UNIVERSITY COLLEGE TATI

UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET		
COURSE CODE	:	BCS 2643
COURSE	:	OPERATIONAL RESEARCH TECHNIQUE
SEMESTER/SESSION	:	SEM 2, SESSION 2024/2025
DURATION	:	3 HOURS

Instructions:

1. This booklet contains **5** questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 7 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

Hariz produces two new products of sambal, namely Sambal Nyet and Sambal Hijau. Each packet of Sambal Nyet contains 12 red chilies, 4 green chilies, 6 onion and 6 tablespoons of oil. Each packet of the same quantity of Sambal Hijau contains 3 red chilies, 20 green chilies, 4 onion and 3 tablespoons of oil. The sambal requires at least 240 red chilies, at least 460 green chilies and at most 300 onions.

How many packets of each sambal should be used to minimize the amount of oil?

a) Formulate the Linear Programming Model by determine the decision variables, objective function, and constraints. (6 marks)

b) Illustrate the Linear Programming graphically and sketch the feasible region. (5 marks)

c) Find the optimal solution. Evaluate the quantities of the two sambal and determine the minimum amount which will minimize the amount of oil (tablespoon). (5 marks)

QUESTION 2

Table 1: Transportation cost

(RM cost)	**Warehouse 1**	**Warehouse 2**	**Warehouse 3**	**Warehouse 4**	***Supply***
F_1	210	140	180	170	***25***
F_2	160	280	240	210	***27***
F_3	120	150	220	100	***48***
Demand	***28***	***22***	***24***	***26***	

a) Farm Fresh has three factories with weekly production rates of 25, 27 and 48 yogurts. These yogurts must be shipped to three warehouses that have a demand of 28, 22, 24 and 26 units. The cost to ship between each location is known (see the **Table 1**).

i. Show your calculation using Vogel's Approximation Method to find initial basic feasible. (13 marks)

ii. Find minimum transportation cost (in RM). (2 marks)

Table 2: Distribution of Person with Different Jobs

	Job			
Person	***J1***	***J2***	***J3***	***J4***
A	20	25	22	28
B	15	18	23	17
C	19	17	21	24
D	25	23	24	24

b) As depicted in **Table 2**, a warehouse has four men available for work on four separate jobs. Only one man can work on any one job. The cost of assigning each man to each job is given in the following table. The objective is to assign men to jobs in such a way that the total cost of assignment is minimum.

Solve the assignment problems below using Hungarian Method and find the optimal solution. (15 marks)

QUESTION 3

a) Suppose all car owners fill up their tanks are exactly half full. At present time, an average of 7.5 customers per hour arrive at single pump gas station. It takes 4 minutes to service a car. Assume the interarrival and service times are both exponential, show your calculation to determine:

i. Mean arrival λ and mean service μ. (4 marks)
ii. Probability zero customer arrive at pump gas station. (2 marks)
iii. Probability more than 5 customers in the pump gas station. (2 marks)

b) Assume 5 customers Bank A arrived on an average of every 5 minutes (Poisson arrival) and the bank receptionist can served 7 customers in 5 minutes. If both arrival and service time exponentially distributed, show your calculation to determine:

i. Mean arrival λ and mean service μ. (4 marks)
ii. Average number of patients waiting in queue for service. (2 marks)
iii. Expected waiting time in the queue. (2 marks)

c) Use Johnson's rule to determine the optimal sequencing for the five jobs to be processed on two machines in a fixed order (Machine 1 before Machine 2). The processing times are given in the **Table 3**:

Table 3: Job Sequence with Two Machine

Job Processing Data		
Job	**Machine 1**	**Machine 2**
A	12	9
B	10	13
C	15	11
D	17	14
E	14	19

i. Illustrate a Gantt Chart of two machine. (5 marks)
ii. Find a completion time. (1 mark)
iii. Calculate a total idle time. (2 marks)

QUESTION 4

Table 4: Yearly Running Cost

Year	1	2	3	4	5	6	7	8
Running Cost (RM)	200	500	800	1,200	1,800	2,500	3,200	4,000

a) A firm is considering replacing a machine, which was acquired cost price RM12,200 and its scrap value is RM210. From experience the running (maintenance and operating) cost have been documented in **Table 4**.

i. Show your calculation in a table. (5 marks)

ii. From your calculation describe when the machine should be replaced. Justify your reason. (2 marks)

Table 5: Yearly Running Cost

Year	1	2	3	4	5	6	7	8
Running Cost (RM)	200	500	800	1,200	1,800	2,500	3,200	4,000
Scrap value	100	50	35	25	15	10	5	0

b) A workshop is considering using an engine which purchase cost is RM3000 and installation charges amount to RM240. The maintenance cost is based on **Table 5**.

i. Show your calculation in a table. (6 marks)

ii. From your calculation, explain when the engine should be replaced. Justify your reason. (2 marks)

QUESTION 5

Table 6: Game strategy for Player A and Player B

		Player B's Strategies	
		B_1	**B_2**
Player A's Strategies	**A_1**	12	-3
	A_2	5	10
	A_3	-3	6
	A_4	10	4
	A_5	2	1
	A_6	-7	5

Solve the following 6 x 2 game by graphical method based on information in **Table 6**.

a) Illustrate the game using graphical approach by plotting each pay-off matrix (B_1) and (B_2). (3 marks)

b) Identify the feasible region in a graph Question 5(a). State Upper or Lower envelope? (2 marks)

c) Locate the optimal point in Question 5(a). State minimax or maximin point? (1 mark)

d) Write the game written as a 2x2 pay-off matrix. (2 marks)

e) Solve the value of game. (3 marks)

f) Find the probability of selecting strategies for the two players of Player A and Player B. (4 marks)

FORMULA

$$Value\ of Game: \frac{a_1(b_1 - b_2) + b_1(a_1 - a_2)}{(b_1 - b_2) + (a_1 - a_2)}$$

$$Probabilities\ for\ X_1: \frac{b_1 - b_2}{(b_1 - b_2) + (a_1 - a_2)}, \qquad X_2: \frac{a_1 - a_2}{(b_1 - b_2) + (a_1 - a_2)}$$

$$Probabilities\ for\ Y_1: \frac{a_2 - b_2}{(a_2 - b_2) + (a_1 - b_1)}, \qquad Y_2: \frac{a_1 - b_1}{(a_2 - b_2) + (a_1 - b_1)}$$

$$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)}$$

$$W_q = \frac{Lq}{\lambda}$$

$$P = \frac{\lambda}{\mu}$$

$$P_0 = 1 - \frac{\lambda}{\mu}$$

$$P_n = P_0 - \left(\frac{\lambda}{\mu}\right)^n$$

$$P_{n\ or\ more} = \left(\frac{\lambda}{\mu}\right)^n, n+1$$

$$L = L_q + \frac{\lambda}{\mu}$$

$$W = W_q + \frac{1}{\mu}$$

----------End of question----------