Exam Date & Time: 07-Dec-2023 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

VII SEMESTER MECHANICAL ENGINEERING END SEMESTER REGULAR EXAMINATION NOV/DEC 2023

Operations Research [MME 4080]

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

PROGRAM ELECTIVE VI

Answer all the questions.

Draw relevant graphs on a seperate graph sheet provided.

1A) A mining company owns two mines that produce a given kind of ore in grades A, B, and C. The mining company has contracted to provide a smelting plant with 12T of A, 8T of B, and 24T of C grade ores per week. It costs the company ₹ 2000/- per day to run the first mine and ₹ 1600/- per day to run the second. In a day's operation, the first mine produces 6T of A, 2T of B, and 4T of C grade ores. The other mine produces 2T of A and 2T of C grade ores. How many days a week should each mine be operated to fulfill the company's orders most economically? Solve graphically. (4)

1B)

	1	2	3	4	5
I	3	5	4	9	6
II	5	6	3	7	8
III	8	7	9	8	7
IV	4	2	8	5	3

(3)

Solve the game using the concept of dominance.

1C)

$$Min\ z = 3x_1 + 2x_2 + 4x_3 \quad \text{subject to the conditions,}$$

$$3x_1 + 5x_2 + 4x_3 \geq 7$$
$$6x_1 + x_2 + 3x_3 \geq 4$$
$$7x_1 - 2x_2 - x_3 \leq 10$$
$$x_1 - 2x_2 + 5x_3 \geq 3$$
$$4x_1 + 7x_2 + 2x_3 \geq 2$$
$$x_1 x_2 x_3 \geq 0$$

(3)

Develop the dual of the above LP problem.

2A) A company has factories at A, B, and C which supply warehouses at P, Q, R, S, and T. Monthly production capacities for regular production are 300, 400, and 600 units respectively for A, B, and C, the cost of production per unit being ₹ 40, ₹ 30 and ₹ 40 respectively. By working overtime it is possible to have additional production of 100, 150, and 200 units, with incremental costs of ₹ 5, ₹ 9, and ₹ 8 respectively. If the cost of transportation per unit is as given in the table below. Investigate the allocation at all warehouses for getting maximum profit, if the sales price/unit at all warehouses is ₹ 70/- (5)

	P	Q	R	S	T
A	12	14	18	13	16
B	11	16	15	11	12
C	16	17	19	16	14
Demand	400	400	200	200	300

2B) Identify the saddle point and solve the game.

	I	II	III	IV	V
I	9	3	1	8	0
II	6	5	4	6	7
III	2	4	4	3	8
IV	5	6	2	2	1

(2)

2C) A shop has a checkout counter with service time and inter-arrival times are given below. The Service time follows a uniform distribution of U (5, 10) minutes. The interarrival time of customers is a uniform distribution of U (4, 20) minutes. Simulate the scenario for the arrival of 12 citizens at the distribution centres. Use the following random digits sequentially, for the inter-arrival time of citizens 60, 94, 7, 20, 24, 17, 86, 82, 49, 43, 61, 79. Use the following random digits sequentially, for the service time of the employee 36, 0, 91, 93, 65, 15, 41, 23, 96, 38, 85, 45 (3)

a. Estimate the expected time between arrivals for 12 citizens.
b. Estimate the expected service time for 12 citizens.
c. Estimate the average time of a citizen in the system.

3A) A trip from Chennai to Coimbatore takes six hours by bus. A typical bus service timetable in both directions is given in Table 1. The cost of providing this service by the company is based on the time spent by the bus crew i.e. driver and conductor away from their places and service times. The company has five crews. The condition here is that every crew should be provided with more than 4 hours of rest before the return trip and should not wait for more than 24 hours for the return trip. Also, the company has guest house facilities for the crew of Chennai as well as at Coimbatore. Identify which line of service is connected with which other line so as to reduce the waiting time to the minimum.

Departure from Chennai	Route No.	Arrival at Coimbatore	Arrival to Chennai	Route No.	Departure from Coimbatore
06.00	1	12.00	11.30	A	05.30
07.30	2	13.30	15.00	B	09.00
11.60	3	17.30	21.00	C	15.00
19.00	4	01.00	00.30	D	18.30
00.30	5	06.30	06.00	E	00.00

(5)

3B) (3)

An air conditioning installation has been broken down into the following activities and restrictions:

	Activity List	Time(days)	Restrictions
A	Order & deliver packaged AC unit	14	A<H, K
B	Order delivery piping	4	B<I
C	Order & deliver grills, dampers & louvers	11	C<F
D	Order & deliver duct	8	D<F
E	Determine the layout of duct	3	E<D, G
F	Install ductwork, dampers, and louvers	18	F<G
G	Install grills	1	G<M
H	Install AC unit	1	H<L, J
I	Rough in piping	10	I<J
J	Connect piping to unit	1	J<M
K	Electric wiring main line of Mostar	4	K<L
L	Controls of final wiring	2	L<M
M	Testing	2	M<N
N	Installation & Cleaning	4	---

Draw the network. Note: X< Y, implies that Y follows X immediately in the above notation)

3C) In the above problem determine the event times, and identify the critical path. Determine also activity times and float for each activity. (2)

4A) A firm has two plants producing the same product. Orders from three customers have been received. The number of units ordered by each customer and shipping costs from each plant are shown below:

Customers	Units Ordered	Shipping Cost/unit	
		Plant 1	Plant 2
A	500	1.50	4.00
B	300	2.00	3.00
C	1000	3.00	2.50

Each unit of the product must be machined and assembled. These costs, together with the capacities at each plant are shown below. Formulate an LPP to minimize the cost. (4)

		Hours/Unit	Cost/Hour	Hours Available
Plant 1	Machining	0.10	4.00	120
	Assembling	0.20	3.00	260
Plant 2	Machining	0.11	4.00	140
	Assembling	0.22	3.00	250

4B) A salesman travels from one place to another. He cannot, however, travel from one place to the same place. The distances between pairs of cities are given below. The problem for the salesman is to identify a route, which enables him to visit each of the cities only once, at the minimum total distance traveled.

	P	Q	R	S
P	∞	15	25	20
Q	22	∞	45	55
R	40	30	∞	25
S	20	26	38	∞

(3)

4C) (3)

Solve the LPP by Simplex method.

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

$$3x_1 + 2x_2 + x_3 \leq 3$$

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

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

5A) A company produces two items A and B using 3 resources namely sheet metal, equipment, and labor. The input-output relationships and resource availability per week are as given below: (5)

Input	Output		Resource availability
	Product A	Product B	
Sheet Metal	1	1	50
Labor Hours	1	2	80
Machine Hours	3	2	140
Profit/Unit	₹4/-	₹3/-	

i) Determine optimal product mix using the simplex algorithm.
ii) Interpret the numbers in the net evaluation row of the optimal tableau.

5B) A and B play a game in which each has three coins 5p 10p and 20p. Each selects a coin without the knowledge of the other's choice. If the sum of the coins is an odd amount, A wins B's coin. If the sum is even, B wins A's coin. Identify the best strategy for each player and the value of the game. (3)

5C) Explain the different rules of Dominance in game theory. (2)

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