Data Structure, Quiz 2

A. Single Choice Questions (5% each, 60%)

(1) Which of the following statements about sorting algorithms is TRUE?

(A) Insertion sort performs consistently regardless of the initial order of the array because it always identifies the smallest (or largest) element to position it correctly.

(B) The worst-case scenario for selection sort occurs when the array is in reverse order, requiring each element to be compared and potentially swapped multiple times to reach its correct position.

(C) Merge sort is considered a stable sorting algorithm because, during the merging process, if two elements from the merged arrays are equal, the element from the left (or first) array is always prioritized.

(D) The time complexity of shell sort is consistently $O(n \log n)$, independent of the array's initial arrangement.

(2) Given the list of numbers `[15, 19, 11, 5, 2, 29, 12, 14, 13, 22]`, identify the resulting array after the first partitioning step in a quicksort algorithm, assuming the first element is used as the pivot. Which of the following represents the correct order?

(A) `[12, 13, 11, 5,  2, 14, 15, 29, 19, 22]`

(B) `[14, 11, 19, 5,  2, 15, 12, 13, 29, 22]`

(C) `[13, 12, 11, 2,  5, 14, 15, 19, 29, 22]`

(D) `[15, 12, 13, 11, 5, 22, 29, 14,  2, 19]`

(3) Identify the preferred data structures used in BFS (Breadth-First Search), DFS (Depth-First Search), Dijkstra's algorithm, and Prim's algorithm, respectively:

(A) Stack, Queue, Priority Queue, Priority Queue.

(B) Priority Queue, Stack, Priority Queue, Queue.

(C) Queue, Stack, Priority Queue, Hash table.

(D) Queue, Stack, Priority Queue, Priority Queue.

(4) Which of the following tree is NOT a binary tree, assuming each number is a node?

(A)

```
    15
   /
   6
  /
  3
```
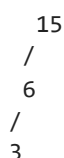
(B)

```
   13
```

(C)

```
   13
  / | \
 8 5 3
```

(D)

```
   21
  /   \
 8    23
/
1
```

(5) What is the last node you will visit when you search number 8 in the following binary search tree?

```
    17
   /  \
  6   19
 / \ / \
3 9 18 22
```

(A) 17

(B) 3

(C) 9

(D) 18

(6) Given $[1,15,5,21,29,12,16]$. Identify the FALSE statement:

(A) Insertion sort requires six passes to completely sort the list.

(B) Using a sequential search, the number 5 will be found more quickly than the number 29.

(C) After sorting the list in ascending order using bubble sort and employing a binary search, the number 15 will be found more quickly than the number 16.

(D) If the list is sorted in ascending order using shell sort, then using a sequential search will find the number 15 more quickly than a binary search would.

(7) For the postorder traversal sequence of the binary tree below, which of the statement is TRUE?

```
        A
       /   \
      B     D
     /     / \
    E     H   J
   /\    /\
  K L   F M
```

(A) Node B appears at the second position.

(B) Node M appears after node D.

(C) Node A appears between node B and node D.

(D) Node H appears immediately before node J.
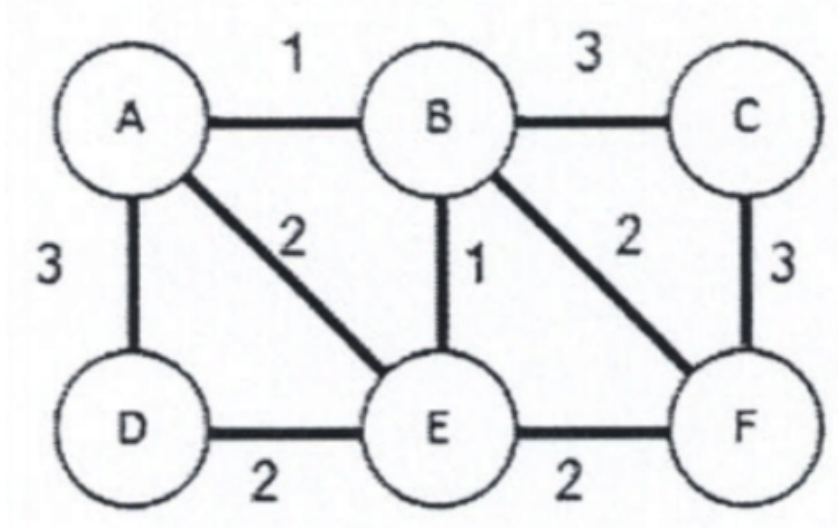
(8) Which of the following statements is TRUE?

(A) Prim's algorithm identifies the same minimum spanning tree in a graph, regardless of the starting vertex.

(B) Dijkstra's algorithm cannot find the shortest path correctly if there are negative weights.

(C) The adjacency matrix representation is more memory efficient compared to the adjacency list for a graph.

(D) The BFS algorithm can find the shortest path between two nodes in a weighted graph.

(9) Given a weighted directed graph with negative edges as follows, what are the vertices in the order they are selcted bt the Dijkstra's algorithm?
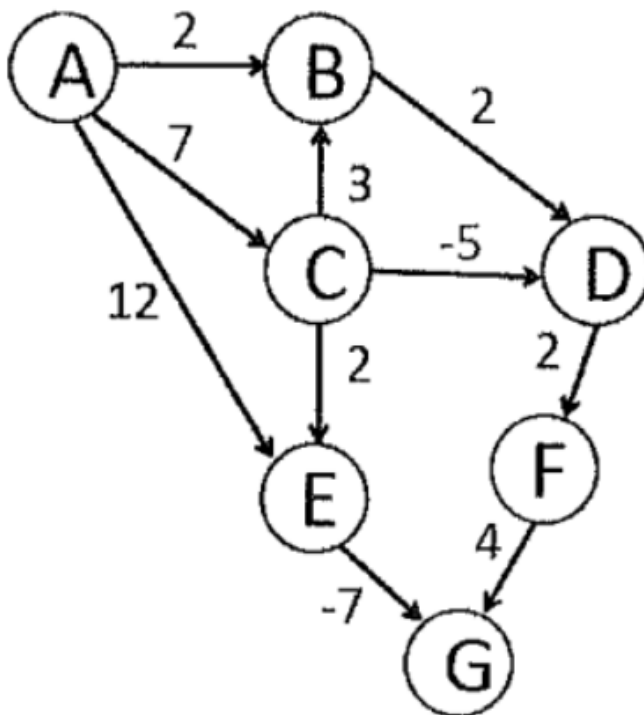
(A) A, B, D, F, C, G, E

(B) A, B, D, F, C, E, G

(C) A, B, C, F, D, F, G

(D) A, B, D, F, G, C, E

(10) Considering the graph provided, which edge does not appear in any minimum spanning tree of the graph?

(A) (B, E)

(B) (A, E)

(C) (C, F)

(D) (B, C)

(11) Which of the following lists would NOT be obtained at some point when applying the insertion sort algorithm to the list below?

[9,2,5,5,7,9,1]

(A) [2,9,5,5,7,9,1]

(B) [2,5,5,9,7,9,1]

(C) [2,5,5,7,9,9,1]

(D) [2,5,5,9,9,7,1]

(12) Which of the following statements is FALSE?

(A) A binary tree can still be considered a binary tree even if it contains only one element.

(B) In inorder traversal, the left subtree is processed first, followed by the root node, and finally the right subtree.

(C) The balance factor of an AVL tree is always -1, 0, or 1.

(D) The time complexity of DFS and BFS for a tree can be reduced to $O(|E|)$.

B. Short-answer questions, please provide the derivation for each question along with your answer (8% each, 40%).

## (13) Briefly explain each of the following terms.

(a) Collision Resolution

(b) Stable sort

(c) Priority Queue

(14) Suppose you are given the following set of keys to insert into a hash table that holds exactly 11 values: `113` , `117` , `97` , `100` , `114` , `108` , `116` , `105` , `99`. What is contents of the hash table after all the keys have been inserted using remainder method and quadratic probing?

(15) Consider the sequence of keys: `10, 4, 9, 8, 12, 15, 3, 5, 14, 18` for insertion into a heap. Please illustrate the min heap after each insertion step, and provide the final configuration of the min heap after all these keys have been inserted into the min heap.

(16) Given the following weighted graph, illustrate the order in which the edges are added to the minimum spanning tree using Prim's algorithm, assuming we start from vertex A. Also, calculate the total cost of the minimum spanning tree.
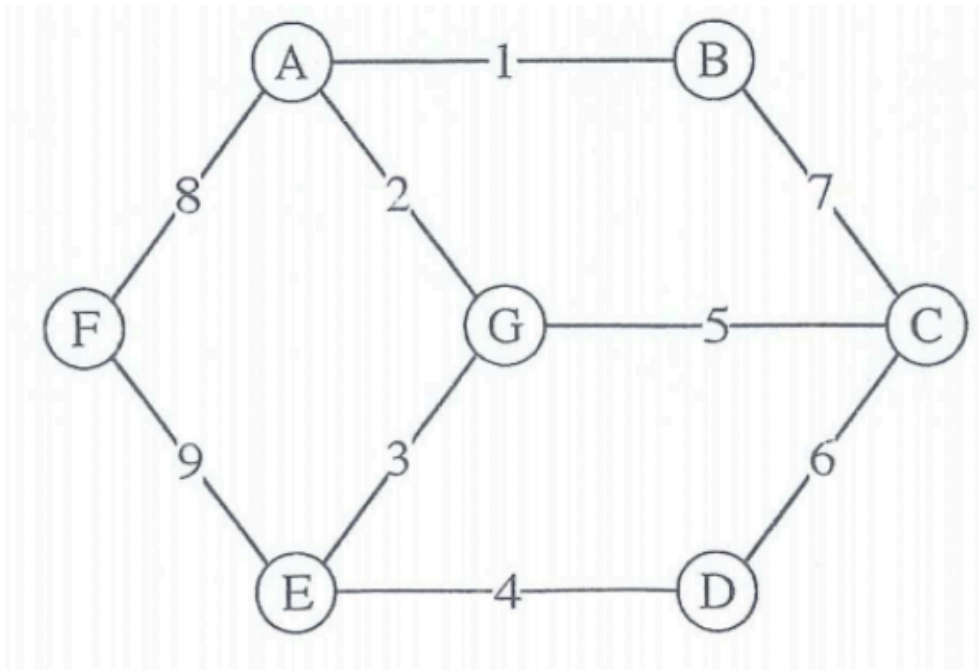
(17) A binary tree consists of six nodes. Given the preorder and inorder traversal sequences of the tree as follows, determine whether it is possible to construct the tree. If possible, please draw the tree. If not, provide an explanation as to why the tree cannot be constructed.

```
Preorder: ABEFCD
Inorder:  CBDAEF
```