BA5201 APPLIED OPERATION RESEARCH

IMPORTANT QUESTIONS AND QUESTION BANK

UNIT-I INDRODUCTION TO LINEAR PROGRAMMING

2-Marks

1. Define operation research?
2. Define degenerate solution in (L.P.P) Linear programming problem?
3. What are three properties (characteristics) of linearity?
4. What is decision variable?
5. Define SLACK variable?
6. Define surplus variable?
7. List down the variant of the simplex method?
8. What is a feasible solution in LPP?
9. The dual of the dual problem is the primal problem. Why?
10. What is sensitivity analysis?
11. What is the major assumption of linear programming?
12. Give the application of duality?
13. What is the classification of simplex problem?
14. What are the different types of models?
15. What is two phase methods?

13-Marks

1. Solve the following LPP maximise $z=2x_1+x_2$ subject to:
   $x_2+2x_2 \leq 10$,
   $x_2+x_2 \leq 6$,
   $x_1-x_2 \leq 2$,
   $x_1-2x_2 \leq 1$,
   $x_1, x_2 \geq 0$
2. Solve the following minimise: $z=3x_1+2x_2$ subject to:
   $5x_1+x_2 \geq 10$,
   $x_1+x_2 \geq 6$,
   $x_1-4x_2 \geq 12$,
   $x_1, x_2 \geq 0$
3. A manufacture has two products, P1 and P2 both of which are produced in two steps by machines M1 and M2. The process times per hundred for the products on the machines are;

	M1	M2	Contribution
P1	4	5	10
P2	5	2	5

Available

Hour. 100-80

The manufacturing is in a market swing and can sell as much as he can produce of both products. Formulate the mathematical model and determine optimal productivity. Using simplex method?

4. A company produce, three products: P, Q and R from three raw material A, B and C 1 unit product P requires 2 unit of A and 3 units of A unit of product Q requires 2 unit of B and 5 units of C and one unit of product R requires 3 units of A, 2 units of A, 2units of B and 4 units of C. the company has 8 units of material A. 10 units of material B and 15 units of material C available to it. Profits per unit of products P, Q and R. are Rs. 3 Rs. 5 and Rs. 4 respectively.
   a) Formulate this problem as an L.P problem.
   b) How many units of each product should be produced to maximize profit?
   c) Write the dual of this problem?
5. Solve the problem LPP by the graphical method max $Z= 3x_1+2x_2$ subject to:
   $2x_1+x_2 \leq 1$,
   $x_1 \leq 2$,
   $x_1+x_2 \leq 3$,
   $x_1, x_2 \geq 0$.
6. Using dual simplex method to solve a min $Z=2x_1+x_2$ subject to:
   $3x_1+x_2 \geq 3$,
   $4x_1+3x_2 \geq 6$,
   $x_1+2x_2 \geq 3$,
   $x_1, x_2 \geq 0$.
7. Explain the procedure for formulating LP model?
8. Find the non-negative value of x_1, x_2, x_3 which maximize Z=3.
   Max $z= 3x_1+2x_2+5x_3$ subject to:
   $x_1+4x_2 \leq 420$,
   $3x_1+2x_3 \leq 460$,
   $x_1+2x_2+x_3 \leq 430$,
   x_1, x_2, x_3
9. Use penalty method to solve max $Z= 2x_1+x_2+x_3$ subject to:
   $4x_1+6x_2+3x_3 \leq 8$
   $3x_1-6x_2-4x_3 \leq 1$
   $2x_1+ 3x_2-5x_3 \geq 4$
   $x_1, x_2, x_3 \geq 0$.
10. Write down the dual of the following LPP min $Z= 2x_1+2x_2$
    Subject to: $2x_1+4x_2 \geq 1$
    $-x_1-2x_2 \leq -1$
    $2x_1+x_2 \geq 1$
    $x_1, x_2 \geq 0$.

UNIT-II LINEAR PROGRAMMING EXTENSIONS

2-Marks

1. Define transportation problem?
2. What are the types of transportation problem?
3. What is meant by unbalanced transportation problem?
4. What is meant by balanced transportation problem?
5. Difference between the transportation problem and assignment problem?
6. Explain assignment algorithm (or) Hungarian method?
7. What are the conditions that would enable a travelling salesman problem to be solved as an assignment problem?
8. Distinguish between transportation problem and transhipment problem?
9. What are the methods use to solve the transportation problem?
10. Define assignment problem?
11. How is degeneracy handled in MODI method?
12. Explain the branch and bound technique for assignment model?
13. What are the conditions followed maximization case in assignment problems?
14. List some application of assignment model?
15. What is restrictions in assignment?

13-Marks

1. Minimize the transportation cost

		Destination				Supply
		A	B	C	D	
source	I	19	30	50	10	7
	II	70	30	40	60	9
	III	40	8	70	20	18
Demand		5	8	7	14	34

2. Assign jobs to men.

Jobs	Men				
	I	II	III	IV	V
A	2	9	2	7	1
B	6	8	7	6	1
C	4	6	5	3	1
D	4	2	7	3	1
E	5	3	9	5	1

3. Consider the following unbalanced transportation problem:

		To		
From	1	2	3	Supply
1	5	1	7	10
2	6	4	6	80
3	3	2	5	15
Demand	74	20	50	

Since there is not enough supply, some of the demands at those destination may not be satisfied. Suppose there are penalty costs for every unsatisfied demand unit which are given by 5,3 and 2 for destination 1,2, and 3 respectively. Find the optimal solution.

4. A construction company has requested bids for sub contracts on five different projects. Five companies have responded their bids are represented below:

		Bid amount ('000 s Rs)				
		I	II	III	IV	V
Bidders	1	41	72	39	52	25
	2	22	29	49	65	81
	3	27	39	60	51	40
	4	45	50	48	52	37
	5	29	40	45	26	30

Determine the minimum cost assignment of sub contracts to bidders, assuming that each bidder can receive only one contract?

5. Consider the problem of assigning 5 jobs to 5 persons. The assignment cost of given as follows:

Person	1	2	3	4	5
A	8	4	2	6	1
B	0	9	5	5	4
C	3	8	9	2	6
D	4	3	1	0	3
E	9	5	8	9	5

6. Four different jobs can be done on 4 different machines. The set up and take down time cost are assumed to be prohibitively high for change overs. The matrix below given the cost in rupees of processing job on machine.

	m1	m2	m3	m4	m5
J1	8	4	2	6	1
J2	0	9	5	5	4
J3	3	8	9	2	6
J4	4	3	1	0	3
J5	9	5	8	9	5

7. A matrix shop purchases a drilling machine and 2 lathes of difference of capacity. The position of machine among is possible location on the shop floor is important from the standard of material handling even the cost estimate per unit of material time, determine the optimal location of the machines.
8. Game without saddle point:
   Solve the following game

$$\text{Player A} \begin{bmatrix} 2 & -1 \\ -1 & 0 \end{bmatrix} \quad \text{Player B}$$

   1)Probability method
   2)Formulation method
   3)maximum $v=-1 \neq$ minimum $\bar{v}=0$
9. Matrix oddment method for n x n game.

$$\text{Player A} \begin{bmatrix} 3 & -1 & -3 \\ -3 & 3 & -1 \\ -4 & -3 & 3 \end{bmatrix} \quad \text{Player B}$$

10. Solve the following 3 x 3 game

$$\text{Player A} \begin{bmatrix} 1 & -1 & -1 \\ -1 & -1 & 3 \\ -1 & 2 & -1 \end{bmatrix} \quad \text{Player B}$$

UNIT-III INTEGER PROGRAMMING AND GAME THEORY

2-Marks

1. Define saddle point?
2. What is dominance property?
3. Linear programming method in game theory?

4. What is integer programming problem?
5. Pure (all) integer programming problem?
6. Mixed integer programming problem?
7. Two-person-sum game?
8. Pure strategies?
9. What are the different types of decision-making situation?
10. Define a game?
11. What is the game fair?
12. State the role of lower bound and upper bound in the branch and bound method?
13. What do you mean by dominance rule and saddle point?
14. Why is called a zero-sum game in game theory?
15. When can the graphical solution be applied in an IPP?

13-Marks

1. Solve the following all integer programming problems, Using Gamry's cutting plane algorithm.

   1)Max $Z=x_1+2x_2$ subject to

   $2x_2 \leq 7$,

   $X_1+x_2 \geq 7$,

   $2x_1 \geq 11$ and

   $x_1, x_2 \geq 0$ and integers

   2) Max $Z=3x_1+2x_2+5x_2$ subject to

   $5x_1+3x_2+7x_3 \leq 28$,

   $4x_1+5x_2+5x_3 \leq 30$ and

   $x_1, x_2, x_3 \geq 0$ and integers.

   3) Max $Z=4x_1+3x_2$ subject to

   $2x_2 \leq 7$,

   $x_1+2x_2 \geq 4$,

   $2x_1+x_2 \geq 6$ and

   $x_1, x_2 \geq 0$ and integers

2. Explain the assumptions underlying game theory. Describe the role of theory of games for scientific decision-making?

3. Solve the following game for the payoff matrix shown below.

		Player B		
		B1	B2	B3
Player A	A1	20,000	30,000	60,000
	A2	45,000	45,000	30,000

4. Solve the following IPP. Minimize $Z= 3x_1+2.5x_2$
   Subject to:
   $X_1+2x_2 \geq 20$,
   $3x_1+2x_2 \geq 50$,
   $x_1, x_2 \geq 0$ and integers.
5. Solve the following game:

		Player B		
		1	2	3
Player A	I	0	-2	7
	II	2	5	7
	III	3	-3	8

6. Solve the following game:

	Player B			
		Y1	Y2	Y3	Y4
Player A	X1	19	6	7	5
	X2	7	3	4	6
	X3	12	8	18	4
	X4	8	7	13	-1

7. Solve the following game by graphical method:

		Player B				
		Y1	Y2	Y3	Y4	Maxi(min)
Player A	X1	3	3	4	0	0
	X2	5	4	3	7	3
	Mini(max)	5	4	3	7	

Try to draw the graph on your own and see which strategy gets eliminated you will see that in graph y1 strategy gets eliminated. Using subgames method to find the value of games?

8. Solve the game by using convex linear combinations:

		Player B					
		1	2	3	4	5	6
Player A	1	4	2	0	2	1	1
	2	4	3	1	3	2	2
	3	4	3	7	-5	1	2
	4	4	3	4	-1	2	2
	5	4	3	3	2	2	2

9. Solve the game by LPP method

		Player B			
		1	2	3	Max(min)
Player A	1	3	-4	2	-4
	2	1	-3	-7	-7
	3	-2	4	7	-2
	Mini (max	3	4	7	

10. Solve the following game:

		Player B		
		1	2	3
Player A	I	0	-2	7
	II	2	5	6
	III	3	-3	8

UNIT-IV INVENTORY MODELS SMULATION AND DECISION THEORY

2-Marks

1. What is meant by inventory?
2. What are the main objectives of an inventory model?
3. Define holding cost and set-up cost?
4. Define buffer stock or safety stock?
5. Define simulation. Why is used?
6. what are the uses of simulation?
7. Distinguish between decision under certainly and decision under uncertainty?
8. Describe some methods which are useful for decision making under uncertainty?
9. What is meant by a quantity discount?
10. What is risk?
11. What is monte-carlo simulation?
12. What are the types of decision-making situation?
13. Define pseudo-random number?
14. What is Bayesian rule?
15. What is expected monetary value?

13-Marks

1. 1)Compute EOQ and the total variable costs for the following items?
   Actual demand = Rs. 20.
   Unit price = Rs.16.
   Storage rate =2% per annum
   Interest rate = 12% per annum
   Obsolescence rate = 6% per annum.
   2)Determine the total variable cost that would result for the item if an incorrect price of Rs. 12.80 were used.
2. 1)What are the various assumptions of EOQ formula?
   2)Identify the two basic decisions addressed by inventory management and discuss why the responses to these differ for continuous and periodic inventory systems?
3. Find the optimum order quantity of an item for which the price breaks are as follows. The monthly demand for the items is 400 units, the cost of storage is 20% of the unit cost and ordering cost is rupees 50 per order.

Quantity	Purchasing cost
0-100	200
101-200	180
Above 200	160

4. The demand for a bakery product is tabulated below based on previous data.

Daily demand	0	10	20	30	40	50
Probability	0.01	0.20	0.15	0.50	0.12	0.02

   Using the following random numbers simulate the demand for 10 days random numbers: 25,65,76,12,05,73,89,19,49.
5. A retail marketing company has a salesman, which it wants to assign to 3 districts sales revenues generated:

Districts/salesman	0	1	2	3	4	5	6	7	8	9
A	38	41	48	58	66	72	83	85	89	93
B	40	42	50	60	66	75	82	84	87	90
C	60	64	68	78	90	102	09	110	113	115

   Identify the number salesman to be allocated to each district to maximize sales revenue?
6. Solve the following LPP through PP?
   Maximize $Z=2x_1+5x_2$
   Subject to: $2x_1+x_2 \leq 430$,
   $x_2 \leq 230$
   $x_1, x_2 \geq 0$

7. During the post year a bank has recorded receipts and payment patterns:

Receipts	Probability	Payment	Probability
3,000	0.2	4,000	0.3
5,000	0.3	6,000	0.4
7,000	0.4	8,000	0.2
12,000	0.1	10,000	0.1

Using independent of random number for receipts and payment simulate the receipts and payment of the bank for a week if the opening balance is Rs. 8000?

8. A company manufactures 200 mopeds. Depending upon raw materials etc. the daily production has been varying from 196 to 204 probability distribution is given:

No. of mopeds	196	197	198	199	200	201	202	203	204
Probability	05	09	12	14	2	15	11	08	06

The mopeds are transported in a 3-storied lorry that can accommodate date only 200 mopeds. Using the given set of random numbers generate space availability of the truck or days in which mopeds are kept waiting and find the average number of mopeds waiting and average space in the truck during the given period

Random number: 82,89,78,24,53,61,18,45,04,23,50,77,27,54,10.

No of mopeds	196	197	198	199	200	201	202	203	204
Probability	05	09	12	14	2	15	11	08	06
WM probability	05	14	26	40	60	75	86	94	1
Range	0-4	5-13	14-25	26-39	40-59	60-74	75-85	86-93	94-99

9. Customer arrive at a milk booth for the required services. Assuming that inter arrivals and service times are constant and are given by 1.8- and 4-time units respectively. Simulate the system by hand computation for 14-time units. What is the average waiting time for the customer and percentage idle time? Assume simulation start at 0-time units?

10. You have an option to invest Rs 10,000 in the stock market by buying shares of company A or B. shares of company A are risky but could yield 50% ROI during the next year. If the stock market condition is not favourable. The stock will lose 20% of its value. Company B provides soft investment with 15% returns in bullish market and only 5% in a bearish market. All stock market journals predict 60% chance for a bull market. In which company would you invest?

UNIT-V QUEUING THEORY AND REPLACEMENT MODELS

2-Marks

1. What are the basic elements of queuing system?
2. What is meant by “queue discipline”?
3. What is queue service discipline?
4. List some application of the queuing theory?
5. Define a queue?
6. What are the basic characteristics of queuing system?
7. Define customer?
8. Define transient and steady state.
9. Define traffic intensity or utilization factor?
10. What is replacement?
11. Mention any two queuing rules used?
12. What is discounted operation cost?
13. Define a waiting line?
14. What are the situations which make the replacement of items necessary?
15. Explain Kendall’s notation?

13- Marks

1. Explain the basic queuing process. What are the important random variates in queuing system to be investigated?
2. Explain how the theory of replacement is used in the following problems.
   1)Replacement of items whose maintenance cost varies with time.
   2)Replacement of items that fail completely?
3. A car washing unit has two cleaning boys manned by the three-man crew. Cars arrive at an average rate of 10 cars per hour and the arrival rate Poisson distributed. The under-chassis cleaning of a car takes 4 minutes of an average and can be assumed to be exponentially distributed determine the,
   1)probability that a customer has to wait before being served
   2)Expected percentage of idle time for each bay and
   3)What is the expected waiting time foe ac car?

4. A pipeline is due for repair. The repair would cost Rs 10,000 and would last for three years, alternatively a new pipeline can be laid at a cost of Rs. 30,000 which would last for 10 years assuming the interest rate to be 10% and ignoring salvage value, which is better alternative?
5. A super market has two girls ringing up sales at the counters. If the services time for each customer is exponential with mean 4 minutes and if the people arrive in a Poisson fashion at the rate of 10 per hour.
   1)What is the probability of having to wait for service?

2)What is the expected percentage of idle time for each girl?
3)If a customer has to wait, what is the expected length of his waiting time?

6. A manufacture is offered two machines A and B. A is priced at Rs. 5,000 and running cost are estimated at Rs. 800 for each of the first five years, increasing by Rs. 200 per year in the sixth and subsequent years machine B, which has the same capacity as A, costs Rs. 2,500 put will have running costs of Rs. 1,200 per year for six years. Increasing by Rs 200 per year after. If money is worth 10% per year which machines should be purchased? Assume that the machines will eventually be sold for shop at a negligible price?
7. If cost of capital is 11% per year suggest when to replace a machine which has a capital cost of Rs. 3,00,000 and running costs as even in the table below:

Year	1	2	3	4	5	6	7
Running cost	25,000	30,000	50,800	80,000	1,20,000	1,50,000	1,80,000

8. Discuss the various types of replacement decision with suitable example?
9. The following morality rates have been observed for an electric tube.

Month	1	2	3	4	5	6
% Failure by end of month	10	12	29	55	78	100

There are 1000 tubes in a factory and it costs Rs. 5 to replace an individual tube, which has burnt out, if all tubes were to be replaced simultaneously. It would cost Rs. 1 per tube. It is proposed to place all tubes at fixed intervals. At what intervals fixed intervals. At what intervals should the tubes be replaced?

10. A machine costs Rs. 6000 the running cost and salvage values at the end of the year is given below:

Year	1	2	3	4	5	6	7
Running cost (Rs)	1,200	1,400	1,600	1,800	2000	2400	3000
Salvage value (Rs)	4,000	2,666	2,000	1,500	1000	600	600

If interest rate is 10% per year, find when the machines is to be replaced.