UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 8 Examination in Engineering: February 2020

Module Number: EE8207 **Module Name: Optimization Techniques for Engineers**

[Three Hours]

[Answer **all questions**, each question carries **10 marks**]

Q1 a) i) List four characteristics of a game.

ii) In a two person game, both players have more than one strategy. Explain a numerical way to identify the Nash Equilibrium in its payoff matrix.

[2.0 Marks]

b) Ranil is organizing the Electrical Engineer's conference in Matara District. He is planning to invite Mervin, the General Manager of Electricity Board to the conference. Ranil must decide whether to invite his friend Dudley, the local politician as the chief guest. Mervin likes Ranil, but hates Dudley.

- Mervin's payoff in attending the conference is 4 if Dudley is not there, but it is 0 if he is there.
- Mervin's payoff for not attending to the conference is 3 if Dudley is not there, but it is 1 if he is there.
- Ranil's payoff if Mervin comes for the conference is 4 if Dudley is not there, but it is (8-x) if Dudley comes for the conference, where x is a variable.
- If both Mervin and Dudley do not come, Ranil's payoff is 2.
- If Mervin does not come and Dudley comes, Ranil's payoff is (3-x).

i) Model the above situation as a game and prepare a payoff matrix.

ii) If x=0, identify dominated strategies (if any). Find Nash Equilibrium (if exists) and equilibrium payoffs.

iii) If x=3, identify dominated strategies (if any). Find Nash Equilibrium (if exists) and equilibrium payoffs.

[6.0 Marks]

c) Consider the following two-player zero sum game with the payoff matrix for the player 1 (row player) given in Table Q1 c).

Table Q1 c)

		Player 2				
		A	B	C	D	E
Player 1	A	1	2	1	2	2
	B	4	0	1	2	4
	C	0	1	-1	2	0
	D	1	1	0	1	0
	E	2	-2	2	0	3

Determine the optimal strategy for player 2.

[2.0 Marks]

Q2 A paint company makes two products (X_1 and X_2) using two machines (A and B).

- Each unit of X_1 that is produced requires 50 minutes processing time on machine A and 30 minutes processing time on machine B.
- Each unit of X_2 that is produced requires 24 minutes processing time on machine A and 33 minutes processing time on machine B.
- At the start of the current week there are 30 units of X_1 and 90 units of X_2 in stock.
- The demand for X_1 in the current week is forecasted to be 75 units and for X_2, it is forecasted to be 95 units.

Available processing time on machine A is forecasted to be 40 hours and on machine B, it is 35 hours. Company policy is to maximize the combined sum of the units of X_1 and the units of X_2 left in stock at the end of the week.

a) Formulate this problem as a linear programming model.

[2.0 Marks]

b) Using the simplex tabular method, determine the units of each product required to be made to satisfy the company policy.

[8.0 Marks]

Q3 a) i) State two differences between the Dynamic Programing and the Linear Programming.

ii) A travel path for a salesperson is shown in Figure Q3 a), where location A is the starting city and location J is the end city. The numbers give the profit of following each path in thousand rupees. Using dynamic programing techniques, find the path/paths the salesperson should follow from starting point A to end point J in order to maximize the profit. (Answers without mathematical formulations and calculations carry no marks)

[6.0 Marks]

b) A container which has a capacity of four tons can be loaded with one or more of three items as indicated in Table Q3 b). It gives the unit weight w_i in tons and unit revenue r_i in thousands of rupees for each item.

Table Q3 b)

Item (i)	Weight (w_i)	Revenue (r_i)
1	2	31
2	3	47
3	1	14

How should the container be loaded in order to maximize the revenue? (Answers without mathematical formulations and calculations carry no marks)

[4.0 Marks]

Q4 a) Briefly explain the followings under graph theory terminologies,

i) Strongly Connected Graph

ii) Minimum Spanning Tree

[2.0 Marks]

b) A new television company is planning to establish a cable television network in southern Sri Lanka. Table Q4 b) gives the selected towns and the distances (km) between them. Note that due to topographical reasons there is no direct path between some towns.

Table Q4 b)

Town	A	B	C	D	E	F	G	H
A								
B	23							
C	48	26						
D	-	29	26					
E	44	39	24	32				
F	-	-	-	-	19			
G	32	47	28	-	27	18		
H	55	-	-	75	38	25	17	

Determine the minimum length of cables required to connect all towns.

[4.0 Marks]

c) An oil pipe network in a central city along with the pipe capacities in liters is shown in Figure Q4 c).

i) Using Ford-Fulkerson algorithm, find the maximum amount of liters of oil that can be pumped from node A to node F.

ii) Use Max-Flow-Min-Cut theorem to prove that you have arrived to the optimum solution.

[4.0 Marks]

Q5 a) Can an assignment problem be solved by using the Hungarian method when the number of persons are less than the number of jobs? Justify your answer.

[2.0 Marks]

b) A software company has four vacancies in their offices in Galle, Kandy, Matale and Vavunia. However, they managed to hire only three programmers, Namal, Kamal and Raja. One programmer can be assigned only to one office. The cost of assigning a programmer to an office is given in table Q5 b).

Table Q5 b)

	Galle	Kandy	Matale	Vavunia
Namal	800	1100	1200	1000
Kamal	500	1600	1300	800
Raja	500	1000	2300	1500

Find the assignment that will minimize the total cost of allocation. (Note that there will be one office without a programmer)

[8.0 Marks]

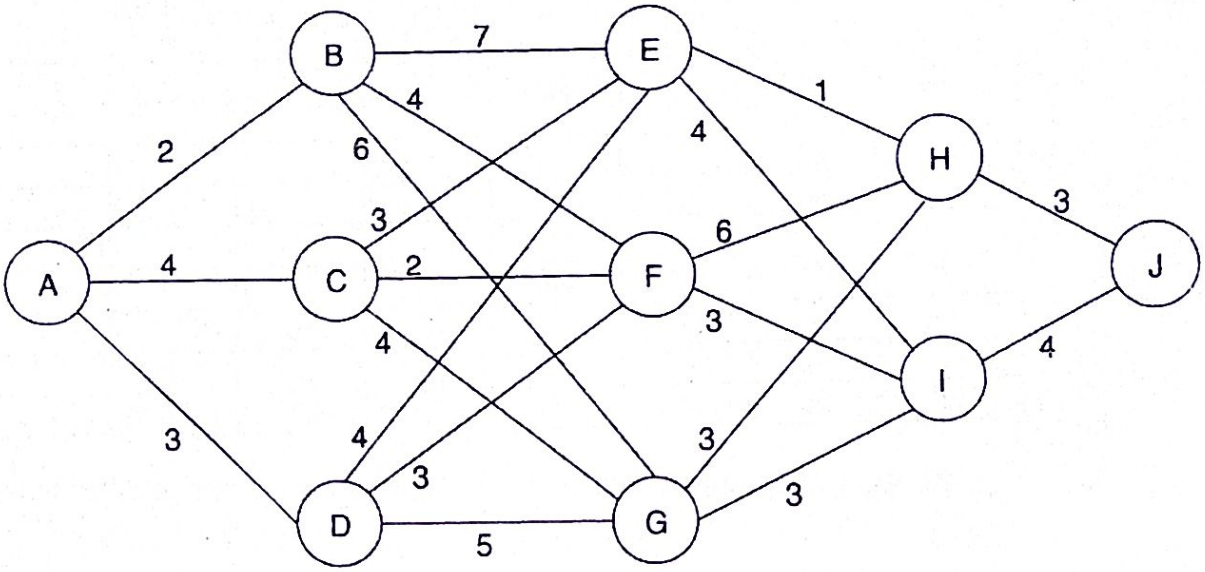

Figure Q3 a)

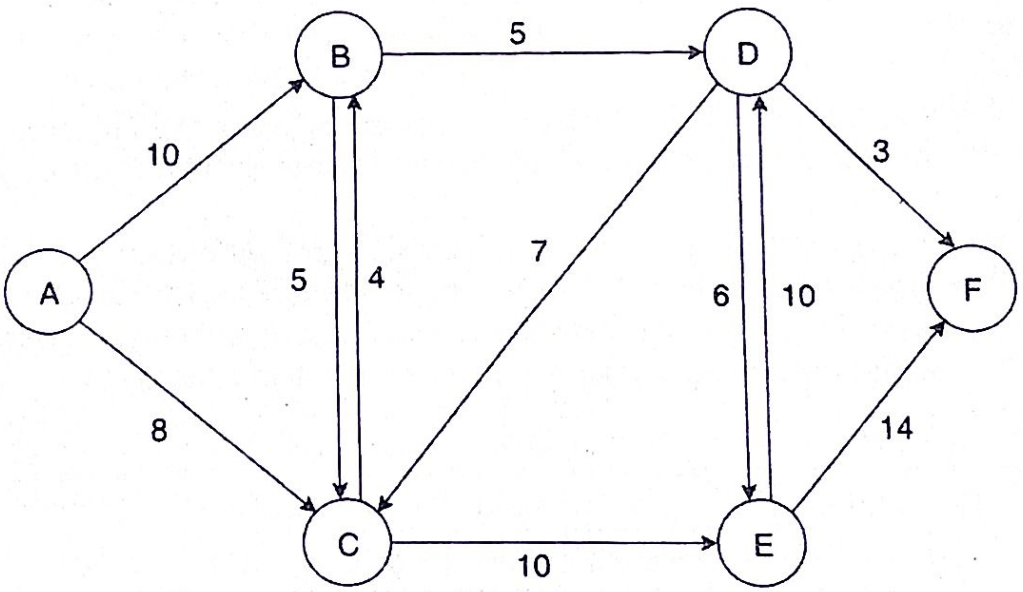

Figure Q4 c)