Exam Date & Time: 12-Jan-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

Program Elective VI

Operations Research [MME 4080]

Marks: 50 **Duration: 180 mins.**

A

Answer all the questions. Section Duration: 180 mins

1A)

	I	II	III	IV	V
I	-2	0	0	5	3
II	3	2	1	2	2
III	-4	-3	0	-2	6
IV	5	3	-4	2	-6

(2)

The payoff matrix of a game is given. Find the solution of the game to the players' A and B

1B) Two companies A and B are vying for more shares of the market. If 'A' does no advertising, it will not lose any market share if 'B' does nothing. However, it will lose 2% of the market if 'B' invests ₹ 10,000/- in advertising and it will lose 5% of the market if 'B' invests ₹ 20,000/- in advertising. On the other hand, if 'A' invests ₹ 15,000/- in advertising it will gain 3% of the market, if 'B' does nothing it will gain 1% of the market if 'B' invests ₹ 10,000/- in advertising and it will lose 1% if 'B' invests ₹ 20,000 in advertising. i)Develop a payoff table for this problem if a 1% increase in the market means a profit of ₹ 1000/- ii)Determine the optimal strategies. (4)

1C) A computer company specializes in computerized tax returns and financial reports. •Each tax return requires 5 minutes of computer time, 40 minutes of staff review, and 1 hour of packaging, yielding a net profit of ₹ 250/-. •Each financial report requires 20 minutes of computer, 15 minutes of staff review, and 1.5 hours of packaging and yields a net profit of ₹400/- In addition, each financial report must be reviewed by the consulting accountant for 10 minutes. The computer runs 7 hours a day and 5 staff members work for 8 hours a day. There are 200 hours of packaging and 7 hours of consulting available daily. The firm also has a contract to complete 25 returns each day. •Formulate an LPP •Give the dual of the above problem. (4)

2A) Solve the LPP by Simplex method.

$$Max\ Z = 3x_1 + 2x_2 + 5x_3 \quad \text{subject to the conditions}$$

$$x_1 + 2x_2 + x_3 \leq 430$$

$$3x_1 + 2x_3 \leq 460$$

$$x_1 + 4x_2 \leq 420$$

$$x_1\ x_2\ x_3 \geq 0$$

(3)

2B) (3)

	A	B	C	D
A	∞	4	7	3
B	4	∞	6	3
C	7	6	∞	7
D	3	3	7	∞

A machine operator processes four types of items on his machine each week and must choose a sequence for them. The setup cost per change depends on the items presently on the machine and the setup to be made according to the following table. If he processes each type of item once and only once each week how should he sequence the items on his machine?

2C) A certain farming organization operates three farms of comparable productivity. The output of each farm is limited both by the usable acreage and by the amount of water available for irrigation. Following are the data for the upcoming season: The organization is considering three corps for planting which differs primarily in their expected profit/acre and in their consumption of water. Furthermore, the total acreage that can be devoted to each of the crops is limited by the amount of appropriate harvesting equipment available. To maintain a uniform workload among the farms it is the policy of the organization that the percentage of the usable acreage planted must be the same at each farm. However, any combination of the crops may be grown at any of the farms. Formulate an LPP model that maximizes profit.

Farm	Usable Acreage	Water available in acre feet
1	400	1500
2	600	2000
3	300	900

(4)

Max. Acreage	Water consumption in acre feet/acre	Expected prof
700	5	₹ 400/-
800	4	₹ 300/-
300	3	₹ 100/-

3A) (3)

Activity	Immediate Predecessors	Time in weeks
A	---	6
B	---	4
C	---	2
D	C	7
E	B, D	4
F	A, E	10
G	A, E	2
H	F	6
I	G	11
J	C	6
K	H, I	8

Draw the CPM network for the following project:

3B) In the above problem, determine the critical path and total float for non-critical activities. (3)

3C) A machine tool company decides to make four subassemblies through four contractors. Each contractor is to receive only one subassembly. The cost of each subassembly is determined by the bids submitted by each contractor and is as shown in the table in hundreds of rupees. Assign the different sub-assemblies to contractors so as to minimize the total cost. (4)

	C1	C2	C3	C4
SB1	15	13	14	17
SB2	11	12	15	13
SB3	13	12	10	11
SB4	15	17	14	16

4A) A small shop has one checkout counter. Customers arrive at this checkout counter at random from 1 to 10 minutes apart. Each possible value of inter-arrival time has the same probability of occurrence equal to 0.10. Service time varies from 1 to 6 minutes with probabilities shown below. (3)

Develop the simulation table for 10 customers. Take the random digits for arrival as 91, 72, 15, 94, 30, 92, 75, 23, 30 and for service time as 84, 10, 74, 53, 17, 79, 91, 67, 89, 38.

Service time	1	2	3	4	5	6
Probability	0.05	0.1	0.2	0.3	0.25	0.1

4B) Solve the following 2*2 game without saddle point. (2)

	Y1	Y2
X1	5	1
X2	3	4

4C) Three refineries with maximum daily capacities of 6,5 and 8 million gallons of gasoline supply three distribution areas with daily demands of 4, 8, and 4 million gallons through a network of pipelines. The transportation costs in ₹ per 100 gallons are given below. Note that refinery 1 is not connected to distribution area 3. Any surplus production at refineries 1 and 2 must be diverted to other areas by trucks. The resulting transportation cost per 100 gallons is ₹ 150/- from refinery 1 and ₹ 220/- from refinery 2. Refinery 3 can divert its surplus gasoline to a chemical process within its plant. Formulate the problem as a transportation model and solve it. (5)

	Distribution Area		
	1	2	3
Refinery 1	120	180	---
Refinery 2	300	100	80
Refinery 3	200	250	120

5A) A small furniture factory makes tables and chairs. It takes two hours to assemble a table and 30 minutes to assemble a chair. Assembly is carried out by four workers based on a single 8-hour shift per day. Customers usually buy at least four chairs with each table, meaning that the factory must produce at least four times as many chairs as tables. The sale price is ₹ 1500/- per table and ₹ 500/- per chair. Determine the daily production mix of chairs and tables that would maximize the total daily revenue to the factory. Use the graphical method. (4)

5B) Write the dual of the given problem: (3)

$$Max\ Z = 2x_1 - 4x_2 + 5x_3 - 6x_4$$
$$subject\ ¿\ 2x_1 - 4x_2 + 5x_3 - 6x_4 \leq 2$$
$$-x_1 + 2x_2 + 3x_3 + 4x_4 \leq 1$$
$$x_1, x_2, x_3, x_4 \geq 0$$

5C) A hospital has the following minimal daily requirements for nurses. Nurses report to the hospital at the beginning of each period and work for 08 consecutive hours. The hospital wants to determine the minimal number of nurses to be employed so that there will be sufficient number of nurses available for each period. Formulate this as an LPP by setting up appropriate constraints and objective function. Do not solve. (3)

Period	Clock Time (24 hours a day)	Minimal No. of Nurses required
1	06 AM – 10 AM	02
2	10 AM – 02 PM	07
3	02 PM – 06 PM	15
4	06 PM – 10 PM	08
5	10 PM – 02 AM	20
6	02 AM – 06 AM	06

-----End-----