U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

July 2024 Semester End Main Examinations

Programme: B.E. **Semester: V**
Branch: Industrial Engineering and Management **Duration: 3 hrs.**
Course Code: 22IM5PCOPR **Max Marks: 100**
Course: Operations Research

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

			UNIT - I	*CO*	*PO*	Marks
1	a)	"Operations Research is an aid for the executive in making his decisions based on scientific method analysis." Discuss the above statement in brief.		*CO1*	*PO1*	**05**
	b)	A firm can produce three types of cloth say A, B and C. Three kinds of wool are required for it, say red wool, green wool and blue wool. One unit length of type A cloth needs 2 yards of red wool and 3 yards of blue wool; one unit length of type B cloth needs 3 yards of red wool, 2 yards of green wool and 2 yards of blue wool; and one unit of type C cloth needs 5 yards of green wool and 4 yards of blue wool. The firm has only a stock of 8 yards of red wool, 10 yards of green wool and 15 yards of blue wool. It is assumed that the income obtained from one unit length of type A cloth is Rs. 3.00, of type B cloth is Rs. 5.00 and of type C cloth is Rs. 4.00. Formulate the problem as linear programming problem.	*CO2*	*PO2*	**10**
	c)	Prove that the dual of the dual of a given primal is again primal	*CO1*	*PO1*	**05**
		OR				
2	a)	Using Two-Phase method solve the following LPP: $Maximize\ Z = 6\,x_1 + 4\,x_2$ Subject to $2\,x_1 + 3\,x_2 \leq 30$ $3\,x_1 + 2\,x_2 \leq 24$ $x_1 + x_2 \geq 3$ $x_1, x_2 \geq 0$	*CO2*	*PO2*	**10**
	b)	Solve the following LPP by Dual-Simplex Method: $Minimize\ Z = 2\,x_1 + 3\,x_2$ Subject to $2\,x_1 - 3\,x_2 - x_3 \geq 3$ $x_1 - x_2 + x_3 \geq 2$ $x_1, x_2, x_3 \geq 0$	*CO2*	*PO2*	**10**

			UNIT - II			
	3	a)	A company has four manufacturing plants and five warehouses. Each plant manufactures the same product, which is sold at different prices in each warehouse area. The cost of manufacturing and cost of raw materials are different in each plant due to various factors. The capacities of the plants are also different. The relevant data is given in the following table *Plant* *Item* | *1* | *2* | *3* | *4* Manufacturing cost (Rs) per unit | 12 | 10 | 8 | 8 Raw material cost (Rs) per unit | 8 | 7 | 7 | 5 Capacity per unit time | 100 | 200 | 120 | 80 The company has five warehouses. The sale prices, transportation costs and demands are given in the following table: *Warehouse* | *Transportation Cost (Rs) per Unit* (*1* | *2* | *3* | *4*) | *Sale Price* | *Demand per Unit (Rs)* *A* | 4 | 7 | 4 | 3 | 30 | 80 *B* | 8 | 9 | 7 | 8 | 32 | 120 *C* | 2 | 7 | 6 | 10 | 28 | 150 *D* | 10 | 7 | 5 | 8 | 34 | 70 *E* | 2 | 5 | 8 | 9 | 30 | 90 Determine the optimal schedule so as to maximize the profit.	*CO3*	*PO3*	**15**
		b)	Explain the characteristics of Transshipment model	*CO1*	*PO1*	**05**
			OR			
	4	a)	A manufacturer of complex electronic equipment has just received a sizable contract and plans to subcontract part of the job. He has solicited bids for 6 subcontracts from 3 firms. Each job is sufficiently large and any firm can take only one job. The table shows the bids as well as the cost estimates (in lakhs of rupee) for doing the job internally. Not more than three jobs can be performed internally. Jobs / Firm | 1 | 2 | 3 | 4 | 5 | 6 1 | 44 | 67 | 41 | 53 | 48 | 64 2 | 46 | 69 | 40 | 45 | 45 | 68 3 | 43 | 73 | 37 | 51 | 44 | 62 Internal | 50 | 65 | 35 | 50 | 46 | 63 Find the optimal assignment that will result in minimum total cost.	*CO4*	*PO3*	**10**

	b)	Determine the optimal route that minimizes the route cost.	*CO4*	*PO3*	**10**

	A	*B*	*C*	*D*	*E*
A	M	5	8	4	5
B	5	M	7	4	5
C	8	7	M	8	6
D	4	4	8	M	8
E	5	5	6	8	M

		UNIT – III			
5	a)	Ships arrive at a part at the rate of one in every 4 hours with exponential distribution of inter arrival times. The time a ship occupies a berth for unloading has exponential distribution with an average of 10 hours. If the average delay of ships waiting for berths is to be kept below 14 hours, how many berths should be provided at the port?	*CO4*	*PO3*	**08**
	b)	A Bank branch has only one typist. Since the typing work varies in length i.e number of pages to be typed. The typing rate is randomly distributed approximating a Poisson distribution with mean service rate of 8 letters per hour. The letters arrive at a rate of 5 per hour during the entire 8 – hour work day. If the typewriter is valued at Rs. 1.50 per hour, determine: i) The percentage time that an arriving letter has to wait ii) Average system time iii) Average cost due to waiting on the part of typewriter i.e. it remaining idle.	*CO4*	*PO3*	**08**
	c)	Explain Kendall-Lee concept for queuing problem	*CO1*	*PO1*	**04**
		UNIT – IV			
6	a)	Explain the characteristics of Game	*CO1*	*PO1*	**04**
	b)	Two players P and Q play the game. Each of them has to choose one of the three colours: White (W), Black (B) and Red (R) independently of the other. Thereafter the colours are compared. The complete payoff table is shown below. Find the optimum strategies for P and Q and the value of the game.	*CO4*	*PO3*	**06**

Player P	Player Q			
		W	B	R
	W	0	-2	7
	B	2	5	6
	R	3	-3	8

		c)	A multinational company is considering 3 alternative factory investments under different levels of inflation. Economists have assigned probabilities of 0.2, 0.3, 0.4 and 0.1 to the possible inflation levels A, B, C and D respectively. Find the preferred investment alternative using criteria of (a) Maxi-Max (b) Maxi-min (c) Laplace.	*CO4*	*PO3*	**10**

Alternatives	Amount of inflation			
	A = 2 %	B = 5%	C = 10%	D = 15%
Build factory (X)	10	30	50	120
Build factory (Y)	40	50	60	70
Lease plant (Z)	10	40	80	10

UNIT - V

7	a)	A small project involves 7 activities, and their time estimates are listed in the following table. Activities are identified by their beginning (i) and ending (j) node numbers	*CO3*	*PO2*	**10**

Activity	*Estimated Duration (weeks)*		
(i – j)	*Optimistic*	*Most Likely*	*Pessimistic*
1 – 2	1	1	7
1 – 3	1	4	7
1 – 4	2	2	8
2 – 5	1	1	1
3 – 5	2	5	14
4 – 6	2	5	8
5 – 6	3	6	15

- Draw the network diagram of the activities in the project
- Determine Critical path and its variance
- What is probability that the project will be completed at least 4 weeks earlier than expected time.
- If the project due date is 19 weeks, what is the probability of not meeting the due date

	b)	The following table gives data on normal time and cost and crashed time and cost for a project	*CO3*	*PO2*	**10**

Activity	Time (Days)		Time (INR)	
	Normal	Crash	Normal	Crash
1 – 2	9	4	1300	2400
1 – 3	15	13	1000	1380
2 – 3	7	4	7000	1540
2 – 4	7	3	1200	1920
2 – 5	12	6	1700	2240
3 – 6	12	11	600	700
4 – 5	6	2	1000	1600
5 – 6	9	6	900	1200

Find the optimum project time and corresponding minimum total project cost by crashing appropriate activities in proper order. The indirect cost per day is INR 400.

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