

IV B.Tech I Semester Regular Examinations, November 2006
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

1. (a) Give the properties of a Linear Programming Problem

(b) Minimize $P=5X+4Y+4Z$

Subject to

$$X+Y+Z=100$$

$$X \geq 20$$

$$Y \geq 30$$

$$Z \leq 40 \text{ and } X, Y, Z \geq 0$$

[4+12]

2. KEO Technocrat is manufacturing Disk Antennas and the company has two factories and three distribution centres in three cities. The supply and demand conditions for units of Disk Antennas are given below. How should the trips be scheduled so that the cost of transportation is minimum .

Cities	:	Chennai	Mumbai	Kolkata
Requirements	:	50	50	150
Cost per unit from Plants X (in Rs.)	:	5000	7000	2000
	Y	4000	1000	16000
Capacity of plant X	:	150	Units of disk antennas	
	Y	100	"	"

[16]

3. (a) Name two applications of travelling sales man problem
- (b) A machine operator process five types of item on his machine each week, and must choose a sequence for them. The set up cost per change depends on the items presently on the machine and item to be made according to the following table.

		To				
		A	B	C	D	E
From	A	-	4	7	3	4
	B	4	-	6	3	4
	C	7	6	-	7	5
	D	3	3	7	-	7
	E	4	4	5	7	-

If he produces only one pieces of item in a week, how should he sequence the items on his machine in order to minimise the total set up cost. [4+12]

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. (a) For the following pay-off matrix, determine the best strategies and the value of the game

		Y		
		j	k	l
X	p	60	50	40
	q	70	70	40
	r	80	60	75

- (b) Briefly explain the limitations of game theory. [10+6]
6. Customers arrive at one window drive in a bank according to a Poisson distribution with mean 10 per hour. Service time per customer is exponential with mean 5 minutes. The space in front of the window, including that for the serviced car can accommodate a maximum of three cars. Other cars can wait outside the space.
- (a) What is the probability that an arriving customer can drive directly to the space in front of the window?
- (b) What is the probability that an arriving customer will have to wait outside the indicated space?
- (c) How long an arriving customer is expected to wait before starting service?
- (d) How many space should be provided in front of the window so that all the arriving customers can wait in front of the window at least 90 per cent of the time? [16]
7. (a) Derive an expression for economic production quantity with uniform rate of replenishment with no shortages.
- (b) A company uses 8,000 units of a product per year, costing Rs 10 per unit. The administrative costs per purchase are Rs 40. The holding costs are 28% of the unit price of the product. The company is following E.O.Q purchase policy. The company is offered a discount of 1% if the total requirement is purchased in four times in a year only, should the offer be accepted. [8+8]
8. State Bellman's principle of optimality and explain by an illustrative example how it can be used to solve multistage problem with finite number of stages. [16]

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1. (a) Define Operations Research.
- (b) Enumerate the main characteristics Operations Research
- (c) Describe the phases of scientific method in Operations Research. [2+7+7]

2. Solve the following transportation problem. [16]

	R ₁	R ₂	R ₃	Availability
w ₁	12	6	9	20
w ₂	4	1	13	30
w ₃	12	9	1	50
w ₄	2	15	6	50
Requirements	40	50	50	

3. Find the sequence of jobs that minimize the total elapsed time to complete the jobs on M_1 and M_2 with sequence M_1M_2 .

Job	1	2	3	4	5
Machine M_1	14	7	13	13	9
Machine M_2	16	15	20	17	16

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

4. A decision has to be made for group replacement versus individual replacement policy for 500 fluorescent tubes of a particular make in the university campus. Failure rate for the tubes were recorded as under:

End of month	1	2	3	4	5	6
Prob. Of failure	0.11	0.30	0.25	0.20	0.10	0.04

Cost of replacing an individual tube is Rs.55 and when replaced as group it is Rs.35. Find out whether group replacement policy is economical or not. If economical at the end of which month should the tubes be replaced as a group? [16]

5. (a) Briefly explain the importance of game theory
- (b) Two oil companies, Indian oil co. and caltex are trying to increase their market at the expense of the other Indian oil co, is considering possibilities of decreasing the prices, giving free soft drinks on Rs.100 purchase of oil or giving away a free gift with each 40 litre purchase. Obviously caltex cannot ignore this and comes out with its own programme to increase its share in the market.

Catlex

	Decrease price	Free Soft Drinks on Rs 100 purchase	Free gifts on 40 its or more
Indian oil Co. Decrease price	4%	1%	-3%
Free soft drinks on Rs 100 purchase	3	1	6
Free gifts on 40 its or more	-3	4	-2

Determine the optimal strategies for the two oil companies. [4+12]

6. Mumbai post-office has 3 speed-post window-counters. It receives on average 45 customers per hour. Arrivals are poisson distributed and service time exponentially distributed. The post office serve on average 15 customers per hour.

- What is the probability that a customer will be served immediately?
- What is the probability that a customer will have to wait?
- What is the average total time that customer must spend in the post-office.

[16]

7. (a) The annual demand for an automobile component is 36,000 units. The carrying cost is Rs. 0.5/unit/year. The ordering cost is Rs. 25/- per order and the shortage cost is Rs. 15/unit/year. Find the optimal values of

- Economic Order Quantity
- Maximum Inventory
- Cycle time
- No. of orders.

- (b) The demand for an item is 16000 units per year. Its production rate is 900 units per/month. The carrying cost is Rs. 400/- unit/year and the setup cost is Rs. 3000/- per set-up. The Penalty cost is Rs. 1000/- per unit per year. Find out

- Economic Order Quantity
- Number of orders per year
- Time between two consecutive orders.

[8+8]

8. (a) State and explain Richard E. Bellman principle of optimality in dynamic programming.

- (b) A manufacturing organization has the requirements of 100, 200, 300, 300 & 200 items for the ensuing five periods. The procurement cost is Rs.12 per procurement irrespective of the size of the purchase. The holding cost is Rs.2 per

100 items per period. The maximum inventory is not to exceed 400 items at any period. Formulate a dynamic programming problem and find the policy of procurement so as to minimize the total cost. No inventory is to be left in the last season. Maximum quantity ordered is 600. [6+10]

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1. Solve the following LPP using Big-M method.

$$\text{Minimize } Z = 2X_1 + X_2$$

Subject to the constraints

$$3X_1 + X_2 \geq 3$$

$$4X_1 + 3X_2 \geq 8$$

$$X_1 + X_2 \leq 3$$

$$\text{And } X_1, X_2 \geq 0$$

[16]

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 the difference between a assignment problem and a traveling salesmen problem?
 (b) Solve the following assignment problem. The elements given in the matrix are the profits in Rs. derived for such a assignment. [4+12]

		Machines			
		P	Q	R	S
<i>Jobs</i>	A	51	53	54	50
	B	47	50	48	50
	C	49	50	60	61
	D	63	64	60	60

4. A series lamp circuit contains 10,000 bulbs. When any bulb fails, it is replaced. The cost of replacing a bulb individually is Re.1 only. If all the bulbs are replaced

simultaneously, the cost per bulb would be Re.0.35. The percent of surviving, say $s(t)$ at the end of the month 't' and $p(t)$ probabilities of failure during the month are given below:

t	0	1	2	3	4	5	6
s(t)	100	97	90	70	30	15	0
p(t)	-	0.03	0.07	0.20	0.40	0.15	0.15

what is the optimal replacement? [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) 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 fat 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) 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. Use Dynamic programming to solve
 Minimize $Z = y_1^2 + y_2^2 + y_3^2$
 Subjected to $y_1 + y_2 + y_3 = 5$; $y_1, y_2, y_3 \geq 0$ [16]

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1. (a) What is Operations Research? Describe briefly its applications
- (b) Use graphical method to solve the following LPPS:
 Maximise $Z = 3x_1 + 4x_2$
 Subject to
 $2x_1 + x_2 \leq 40$
 $2x_1 + 5x_2 \leq 180$
 $x_1, x_2 \geq 0$ [4+12]

2. (a) Name three methods of finding an initial basic feasible solution to a transportation problem.
- (b) Four gasoline dealers A,B,C and D require 50,000, 40,000, 60,000 and 40,000 gal of gasoline respectively. It is possible to supply these demands from locations 1,2 and 3, which have 80,000, 1,00,000 and 50,000 gal respectively. The costs for shipping 1,000 gal of gasoline are given in the table such that costs Rs.70 per 1000 gal to ship gasoline from location 1 to dealer A, Rs 80 per 1000 gal from location 2 to dealer B, etc.
 Cost of shipping 1000 gas of gasoline

	A	B	C	D
1	70	60	60	60
2	50	80	60	70
3	80	50	80	60

Determine the amounts of gasoline to be shipped from each location to each dealer so that all the dealers's requirements are satisfied and the total shipping costs are a minimum [3+13]

3. (a) What is the difference between travelling salesman problem and transportation problem?
- (b) A salesman has to visit five cities A, B, C, D and E. The distance (in km) between the five cities are given in the following table. If the salesman starts from city A and has to come back to city A, which route should he select so

that the total distance travelled by him is minimised.

[4+12]

		To				
		A	B	C	D	E
From	A	-	4	7	3	4
	B	4	-	6	3	4
	C	7	6	-	7	5
	D	3	3	7	-	7
	E	4	4	5	7	-

4. (a) Equipment A costs Rs.9000. Annual operating costs are Rs.200 for the first year and then increases by Rs.2,000 every year. Determine the best age at which to replace the equipment.
- (b) Equipment B costs Rs.10,000. Annual operating costs are Rs.400 for the first year and then increases by Rs.800 every year. Now you have a equipment of type A which is one year old. Should you replace it with B, if so when? [8+8]
5. (a) Briefly explain the general rules for dominance.
- (b) Use dominance property to reduce the game to 2x2 game and hence find the optimal strategies [4+12]

		Player B			
		5	-10	9	0
Player A	6	6	7	8	1
	8	8	7	15	1
	3	3	4	-1	4
	4	4	4	-1	4

6. In a heavy industry, the overhead crane is utilized 75%. Time study observations gave the average slinging time at 10.5 minutes with a standard deviation of 8.8 minutes. What is the average calling rate for the services of the crane and what is the average delay in getting service? If the average service time is cut 8.0 minutes with standard deviation of 6.0 minutes, how much reduction will occur on average in the delay of getting served? [16]
7. (a) List and explain different types of costs incurred in inventory system.
- (b) The annual demand for an items is 3200 units, the unit cost is Rs. 6/- and inventory charges 25% per annum. If the cost of one procurement is Rs. 150/-, Determine
- Economic Order Quantity
 - Number of orders per year
 - Time between two consecutive orders
 - the optimal cost.
- [6+10]

8. Solve the following model of the optimal subdividing of a cable of length 10 units into three parts such that the product of their lengths is maximized, using dynamic programming technique.

$$\text{Maximize } Z = p_1 X p_2 X p_3$$

$$\text{Subjected to } p_1 + p_2 + p_3 = 10; \quad p_1, p_2 \text{ and } p_3 \geq 0$$

[16]
