# COSC 222 Data Structure

Final Exam Review

# Exam Details

- April 22, 2025 7:00PM
  - ASC 140
  - 2 hours
- Contents:
  - Comprehensive

    i.e. covers all course material
  - Excludes advanced topics

    i.e. everything before this lecture
- Format
  - Similar to midterm exam
  - Closed book
  - No notes, no cheat sheet

# Exam Details

- Mid-term mark upgrade
  - All students have the option to replace their midterm mark.
  - If your final exam mark is higher than the midterm
    then the midterm mark will be replaced with the higher mark.

# Review

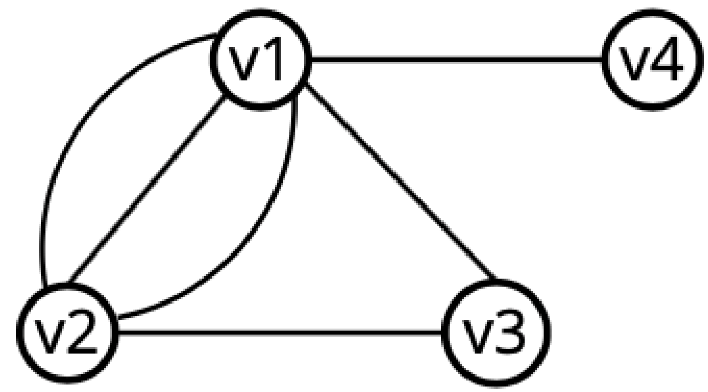
Q. A complete graph with 6 vertices is denoted $K_6$ and has _______ undirected edges.

Q. How many edges are there in an undirected graph with 8 vertices each of degree 4?

Q. A (singly or one way) linked list is an unweighted directed acyclic graph (DAG) within/out degree at most ________ for all nodes.

## Review

Answer the following questions considering the following graph




Q. For the graph above, V = {v1, v2, v3, v4}

- true
- false

Q. Vertex v2 is adjacent to Vertex v4

- true
- false

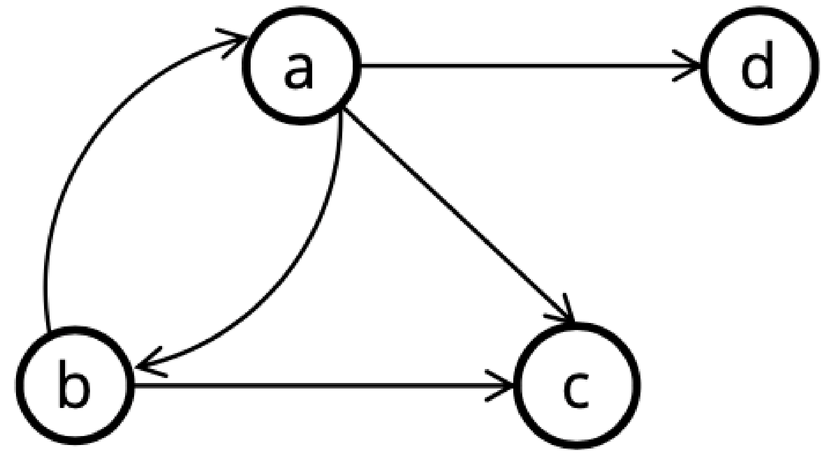
Q. deg(v2) = ______ where deg represents the degree of a vertex.

Q. v1 and v2 are neighbours of v3

- true
- false

## Review

Answer the following questions considering the following graph

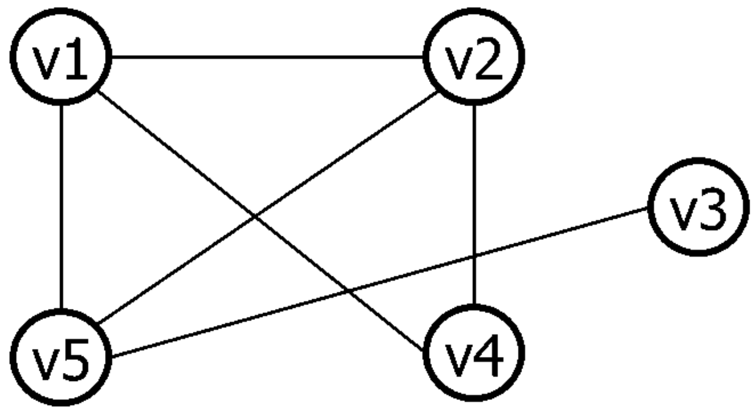



Q. The in-degree of vertex a is ____

Q. Out-degree of vertex c is ______

## Review

Write the adjacency matrix for the following graph:




v1: _, _, _, _, _

v2: _, _, _, _, _

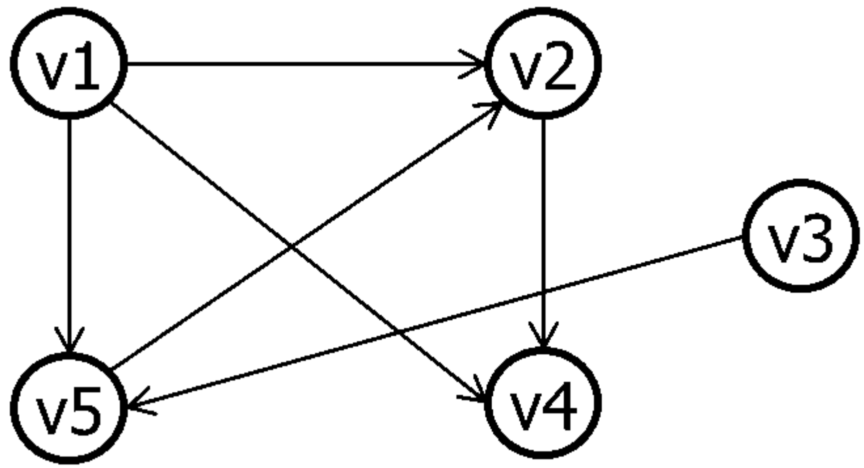
v3: _, _, _, _, _

v4: _, _, _, _, _

v5: _, _, _, _, _

## Review

Write the adjacency matrix for the following graph:




v1: _, _, _, _, _

v2: _, _, _, _, _

v3: _, _, _, _, _

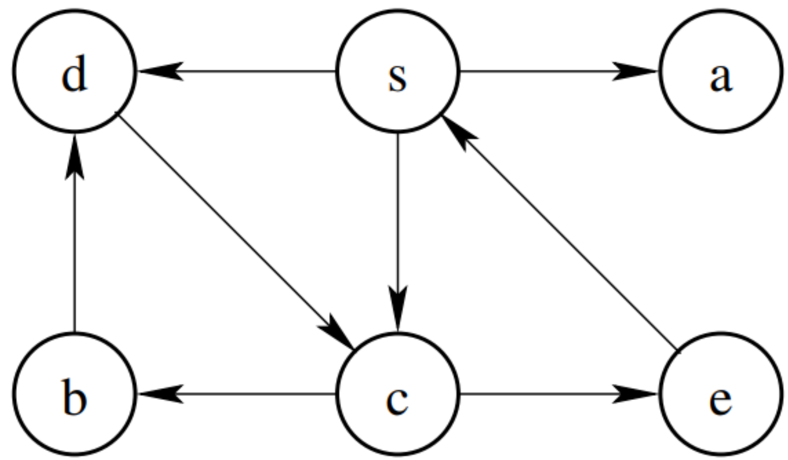
v4: _, _, _, _, _

v5: _, _, _, _, _

## Review

Give the **visited node order** for each type of graph search for the following two questions, starting with **vertex S**.

- Pick nodes to visit using alphabetical order when multiple choices are possible.

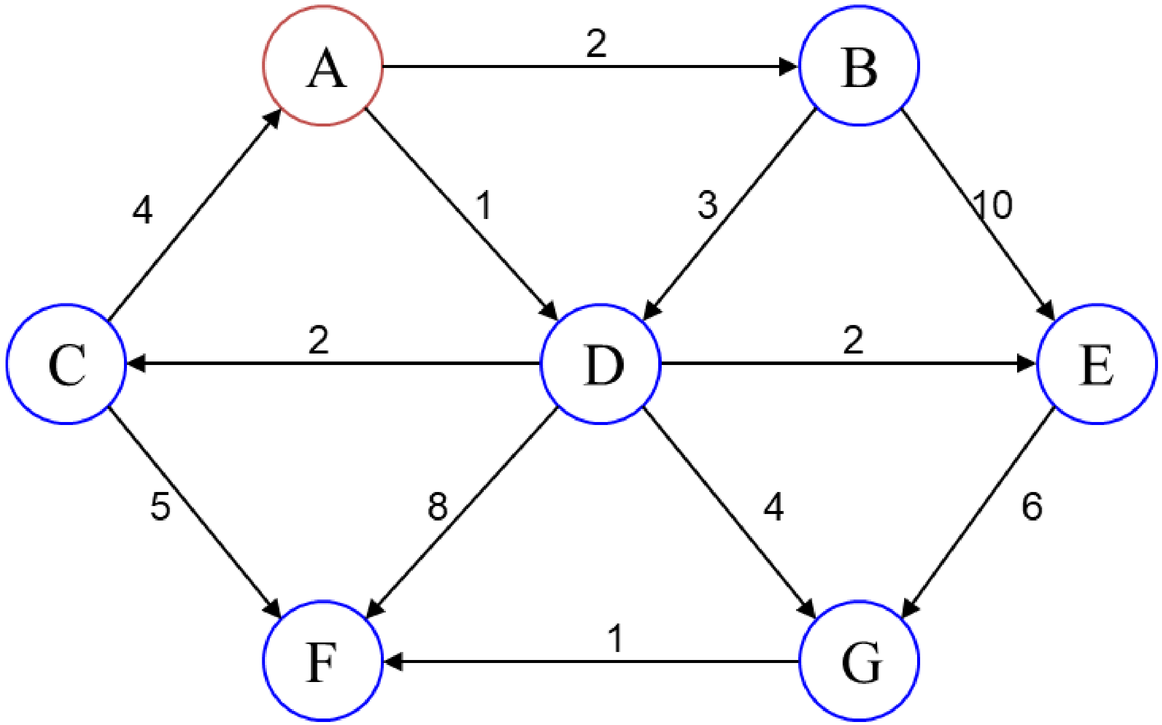



Q. Breadth-first search: __________

Q. Depth-first search: __________

# Review

- Q. Use Dijkstra's algorithm to determine the lowest cost path from vertex A to all other vertices in the graph.



## Review

Q. Dijkstra’s algorithm can not handle edges with ____________ weights

a) positive
b) negative
c) both positive and negative
d) None of the above

Q. Dijkstra's algorithm finds the shortest path between two vertices in a graph.

- True
- False

# Review

Q. Every connected graph has a spanning tree.

- True
- False

Q. Any spanning tree for a graph G = (V; E) has

a) |V| vertices and |V| - 1 edges

b) |V| -1 vertices and |V| - 1 edges

c) |V| -1 vertices and |V| edges

d) |V| vertices and |V| edges

e) None of the above

## Review

Q. _________ can contain a cycle

a) Minimum Spanning Tree
b) Binary Search Tree
c) Both Minimum Spanning Tree and Binary Search Tree
d) Neither Minimum Spanning Tree nor Binary Search Tree

Q. If every edge has a unique weight, there exists a unique MST.

- True
- False

Q. Kruskal's algorithm requires arranging all edges in random order of weight.

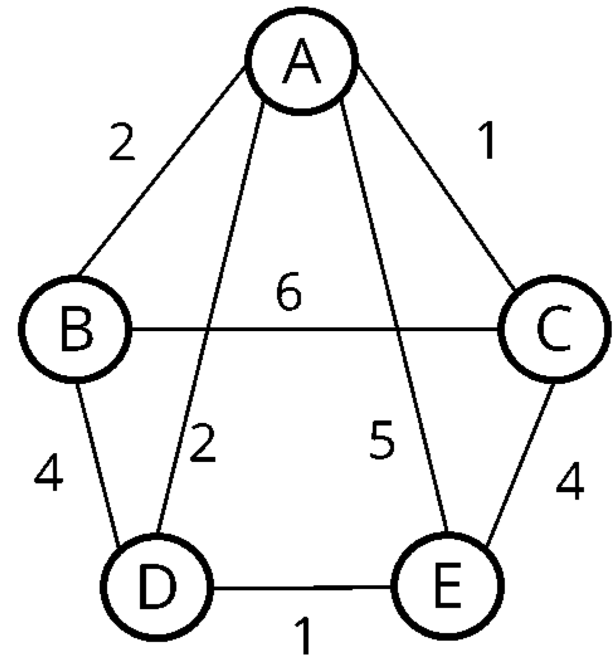
- True
- False

Q. Both Prim's and Kruskal's algorithm pick an edge with the smallest weight

- True
- False

# Review

Consider the following undirected graph shown in the figure below and answer the following two questions.




Q. Apply Prim's algorithm on the graph to construct a minimum spanning tree starting with vertex A. If there are any ties, the vertex with the lower letter comes first (i.e., ‘B’ should come before ‘E’).

V = { }

T = { }

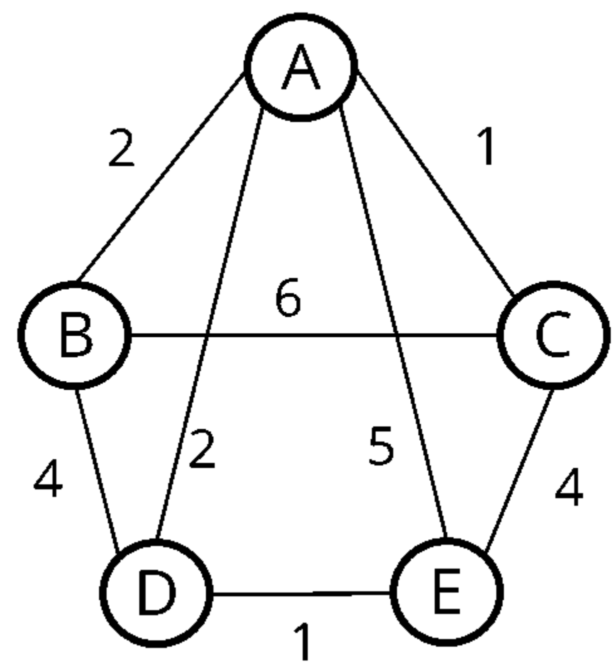
Total cost:

## Review

Q. Apply Kruskal's algorithm on the previous graph to construct a minimum spanning tree starting with vertex A. If there are multiple edges with the same weight, the lower labelled vertex always comes first. e.g., (C, E) comes before (C, F), and (C, F) comes before (D, G). Also, when representing an edge, arrange two letters in alphabetical order, e.g., use (C, E) instead of (E, C). List the edges in the order in which they are added to the tree.

Edge list:

Total cost:



# Review

Q. A set is a collection of unique values that does not allow duplicate items.

- True
- False

Q. ____ is an algorithm that maps values to indexes/indices.

a) A Hash table

b) A Hash Function

c) A Hash code

d) None of the above

Q. is the situation when hash function maps 2 values to the same index.

a) Hash table

b) Hash Function

c) Collision

d) None of the above

# Review

Q. When two items hash to the same slot, we must have a systematic method for placing the second item in the hash table. This process is called __________ .

a) Collision resolution
b) Hash table
c) Hash Function
d) None of the above

Q. ____________ resolves a collision by moving items to the next available index (i.e.,searching the array in order i , i+1, i+2, i+3 .)

a) Linear probing
b) Quadratic probing
c) Double hashing
d) None of the above

## Review

Q. ____________ resolves a collision by moving items to far away (i.e., Search the array in this sequence with a formula. An example: i, i+1^2 , i+2^2 , i+3^2 .)

a) Linear probing
b) Quadratic probing
c) Double hashing
d) None of the above

Q. Prime numbers can be used as hash table sizes to reduce collisions.

- o True
- o False

# Review

Q. Separate chaining is a better solution to solve collisions compared to probing as it cannot run out of indexes.

- True
- False

Q. _________ is the tendency for a collision resolution scheme such as quadratic probing to create long runs of filled slots away from the hash position of keys.

a) Primary clustering

b) Secondary Clustering

c) None of the above

Q. In a hash table of size 9 which index positions would the following two keys map to (assume that we are using linear probing)? 19, 90

a) 1, 10

b) 1, 0

c) 0, 1

d) None of the above

Q. Consider a hash table of size N = 11. Suppose that collisions are resolved by linear probing. Now, insert the following elements into the table in the following order:

Example: Insert 113.

h(113) = 113 mod 11 = 3

index: 3

| Index | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Values | | | | 113 | | | | | | | |

Insert 117, 97, 100, 114, 108, 116, 105, 99

## Review

Q. Consider a hash table of size N = 9, with a hash function
*h( k ) = k mod N*.
Suppose that collisions are resolved by quadratic probing, where the $i^{th}$ probe for a key k is
*h( k , i ) = (h( k ) + i^2) mod N*.
Insert the following elements into the table in the following order:

Example: Insert 14.

h(14) = 14 mod 9 = 5

index: 5

| Index | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| Values | | | | | | 14 | | | |

Insert 4, 22, 8, 6, 18

## Review

Q. In _________, we first find the smallest in the array and exchange it with the element in the first position, then find the second smallest element and then exchange it with the element in the second position and continue this way until the entire array is sorted.

a) Selection sort
b) Insertion sort
c) Bubble Sort
d) Merge sort
e) None of the above

## Review

Q. What is the worst-case time for bubble sort to sort an array of n elements?

a) O(n)
b) O(nlogn)
c) $O(n^2)$
d) None of the above

Q. How many passes are required to sort an array with 10 elements by using the bubble sort algorithm?

a) 10
b) 9
c) 1
d) None of the above

## Review

Q. Insertion sort makes ________ passes over an array with n elements.

a) n
b) n-1
c) 1
d) None of the above

Q. ___________ orders a list of values by comparing elements that are separated by a gap of >1 indices.

a) Shell Sort
b) Bubble Sort
c) Selection sort
d) None of the above

## Review

Q. When n elements are in reverse order in an array, insertion sort takes ____ time.

a) O(n)
b) O(n logn)
c) O($n^2$)
d) None of the above

Q. ______________ uses a divide and conquer approach for sorting an array of elements.

a) Merge sort
b) Insertion Sort
c) Selection Sort
d) None of the above

# Review

Q. While selecting a pivot for quicksort, it is better (in terms of efficiency) if the pivot divides up the array into roughly equal partitions.

- True
- False

Q. What is the worst-case time for quick sort to sort an array of n elements.

a) O(n)

b) O(n logn)

c) $O(n^2)$

d) None of the above

Q. Shell sort is a generalization of _______

a) Selection sort

b) Insertion sort

c) Merge sort

d) Bubble Sort

e) None of the above

## Review

Q. Let's say we are using quicksort to sort a set of elements in an array. After the first partitioning, the array looks like:

2 5 1 7 9 12 11 10.

The pivot could be _______ (list all answers if there is more than one.)

Q. Here is an array of ten integers: 5 3 8 9 1 7 0 2 6 4

Show the array elements after the FIRST pass in a selection sort.

___________________

Show the array elements after the SECOND pass in a selection sort.

___________________

## Review

Q. Assume the array 20, 10, 80, 40, 15, 75 is sent as input to Quick Sort. Show the contents of the array immediately after the first partition operation takes place. Use the first element as the pivot and use the procedure discussed in the class.

______________________________________

Q. Radix sort is applied on the following set of numbers:

21 86 124 33 29 163.

What will be the order of numbers after the second pass (i.e., after sorting by the last digit and tens digit)?

______________________________________