THE UNIVERSITY OF TRINIDAD AND TOBAGO

FINAL ASSESSMENT/EXAMINATION

JANUARY – MAY 2019

Course Code and Title: DSAL3001 – Algorithm Analysis and Design

Programme: Bachelor of Applied Science in Computer Engineering..

Date: 05/09/2019 **Time:** 9:00AM - 12:00Noon

Duration: three (3) hours

PLEASE READ ALL INSTRUCTIONS CAREFULLY BEFORE YOU BEGIN THIS EXAMINATION

Instructions to Candidates

1. **This paper has _15_ pages and _7_ questions for a total of _70_ marks.**
2. **You are required to answer all questions.**
3. **You are required to return this question paper.**
4. **You must write on this question paper in ink.**
5. **Additional writing paper may be requested if required.**
6. **Show working and/or clearly explain how you arrive at your answer.**

Key Examination Protocol

1. Students please note that academic dishonesty (or cheating) includes but is not limited to plagiarism, collusion, falsification, replication, taking unauthorised notes or devices into an examination, obtaining an unauthorised copy of the examination paper, communicating or trying to communicate with another candidate during the examination, and being a party to impersonation in relation to an examination.

2. The above mentioned and any other actions which compromise the integrity of the academic evaluation process will be fully investigated and addressed in accordance with UTT's academic regulations.

3. Please be reminded that speaking without the Invigilator's permission is **NOT** allowed.

For Examiner's Use Only		
Questions	**Total Marks**	**Marks Obtained**
Question 1	5	
Question 2	5	
Question 3	15	
Question 4	5	
Question 5	15	
Question 6	15	
Question 7	10	
Total	**70**	

1. Use the formal definition of Big O to prove that $6n + 8$ is $O(n)$. [5 marks]

2. T(n) is the running time of an algorithm on an input of size n.
   Given that $T(0) = 1$
   $T(n) = 3\,T(n/3) + c$ for $n > 0$

   Determine the order of the algorithm. State any assumptions made and show how you arrive at your answer. [5 marks]

3. A network is represented by the following undirected, weighted graph:

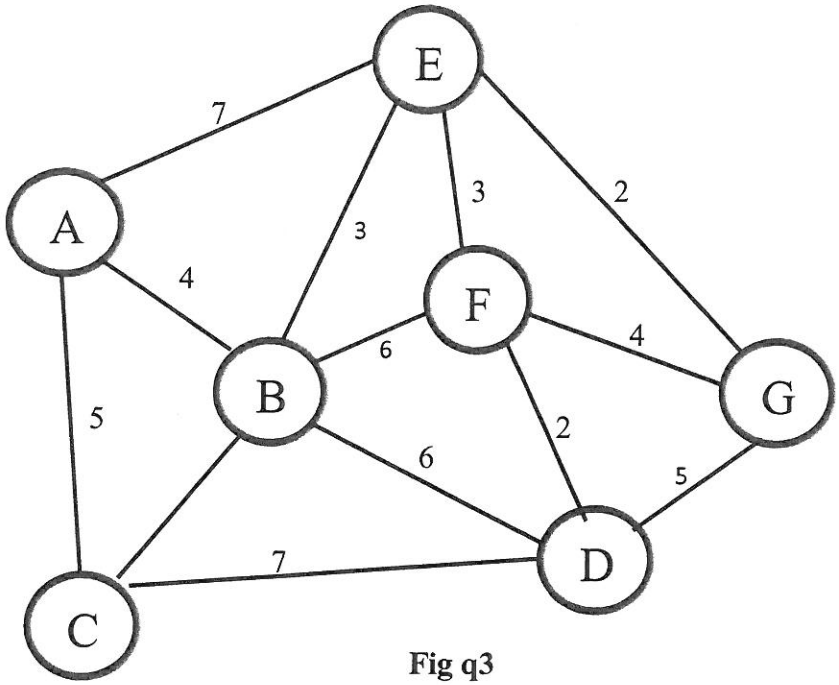


Fig q3

a. Determine the shortest paths from node A to all other nodes and their lengths using Dijkstra's algorithm.

Clearly show all information for each node at each pass of the algorithm in Table q3.1 below and the shortest path to each Node in Table q3.2 that follows on the next page. [7 marks]

	Unvisted (Q)	Visited (S)	Current	A	B	C	D	E	F	G
	{A, B, C, D, E, F, G}	{ - }								
1										
2										
3										
4										
5										
6										
7										

Table q3.1

Show the shortest path to each node in the Table q3.2 below. [3 marks]

From	To	Route	Length
A			
A			
A			
A			
A			
A			

Table q3.2

b. State the complexity of Dijkstra's algorithm in terms of the number of nodes (n) and edges (e). Explain your answer. [3 marks]

c. Would this algorithm work if there were edges with negative weights? Explain clearly why or why not. [2 marks]

4.

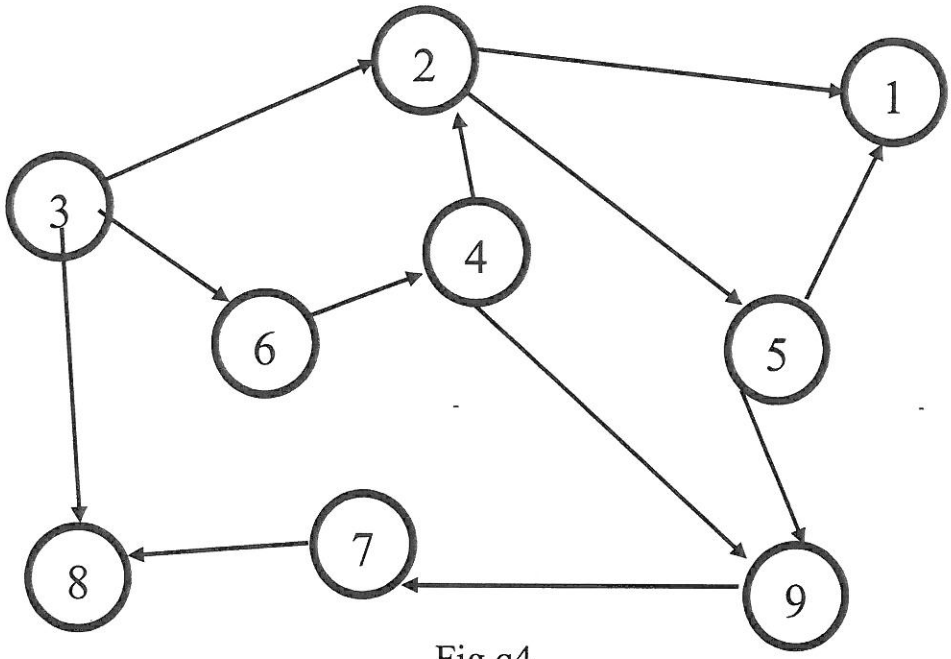


Fig q4

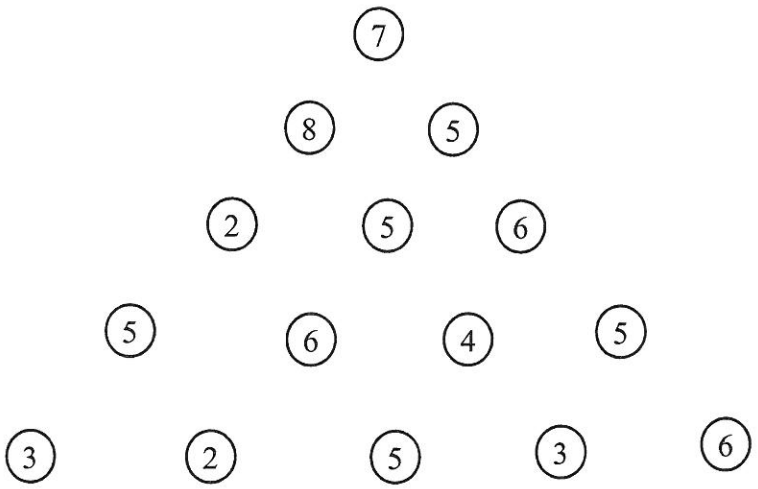
The Graph above shows the dependencies of the various sub-tasks that must be done in order to complete a particular project.

A manager needs to have a proper sequence in which the tasks may be completed to help him in the planning process.

a. For the above graph, use the topological sort algorithm to produce a feasible order in which to carry out the various tasks.
Show step by step how you arrive at your answer. [4 marks]

b. Is it possible to have more than one feasible order?
Explain why or why not. [1 mark]

5. In a new game show on television, a set of pegs with numbers is arranged on a board as shown below but with **n** rows. A contestant drops a ball onto the top peg. The ball may then fall onto either the left or right peg only in the row below and so on until it reaches the last row.



A contestant's score is the sum of the values on the path as the ball moves from top to bottom. The contestant with the largest sum is the winner and will be paid according to this sum. An executive needs to know the maximum sum possible in order to decide if the show is feasible.

a. How many possible path totals will there be for n such rows. [3 marks]

b. Determine the worst case running time of a brute-force algorithm that solves this problem. [2 marks]

c. Write an algorithm using dynamic programming and memoization to solve this problem. [4 marks]

b. What is the order of your memoized algorithm for this problem? [3 marks]

e. Determine the largest value and show the corresponding path used. [3 marks]

6. A vehicle is used to deliver online purchases to customers. The vehicle has a maximum fuel capacity of 12 units. On a particular morning the driver is given a list of parcels which are ready for delivery showing the number of fuel units that is required to deliver and return safely for each parcel and the payment for each item. The driver must now choose the best combination of parcels so that he can get the maximum possible payment while keeping the total fuel requirement within the available fuel capacity of his vehicle. The list is as follows:

Item no.	=	1	2	3	4
Payment	=	10	35	20	25
Fuel units required	=	4	6	3	5

a. What is the order O( ) of an algorithm that checks all possible combinations to solve this problem? [2 marks]

b. What is the order of an algorithm that solves this problem with a Dynamic Programming approach? [4 marks]

c. Use a Dynamic Programming approach to solve this problem in the Table 6c below. [5 marks]

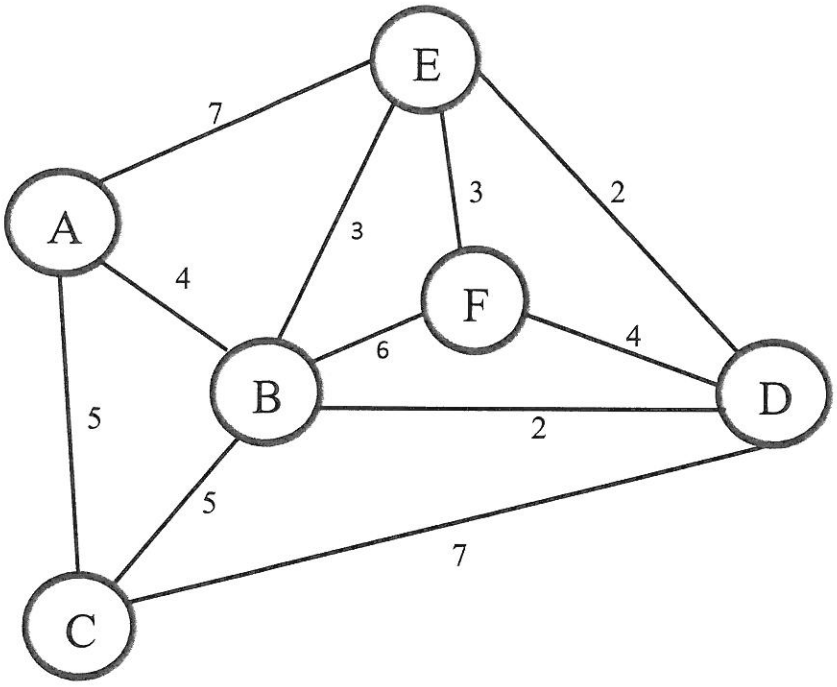
k\w	0	1	2	3	4	5	6	7	8	9	10	11	12
0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0												
2	0												
3	0												
4	0												

Table 6c

d. Write an algorithm using Dynamic Programming to solve the general form of this problem where the maximum fuel capacity of the vehicle is W, and the list is as follows,

item no.	=	i_1	i_2	i_3	i_4		
value	=	v_1	v_2	v_3	v_4		
fuel required	=	w_1	w_2	w_3	w_4	etc for n items	[4 marks]

7. The graph G, as given below, represents a network.



Graph G.

a. Apply Kruskal's Algorithm in the table below to find the minimum spanning tree of the graph G given above. [5 marks]

	K	d_v	p_v
A			
B			
C			
D			
E			
F			

b. State the Big O running time of Prim's algorithm. [2 marks]

c. State the major differences between Prim's and Kruskal's algorithms. [3 marks]

END OF EXAM!