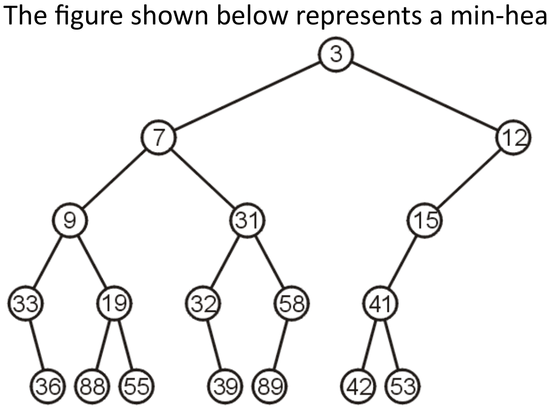
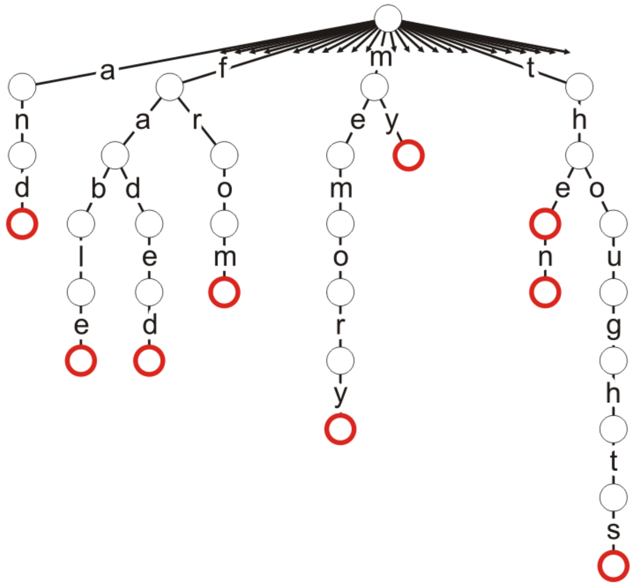
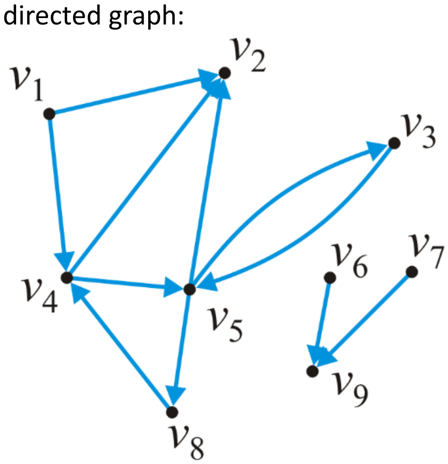
AV121 – Data Structures and Algorithms
Practice Questions – End-sem

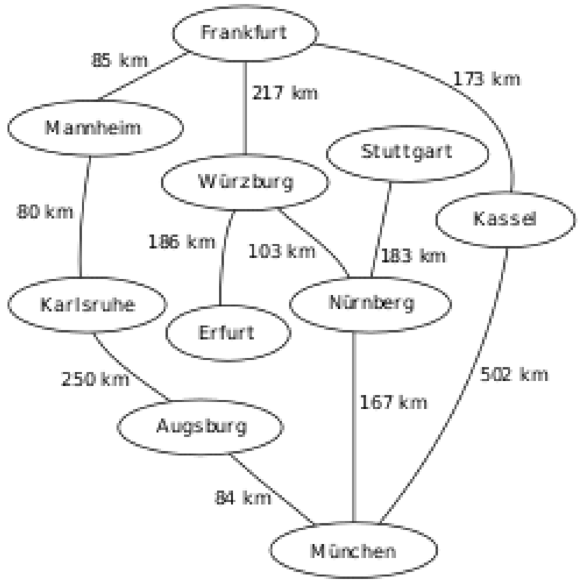
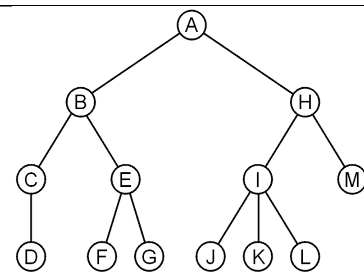
Part 1

Questions in this part carry 5 marks each. Give short answers.

Note 1: Part 1 of the end-semester question paper will contain 10 questions of this type (Total: 50 marks)

1.1	What is a min-heap? What are the basic operations to be supported by a min-heap? What are the applications of a min-heap?	(5 marks)
1.2	Construct at 2-3 tree from the following three numbers inserted in the given order: 100, 150, 120, 130, 140 (Show the tree after each step). Are 2-3 trees binary search trees? Justify your answer with an example.	(5 marks)
1.3	State whether the following statement is true or false: "Dijkstra's Single Source Shortest Path algorithm always gives an optimal solution to the Traveling Salesman Problem" Explain your answer with an example.	(5 marks)
1.4	The figure shown below represents a min-heap data structure:  Answer the following questions based on the above figure: a. Is the above data structure a complete binary tree? b. Show the steps to be carried out in a POP operation is done c. Show the steps to be carried out if PUSH (17) operation is done	(5 marks)

1.5	List down all the valid words in the dictionary represented by the following trie data structure: 	(5 marks)
1.6	Show the adjacency matrix and adjacency list representations for the following directed graph:  Which of the above representations is more suited for a sparse graph? Why?	(5 marks)

1.7	Carry out BFS and DFS on this graph, starting at Frankfurt:  	(5 marks)
1.8	What is the Traveling Salesman Problem? Are there polynomial time algorithms that can solve the TSP? Give an example of an approximation algorithm that solves the TSP in polynomial time.	(5 marks)
1.9	Answer the following questions based on the given tree: a) Which node is the root? b) List any two paths from the root to a leaf node c) Which are the leaf nodes? d) What is the length of the longest path possible?  	(5 marks)
1.10	In a hash table, what do you mean by the term ‘collision’? What is separate chaining and open addressing.	(5 marks)

Part 2

Questions in this part carry 10 marks each. Please give detailed answers.

Note 2: Part 2 of the Quiz 2 question paper will contain 6 questions of this type. You must answer any 5 out of the 6 questions provided (Total: 50 marks)

<table>
<tr><td>2.1</td><td>Construct an undirected graph from the following set of edges and vertices:

V = {A,B,C,D,E,F,G,H,I,J}
E = {(A,B), (B,C), (B,D), (E,F), (E,G), (H,I)}

Show the elements in a disjoint set constructed from the above graph, based on the equivalence relation “Vertex X is equivalent to Vertex Y if X and Y belong to a connected component”.

If an edge (B,E) is added to the set of edges, does it change the above disjoint set? If yes, show the resulting disjoint set.</td><td>(10 marks)</td></tr>
<tr><td>2.2</td><td>What is the worst-case input scenario (In terms of efficiency) for a traditional binary search tree? Explain with an example.

Which other search tree can be used to avoid the above inefficiency for a traditional BST? Demonstrate the benefits of your suggestion using the same example.</td><td>(10 marks)</td></tr>
<tr><td>2.3</td><td>Explain how a Red-black tree can be augmented to store intervals instead of individual values.

Describe an algorithm that can search through the above tree.

Construct an instance of the above tree by inserting the following intervals in the given order:
[16,21]
[8,9]
[5,8]
[15,23]
[0,3]
[6,10]
[25,30]
[17,19]
[26,26]
[19,20]</td><td>(10 marks)</td></tr>
</table>

2.4	Construct a min-heap using the complete binary tree representation by inserting the following numbers in the given order: 50, 75, 80, 100, 125, 90 How can a heap be constructed so that it can be efficiently represented as an array?	(10 marks)
2.5	What are the necessary properties of a hash function? Explain how a hash table works with an example. If you encounter any collisions while inserting values into a hash table what can be done to handle colliding values?	(10 marks)
2.6	What are AVL trees? Explain in detail why they are better than traditional binary search trees for storing large amounts of data? Construct an AVL tree from the following elements (in the order given below) 10, 30, 70, 90, 80, 6, 2 Show the tree after inserting each number. After inserting the last number, what is the height of the resulting AVL tree?	(10 marks)
2.7	Compare the following techniques in the context of hash tables: • Linear Probing • Quadratic Probing • Universal Hashing	(10 marks)
2.8	What is a priority queue? Explain how it can be implemented using a heap data structure. Describe the following operations on a min-heap with examples: • Top • Push • Pop	(10 marks)

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<td>2.9</td>
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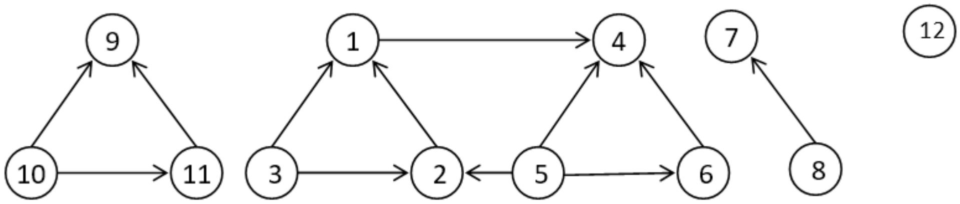
Explain the following terms in the context of graphs:

- Connected component
- Simple Cycle
- Simple Path
- Acyclic Graph

Draw the spanning tree for the graph shown below:



</td>
<td>(10 marks)</td>
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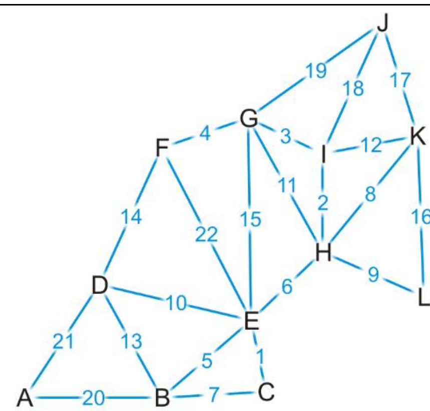
<tr>
<td>2.10</td>
<td>
For the given graph, describe algorithms to find out the following:

- Minimum Spanning Tree
- Shortest Path from A to all other vertices

Explain why the shortest path algorithm may not give the minimum spanning tree always.



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<td>(10 marks)</td>
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