Code No: 07A80809 **R07** **Set No. 2**

IV B.Tech II Semester Examinations,APRIL 2011
OPERATIONS RESEARCH
Common to Chemical Engineering, Metallurgy And Material Technology
Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. The arrivals at a telephone booth are considered to be following Poisson process with an average time of 10 minutes between one arrival and the next. Length of the phone call is assumed to be distributed exponentially with a mean of 3 minutes.
   (a) What is the probability that a person arriving at the booth will have to wait?
   (b) What is the average length of queue that forms from time to time? [16]

2. (a) What is 'strictly determined game'? When the game is said to be determinable?
   (b) For the following payoff matrix for firm A, determine the optimal strategies for both the firms and the value of the game (using maximin-minimax principle): [6+10]

		Firm B			
Firm A	3	−1	4	6	7
	−1	8	2	4	12
	16	8	6	14	12
	1	11	−4	2	1

3. The expected times required to be taken by a salesman in traveling from one city to another are given in table 1.
   How should the salesman plan his trip so that he covers each of these cities not more than once and completes his trip in minimum possible time required for traveling? [16]

4. (a) Define the terms:
      i. Lead time.
      ii. Reorder point.
      iii. Buffer stock.
   (b) A company uses 24,000 units of a raw material which costs Rs.12.50 per unit. Placing each order costs Rs.22.50 and the carrying cost is 5.4% per year of the average inventory. Find the economic order quantity and the total inventory cost (Including the cost of the material). [6+10]

5. (a) What is duality? What is the significance of dual variable in a LP model?
   (b) Applying the concept of duality, solve the LPP
   Maximize Z = $3x_1 + x_2$

From City \ To City	A	B	C	D	E
A	–	10	13	11	12
B	10	–	12	10	12
C	13	12	–	13	11
D	11	10	13	–	10
E	12	12	11	10	–

Table 1:

Subjected to

$x_1 - x_2 \leq 1$
$x_1 + x_2 \leq 4$
$x_1 - 3x_2 \leq 3$
$x_1, x_2 \geq 0.$ [6+10]

6. (a) State some of the simple replacement policies and give the average cost function for the same, explaining notations used.

   (b) A fleet owner finds from his past records that the cost per year of running a vehicle, whose purchase price is Rs. 50,000 as shown below

Year :	1	2	3	4	5	6	7
Running cost (Rs)	5,000	6,000	7,000	9,000	11,500	16,000	18,000
Resale value (Rs):	30,000	15,000	7,500	3,750	2,000	2,000	2,000

   Thereafter, running cost increases by Rs.2,000, but resale value remains constant at Rs. 2,000. At what age is a replacement due? [6+10]

7. What is the importance of simulation and modeling? Explain utility of simulation to solve inventory problems. [16]

8. Use DPP method to
   Minimize $Z = x_2 + 3x_2 + 4x_3$.
   Subject to

$$2x_1 + 4x_2 + 3x_3 \geq 60,$$
$$3x_1 + 2x_2 + x_3 \geq 60$$

$2x_1+x_2+3x_3 \geq 90$ and
$x_1, x_2, x_3 \geq 0.$ [16]

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1. Explain about simulation models and applications. [16]

2. (a) Explain North-West corner method for obtaining an initial basic feasible solution of a transportation problem.
   (b) Solve the transportation problem given in table 2. [6+10]

	D_1	D_2	D_3	D_4	D_5	D_6	Available
O_1	2	1	3	3	2	5	50
O_2	3	2	2	4	3	4	40
O_3	3	5	4	2	4	1	60
O_4	4	2	2	1	2	2	30
Required	30	50	20	40	30	10	180

Table 2:

3. Use Bellman's principle of optimality to find the optimum solution to the following problem:
   Minimize $Z = y_1^2 + y_2^2 + y_3^3$
   Subject to the constraints
   $$y_1+y_2+y_3 \geq 15$$
   $$y_1, y_2, y_3 \geq 0.$$ [16]

4. Find the optimalorder quantity for a product when the annual demand for the products is 500 units, the cost of storage per unit per year is 10% of the unit cost and ordering cost per order is Rs.180. The unit costs are given below: [16]

Quantity	Unit Cost (Rs.)
$0 \leq q_1 < 500$	Rs.25.00
$500 \leq q_2 < 1,500$	Rs.24.80
$1,500 \leq Q3 < 3,000$	Rs. 24.60
$3,000 \leq q_4$	Rs.24.40

5. A T.V. repairman finds that the time spent on his jobs have an exponential distribution with mean of 30 minutes. If he repairs sets in the order in which they come in, and if the arrival of sets is approximately Poisson distribution with an average rate of 10 per 8 hour day, what is repairmen's expected idle time each day? How many jobs are ahead of the average set just brought in? [16]

6. (a) Define:
   i. Competitive game;
   ii. Pure strategies;
   iii. Mixed strategies
   iv. Two-person zero-sum (or rectangular) game,
   v. Payoff matrix.

   (b) Player A and B, each take out one or two matches and guess how many matches the opponent has taken. If one of the players guesses correctly, then the loser to pay him as many rupees as the sum of the number held by both players. Otherwise, the pay out is zero. Write down the payoff matrix and obtain the optimal strategies of both players. [8+8]

7. An electric company, which generates and distributes electricity conducted a study on the life of pole. The appropriate data are given in the following table:

Years after installation :	1	2	3	4	5	6	7	8	9	10
Percentage poles failing :	1	2	3	5	7	12	20	30	16	4

   (a) If company now installs 5,000 poles and follows a policy of replacing poles only when they fail, how many poles are expected to be replaced each year during the next 10 years? To simplify the computation, assume that failures occur and replacements are made only at the end of year.

   (b) The cost of replacing individual poles is Rs 160. If we have a common group replacement policy, it cost Rs 80 per pole. Find the optimal period for group replacement. [16]

8. (a) What are the advantages of using linear programming.

   (b) A farmer has 100 acre farm. He can sell all tomatoes, lettuce, or radishes he can raise. The price he can obtain is Rs 1.00 per kg for tomatoes, Rs 0.75 a head for lettuce and Rs 2.00 per kg for radishes. The average yield per acre is 2000 kg of tomatoes, 3000 heads of lettuce and 1000 kgs of radishes. Fertilizer is available at Rs 0.50 per kg and the amount required per acre is 100 kgs each for tomatoes and lettuce, and 50 kgs for radishes. Labour required for sowing and harvesting per acre is 5 man-days for tomatoes and radishes, and 6 man-days for lettuce. A total of 400 man-days of labour are available at Rs 20.00 per man-day. Formulate this as a Linear-Programming model to maximize the farmers total profit. [6+10]

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1. In 18th century, when transportation systems were not developed, a family wanted to travel from their home to reach a friend's home in other part of the country. They had a choice of alternate routes and haltages between their home and the destination. The costs of travel from each point to the other point on route, based on such factors as distance, difficulty, mode of transportation, etc. are given below:

	1	2	3	4	5	6	7	8	9	10
1	–	7	5	4	–	–	–	–	–	–
2	–	–	–	–	8	3	9	–		
3	–	–	–	–	10	7	6	–	–	–
4	–	–	–	–	4	5	6	–	–	–
5	–	–	–	–	–	–	–	6	8	–
6	–	–	–	–	–	–	–	7	4	–
7	–	–	–	–	–	–	–	3	6	–
8	–	–	–	–	–	–	–	–	–	5
9	–	–	–	–	–	–	–	–	–	4

Find the safest route so that the total traveling cost is minimum. [16]

2. A barber shop has space to accommodate only 10 customers. He can serve only one person at a time. If a customer comes to his shop and finds it full, he goes to the next shop. Customers randomly arrive at an average rate of 10 per hour and the barber's service time is exponential with an average of 5 minutes per customer.
   (a) Write recurrence relations for the steady state, in FCFS steady system.
   (b) Determine the probability of being barber shop is empty. [16]

3. (a) Write briefly about the following:
      i. Iconic models
      ii. Analogue models
      iii. Symbolic models.
   (b) Distinguish between
      i. Stochastic and deterministic models
      ii. Static and dynamic models. [8+8]

4. Define simulation. Explain about applications of simulation in various situations. [16]

5. A company has a demand of 12,000 units/year for an item and it can produce 2,000 such items per month. The cost of one setup is Rs.400 and the holding cost/unit/month is Re.0.15. Find the optimum lot size and the total cost per year, assuming the cost of 1 unit as Rs.4. Also find the maximum inventory, manufacturing time and total time. [16]

6. (a) Solve the game given in table 6a by reducing to 2 × 2 game by graphical method.

		Player B				
Player A		I	II	III	IV	V
	I	3	0	6	-1	7
	II	-1	5	-2	2	1

table 6a

(b) Which competitive situation is called a game? [10+6]

7. (a) Explain Vogel's Approximation method for obtaining an initial basic feasible solution of a transportation problem.

(b) Goods have to be transported from sources S_1, S_2 and S_3 to destinations D_1, D_2 and D_3. The transportation cost per unit, capacities of the sources and requirements of the destinations are given in table 7b.

	D_1	D_2	D_3	Supply
S_1	8	5	6	120
S_2	15	10	12	80
S_3	3	9	10	80
Demand	150	80	50	

table 7b

Determine a transportation schedule so that the total cost is minimized. [6+10]

8. The management of a large hotel is considering the periodic replacement of light bulbs fitted in its rooms. There are 500 rooms in the hotel and each room has 6 bulbs. The management is now following the policy of replacing the bulbs as they fail at a total cost of Rs 3 per bulb. The management feels that this cost can be reduced to Re 1 by adopting the periodic replacement method. On the basis of information given below, evaluate the alternative and make a recommendation to the management.

[16]

Months of use :	1	2	3	4	5
Percent of bulbs failing by that month :	10	20	50	80	100

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1. (a) Give the mathematical formulation of an assignment problem.
   (b) Solve the assignment problem given in table 3. The figures in the table represent the time required for each combination. [6+10]

Jobs \ Persons	1	2	3	4
I	12	30	21	15
II	18	33	9	31
III	44	25	24	21
IV	23	30	28	14

Table 3:

2. Determine the values of u_1, u_2 and u_3 so as to
   Maximize $u_1, u_2, u_3,$
   Subject to $u_1 + u_2 + u_3 = 10$
   and $u_1, u_2, u_3 \geq 0.$ [16]

3. A gas transport company controls pipe-lines between several natural gas fields and out of state distributors. The company has a 1,00,000 unit storage capacity. Because of certain government regulations, the company receives either 40,000 or 60,000 units per day but the probability of receiving such quantity is not equal. The actual demand for natural gas is given by the following table:

Daily Demand	Probability
25,001-45,000	0.30
45,000-55,000	0.30
55,000-65,000	0.40

What is the expected daily demand? [16]

4. Repairing a certain type of machine which breaks down in a given factory consists of 5 basic steps that must be performed sequentially. The time taken to perform each of the 5 steps is found to have an exponential distribution with mean 5 minutes and is independent of other steps. If these machines breakdown follows Poisson fashion at an average rate of two per hour and if there is only one repairman, what is the average idle time for each machine that has broken down? [16]

5. Find the most economic batch quantity of a product on a machine of the production rate of the item on the machine with 200 pieces/day and the demand is uniform at the rate of 100 pieces/day. The set-up cost is Rs.200 per batch and the cost of holding one item in inventory is Rs.0.81 per day. How will the batch quantity vary if the machine production rate was infinite? [16]

6. A game has the payoff matrix

$$A = \begin{bmatrix} 0 & 2 \\ 1 & 1 \end{bmatrix}$$

Show that E(x,y)=1-2x(y-1/2) and deduce that in solution of the game the first player follows a pure strategy while the second has infinite number of mixed strategies. [8+8]

7. (a) What is meant by a feasible solution of an LP problem?
   (b) A company produces two types of leather belts say A and B. Belt A is of superior quality and B is inferior. Profits on the two are 40 and 30 paise per belt, respectively. Each belt of type A requires twice as much time as required by a belt of type B. If all the belts were of type B, the company could produce 1000 belts per day. But the supply of leather is sufficient only for 800 belts per day. Belt A requires a fancy buckle and only 400 of them are available per day. For belt B only 700 buckles are available per day. Solve this problem to determine how many units of the two types of belts the company should manufacture in order to have a maximum overall profit? [6+10]

8. (a) In the theory of replacement models, construct an equation for the cost of maintaining a system as a function of the control variable t (the number of periods between group replacement).
   (b) It has been suggested by a data processing firm that they adopt a policy of periodically replacing all the 1000 tubes in a certain piece of equipment. A tube is known to have the mortality distribution (probability of failure) shown in the table below :

Tube failures/week :	1	2	3	4	5
Probability of failure :	0.3	0.1	0.1	0.2	0.3

The cost of replacing the tubes on an individual basis is estimated to be Re. 1.00 per tube and the cost of a group replacement is Re. 0.30 per tube. Compare the cost of preventive replacement with that of remedial replacement.

[6+10]

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