Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
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VI SEMESTER B. TECH (INDUSTRIAL AND PRODUCTION ENGG.) END SEMESTER EXAMINATIONS, APRIL 2018

SUBJECT: OPERATIONS RESEARCH [MME 3211]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Use of normal tables is permitted

1A. State any four basic assumptions of LPP model **2**

1B. Two companies A and B are competing for an increased market share by employing following 4 strategies. 1) Give coupon 2) Decrease price 3) Maintain status-quo 4) increase advertising. The pay-off matrix is shown below:

		Company B			
		I	**II**	**III**	**IV**
Company A	**I**	2	-2	4	1
	II	6	1	12	3
	III	-3	2	0	6
	IV	2	-3	7	1

Determine the optimal strategy for each player and determine the value of the game. **3**

1C. A manufacturer produces three products x_1, x_2, x_3, which are processed through three production operations with time constraints and then stored. The problem is formulated as.

$$Maximise\ Z = 40x_1 + 35x_2 + 45x_3 \quad (\text{Profit,\$})$$

$$S.T.$$

$$2x_1 + 3x_2 + 2x_3 \le 120 \quad (\text{operation1,hrs})$$

$$4x_1 + 3x_2 + x_3 \le 160 \quad (\text{operation2,hrs})$$

$$3x_1 + 2x_2 + 4x_3 \le 100 \quad (\text{operation3,hrs})$$

$$x_1 + x_2 + x_3 \le 40 \quad (\text{storage space,cubicfeet})$$

$$x_1, x_2, x_3 \le 0$$

The final optimal tableau for the problem is given below.

Basis	Qty	40	35	45	0	0	0	0
		X1	X2	X3	S1	S2	S3	S4
S1	10	-½					½	-4
S2	60	2					1	-5
X3	10	½					½	-1
X2	30	½					-½	2

a) Complete the above tableau and interpret the numbers in the Cj – Zj row.
b) Is the above solution unique? If not give the alternate optima.
c) Conduct sensitivity for the RHS values and profit coefficient. **5**

2A. What is degeneracy in Transportation problem and how to resolve it? **2**

2B. Using Monte Carlo technique, simulate the queuing system given below.

The distribution of inter arrival time(IAT) and service time(ST) is given below:

IAT (minutes)	10	15	20	25
Probability	0.15	0.30	0.30	0.25

ST (minutes)	5	10	15	20
Probability	0.20	0.30	0.35	0.15

Simulate 6 users of the system using the random numbers given below.

R. No. for IAT	46	20	25	46	37	09
R. No for ST	20	31	16	66	59	43

From the simulated data determine the mean waiting time, mean system time, server utilization. **3**

2C. Solve the assignment problem to minimize the total time for doing all the jobs.

Operator	JOBS				
	1	**2**	**3**	**4**	**5**
A	8	3	6	3	7
B	3	6	9	8	8
C	9	9	7	9	9
D	7	2	3	5	6
E	10	3	8	9	7
F	5	7	4	7	8

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3A. Explain the following: (a) pure and mixed strategy (b) zero sum and non-zero sum games **2**

3B. A factory manufacturing tanks for military has a separate tool room where special maintenance tools (SMTs) are stored. The average time between requirements of a tool from tool room is 10 minutes and this follows the Poisson's distribution. Average service time of the storekeeper is 9 minutes determine.

i. Average queue length. **3**

ii. Average length of non-empty queues.
iii. Average number of mechanics in the system including one who is being attended to.
iv. Mean waiting time of mechanic who waits.
v. Whether there is a need of employing another storekeeper so that cost of storekeeper idle time and mechanics waiting is reduced to the minimum. Assuring that a skilled mechanics cost Rs.10 per hour. And the storekeeper cost Rs. 1 per hour.

3C. A special diet for a patient in the hospital must have at least 8000 units of vitamins, 100 units of minerals and 2800 units of calories. Two types of foods X and Y are available in the market at the cost of Rs. 8 and Rs.6 respectively. One unit of X contains 400 units of vitamins, 2 units of minerals and 80 units of calories. One unit of food B contains 200 units of vitamins, 4 units of minerals and 80 units of calories. What combination of foods X and Y be used so that the minimum requirement of vitamins, minerals and calories is maintained and the cost incurred by the hospital is minimized? Use simplex method. **5**

4A. An organization is planning to diversify its business with a maximum outlay of ` 5 crores. It has identified three different locations to install plants. The organization can invest in one or more of these plants subject to the availability of the fund. The different possible alternatives and their investment (in crores of rupees) and present worth of returns during the useful life (in crores of rupees) of each of these plants are summarized in Table. The first row of Table has zero cost and zero return for all the plants. Hence, it is known as do-nothing alternative. Find the optimal allocation of the capital to different plants which will maximize the corresponding sum of the present worth of returns.

	Plant 1		Plant 2		Plant 3	
Alternative	Cost	Return	Cost	Return	Cost	Return
1	0	0	0	0	0	0
2	1	15	2	14	1	3
3	2	18	3	18	2	7
4	4	28	4	21	-	-

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4B. A company has four warehouses and six stores. The warehouses altogether have a surplus of 22 units of a given commodity, divided among them as follows:

Warehouses	1	2	3	4
Surplus	5	6	2	9

The six stores altogether need 22 units of the commodity. Individual requirements at stores1,2,3,4,5 and 6 are 4,4,6,2,4 and 2 units respectively

Cost of shipping one unit of commodity from warehouse I to store j in rupees is given in the matrix below

	Stores					
	1	**2**	**3**	**4**	**5**	**6**
1	9	12	9	6	9	10
2	7	3	7	7	5	5
3	6	5	9	11	3	11
4	6	8	11	2	2	10

(i) Formulate the mathematical model for the problem.
(ii) How should the products be shipped from the warehouses to the stores so that the transportation cost is minimum? **5**

5A. State the "Bellman's principle of optimality in dynamic programming". Differentiate between state and stage variables. **2**

5B. Write the dual of the following LPP.

$$Minimise\ Z = 3x_1 - 6x_2 + 4x_3$$

Subject to

$$4x_1 + 3x_2 + 6x_3 \geq 9; \qquad x_1 + 2x_2 + 3x_3 \geq 6;$$

$$6x_1 - 2x_2 - 2x_3 \leq 10; \qquad x_1 - 2x_2 + 6x_3 \geq 4$$

$$2x_1 + 5x_2 - 3x_3 \geq 6; \qquad \mathbf{x_1, x_2, x_3 \geq 0}$$

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5C. A Project consists of nine activities whose time estimates (in weeks) and other characteristics are given below:

Activity	Preceding activities	Time estimates (weeks)		
		p	q	r
A	-	4	6	2
B	-	6	6	6
C	-	12	24	6
D	A	5	8	2
E	A	14	23	11
F	B, D	10	12	8
G	B, D	6	9	3
H	C, F	15	27	9
I	E	10	16	4

(i) Show the PERT network for the project.
(ii) Identify the critical activities
(iii) What is the expected project completion time and its variance?
(iv) What is the probability of completing the project one week before expected time?
(v) If the project is required to be completed by December 31 of a given year and the manager wants to be 95% sure of meeting the deadline, when should he start the project work?
(vi) A penalty of Rs.15,000 per week is to be imposed on the contractor if the project is not completed in 36 weeks. What is the probability that he has to pay a penalty? A penalty of ` 45,000? **5**