Exam Date & Time: 03-May-2024 (02:30 PM - 05:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

FOURTH SEMESTER B.TECH END SEMESTER EXAMINATIONS, MAY 2024

OPERATIONS RESEARCH [MIE 2226]

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

A

Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) Use the simplex method to solve the following LP problem.

A) (4)

Maximize $Z = 4x_1 + 3x_2 + 6x_3$

subject to the constraints

$2x_1 + 3x_2 + 2x_3 \leq 440$

$4x_1 + 3x_3 \leq 470$

$2x_1 + 5x_2 \leq 430$ and

$x_1, x_2, x_3 \geq 0$

B) Use Big-M method to solve the following LP problem. (4)

Maximize $Z = 3x_1 - x_2$,

subject to $2x_1 + x_2 \leq 2$,

$x_1 + 3x_2 \geq 3$,

$x_2 \leq 4$,

$x_1, \ x_2 \geq 0$.

C) A firm manufactures four different machine parts M1, M2, M3 and M4 made of copper and zinc. The amounts of copper and zinc required for each machine part, their exact availability and the profit earned from one unit of each machine part are as follows : (2)

	M_1 (kg)	M_2 (kg)	M_3 (kg)	M_4 (kg)	Exact availability (kg)
Copper	5	4	2	1	100
Zinc	2	3	8	1	75
Profit (₹)	12	8	14	10	

Formulate this problem as an LP model to maximize the total profit.

2) Use the graphical method to solve the following LP problem. (3)

A)

Maximize $Z = 15x_1 + 10x_2$
subject to the constraints
$4x_1 + 6x_2 \leq 360$,
$3x_1 + 0x_2 \leq 180$,
$0x_1 + 5x_2 \leq 200$
and
$x_1, x_2 \geq 0$

B) Find the initial basic feasible solution of the following transportation problem by Vogel's approximation method:

		Warehouse				
		W_1	W_2	W_3	W_4	*Capacity*
Factory	F_1	19	30	50	10	7
	F_2	70	30	40	60	9
	F_3	40	8	70	20	18
Requirement		5	8	7	14	34 (Total)

(3)

C) The owner of a chain of three grocery stores has purchased six crates of fresh strawberries. The following tables give the estimated profits for each store when it allocated various numbers of boxes.

		Stores		
		1	2	3
Number of boxes	0	0	0	0
	1	4	2	6
	2	6	4	8
	3	7	6	8
	4	7	8	8
	5	7	9	8
	6	7	10	8

(4)

The owner does not wish to split crates between stores but is willing to make zero allocations. Find the allocation of six crates to maximize the profits.

3) Write the dual linear programming problem to the following linear programming problem. (2)

A) Minimize $Z = x_1 - x_2 + 3x_3$
subject to the constraints

$x_1 + x_2 + x_3 \geq 5,$

$x_1 - 2x_2 - x_3 \geq 2,$

$x_1 - 2x_2 - 3x_3 \geq 6$

and $x_1, x_2, x_3 \geq 0$

B) A department of a company has five employees with five jobs to be performed. The time (in hours) that each man takes to perform each job is given in the effectiveness matrix.

		Employees				
		I	*II*	*III*	*IV*	*V*
Jobs	*A*	10	5	13	15	16
	B	3	9	18	13	6
	C	10	7	2	2	2
	D	7	11	9	7	12
	E	7	9	10	4	12

(3)

How should the jobs be allocated, one per employee, to minimize the total man-hours?

C) A machine operator processes four types of items on his machine and he must choose a sequence for them. The setup cost per change depends on the items currently on the machine and the set-up to be made according to the following table:

		To			
		A	*B*	*C*	*D*
From Item	*A*	–	4	7	3
	B	4	–	6	3
	C	7	6	–	7
	D	3	3	7	–

(5)

If he processes each of the items once and only once each week, then how should he sequence the items on his machine? Use the method for the problem of travelling salesman.

4) (2)

A)

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

		B				
		I	II	III	IV	V
A	I	-4	-2	-2	3	1
	II	1	0	-1	0	0
	III	-6	-5	-2	-4	4
	IV	3	1	-6	0	-8

B) Solve the following game by graphical method

		Player B			
		1	**2**	**3**	**4**
Player A	**1**	**3**	**3**	**4**	**0**
	2	**5**	**4**	**3**	**6**

(3)

C) The data on normal time and cost along with crashed time and cost associated with a project are shown in the following table:

	Time		Cost	
Activities	normal	crash	normal	crash
A (1-2)	4	3	60	90
B (1-4)	6	4	150	250
C (1-3)	2	1	38	60
D (2-4)	5	3	150	250
E (3-4)	2	2	100	100
F (2-5)	7	5	115	175
G (4-5)	4	2	100	240

(5)

The indirect cost is Rs. 60 per day. Find the optimum duration and the associated minimum project cost.

5) A) An established company has decided to add a new product to its line. It will buy the product from a manufacturing concern, package it, and sell it to a number of distributors that have been selected on a geographical basis. Market research has already indicated the volume expected and the size of the sales force required. The steps shown in the following table are to be planned. (3)

Activity	*Description*	*Predecessors*	*Duration (days)*
A	Organize sales office	–	6
B	Hire salesmen	*A*	4
C	Train salesmen	*B*	7
D	Select advertising agency	*A*	2
E	Plan advertising campaign	*D*	4
F	Conduct advertising campaign	*E*	10
G	Design package	–	2
H	Setup packaging facilities	*G*	10
I	Package initial stocks	*J, H*	6
J	Order stock from manufacturer	–	13
K	Select distributors	*A*	9
L	Sell to distributors	*C, K*	3
M	Ship stocks to distributors	*I, L*	5

(a) Draw the network diagram showing the interrelations between the various activities of the project.

(b) Find E and L values for each event point

(c) Indicate the critical path.

B) Workers come to the tool storeroom to receive special tools (required by them) for accomplishing a particular project assigned to them. The average time between two arrivals is 60 seconds and the arrivals are assumed to be in Poisson distribution. The average service time (of the tool room attendant) is 40 seconds. Determine

(a) average queue length,

(b) average length of non-empty queues, (3)

(c) average number of workers in system including the worker being attended,

(d) mean waiting time of an arrival,

(e) average waiting time of an arrival (worker) who waits.

C) Observations of past data show the following patterns with respect to interarrival durations and service durations in a single-channel queuing system. Simulate the queue behaviour for a period of 60 minutes using the random numbers 93, 14, 72, 10, 21, 81, 87, 90, 38 for arrival and random numbers 71, 63, 14, 53, 64, 42, 07, 54, 66 for service time and estimate the mean time of the service being idle and the mean time spent by a customer waiting to be served.

Interarrival Time		*Service Time*	
Minutes	*Probability*	*Minutes*	*Probability*
2	0.15	1	0.10
4	0.23	3	0.22
6	0.35	5	0.35
8	0.17	7	0.23
10	0.10	9	0.10

(4)

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