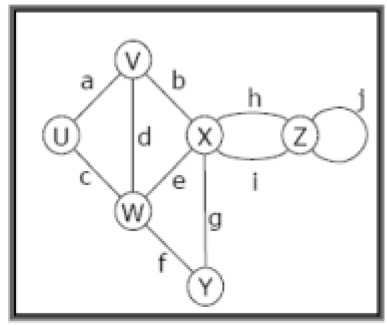
Alexandria University
Faculty of Engineering
Computer and Systems Engineering Department

CSE-X22: Data Structures I

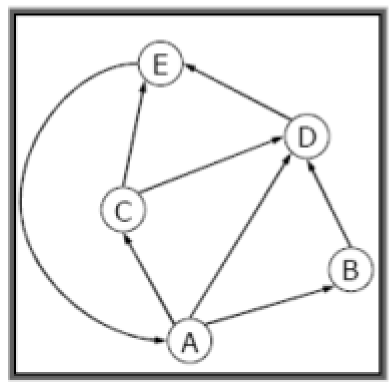
Sheet 5
Graphs and Hashing

1. For the following graphs, list the following:

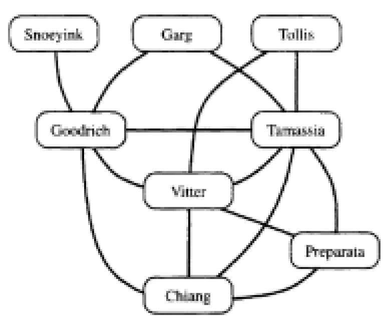
1. Vertices
2. Degree of each vertex
3. Parallel edges
4. Self loops
5. Adjacent vertices



1. Vertices
2. In-degree and out-degree of each vertex



2. Draw the adjacency list and adjacency matrix representation of the following undirected graph



3. Let G be a graph whose vertices are the integers 1 through 8 and let the adjacent vertices of each vertex be given by the table below:

Vertex	Adjacent vertices
1	(2, 3, 4)
2	(1, 3, 4)
3	(1, 2, 4)
4	(1, 2, 3, 6)
5	(6, 7, 8)
6	(4, 5, 7)
7	(5, 6, 8)
8	(5, 7)

Assume that, in a traversal of G, the adjacent vertices of a given vertex are returned in the same order as they are listed in the table.

1. Draw G.
2. Give the sequence of vertices visited using a DFS traversal starting at vertex 1.
3. Give the sequence of vertices visited using a BFS traversal starting at vertex 1.

4. Bob loves foreign languages and wants to plan his course schedule for the following years. He is interested in the following 9 language courses: LA15, LA16, LA22, LA31, LA32, LA126, LA127, LA141 and LA 169.

The course prerequisites are:

- LA15 : (none)
- LA16 : LA15
- LA22 : (none)
- LA31 : LA15
- LA32 : LA16, LA31
- LA126 : LA22, LA32
- LA127 : LA16
- LA141 : LA22, LA16
- LA 169 : LA32

Find the sequence of courses that allows Bob to satisfy all the prerequisites.
Hint: Check topological sort

5. Prove that:

• If G is an undirected graph having n vertices and m edges:

1. If G is connected then $m \geq n - 1$
2. If G is a tree then $m = n - 1$
3. If G is a forest then $m \leq n - 1$
4. If G is a complete graph then $m = n * (n - 1) / 2$

• If G is a directed graph having n vertices, then the maximum number of edges is $n(n - 1)$

Hint: A tree is a connected graph with no cycles. A forest is a graph with each connected component a tree.

6. Write an algorithm to detect if an undirected graph contains cycles.

7. Draw the 11-entry hash table that results from using the hash function

h(i) = (2i + 5) mod 11

to hash the keys:

12, 44, 13, 88, 23, 94, 11, 39, 20, 16 and 5.

assuming collisions are handled by **separate chaining.**

8. Solve the previous problem again assuming collisions are handled by linear probing.

9. Solve the previous problem again assuming collisions are handled by quadratic probing.

10. Solve the previous problem again assuming collisions are handled by double hashing using the secondary hash function:

h‘(k) = 7(k mod 7)

11. Describe how to perform a removal from a hash table that uses linear probing to resolve collisions where we do not use a special marker to represent deleted elements. That is, we must rearrange the contents so that it appears that the removed entry was never inserted in the first place.