

IV B.Tech I Semester Supplementary Examinations, February 2008
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. Use Simplex method to solve the following LP problem

Maximise $Z = 50x + 60y$ subject to the following constraints

$$2x + y \leq 300$$

$$3x + 4y \leq 480$$

$$4x + 7y \leq 812 \text{ and } x, y \geq 0$$

[16]

2. Solve the following transportation problem.

[16]

	To					Supply
	10	7	3	6	3	3
	1	6	8	3	5	5
From	7	4	5	3	7	7
Demand	3	2	6	4	15	15

3. (a) Distinguish between assignment and transportation problems.

- (b) The owner of a small machine shop has four machinists available to assign to jobs for the day. Five jobs are offered with expected profit for each machinist on each job as follows.

		Jobs				
		A	B	C	D	E
Machines	M1	12	28	0	51	32
	M2	12	34	11	23	9
	M3	37	42	61	21	31
	M4	0	14	37	27	30

Assign machinist to jobs which results in overall maximum profit. [4+12]

4. (a) Explain briefly "how the replacement problems are classified"?

- (b) Fleet of cars have increased their costs as they continue in service due to increased direct operating cost (gas and oil) and increased maintenance (repairs, tyres, batteries, etc.). The initial cost is Rs.3,50,000 and the trade in value drop as time passes until it reaches a constant value of Rs.40,000. Given the cost of operating, maintaining and the trade in value, determine the proper length of service before cars should be replaced. [4+12]

Years of service	1	2	3	4	5
Year end trade in value (Rs.)	2,90,000	2,10,000	1,50,000	1,10,000	40,000
Annual operating cost (Rs.)	11,500	12,800	13,600	14,000	15,000
Annual maintaining	3000	5000	8000	12,000	15,000

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) Define the terms

- i. Inventory
- ii. Economic Order Quantity
- iii. Lead time.

- (b) A Manufacturing company has determined from an analysis of its accounting and production data for a certain part that

- i. its demand is 9000 units per annum and is uniformly distributed over the year,
- ii. its cost price is Rs. 2 per unit.
- iii. its ordering cost is RS. 40 per order
- iv. The inventory carrying charge is 9 percent of the inventory value.

Further it is known that the lead time is uniform and equals 8 working days, and that the total working days in a year are 300. Determine

- i. economic order quantity
- ii. optimum number of orders per annum
- iii. total variable cost
- iv. recorder level
- v. the length of the inventory cycle. [3+13]

8. A man is engaged in buying and selling identical item. He operates from a warehouse that can hold 500 items. Each month he can sell any quantity that he chooses up to the stock at the beginning of the month. Each month he can buy as much as he wishes for delivery at the end of the month. So long as his stock does not exceed 500 items. For the next four months he has the following error free forecasts of the cost sales prices.

Code No: RR410301

Set No. 1

Month	i	1	2	3	4
Cost	C_i	27	24	26	28
Sales price	P_i	28	25	25	27

If he currently has a stock of 200 units, what quantity should he sell and buy next four months. Find the solution using dynamic programming. [16]

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1. A mining company owns two different mines that produces a given kind of ore in grades A, B and C. The mining company has contracted to provide a smelting plant 12 Tons of A, 8 Tons of B and 24 Tons of C grade ores per week. It costs the company Rs. 2,000/- per day to run the first mine and Rs. 1,600/- per day to run the second. In a day's operation the first mine delivers 6 Tons of A, 2 Tons of B and 4 Tons of C grade ores, where as the other mine delivers 2 tons of A and 6 tons of C grade ores. How many days in a week each mine should be operated to fulfill the orders most economically?
 - (a) Formulate as an LPP
 - (b) Solve graphically. [6+10]

2. (a) How transportation problem is solved when demand and supply are not equal?
 (b) The Transafe Transport Company has trucks available at four different localities A, B, C and D and the number of trucks at these localities are 5,10,7 and 3 respectively. The three customers P,Q and R require 5,8 and 10 trucks respectively. Variable costs (in hundreds of rupees) of getting trucks to the customers are given below. Find the optimal transportation cost. [4+12]

From/To	P	Q	R
A	7	3	6
B	4	6	8
C	5	8	4
D	8	4	3

3. (a) Four engineers are available to design four projects. Engineer 2 is not competent to design the project B. Given the following time estimates needed by each engineer to design a given project, find how should the engineers be assigned to projects so as to minimize the total design time of four projects.

Projects

	A	B	C	D
1	12	10	10	8
2	14	Not suitable	15	11
3	6	10	16	4
4	8	10	9	7

- (b) Write the Johnson algorithm for solving a sequencing problem. [10+6]

4. A machine has initial investment of Rs.30,000 and its salvage value at the end of 'i' years of its use is estimated as $Rs.30,000/(i+1)$. The annual operating and maintenance cost in the first year is Rs.15,000 and increases by Rs.1000 in each subsequent years for the first five years and increases by Rs.5000 in each year thereafter. Replacement policy is to be planned over a period of seven years. During this period cost of capital may be taken as 10% per year. Solve the problem for optimal replacement. [16]
5. (a) Briefly explain the properties found in competitive games
 (b) Reduce the following game by dominance and find the game value: [4+12]

		Player B			
		I	II	III	IV
Player A	I	3	2	4	0
	II	3	4	2	4
	III	4	2	4	0
	IV	0	4	0	8

6. Assume in a hotel a server is to look after supply of three tables, which would accommodate in total six customers. Assume customers who arrive when all the six seats of the three tables are full. Customers arrive at the average rate of 4 per hour and spend an average of 15 minutes in the hotel. Find
- (a) The probability a customer can directly sit in a seat upon his arrival
 (b) Expected number of customers waiting for a seat?
 (c) The time a customer can expect to spend in the hotel? [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. A man is engaged in buying and selling identical item. He operates from a warehouse that can hold 500 items. Each month he can sell any quantity that he chooses up to the stock at the beginning of the month. Each month he can buy as much as he wishes for delivery at the end of the month. So long as his stock does not exceed 500 items. For the next four months he has the following error free forecasts of the cost sales prices.

Month	i	1	2	3	4
Cost	C_i	27	24	26	28
Sales price	P_i	28	25	25	27

If he currently has a stock of 200 units, what quantity should he sell and buy next four months. Find the solution using dynamic programming. [16]

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Set No. 2

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1. Find the dual of the following problem and hence or otherwise solve the given problem.
 Minimize $Z = 3x_1 + 4x_2 + 6x_3$
 Subject to :
 $x_1 + 4x_2 + 3x_3 \geq 2$
 $x_1 - 2x_2 - 6x_3 \leq 3$
 $x_1 + x_2 + x_3 \geq 1$
 $x_1, x_2, x_3 \geq 0$ [16]

2. Solve the following transportation problem. [16]

	To					Supply
	10	7	3	6	3	
	1	6	8	3	5	
From	7	4	5	3	7	
Demand	3	2	6	4	15	

3. (a) The owner of a small machine shop has four machinists available to assign to jobs for the day. Five jobs are offered with the expected profit (in hundreds of rupees) for each machinist on each job being as follows :

Machinist	A	B	C	D	E
1	6	8	5	10	8
2	7	9	6	7	6
3	9	9	11	7	8
4	5	6	9	8	8

Find the assignment of machinists to jobs that result in a maximum profit. Which job should be declined.

- (b) Find the sequence that minimizes total elapsed time required to complete the following jobs : [8+8]

Job nummber	1	2	3	4
Machine A	4	3	7	5
Machine B	6	7	8	4

4. (a) Briefly explain “present worth factor” in Replacement analysis.
 (b) Let the value of the money be assumed to be 10% per year and suppose that machine ‘A’ is replaced after every three years where as machine B is eplaced after every six years. The yearly costs of both the machines are given as:

Year	1	2	3	4	5	6
Machine A (Rs.)	1000	200	400	1000	200	400
Machine B (Rs.)	1700	100	200	300	400	500

Determine which machine should be purchased? [4+12]

5. (a) Briefly explain
- i. pure strategy
 - ii. mixed strategy
 - iii. optimal strategy
- (b) Find the saddle point, optimum strategies and value of the game in the following pay off matrix [6+10]

		Y			
		A	B	C	D
X	I	-3	4	2	9
	II	7	8	6	10
	III	6	2	4	-1

6. In a bank 4 cash counters are operated for drawing money. On average 40 persons arrive in an 4 hour a day. Each cashier is to spend 10 minutes on the average on an arrival. If the arrivals are Poissonally distributed and service times are according to exponential distribution, determine
- (a) Average number of customers in the system
 - (b) average number of customers waiting in the system
 - (c) average time a customer spends in the system
 - (d) The probability that a customer has to wait before he gets service [16]
7. (a) Derive the optimal economic lot size per run with minimum total cost if R is annual demand, Co is ordering cost per order, Ch is holding cost / unit/ year, and K is production rate where ($K > R$).
- (b) A contractor has to supply 10,000 bearings per day to an automobile manufacturer. He finds that when he starts a production run, he can produce 20,000 bearings per day. The cost of holding a bearing in stock for one year is 30 paise and setup cost of production run is Rs. 280/- how frequently, should production run be made. [8+8]
8. An organization is planning to diversify its business with a maximum outlay of Rs. 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 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. [16]

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

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1. A confectioner sells two products A and B . The selling price of A is Rs. 60 and B is Rs.40. The unit cost of product A is Rs30 and of B Rs.10. The two products are produced in a common production process. The production process has a capacity of 30,000 man hours. . It takes three hours to produce a unit of A and one hour to produce unit of B. The market for the product has been surveyed and confectioner knows that the maximum number of units of A that can be sold is 8000 and B is 12000. Formulate and solve the equation graphically to maximize contribution.[16]
2. (a) Distinguish between a transportation problem and an assignment problem.
 (b) Solve the following transportation problem with transportation cost, demand and supplies as given below. [4+12]

Ware House

		W1	W2	W3	W4	Demand
		Factory	F1	19	30	50
F2	70		30	40	60	9
F3	40		8	70	20	18
Supply		5	8	7	14	

3. (a) What do you understand by restricted assignments?
 (b) Four trucks available in location are to be sent to 1,2,3 & 4 vacant spaces A,B,C,D,E & F so that the total distance travelled is minimised. The elements in the matrix below shows the distance in km. Determine the optimal assignment of the trucks to the spaces. [4+12]

	1	2	3	4
A	4	7	3	7
B	8	2	5	5
C	4	9	6	9
D	7	5	4	8
E	6	3	5	4
F	6	8	7	3

4. A large hospital complex has several operation theaters. Each operation table has a special light bulb attachments. The bulb is prone to failure. There are 200 bulbs installed in all. Considering 500 hours as period, the failure of similar bulb has been as under: Out of 100 bulbs;

9 failed by the end of first period
 20 failed by the end of second period
 33 failed by the end of third period
 61 failed by the end of fourth period
 77 failed by the end of fifth period
 90 failed by the end of sixth period
 100 failed by the end of seventh period

The management considers to make it a practice to replace all in a group at one time, then replace the individual bulb as and when it fails and after fixed interval of time again replace entire group of 200 bulbs. If the bulbs are replaced in group it costs Rs.5 per bulb and when replaced individually it costs Rs.20 per bulb. What should be the replacement policy of the hospital? [16]

5. (a) For what value of 'a', the game with the following pay-off matrix is strictly determinable?

		Player B		
		B1	B2	B3
Player A	A1	A	6	2
	A2	-1	A	-7
	A3	-2	4	a

- (b) Differentiate between strictly determinable games and non strictly determinable games. [12+4]

6. Customers arrive at one teller counter in a bank according to a poisson distribution with mean 12 per hour. Service time per customer is exponential with mean 6 minute. The space in front of the counter can accommodate a maximum of 10 customers. Other customers can wait outside the space.

- (a) What is the probability that an arriving customer can come directly to the counter?
 (b) What is the probability that an arriving customer will have to wait outside the indicate space?
 (c) How long an arriving customer is expected to wait before starting service?

[16]

7. (a) Write a note on periodic review inventory system and Fixed order quantity system
 (b) A company consumes 200 items/month working 30 days in a month. The cost of the item is Rs.1000. For a lot of more than 50, the price is Rs.950. Find out the optimum purchase quantity if ordering cost is Rs.10,000 and handling charges are 1% of unit cost per month. If the discounted price is available for a lot of more than 75 items, find the optimum purchase quantity. [6+10]

8. Solve the following linear programming problem using dynamic programming technique.

Code No: RR410301

Set No. 4

$$\text{Maximize} = 30x_1 + 15x_2 + 6x_3$$

$$\text{Subjected to } 6x_1 + 8x_2 + 9x_3 \leq 210;$$

$$12x_2 + 6x_3 \leq 180;$$

$$x_1, x_2 \text{ and } x_3 \geq 0.$$

[16]
