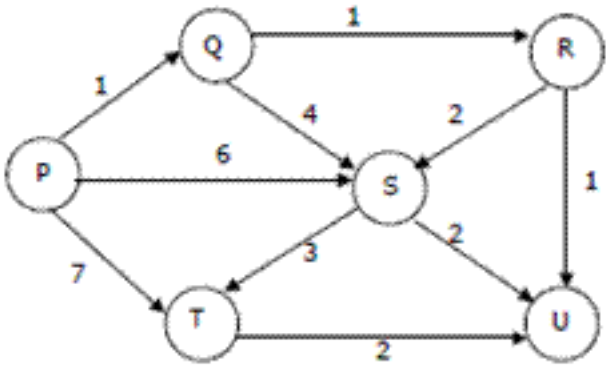
____ 3. (2 points) When implemented correctly, all methods of the Stack have the time complexity O(1).

____ 4. (2 points) With most efficient sorting algorithm, soting N numbers range from 1 to 10 takes O(N Log N) time.

____ 5. (2 points) To start the execution of a thread after you create it, you must call the run() method.

Multiple Choice (14 points, 2 points each)
Identify the choice that best completes the statement or answers the question.

____ 6. (2 points)
Suppose we run Dijkstra's single source shortest-path algorithm on the following edge weighted directed graph with vertex P as the source. In what order do the nodes get
included into the set of vertices for which the shortest path distances are finalized?

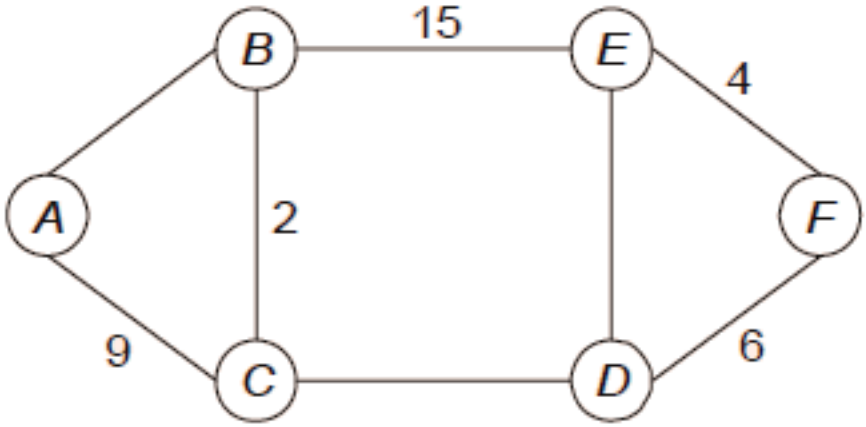


a. P, Q, R, S, T, U
b. P, Q, R, U, T, S
c. P, Q, R, U, S, T
d. P, Q, T, R, U, S

____ 7. (2 points) Let G be an undirected connected graph with distinct edge weight. Let emax be the edge with maximum weight and emin the edge with minimum weight. Which of the following statements is false?
a. Every minimum spanning tree of G must contain emin
b. If emax is in a minimum spanning tree, then its removal must disconnect G
c. No minimum spanning tree contains emax
d. G has a unique minimum spanning tree

Name: _____

____ 8. (2 points) The graph shown below 8 edges with **distinct integer** edge weights. The minimum spanning tree (MST) is of weight 36 and contains the edges: {(A, C), (B, C), (B, E), (E, F), (D, F)}. The edge weights of only those edges which are in the MST are given in the figure shown below. The minimum possible sum of weights of all 8 edges of this graph is .



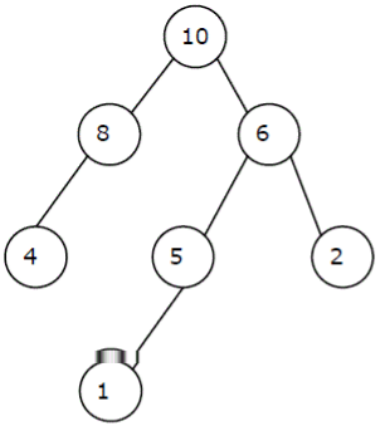
a. 66
b. 69
c. 68
d. 70

____ 9. (2 points) Which of the following traversal outputs the data in sorted order in a BST?
a. Preorder
b. InOrder
c. Postorder
d. Levelorder

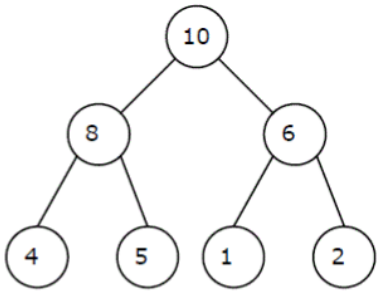
Name: _____

____ 10. (2 points) Which of the following is a max-heap?

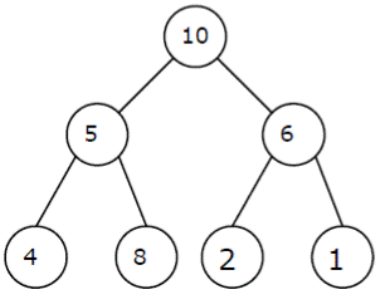
(A)



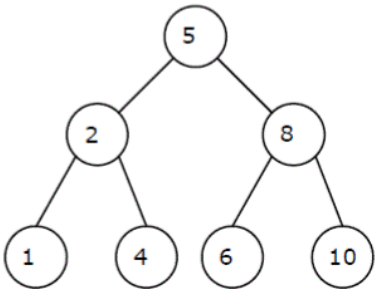
(B)



(C)



(D)



a.
b.
c.
d.

____ 11. (2 points) What is the value of mystery(4)?

```
public static int mystery(int n)
{
  if(1 == n) return 1;
  else return 3*mystery(n-1);
}
```

a. 27
b. 18
c. 36
d. 24

____ 12. (2 points) What are the correct intermediate steps of the following data set when it is being sorted with the Selection sort?
15,20,10,18

a. 10, 20,15,18 -- 10,15,20,18 -- 10,15,18,20
b. 15,20,10,18 -- 15,10,20,18 -- 10,15,20,18 -- 10,15,18,20
c. 15,18,10,20 -- 10,18,15,20 -- 10,15,18,20 -- 10,15,18,20
d. 15,10,20,18 -- 15,10,18,20 -- 10,15,18,20

Name: _____

Short Answer (44 points)

13. (2 points) Describe the order of magnitude of the following fucntions using Big-O notation:
    a) $N^2 + 2N$ O( )
    b) $N^5 + 100N^3 + 245$ O( )
    c) 3N Log N $+ N^2$ O( )
    d) (N * (N-1))/2 O( )

14. (2 points) Describe the order of magnitude of the following fucntions using Big-O notation:
    a)

```
f(N) =  O(          )
value = N;
count = 0;
while(value > 1){
        value = value/2
        count++;
}
```

    b)

```
f(N) =  O(          )
count = 0;
for(i = 1; i <= N; i++)
        count++;
for(i = N; i >= 0; i--)
        count++;
```

Name: _____

15. (6 points)
```
class MyRunnable implements Runnable{
        static Object lock = new Object();

        @Override
        public void run() {
                synchronized (lock) {                   // line #a
                        System.out.print("1 ");
                        System.out.print("2 ");
                }                                                       // line #b
        }
}

public class Main {
        public static void main(String[] args) throws InterruptedException {
                Thread t1 = new Thread(new MyRunnable());
                Thread t2 = new Thread(new MyRunnable());
                t1.start();
                t2.start();
                t1.join();
                t2.join();
        }
}
```

1) Will the code above have a data race ? Show all possible output(s) that can be printed. Note that each output will be printed in one line.
Answer:

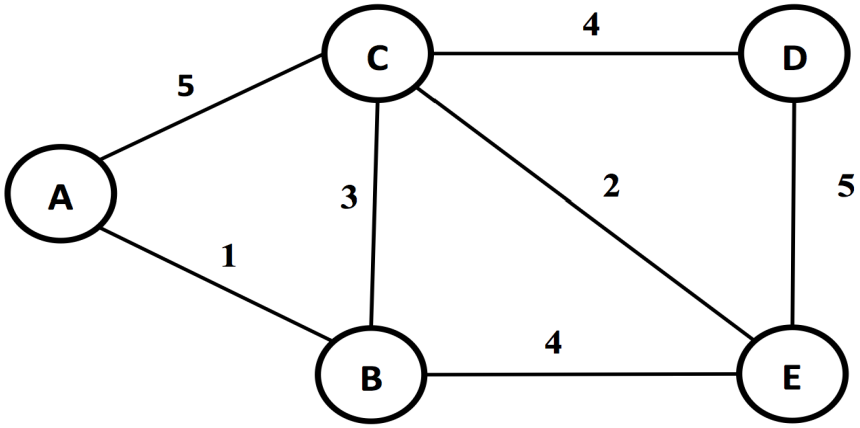
2) Answer the same question if we change line #a to synchronized(this).
Answer:

3) Answer the same question if we remove lines #a and #b.
Answer:

16. (2 points) Explain the difference between "==" and .equals()?
Answer:

.

Name: _____



17. (12 points)

A) (6 points) If we run the Dijkstra algorithm on the graph above starting from node A,

1. What is the distance from A to C after the ***first*** step of the algorithm?

Answer:

2. What is the distance from A to C after the ***second*** step of the algorithm?

Answer:

3. What is the set of reachable nodes from A after the ***third*** step of the algorithm?

Answer:

4. What are the shortest path and the distance from A to E at the end of the algorithm?

Answer:

B) (6 points) MST using the same graph

1. If we run the Prim's algorithm starting from node C, how does the current spanning tree look after the first two steps of the algorithm?

Answer:

2. If we run the Kruskal's algorithm, what is the set of edges (e.g. AC) after the first three steps of the algorithm?

Answer:

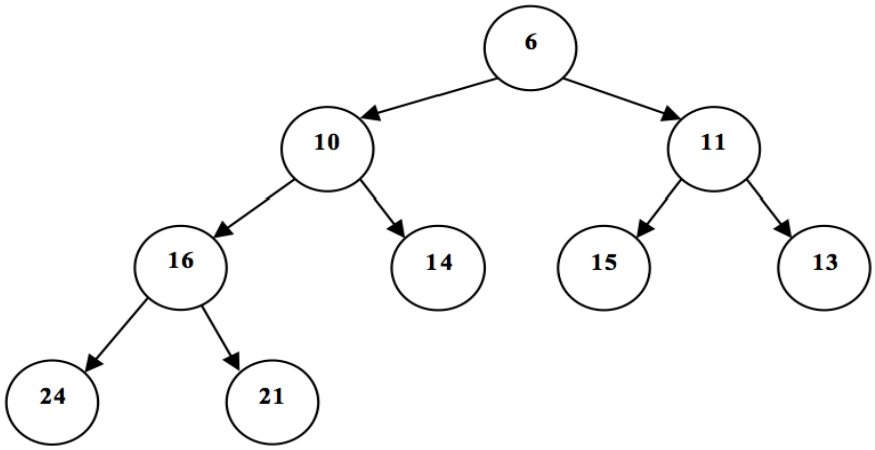
3. (True/False) The Prim's and Kruskal's algorithm will give the same minimum spanning tree for this instance of graph.

4. (True/False) Given a minimum spanning tree of the graph, the path from A to E in the tree is equivalent to the shortest path given by Dijkstra algorithm.

Name: _____

18. (2 points) What are the differences between shallow copy and deep copy?

19. (4 points) Use the following heap to answer the questions that follow.



a) Draw the heap that would result from inserting 8 in the above heap.

b) Draw the heap that would result by deleting 6 from the original heap.

Name: _____

20. (2 points) What does the following code fragment print when N is 50? Give a high level description of what it does when the input N is a positive integer.

```
Stack<Integer> stack = new Stack();
while(N>0){
   stack.push(N%2);
  N = N/2;
}
for(int d:stack) {
        System.out.print(d);
}
```

Answer:

.

21. (5 points) Construct a RED & Black Tree by inserting M, G C,D. Draw the tree for each insertion. Use dotted line for red edges.

step 1: insert M

(M)

step 2: insert G

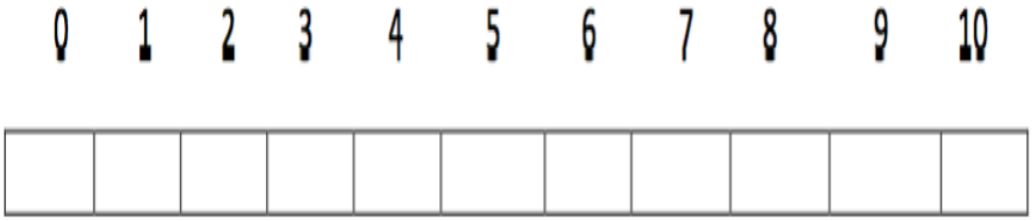
step 3: insert C

step 4: insert D

.

Name: _____

22. (5 points) Let the hash table be an 11-element array. If k is the key of a data record, let H(k) represent the hash function, where H(k)=k mod 11.
a) Insert the keys 83, 14, 29, 70, 10, 55, 72,36



b) How many collision occurred during the insertion of the value "36"?
Answer:

.

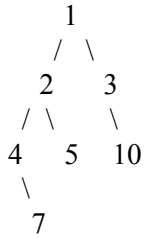
23. (2 points) What is difference between List<? extends T> and List <? super T> ?

Name: _____

Coding Problems (32 points)

24. (6 points) Given a Binary Tree and a key, write a function that prints all the ancestors of the key in the given binary tree.

    For example, if the given tree is following Binary Tree and key is 7, then your function should print 4,2,1.

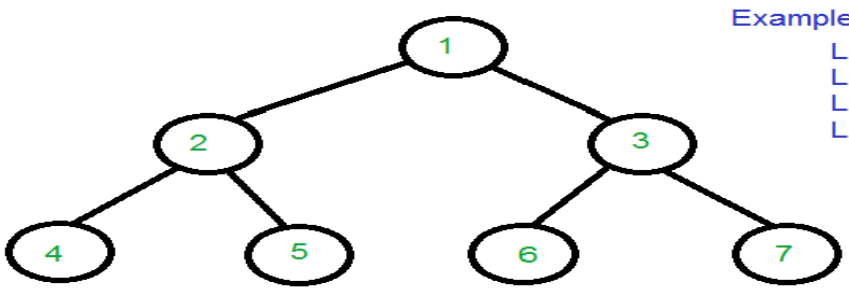


    Answer:

.

Name: _____

25. (6 points) Let T be a rooted tree. The lowest common ancestor between two nodes n1 and n2 is defined as the lowest node in T that has both n1 and n2 as descendants



Examples

LCA(4, 5) = 2
LCA(4, 6) = 1
LCA(3, 4) = 1
LCA(2, 4) = 2

```
class Node{
        int key;
        Node left, right;
        Node parent; //references the parent node
}
```

Given a binary tree and two values say n1 and n2, write a function "
public Node lca(Node n1, Node n)" to find the least common ancestor.
Answer:

.

Name: _____

26. (5 points) A binary tree node is defined as:

```
class Node {
     private Integer key;
     private Node left, right;
}
```

A full binary tree is a tree in which every node other than the leaves has two children. Write a method isFull() that returns true if the binary search tree is full and returns false otherwise. It should return false if the tree is empty.

Answer:

.

Name: _____

27. (5 points) The linked list node is defiend as:

```
class Node{
      Integer data;
      Node next;
}
```

Write a recursive method "int sum(Node r)", which receives a linked list and returns the sum of all data in the list
Answer:

.

28. (5 points) A binary heap is stored in an array pq[]. Root is stored in index 1. Design a linear-time function to check whether an array is a min-oriented heap.
Answer:

.

Name: _____

29. (5 points) MaxPQ is the max oriented priority queue class, which stores the data in an array pq[ ]. Add a min() method to MaxPQ. Your implementation should use constant time and constant extra space. You are allowed to add member variables in MaxPQ class and change member methods.

Answer:

.