

**IV B.Tech I Semester Regular Examinations, November 2007**  
**OPERATIONS RESEARCH**  
 ( Common to Mechanical Engineering, Mechatronics and Production  
 Engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions  
 All Questions carry equal marks

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1. (a) A machine tool company conducts a Job training programme for machinists. Trained machinists are used as teachers in the programme at a ratio of one for every ten trainees. The training lasts for one month. From past experience it has been found that out of ten trainees hired, only six complete the programme successfully. The unsuccessful trainees are released. Trained machinists are needed for machining and company's requirements for the next three months are January: 120, February: 180 and March: 220. Further, the company requires 250 trained machinists by April. There are 150 trained machinists available at the beginning of the year. The relevant costs per month are:

Each trainee : Rs. 1,000.00

Each trained machinists

(Machining or Teaching) : Rs. 2,000.00

Each trained machinist idle. : Rs. 1,500.00

Formulate as an LPP that will result in minimum cost hiring and training schedule and meet the company's need.

- (b) Solve graphically:

$$\text{Maximize } Z = 3x_1 + 5x_2$$

Subject to:

$$2x_1 + 6x_2 \leq 50$$

$$3x_1 + 2x_2 \leq 35$$

$$5x_1 - 3x_2 \leq 10$$

$$x_2 \leq 20 \text{ and } x_1, x_2 \geq 0$$

[6+10]

2. There are three parties who supply the following quantities of coal and three consumers who require the coal as follows :

Party 1 : 14 tons      Consumer A : 6 tons

Party 2 : 12 tons      Consumer B : 10 tons

Party 3 : 5 tons      Consumer C : 15 tons

The cost matrix is as shown below :

	A	B	C
1	6	8	4
2	4	9	3
3	1	2	6

Find the schedule of a transportation policy which minimizes the cost.

[16]

3. (a) Define total elapsed time and idle time on machines as referred to sequencing of Job in machines.
- (b) There are five jobs each of which must go through the machines A, B and C in the order ABC. The processing time ( in hours) are as follows.

Jobs	1	2	3	4	5
Machines					
A	4	3	8	6	5
B	5	6	2	3	4
C	8	10	6	7	11

- i. Determine the optimal sequence.
- ii. What will be the elapsed time?
- iii. What will be the idle time of the machines? [4+12]
4. (a) Running cost and resale value of a small machine whose purchase price is Rs.6000 are given below

Year	1	2	3	4	5	6	7
Running cost(Rs.)	1000	1200	1400	1800	2300	2800	3400
Resale value(Rs.)	3000	1500	750	375	200	200	200

Determine at what age replacement is due?

- (b) Let the owner has three of above type machines, two of which are two years old. Now he is considering a new type of equipment with 50% more capacity than one of the old ones at a unit price of Rs.8000 with the running costs and resale price as follows:

Year	1	2	3	4	5	6	7	8
Running cost (Rs.)	1200	1500	1800	2000	3100	4000	5000	6100
Resale price (Rs.)	4000	2000	1000	500	300	300	300	300

Assuming the loss of flexibility due to fewer machines is of no importance and that he will continue to have sufficient work for three of the old machine, what should his policy be? [6+10]

5. (a) Explain briefly:
- i. Competitive games
- ii. zero-sum games
- iii. strategy
- (b) Find the solution of the following game [6+10]

		B		
		I	II	III
A	I	1	3	11
	II	8	5	2

6. (a) Discuss the machine repair problem as a birth and death problem

- (b) What do you understand by optimum service rate? Show how some important waiting line formulae may be used in the determination of optimum service rate? [8+8]
7. (a) Write a note on news paper-boy problem.
- (b) A baking company sells cake by Kg. weight. It makes a profit of Rs 5.00 a Kg. on each Kg. sold on the day it is baked. It disposes of all cake not sold on the date it is sold at a loss of Rs 1.20 a Kg. if the demand is known to be rectangular between 2000 and 3000 Kgs. Determine the optimal daily amount baked. [6+10]
8. Use Dynamic Programming to solve the Linear Programming Problem:  
Maximize  $Z = x_1 + 9x_2$  subjected to  $2x_1 + x_2 \leq 8$ ;  $5x_1 + 2x_2 \leq 15$  where  $x_1, x_2 \geq 0$ . [16]

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1. (a) Explain the role of OR in decision-making .  
 (b) Solve the following LPP using Simplex method.  
 Minimize  $Z=2X_1 + X_2$   
 Subject to the constraints  
 $3X_1 + X_2 = 3$   $4X_1 + 3X_2 \geq 6$   
 $X_1 + 2X_2 \leq 4$  and  $X_1, X_2 \geq 0$ . [4+12]

2. Solve the following Transportation problem [16]

		Destination			
		D1	D2	D3	Supply
Source	S1	5	1	7	10
	S2	6	4	6	80
	S3	3	2	5	15
Demand		75	20	50	

3. (a) Distinguish between a Travelling salesman problem and a Assignment problem  
 (b) Solve the following travelling salesman problem [4+12]

		To				
		A	B	C	D	E
From	A	-	3	6	2	3
	B	3	-	5	2	3
	C	6	5	-	6	4
	D	2	2	6	-	6
	E	3	3	4	6	-

4. The following mortality has been observed for a certain type of IC's used in a digital computer :

Week	1	2	3	4	5
Percent failing by the end of week	10	25	50	80	100

Group replacement of IC's costs Rs.0.30 per transistor, where as individual replacement costs Rs.1.25. What is the best interval between group replacements? At what group replacement price per transistor would a policy of strictly individual replacement become preferable to the adopted policy. [16]

5. Solve the following game by LPP [16]

		B		
		1	2	3
A	1	0	2	2
	2	3	-1	3
	3	4	4	-2

6. A computer shop has a laser printer. The jobs for laser printing are randomly distributed approximating a Poisson distribution with mean service rate of 10 jobs per hour, since job pages vary in length (pages to be printed). The jobs arrive at a rate of 6 per hour during the entire 8 hours workday. If the laser printer is valued Rs.30/- per hour, determine

- (a) The percent time an arriving job has to wait
- (b) Average system time
- (c) Average idle time cost of the printer per day. [16]

7. (a) What is inventory management?. Briefly, explain the major decisions concerning inventory.
- (b) A motor manufacturing co. purchases 18,000 items of certain motor part for its annual requirements, ordering one-month usage at a time. Each spare costs Rs 20. the ordering cost per order is Rs 15 and carrying charges are 15% of the unit item cost per year. Make a more economical purchasing policy. What is the savings by the new purchasing policy? [6+10]

8. A distance network consists of 11 nodes which are distributed as shown in figure. Find the shortest path from node 1 to node 11 and also the corresponding distances. [16]

Arc	Distance	Arc	Distance
1-2	8	5-7	8
1-3	7	5-8	1
1-4	4	6-9	3
1-5	2	6-10	5
2-6	4	7-9	5
3-6	8	7-10	1
3-7	4	8-10	5
4-7	6	9-11	5
		10-11	5

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1. (a) Define and discuss the scientific method in OR Problem.  
 (b) Find the maximum value of  
 $Z = 2x + 3y$   
 subject to the constraints  
 $x + y \leq 30, Y \geq 3$   
 $x - y \geq 0, 0 \leq y \leq 12$   
 $0 \leq x \leq 20$   
 Use the graphical method. [4+12]
  
2. (a) What is a transportation problem?  
 (b) Distinguish between a balanced and an unbalanced transportation problem.  
 (c) A Product is manufactured by 3 factories A,B and C. Their production capacities are 800,500 and 900 units respectively. These factories supply the products to five stores S1, S2, S3, S4 and S5 whose requirements are 400,400,500,400 and 800 units respectively. Unit transportation cost (in Rs) are given below.

	S1	S2	S3	S4	S5
A	5	8	6	6	3
B	4	7	7	6	5
C	8	4	6	6	4

Determine an optimum distribution for the company in order to minimize the total transportation cost. [2+2+12]

3. (a) What is a travelling salesman problem?  
 (b) Solve the following travelling salesman problem [4+12]

		To			
		A	B	C	D
From	A	-	46	16	40
	B	41	-	50	40
	C	82	32	-	60
	D	40	40	36	-

4. A manufacturer is offered two machines A and B. A is priced at Rs.5000 and running costs are estimated at Rs.800 for each of the first five years, creasing by Rs.200per

year in the sixth and subsequent years. Machine B, which has the same capacity as A, costs Rs.2500 but will have running costs of Rs.1200 per year for six years, increasing by Rs.2000 per year thereafter. If the money is worth 10% per year, which machine should be purchased assuming that both machines will eventually be sold for a scrap at a negligible value. [16]

5. (a) Briefly explain “dominance property”  
(b) A and B play game in which each has three coins 5p,10p and a 20p. Each selects a coin without the knowledge of the others 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. Find the best strategy for each player and the value of the game. [4+12]
6. (a) Gives a brief description of the various types of queues.  
(b) In a color TV manufacturing plant, a loading unit takes exactly 10 minutes to load two TV sets at a time into a wagon and again comes back to the position to load another set of TVs. If the arrival of TVs is a Poisson stream at an average of 2 TVs every 20 minutes calculate the average waiting time of 2 TV sets in a stationary state. [6+10]
7. (a) Discuss the impact on Economic Order Quantity if shortages are allowed.  
(b) The demand for an item is deterministic and instantaneous time and it is equal to 600 units per year. The per unit cost of the item is Rs. 40/- while the cost of placing an order is Rs.10/- The inventory carrying cost is 20% of the cost of inventory per annum and the cost of shortage is Rs. 2/- per unit per month. Find the optimal ordering quantity when stock outs are permitted. If the stock outs are not permitted, what would be the loss to the company? [4+12]
8. Solve the following problem using Dynamic Programming.  
Maximize  $Z = y_1^2 + y_2^2 + y_3^2$  subjected to  $y_1, y_2, y_3 \leq 4$  where  $y_1, y_2, y_3$  are positive integers. [16]

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(Machining or Teaching) : Rs. 2,000.00

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Formulate as an LPP that will result in minimum cost hiring and training schedule and meet the company's need.

- (b) Solve graphically:

$$\text{Maximize } Z = 3x_1 + 5x_2$$

Subject to:

$$2x_1 + 6x_2 \leq 50$$

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$$5x_1 - 3x_2 \leq 10$$

$$x_2 \leq 20 \text{ and } x_1, x_2 \geq 0$$

[6+10]

2. A Securable Sales Group wishes to purchase the following quantities of uniforms:

Uniform type :	A	B	C	D	E
Quantity:	150	100	75	250	200

Tenders are submitted by four different manufacturers who undertake to supply not more than the quantities indicated below.

Manufacturers:	P	Q	R	S
Total uniform quantity:	300	250	150	200

The group estimates that its profit (in Rs. ) per uniform will vary with the



manufacturer as shown in the following table :

	A	B	C	D	E
P	27.50	35.00	42.50	22.50	15.00
Q	30.00	32.50	45.00	17.50	10.00
R	25.00	35.00	47.50	20.00	12.50
S	32.50	27.50	40.00	250.00	17.50

How should the orders for uniforms be placed. [16]

3. Find the sequence of jobs that minimizes the total time elapsed to complete the jobs with the following data. Sequence is  $M_1 M_2$ .

Job	1	2	3	4	5	6
Machine $M_1$	4	10	16	10	12	9
Machine $M_2$	8	9	8	6	12	2

Also find the total elapsed time and idle times of each machine [16]

4. A manufacturer is offered two machines A and B. A is priced at Rs.5000 and running costs are estimated at Rs.800 for each of the first five years, creasing by Rs.200per year in the sixth and subsequent years. Machine B, which has the same capacity as A, costs Rs.2500 but will have running costs of Rs.1200 per year for six years, increasing by Rs.2000 per year thereafter.If the money is worth 10% per year, which machine should be purchased assuming that both machines will eventually be sold for a scrap at a negligible value. [16]
5. (a) Consider the following pay-off matrix and determine the optimal strategy.

		B		
		I	II	III
A	I	6	9	4
	II	5	10	7
	III	9	8	9

- (b) Write a note on zero-sum games [12+4]
6. (a) Write some important applications of queuing theory.  
 (b) A P.C. repairperson finds that the time spent on jobs has an exponential distribution with mean 30 minutes. If the sets are repaired in the order in which they come in, and if the arrival of sets is approximately poisson with an average of 10 per 8 hour day, what is the repairperson's expected idle time each day ? How may jobs are ahead of the average set just brought in? [6+10]
7. (a) Discuss the inventory policies for A,B and C items.  
 (b) ABC company purchases 9000 parts of a machine for its annual requirement. Ordering one month usage at a time, each part cost is Rs.20, ordering cost per order is Rs.15 and carrying cost is 15% of the average inventory per year. Suggest a more economical purchasing policy for the company. What advice would you offer and how much would it save for the year? [6+10]

8. Consider a cable of length  $k$  units. The objective is to subdivide this cable into  $n$  parts each having a length  $p_i$  where  $i$  varies from 1 to  $n$  such that the product of the lengths of the parts is maximized. A mathematical model for the above situation is presented below.

$$\text{Maximize } Z = p_1 p_2 p_3 \dots p_i \dots p_n$$

$$\text{Subjected to } p_1 + p_2 + p_3 + \dots + p_i + \dots p_n = k$$

$$P_i > 0, i = 1, 2, 3, \dots, n.$$

Solve the problem using dynamic programming technique. [16]

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