1. Select the correct choice. (10 scores)

(3) For sequential search,

(A) The best, average, and worst cases are asymptotically the same.

(B) The best case is asymptotically better than the average and worst cases.

(C) The best and average cases are asymptotically better than the worst case.

(D) The best case is asymptotically better than the average case, and the average case is asymptotically better than the worst case.

(4) We use the parent pointer representation for general trees to solve which problem?

(A) Shortest paths (B) General tree traversal

(C) Equivalence classes (D) Exact-match query

(5) The most effective way to reduce the time required by a disk-based program is to:

(A) Improve the basic operations. (B) Minimize the number of disk accesses.

(C) Eliminate the recursive calls. (D) Reduce main memory use.

(9) The most important advantage of a 2-3 tree over a BST is that:

(A) The 2-3 tree has fewer nodes. (B) The 2-3 tree has a higher branching factor.

(C) The 2-3 tree is height balanced. (D) None of all above.

(10) Which best characterizes the performance of the splay tree?

(A) All operations require O(log n) time.

(B) m operations require a total of O(m log n) time for m > n.

(C) All operations require O(n) time. (D) None of all above.

2. Determine Θ for the following code fragments in the average case. Assume that all variables are of type int. (9 scores)

(1)
```
sum=0;
for (i=0; i<3; i++)
   for (j=0; j<n; j++)
      sum++;
```

(2) Assume array A contains a random permutation of the values from 0 to n-1.
```
sum=0;
for (i=0; i<n; i++)
   for (j=0; A[j]!=i; j++)
      sum++;
```

(3)
```
sum=0;
if (EVEN(n))
  for (i=0; i<n; i++)
     sum++;
else
     sum=sum+n;
```

5. Show the max-heap that results from running buildheap on the following values stored in an array: 44, 66, 33, 88, 77, 55, 22. (10 scores)

7. Show the shortest paths generated by running Dijkstra's shortest-paths algorithm on the graph, beginning at Vertex 1. Show the D values as each vertex is processed. (10 scores)