CSE 2320 Name _____
Test 1
100 points UTA Student ID # _____

Multiple Choice. Write your answer to the LEFT of each problem. 5 points each

1. Which of the following statements is true about HEAPSORT?
   A. It is stable.
   B. It has a worse-case time in $\theta(n^2)$.
   C. Its average-case time is in $\theta(n \log n)$
   D. The decision-tree lower bound does not apply to it.
2. The worst-case time to change the priority of a heap element is:
   A. $\theta(1)$
   B. $\theta(\log n)$
   C. $\theta(n)$
   D. $\theta(n \log n)$
3. Assuming that comparisons take $\theta(1)$ time, the worst-case time to merge two ordered tables with m and n elements is:
   A. $\theta(1)$
   B. $\theta(\log n)$
   C. $\theta(mn)$
   D. $\theta(m+n)$
4. You would like to determine if an ordered table of n numbers has any duplicated values. This will take how much time in the worst case?
   A. $\theta(1)$
   B. $\theta(\log n)$
   C. $\theta(n)$
   D. $\theta(n \log n)$
5. Suppose the 201 priorities in a max-heap are unique. Which of the following subscripts may not contain the minimum priority?
   A. 100
   B. 101
   C. 199
   D. 200
6. As n approaches infinity, H_{2n}/H_n approaches?
   A. 1
   B. 2
   C. ln n
   D. n!
7. Suppose that $f(n) \in \theta(h(n))$ and $g(n) \in \theta(h(n))$. Which of the following is not required?
   A. $h(n) \in \theta(g(n))$
   B. $g(n) \in \Omega(h(n))$
   C. $h(n) \in O(f(n))$
   D. There is a constant c such that $cf(n)=g(n)$ for all n.
8. Which of the following functions is in $O(n^3)$ and $\Omega(\log n)$, but not $\Omega(n^2)$?
   A. 3
   B. n log n
   C. n^2 log n
   D. n^2

Long Answer.

1. Use the recursion-tree method to show that $T(n) = 2T(n/4) + n^2$ is in $\Theta(n^2)$. 15 points
2. Use the substitution method to show that $T(n) = 2T(n/4) + n^2$ is in $\Theta(n^2)$. 15 points
3. Indicate precisely what each of the following three functions will return. DO NOT GIVE THE NAME OF A VARIABLE!!! 10 points

```
int test1a(a,N,key)
int *a;
int N,key;
{
  int low,high,mid;
  low=0;
  high=N-1;
  while (low<=high)                    Returns:
  {
    mid=(low+high)/2;
```

```
    if (a[mid]<=key)
      low=mid+1;
    else
      high=mid-1;
  }
  return high;
}

int test1b(a,N,key)
int *a;
int N,key;
{
  int low,high,mid;
  low=0;
  high=N-1;
  while (low<=high)                    Returns:
  {
    mid=(low+high)/2;
    if (a[mid]<key)
      low=mid+1;
    else
      high=mid-1;
  }
  return low;
}

int test1c(a,N,key)
int *a;
int N,key;
{
  int low,high,mid;
  low=0;
  high=N-1;
  while (1)                        Returns:
  {
    if (high<low)
      return (-1);
    mid=(low+high)/2;
    if (a[mid]==key)
      return mid;
    if (a[mid]<key)
      low=mid+1;
    else
      high=mid-1;
}
}
```

4. Show the result after PARTITION manipulates the following subarray. 10 points.
   1 10 2 9 3 8 4 7 6 5
5. Briefly explain the phases in a counting sort. 5 points
6. Explain why the decision-tree model does not apply to radix sort. 5 points

CSE 2320 Name _____
Test 2
100 points UTA Student ID # _____

Multiple Choice - 5 points each. WRITE your answer to the LEFT of each problem.

1. Which of the following statements is not true about linear probing?
   A. It has primary clustering.
   B. It has secondary clustering.
   C. Ordered retrieval is not supported
   D. The size of the table should be prime.
2. A double hash table is 80% full. How many probes do you expect to use for unsuccessful searches?
   A. 1
   B. 3
   C. 5
   D. 7
3. What color is the sentinel in a red-black tree?
   A. Black
   B. Red
   C. The color of the last node deleted.
   D. Unlike any other node, it is both black and red.
4. The conventional way to check if a circular queue is empty is to test:

A. head == tail
B. SP == 0
C. SP == (-1)
D. queue[queue[head].next] == queue[queue[tail].prev]

5. In a binary search tree, which element does not have a predecessor?
   A. any one of the leaves
   B. the maximum
   C. the minimum
   D. the root
6. Operations on a binary search tree for n keys take this amount of time.
   A. O(log n)
   B. O(n)
   C. O(n log n)
   D. O(h), where h is the height of the tree
7. If POP is implemented as return stack[SP--], then PUSH of element X is implemented as:
   A. return stack[SP++]
   B. stack[SP++] = x
   C. stack[--SP] = x
   D. stack[++SP] = x
8. Which type of linked list is most convenient if PREDECESSOR and SUCCESSOR operations will be frequent?
   A. ordered, doubly-linked
   B. ordered, singly-linked
   C. unordered, doubly-linked
   D. unordered, singly-linked

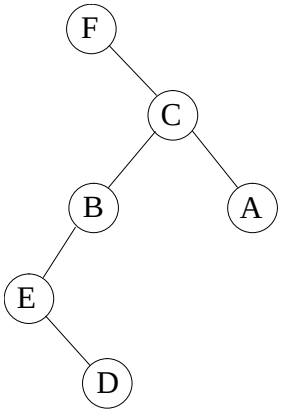
Long Answer. 10 points each

1. Place the given keys into a hash table in the indicated order. The h_1 function is $h_1(x) = (x + 3) \bmod 7$. The h_2 function is $h_2(x) = 1 + (x \bmod 6)$. 10 points

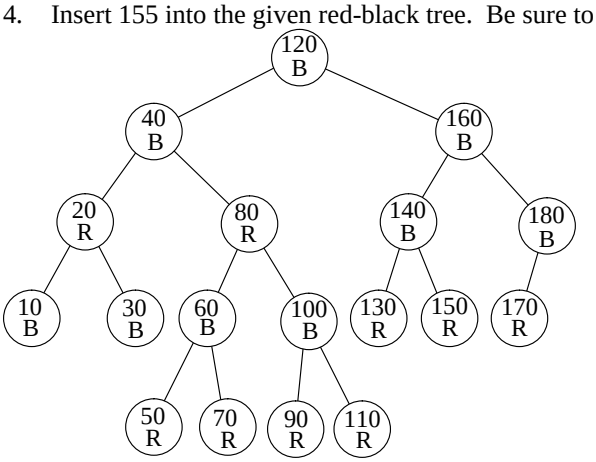
0	
1	
2	
3	
4	
5	
6	

86
94
87
62
122
110
20

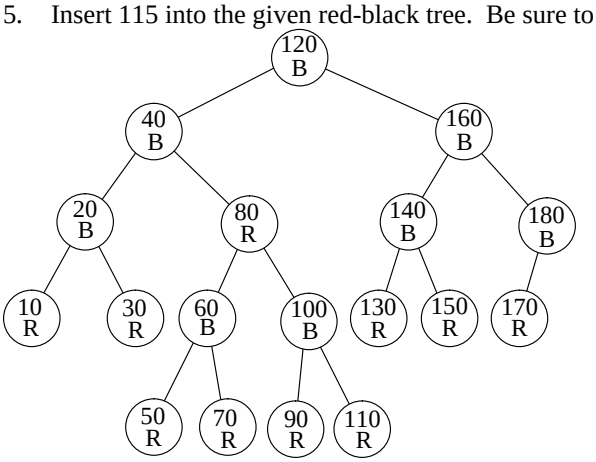
2. List the three traversals for the following binary tree. 5 points.



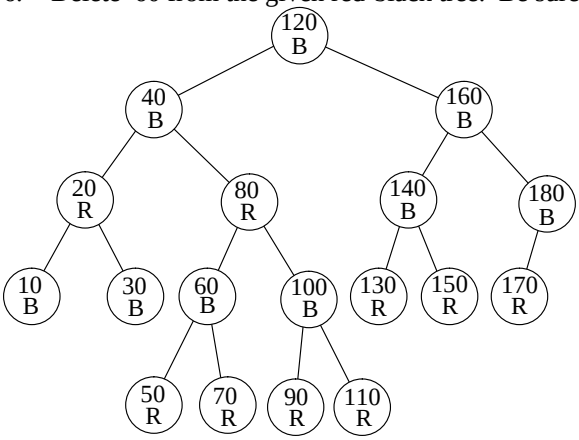
3. What is a load factor? 5 points.
4. Insert 155 into the given red-black tree. Be sure to indicate the cases that you used. 10 points



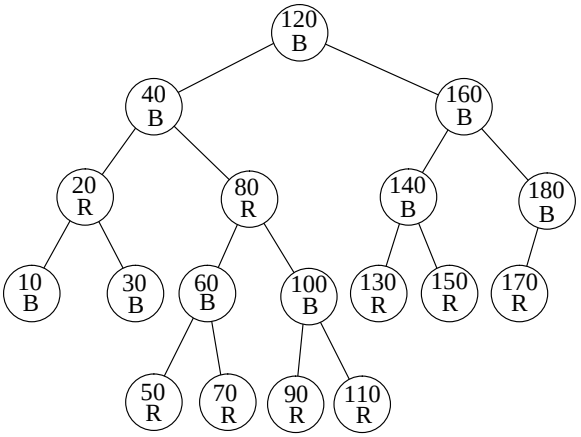
5. Insert 115 into the given red-black tree. Be sure to indicate the cases that you used. 10 points



6. Delete 60 from the given red-black tree. Be sure to indicate the cases that you used. 10 points



7. Delete 20 from the given red-black tree. Be sure to indicate the cases that you used. 10 points



CSE 2320 Name _____

Test 3

100 points UTA Student ID # _____

Multiple Choice - 4 points each

1. Dijkstra's algorithm computes:
   A. All-pairs shortest paths
   B. The minimum spanning tree
   C. The reachability matrix
   D. The shortest-path tree from a single source
2. Prim's algorithm computes:
   A. All-pairs shortest paths
   B. The minimum spanning tree
   C. The reachability matrix
   D. The shortest-path tree from a single source
3. The time to compute the KMP fail links for a pattern with m symbols and a text with n symbols is:
   A. O(m)
   B. O(n)
   C. O(m+n)
   D. O(mn)
4. The time to compute the optimal strategy for multiplying n matrices is:
   A. O(n)
   B. O(n log n)
   C. $O(n^2)$
   D. $O(n^3)$
5. A directed graph has a topological sort only if what edge type does not occur during depth-first search?
   A. Back
   B. Cross
   C. Forward
   D. Tree
6. During breadth-first search, having a vertex colored gray means:
   A. All vertices reachable from this vertex have been discovered
   B. The vertex has not been discovered yet
   C. The vertex is in the queue
   D. The vertex is in the stack (e.g. due to recursion)
7. A minimum cut is found by:
   A. Breadth-first search on the original network.
   B. Determining the minimum of the sum of the capacities into the sink and the sum of the capacities leaving the source.
   C. Determining the vertices reachable from the source in the residual graph when no augmenting paths remain.
   D. Enumerating all cuts and finding the one with the smallest capacity.
8. The Huffman code tree construction is an example of:
   A. Breadth-first search
   B. Dynamic programming
   C. Greedy technique yielding an approximate solution
   D. Greedy technique yielding an optimal solution
9. Suppose an instance of bipartite matching is to be translated into an instance of the network flow problem and solved using Ford-Fulkerson. If the graph has 10 vertices in the left column and 20 vertices in the right column, what is the maximum number of augmenting paths?
   A. 10
   B. 20

C. 30
D. 100

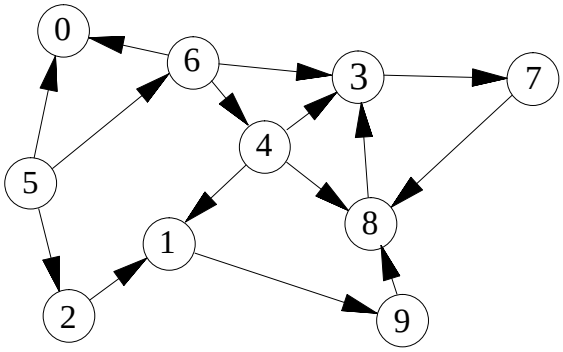
10. The fractional knapsack problem is an example of:
    A. Breadth-first search
    B. Dynamic programming
    C. Greedy technique yielding an approximate solution
    D. Greedy technique yielding an optimal solution

Long Answer.

1. Complete the following instance of KMP failure link table construction. 10 points

	1	2
0	a	
1	b	
2	c	
3	a	
4	b	
5	d	
6	a	
7	b	
8	a	

2. Perform depth-first search on the following graph, including start/finish times and edge types (T=tree, B=back, C=cross, F=forward. Assume that the adjacency lists are ordered. Write your answer in the tables below. 10 points

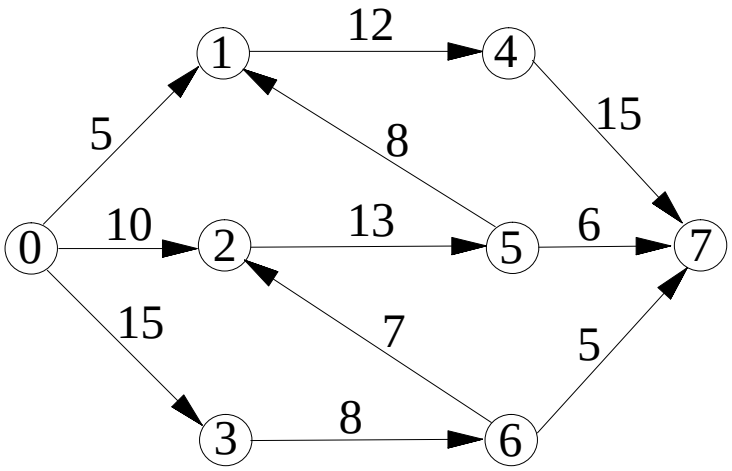


Vertex	Start	Finish	Edge	Type	Edge	Type
0	_____	_____	$1 \rightarrow 9$	_____	$6 \rightarrow 3$	_____
1	_____	_____	$2 \rightarrow 1$	_____	$6 \rightarrow 4$	_____
2	_____	_____	$3 \rightarrow 7$	_____	$7 \rightarrow 8$	_____
3	_____	_____	$4 \rightarrow 1$	_____	$8 \rightarrow 3$	_____
4	_____	_____	$4 \rightarrow 3$	_____	$9 \rightarrow 8$	_____
5	_____	_____	$4 \rightarrow 8$	_____		
6	_____	_____	$5 \rightarrow 0$	_____		
7	_____	_____	$5 \rightarrow 2$	_____		

8 _____ _____ $5 \rightarrow 6$ _____

9 _____ _____ $6 \rightarrow 0$ _____

3. Determine augmenting paths for determining a maximum flow and give a minimum cut for the following network. 0 is the source and 7 is the sink. 10 points.



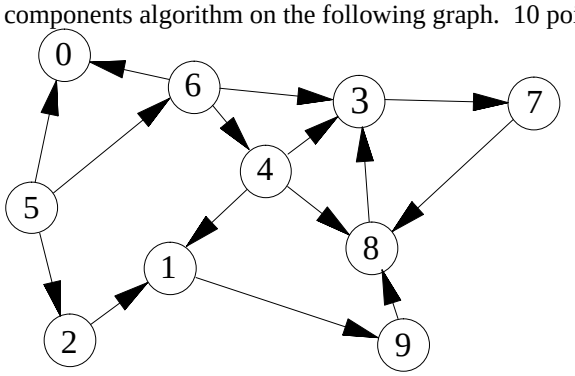
S vertices: 0
T vertices: 7
Augmenting Paths and Contribution to Flow:

4. Complete the following instance of the optimal matrix multiplication ordering problem, including the tree showing the optimal ordering. 10 points

```
p[0]=2
p[1]=6
p[2]=5
p[3]=4
p[4]=6
p[5]=2
```

	1	2	3	4	5
1	0 0	60 1	100 2	148 3	??? ?
2	-------	0 0	120 2	264 3	148 2
3	-------	-------	0 0	120 3	88 3
4	-------	-------	-------	0 0	48 4
5	-------	-------	-------	-------	0 0

5. Demonstrate the strongly-connected components algorithm on the following graph. 10 points.



6. Demonstrate Warshall's algorithm, with successors, on the following graph. 10 points.