Student ID: _____

Name: _____

資料結構 Data Structures
Spring 2019
10720EECS204001
Professor Yi-Shin Chen
Final Exam

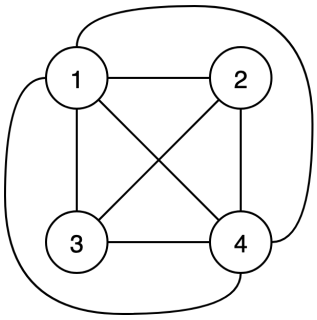
1. [10%]Graph types

Consider the 6 graphs below.

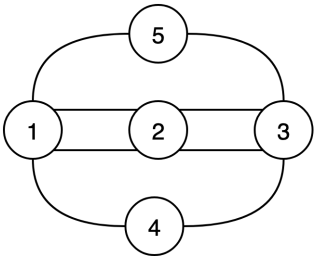
a. [6%]For each one of the graphs, state whether it is legal or illegal. If it's **illegal**, explain **why**. If it's **legal**, explain which of the following **attribute(s)** apply:
complete, directed, undirected, cycle, network, strongly connected

b. [4%]Give the in-degree and out-degree of each of the **legal directed** graphs. (Copy and fill the table below in your answer sheet) :

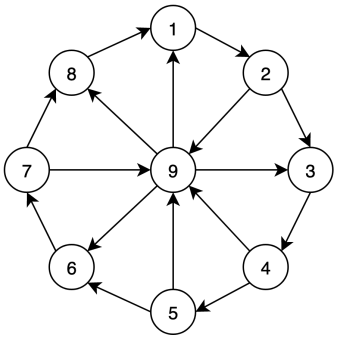
Graph (Letter)	Node No.	In-degree	Out-degree
...	...	...	...



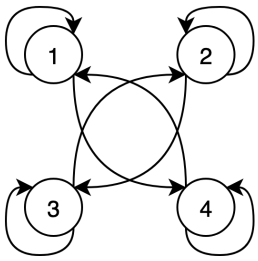
A.



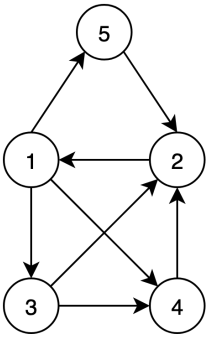
B.



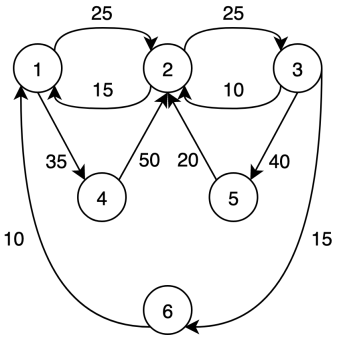
C.



D.

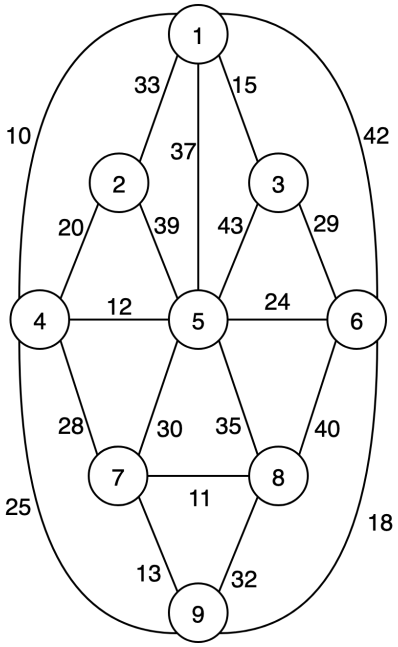


E.



F.

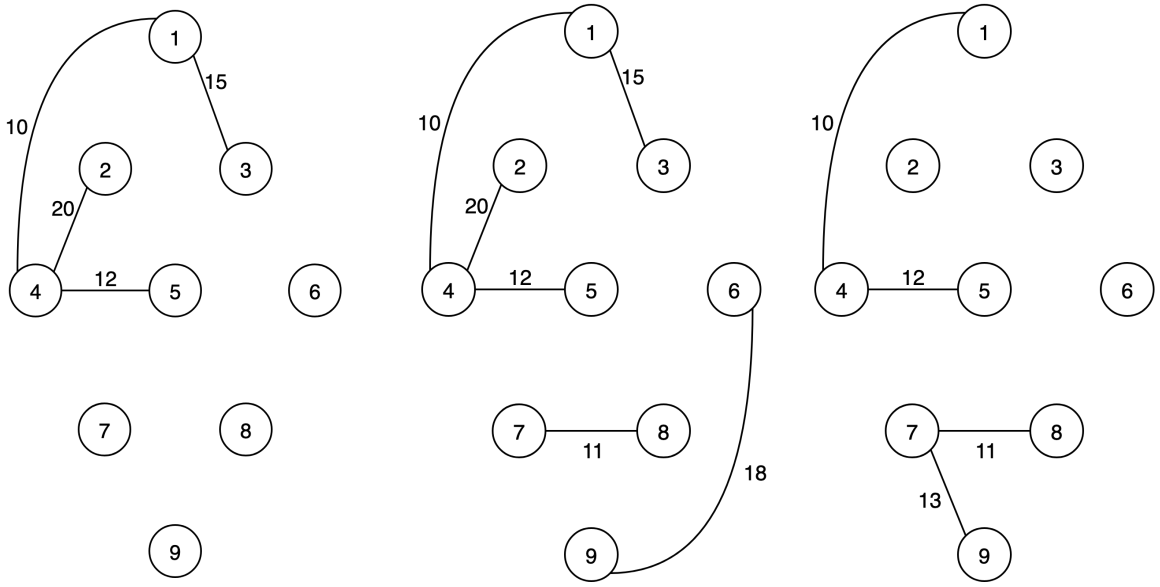
2. [9%]Minimum Spanning Trees (MST)



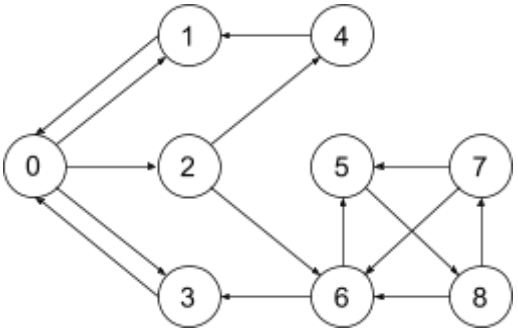
We want to construct a Minimum Spanning Tree (MST) for the graph above. Eva started drawing the MST using 3 different algorithms, but she got lazy. Help her out. For each of the figures below:

a. [3%]Identify what algorithm was used to create that figure (Kruskal's Algorithm, Prim's Algorithm or Sollin's Algorithm). (Note: Consider node 1 as the starting point if needed).

b. [6%]Continue finding the MST. Draw the figure **step by step** until termination.



3. [10%]Breadth-first search (BFS) and Depth-first search (DFS) traversal



Consider the graph above.

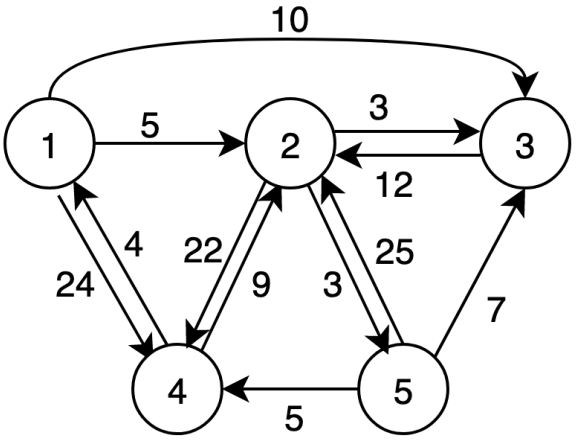
a. [4%]Find a Breadth-first search (BFS) and Depth-first search (DFS) for the graph above. Start at node 0.

b. [2%]There are 2 data structures that we can use to implement DFS, namely: Adjacency Matrix and Adjacency Lists. Explain how these data structures can be used to implement DFS.

c. [2%]What are the resulting Time Complexities for the Adjacency Matrix and Adjacency Lists implementation of the DFS algorithm?

d. [2%]Give a Spanning Tree for the graph above.

4. [15%]Shortest Paths



Consider the graph above.

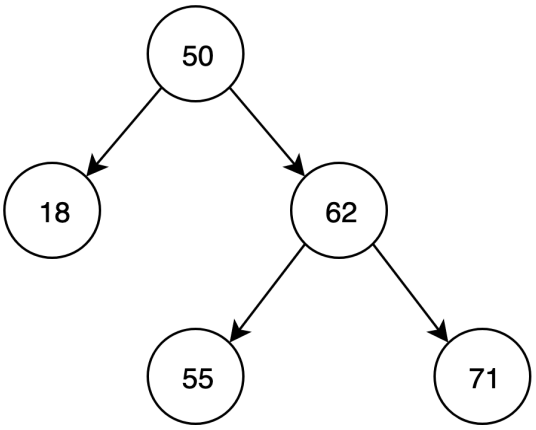
a. [5%]The Floyd Warshall's Algorithm is used to find all pairs of shortest paths in a graph. It can be implemented using Dynamic Programming techniques. Explain the concept of "Dynamic Programming" in your own words. What are the advantages of using Dynamic Programming?

b. [10%]Find all pairs shortest paths using Floyd Warshall's Algorithm. The table below contains the initial values for the all pairs shortest paths problem. Copy the table below and show the final results at the end of the algorithm.

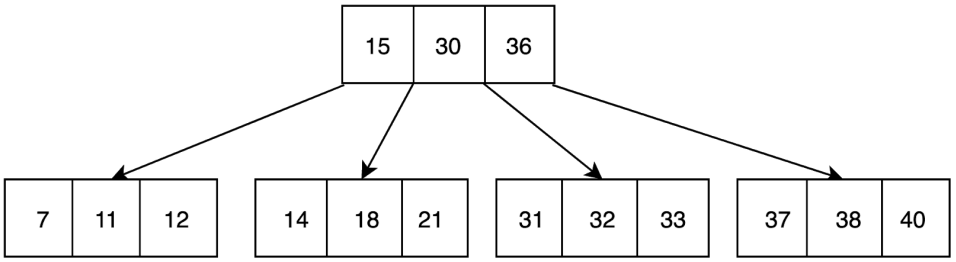
	1	**2**	**3**	**4**	**5**
1	0	5	10	24	∞
2	∞	0	∞	4	∞
3	∞	12	0	∞	∞
4	4	9	∞	0	∞
5	∞	25	7	5	0

5. [16%]Advanced topics

a. [8%]Insert the node 51 into the AVL tree below. Draw each step. What kind of rotation is needed?



b. [8%]Consider the B-tree below, where each bucket should contain at least one and at most three values. Insert the number 35 and draw each step of the insertion.



6. [10%]Quiz Questions

a. [5%]Which sorting algorithms from the list below can be employed for external sorting? Illustrate with reasons.

Merge Sort, Heap Sort, Quick Sort

b. [5%]What are the advantages and disadvantages of using the methods below for handling overflow in hashing?

Doubling bucket size, Doubling number of buckets

7. [20%]Sort

a. [8%]Eva is trying to sort an “unordered list” below by quick sort, if she sets the first number 37 as pivot point, what are the two resulting list numbers? What will the new pivot of the left list be ?
What are the average time complexity of quick sort?

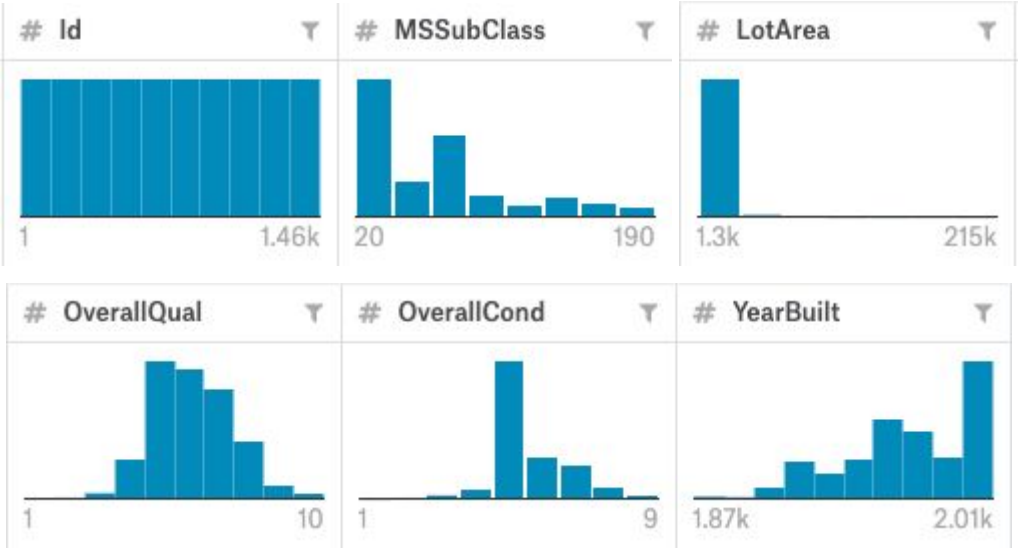
37 65 6 10 45 47 100 80 45 61

b. [12%]Use radix sort to sort the following numbers in ascending order and write down each pass. [*16.9, 4, 20.6, 10.5, 8.8, 3.2, 0.5, 4, 27, 1.1*]. Should the radix sort be stable sort? Why?

8. [20%]Hashing

a. [10%]Why do we need a directory for dynamic hashing?

b. [10%]Ron is going to join a machine learning competition. Here is the house price dataset she got and some attributes are continuous.



Ron prints the data distribution of those continuous attributes and she wants to reduce these features into discrete form by using hashing, but there might be some problems she is supposed to watch out for. Please explain it and show what are the attributes appropriate for hashing? Why?