INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	OPERATIONS RESEARCH
Course Code	:	A70352-JNTUH R15
Class	:	IV B.TECH – I Semester
Branch	:	MECHANICAL ENGINEERING
Year	:	2018 – 2019
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COURSE OBJECTIVES:

Operation Research is also called OR for short and it is a scientific approach to decision making which seeks to determine how best to design and operate a system under conditions requiring allocation of scarce resources. Operations research as a field, primarily has a set or collection of algorithms which act as tools for problems solving in chosen application areas. OR has extensive applications in engineering, business and public systems and is also used by manufacturing and service industries to solve their day to day problems. This course is titled in Fundamentals of Operations Research. This course facilitates to learn various models to optimize a problem.

S. No.	Question	Blooms Taxonomy Level	Course Outcomes
	UNIT-I		
Part A(Very Short Answer Questions)			
1	Explain scope of operations Research?	Understand	1
2	State the applications of operations Research?	Remember	1
3	Brief the history of operations Research?	Understand	1
4	List different characteristics of operations Research?	Remember	1
5	Explain history of operations Research?	Understand	1
6	Define phases of operations Research?	Remember	1
7	Write about physical model of operations Research?	Understand	1
8	Illustrate about Symbolic models of operations Research?	Remember	1
9	Describe about deterministic models of operations Research?	Understand	1
10	Explain about probabilistic models of operations Research?	Remember	1
11	Describe about simulation models of operations Research?	Understand	1
12	Brief about analytical models of operations Research?	Remember	1
14	Explain applications of operations research in production management?	Understand	1
15	Discuss the importance of operations Research in the decision making process?	Remember	2
16	What is a purpose of mathematical model?	Understand	1
17	Explain general representation of LPP?	Remember	1
18	Discuss objective functions in brief?	Understand	1
19	Explain about decision variables?	Understand	1
20	Describe about non- negativity constraints?	Remember	1

21	Explain about constraints of a LPP?	Understand	1
22	Define slack variables with examples?	Remember	1
23	State surplus variables with examples?	Understand	1
24	Explain about artificial variables?	Remember	2
25	Discuss basic feasible solution?	Understand	1
26	Describe optimal solution?	Remember	1
27	Define feasible region?	Understand	1
28	State basic and non basic variables?	Remember	1

Part B (Long Answer Questions)

1	Discribe the terminology involved in formulating a linear programming problem?	Understand	1
2	Explain applications of LPP in production management?	Remember	1
3	Discuss the limitations of operations research?	Understand	1
4	Explain what is meant by degeneracy in LPP? How can this be solved?	Remember	1
5	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.	Understand	2
6	Describe step-by-step procedure to solve LPP by BIG-M method?	Remember	1
7	Discuss the algorithm of simplex method to solve an LPP?	Understand	1
8	Explain the structure of an LPP with examples?	Remember	1
9	What is an unbounded solution? Explain.	Understand	1
10	Elaborate infeasibility solution?	Remember	1
11	Explain assumptions to solve LPP using simplex?	Understand	1
12	Describe alternate solution of a LPP with example?	Remember	1
13	What are the limitations of graphical method?	Understand	1
14	Explain the term artificial variables? Why do we need them?	Remember	1
15	Solve the below LPP Maximize $z = 18x_1 + 16x_2$ subject to $15x_1 + 25x_2 \leq 375$ $24x_1 + 11x_2 \leq 264$ $x_1, x_2 \geq 0$	Understand	2
16	Use big –M method to solve the following Maximize $Z = 8x1 + 5x2$ Subjected to $2x1 + 4 x2 \leq 45$ $3x1 + 2x2 \leq 40$ $x1 + x2 \geq 30$ $x1, x2 \geq 0.$	Remember	2
17	Solve the following LP Problem by two phase method Maximize $Z = 5x1 - 2x2 + 3x3$ Subject to $2x1 + 2x2 - x3 \geq 2$, $3x1 - 4x2 \leq 3$, $x2 + 3x3 \leq 5$ $x1, x2, x3 \geq 0$	Understand	2
18	A firm produces three types of biscuits A,B,C it packs them in arrortments of two sizes 1 and 11. The size 1 contains 20 biscuits of type A, 50 of type B and 10 of type C. the size 11 contains 10 biscuts of thpe A, 80 of type B and 60 of type C. A buyer intends to buy atleast 120 biscuits of type A, 740 of type B and 240 of type C. Determine the least number of packets he should buy.	Remember	2

19	Solve the following LP problem by two phase method. Maximize $z = 5x_1 + 8x_2$ S.T $3x_1 + 2x_2 \geq 3$ $x_1 + 4x_2 \geq 4$ $x_1 + x_2 \leq 5$ $x_1 + x_2 \geq 0$	Understand	2
20	Solve the following LP problem graphically Maximize $z = -x_1 + 2x_2$ S.T $x_1 - x_2 \leq -1,\ -0.5x_1 - x_2 \leq 2,\ x_1, x_2 \geq 0$	Remember	2

Part C(Critical Analytical Questions)

1	Let us consider a company making single product. The estimated demand for the product for the next four months are 1000, 800, 1200, 900 respectively. The company has a regular time capacity of 800 per month and an overtime capacity of 200 per month. The cost of regular time production is Rs.20 per unit and the cost of overtime production is Rs.25 per unit. The company can carry inventory to the next month and the holding cost is Rs.3/unit/month the demand has to be met every month. Formulate a linear programming problem for the above situation	Understand	2
2	Solve the following LP problem graphically. Maximize $z = 2x_1 + x_2$ S.T $x_1 + 2x_2 \leq 10, x_1 + x_2 \leq 6, x_1 - x_2 \leq 2, x_1 - 2x_2 \leq 1$ $x_1, x_2 \geq 0$	Remember	2
3	Solve the following LP problem using simplex method. Maximize $6x_1 + 8x_2$ S.T $x_1 + x_2 \leq 10, 2x_1 + 3x_2 \leq 25, x_1 + 5x_2 \leq 35$ $x_1, x_2 \geq 0$	Understand	2
4	Solve the following LPP by Big-M penalty method Minimize $z = 5x_1 + 3x_2$ S.T $2x_1 + 4x_2 \leq 12, 2x_1 + 2x_2 = 10, 5x_1 + 2x_2 \geq 10$ and $x_1, x_2 \geq 0$	Remember	1
5	Solve the following LPP by two phase method Minimize $z = 3x_1 + 4x_2$ S.T $2x_1 + 3x_2 \geq 8, 5x_1 + 2x_2 \geq 12, x_1, x_2 \geq 0$	Understand	1

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UNIT – II
Part A(Very Short Answer Questions)

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S. No.	Question	Blooms Taxonomy Level	Course Outcomes
1	Explain mathematical model of a transportation problem?	Understand	3
2	What are different methods of solving transportation problems to get basic feasible solution?	Remember	3
3	Why is LCM is optimal than NWCR in solving transportation problem?	Understand	3
4	Why does Vogel's approximation method provide a good initial feasible solution?	Remember	3
5	What are the methods to test for optimality in transportation problem?	Understand	3
6	What is degeneracy in transportation problem?	Remember	4
7	Explain MODI method in brief?	Understand	3
8	Define unbalance problem in transportation?	Remember	3
9	Describe balanced problem in transportation?	Understand	3

10	Explain constraints of a transportation problem?	Remember	3
11	What is assignment problem?	Understand	3
12	Explain applications of assignment problem?	Remember	3
13	Give the mathematical representation of an assignment problem	Understand	3
14	What is the difference between assignment problem and travelling salesman problem?	Remember	3
15	Discuss the method of solving assignment problems?	Understand	3
16	Show that an assignment problem is a special case of a transportation problem?	Remember	3
17	Explain an algorithm to solve an assignment problem?	Understand	3
18	Describe Hungarian method?	Remember	3
19	Explain unbalanced assignment problem?	Understand	4
20	Discuss travelling sales man problem?	Remember	4

Part B (Long Answer Questions)

1	A Company has three plants at locations A,B and C which supply to warehouses located at D,E,F,G and H. monthly plant capacities are 800,500 and 900 respectively. Monthly warehouse requirements are 400, 500,400 and 800 units respectively. Unit transportation cost in rupees is given below.	Understand	4

	D	E	F	G	H
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 by NWCR.

2	A company has factories at F_1, F_2 and F_3 that supply products to ware houses at W_1, W_2 and W_3 .The weekly capacities of the factories are 200,160 and 90 units. The weekly warehouse requirements are 180,120 and 150/units respectively. The unit shipping costs in rupees are as follows. Find the optimal solution.	Remember	3

	W_1	W_2	W_3	Supply
F1	16	20	12	200
F2	14	8	18	160
F3	26	24	16	90
Demand	180	120	150	450

3	Solve the following assignment problem to minimize the total time of the operator;	Understand	4

Operator	Jobs
	1	2	3	4	5
1	6	2	5	2	6
2	2	5	8	7	7
3	7	8	6	9	8
4	6	2	3	4	5
5	9	3	8	9	7
6	4	7	4	6	8

4	Different machines can do any of the five required jobs, with different profits resulting from each assignment as shown in the adjusting table. Find out maximum profit possible through optimal assignment.	Remember	3

Jobs	Machines
	A	B	C	D	E
1	30	37	40	28	40
2	40	24	27	21	36
3	40	32	33	30	35
4	25	38	40	36	36
5	29	62	41	34	39

5	A typical assignment problem, presented in the classic manner. Here there are five machines to be assigned to five jobs. The numbers in the matrix indicate the cost of doing each job with each machine. Jobs with costs of M are allowed assignments. The problem is to find the minimum cost matching of machines to jobs.	Understand	3

	J1	J2	J3	J4	J5
M1	M	8	6	12	1
M2	15	12	7	M	10
M3	10	M	5	14	M
M4	12	M	12	16	15
M5	18	17	14	M	13

6	A salesman has to visit five cities A, B, C, D, E. The intercity distances are tabulated below.	Remember	3

	A	B	C	D	E
A	-	12	24	25	15
B	6	-	16	18	7
C	10	11	-	18	12
D	14	17	22	-	16
E	12	13	23	25	-

Find the shortest route covering all the cities.

7	The assignment cost of assigning any one operator to any one machine is given in the following table.	Understand	3

		Operators			
		I	II	III	IV
Machine	A	10	5	13	15
	B	3	9	18	3
	C	10	7	3	2
	D	5	11	9	7

Solve the optimal assignment by Hungarian method

8	The profits after assigning the machines to jobs are given as follows. Solve the problem to maximize the profits	Remember	3

	J1	J2	J3	J4	J5	J6
M1	5	3	7	6	5	3
M2	7	6	1	4	2	8
M3	**6**	2	4	3	4	5
M4	4	6	4	7	3	8

9	Explain the algorithm for solving transportation problem by Vogel's approximation rule? With example?	Understand	3

10	Solve the following transportation problem.	Remember	3

	A	B	C	D	Supply
I	9	16	15	6	15
II	2	1	3	5	25
III	6	4	7	3	20
Demand	10	15	25	10	

UNIT – III

Part A(Very Short Answer Questions); MID – I (24 Questions)

1	Explain different types of sequencing problems?	Understand	5
2	State general representation of sequencing?	Remember	5
3	Describe applications of sequencing?	Understand	5
4	Explain the terminology of sequencing techniques in operations research?	Remember	5
5	What are the conditions to be satisfied to convert a 'n' jobs 3 machine problem into 'n' jobs 2 machine problem? Explain the method clearly?	Understand	5
6	Write short note on sequencing.	Understand	5
7	Describe various sequencing models?	Remember	5
8	What are the assumptions made in sequencing problem?	Understand	5
9	Give the justification of Johnson's rule for sequencing n jobs x 2	Remember	5

		machines?		
10		What is the need for a replacement?	Understand	5
11		Define individual replacement policy?	Remember	5
12		What is group replacement policy?	Understand	5
13		Explain replacement problem?	Remember	5
14		Give some examples for replacement situations.	Understand	5
15		Define routine replacement.	Remember	5
16		Discuss preventive replacement.	Understand	5
17		What do you mean by replacement policy of items which deteriorate with time?	Remember	5
18		Give the examples of group replacement concept.	Understand	5
19		Define optimal replacement.	Remember	5
20		What is the need for a replacement?	Understand	5
21		Explain various sequencing models.	Remember	5
22		What are the advantages of sequencing?	Understand	5
23		Discuss the importance of sequencing.	Remember	5
24		Define sequencing?	Understand	5
Part A(Very Short Answer Questions); MID – II (24 Questions)				
1		Explain different types of replacement problems?	Understand	5
2		Describe general representation of replacement?	Remember	5
3		Discuss the applications of replacement?	Understand	5
4		Explain the terminology of replacement techniques in operations research?	Remember	5
5		What is the need for a replacement?	Undersand	5
6		Explain the importance of replacement analysis.	Remember	5
7		Define routine replacement.	Understand	5
8		What is replacement problem?	Understand	5
9		List some examples for replacement situations.	Remember	5
10		What is group replacement policy?	Understand	5
11		State preventive replacement.	Remember	5
12		What do you mean by replacement of items which deteriorate with the time?	Understand	5
13		State the examples of group replacement concept.	Remember	5
14		Define optimal replacement.	Understand	5
15		What is the need for a replacement?	Understand	5
16		Describe individual replacement policy.	Remember	5
17		Explain with examples the failure mechanism of items.	Understand	5
18		Write about 'replacement policy of items which deteriorate with time'.	Remember	5
19		Explain how replacement problems are classified?	Understand	5
20		Define replacement of items with gradual deterioration	Remember	5
21		Define replacement of that completely fail.	Understand	5
22		Give examples for replacement of items which do not deteriorate but completely fail.	Understand	5
23		State examples for replacement of items that deteriorate with time.	Remember	5
24		Discuss the examples for replacement of items which fail suddenly.	Understand	5
Part B (Long Answer Questions)				
1		Explain the importance of replacement analysis.	Understand	5
2		Describe with examples the failure mechanism of items.	Remember	5
3		Write about 'replacement policy of items which deteriorate with time'.	Understand	5

4	Derive the expression for the average annual cost of an item over a period of 'n' years, when the money value remains constant.	Remember	5
5	Discuss the policy of replacement of items whose maintenance cost increases with time but the value of money remains constant during the period.	Understand	5
6	Explain how replacement problems are classified?	Remember	5
7	Explain the difference between age replacement and preventive maintenance.	Understand	5
8	Calculate the following sequencing problem to minimize the time elapsed with sequence; Also find the total elapsed time and idle times of each machine.	Remember	5

Job	1	2	3	4	5
Machine M1	7	10	8	9	7
Machine M2	2	1	4	0	5

9	Determine the best sequence for '5' jobs that will minimize the elapsed time T, if each of the '5' jobs must go through machines A, B and C in the order ABC, The processing times are.	Understand	5

Job	Processing time		
	A	B	C
1	8	5	4
2	10	6	9
3	6	2	8
4	7	3	6
5	11	4	5

10	A book binder has one printing press, one binding machine and manuscripts of 7 different books. The time required for performing printing and binding operations for different books are shown below.	Remember	5

Book	1	2	3	4	5	6
Printing time (hr)	20	90	80	20	120	15
Binding time(hrs)	25	60	75	30	90	35

Decide the optimum sequence of processing of books in order to minimize the total time required to bring out all the books.

11	Solve the following sequence problem, given an optimal solution when passing is not allowed.	Understand	5

Machines	Jobs				
	A	B	C	D	E
M1	11	13	9	16	17
M2	4	3	5	2	6
M3	6	7	5	8	4
M4	15	8	13	9	11

12	Six jobs go first on machine A, then on machine B and last on machine C. The order of completion of jobs has no significance. The following table gives machine time for the six jobs and the three machines. Find the sequence of jobs that minimizes elapsed time to complete the jobs.	Remember	5

Jobs	Processing Time		
	Machine A	Machine B	Machine C
1	8	3	8
2	3	4	7
3	7	5	6
4	2	2	9
5	5	1	10
6	1	6	9

Part C (Critical Analytical Questions)			
1	Machine A costs of Rs: 80,000. Annually operating cost are Rs:2,000 for the first years and they increase by Rs:15,000 every years (for example in	Understand	5

	the fourth year the operating cost are Rs:47,000).Determine the least age at which to replace the machine. If the optional replacement policy is followed. (a)What will be the average yearly cost of operating and owing the machine (Assume that the reset value of the machine is zero when replaced, and that future costs are not discounted. (b)Another machine B cost Rs: 1,00,000. Annual operating cost for the first year is Rs:4,000 and they increase by Rs:7,000 every year .The following firm has a machine of type A which is one year old. Should the firm replace it with B and if so when? (c)Suppose the firm is just ready to replace the M/c A with another M/c of the same type, just the the firm gets an information that the M/c B will become available in a year .What should firm do?		
2	Machine A costs Rs:45,000 and it's operating costs are estimated to be Rs:1,000 for the first year increasing by Rs:10,000 per year in the second year and subsequent years .Machine B costs Rs:50,000 and operating cost are Rs:2,000 for the first year and increasing by Rs:4,000 in the second and subsequent years. If at present we have a machine of type A, should we replace it with B? If so when? Assume both machines have no resale value and these future costs are not discounted?	Remember	5
3	The data collected in running a Machine the cost of which is Rs:60,000 are given below	Understand	5

Resale value	1	2	3	4	5
Resale value (Rs)	42,000	30,000	20,400	14,400	9,650
Cost of Spares (Rs)	4,000	4,270	4,880	5,700	6,800
Cost of Labour	14,000	16,000	18,000	21,000	25,000

Find the time when the machine should be replaced?

4	Let the value of the money be assumed be 10% per year and suppose that the machine A is replaced after every three years whereas machine B is replaced every six years .The yearly cost in (Rs) of both the machines are given below.	Remember	5

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

Determine which Machine should be purchased?

5	The management of a large hotel is considering the periodic replacement of light bulbs fitted in it's room .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 the total cost of Rs:3 per bulb .The management feels that this cost can be reduced to Rs:1 by adopting the group replacement method. On the basis of the information given below, evaluate the alternative and make a recommendation to the management.	Understand	5

Month of use	1	2	3	4	5
Percent of bulbs failing by that month	10	25	50	80	100

6	A firm is considering the replacement of a machine, whose cost price is Rs.12, 200 and its shop value is Rs.200. From experience the running (maintenance and operating) costs are found to be as follows.	Remember	5

Year	1	2	3	4	5	6	7	8
Ruuning cost	200	500	800	1200	1800	2500	3200	4000

When should the machine be replaced?

	UNIT – IV		
	Short Answer Questions		
1	Define a player.	Understand	5
2	Explain a strategy.	Remember	5
3	Define a pure strategy	Understand	5
4	Discuss a mixed strategy.	Remember	5
5	What is the advantage of a mixed strategy over a pure strategy?	Understand	5
6	Define a two-person zero-sum game.	Remember	5
7	Describe n-person zero-sum game.	Understand	5
8	Explain a rectangular game?	Remember	5
9	What are the characteristics of a two-person zero-sum game?	Understand	5
10	State the rules for a game theory.	Remember	5
11	Describe a mixed strategy.	Understand	5
12	Define inventory	Understand	5
13	What is the necessity of maintaining inventory?	Remember	5
14	Explain different types of variables used in inventory?	Understand	5
15	Give the examples of controlled variables.	Remember	5
16	State the examples of uncontrolled variables.	Understand	5
17	What are the different types of inventory models?	Remember	5
18	Why many organizations hold safety stocks as part of their inventory.	Understand	5
19	Define inventory analysis?	Remember	5
20	What is a reorder point?	Understand	5
21	Describe the cost to store inventory?	Remember	5
22	What is the EOQ reorder point?	Understand	5
23	Define inventory	Understand	5
24	What is the necessity of maintaining inventory?	Remember	5
25	Explain different types of variables used in inventory?	Understand	5
26	Give the examples of controlled variables.	Remember	5
27	State the examples of uncontrolled variables.	Understand	5
	Long Answer Questions		
1	Explain two person zero sum game and n person game?	Understand	6
2	Define pay of matrix and types of strategy in game theory?	Remember	6
3	What are inventory models? Enumerate various types of inventory models and describe them briefly.	Understand	6
4	State the four properties which a competitive situation should have, if it is to be called a competitive game.	Remember	6
5	What is the problem studied in game theory.	Understand	2
6	Write about zero sum games.	Remember	2
7	Differentiate between determinable and non-determinable games.	Understand	2
8	Establish the relation between a linear programming problem and a two person zero sum game.	Remember	5
9	Show how a game can be formulated as a linear programming problem.	Understand	5
10	Discuss limitations of game theory	Remember	2
11	Explain the various costs are involved in inventory problems with suitable examples. How they are inter-related.	Understand	5
12	Discuss in detail, what constitutes the ordering cost and carrying cost? With the help of a graph show how they behave with the increase in order quantity.	Understand	1
13	What are the different inventory costs associated with inventory control? How are they obtained in real life situations?	Remember	5
14	What are the advantages and disadvantages of increased inventory?	Understand	2

15	Why inventory is maintained?	Remember	2
16	What is EOQ? Discuss step by step the development of EOQ formula.	Understand	5

<p align="center" style="color:red">Analytical Questions</p>

1	Solve the following game;	Understand	5

	Y1	Y2	Y3
X1	4	20	6
X2	18	12	10

2	Solve the following game	Remember	6

B

	5	20	-10
A	10	6	2
	20	15	18

3	Using the dominance property obtain the optimal strategy for both the players and determine the value of game. The payoff matrix for player A is given	Understand	6

		Player-B				
		I	II	III	IV	V
Player-A	I	2	4	3	8	4
	II	5	6	8	7	8
	III	6	7	9	8	7
	IV	4	2	8	4	3

4	Solve the following game graphically;	Remember	2

		1	2	3	4	5
A	1	-5	5	0	-1	8
	2	8	-4	-1	6	-5

5	Find the range of value of P and Q that will render the entry (2,2) a saddle point for the following game;	Understand	6

		Player-B		
	A	B_1	B_2	B_3
Player-A	A_1	2	4	5
	A_2	10	7	9
	A_3	4	P	6

6	Solve the following 2x2 game without saddle point	Understand	6

B

a. $A \begin{bmatrix} 5 & 1 \\ 3 & 4 \end{bmatrix}$

B

b. $A \begin{bmatrix} 2 & 5 \\ 7 & 3 \end{bmatrix}$

7	A company is currently involved in negotiation with it's union on the upcoming wage contract positive signs in the table represent wage increase while negative sign represents wage reduction what are the optimal strategies for the company as well as the union ?what is the game value?	Remember	2

	Union Strategy			
C1	0.25	0.27	0.35	-0.02
C2	0.20	0.16	0.08	0.08
C3	0.14	0.12	0.15	0.03
C4	0.30	0.14	0.19	0.00

8	Two breakfast food manufacturers ABC and XYZ are competing for an increased market share. The pay off matrix, shown in the following table describes the increase in market share for ABC and decrease in market share of XYZ.	Understand	2

ABC	Give coupons	Dec price	Maintain present strategy	Increase and advertizing
Give coupons	2	-2	4	1
Decrease price	6	1	12	3
Maintain present strategy	-3	2	0	6
Increase adv	2	-3	7	1

9	Use the graphical method for solving the following game and find the value of the game	Remember	6

		Player-B				
		B1	B2	B3	B4	Probability
Player-A	A1	2	2	3	-2	P1
	A2	4	3	2	6	P2

10	Obtain the optimal strategies for both pensions and the value of the game for two persons zero sum game whose payoff matrix is as follows.	Understand	2

		player-B	
		B1	B2
Player-A	A1	1	-3
	A2	3	5
	A3	-1	6
	A4	4	1
	A5	2	2
	A6	-5	0

11	The production department of a company required 3,600kg of raw material for manufacturing a particular item per year. It has been estimated that the cost of placing an order is Rs.36 and the cost of carrying inventory is 25% of the investment in the inventories, the price is Rs.10/kg. help the purchase manager to determine and ordering policy for raw material, determine optimal lot size.	Remember	2
12	Purchase manager places order each time for a lot of 500 no of particular item from the available data the following results are obtained, inventory carrying 40%, ordering cost order Rs.600, cost per unit Rs.50 annual demand 1000, find out the loser to the organization due to his policy.	Understand	2
13	A dealer supplies you the following information with regards to an product that he deals in annual demand =10,000 units, ordering cost Rs.10/order, Price Rs.20/unit. Inventory carrying cost is 20% of the value of inventory per year. The dealer is considering the possibility of allowing some back orders to occurs. He has estimated that the annual cost of back ordening will be 25% of the value of inventory. a. What should be the optimum no of units he should buy in 1 lot? b. What qty of the product should be allowed to be back ordered c. What would be the max qty of inventory at any time of year d. Would you recommend to allow backordering? If so what would be the annual cost saving by adopting the policy of back ordering.	Understand	2
14	The annual demand of a product is 10,000 units. Each unit costs Rs.100 if the orders are placed in quantities below 200 units. for orders above 200 or above, however the price is Rs.95. The annual inventory holding costs is 10% of the value of the item and the ordering costs is Rs.5/order. Find economic lot size?	Remember	2
15	A shopkeeper estimates the annual requirement of an item as 2000 units. He buys it from his supplier at a cost of Rs 10 per item and the cost of ordering is Rs 50 each time he order if the stock holding cost are 25% per year of stock value, how frequently should he replenish his stocks? Further suppose the supplies offers a 10% discount on orders b/w 400 and 699 stems and a 20% discount on orders exceeding or equal to 700. Can the shop keeper reduce his costs by taking advantage of either of these discounts?	Understand	2
16	Find the optimal economical order Qty for a product having the following characteristics. Annual demand 2400 units, ordering cost C0=Rs 100 lost of storage Ch=24% of unit cost price break Qty $0 \le Q < 500$	Remember	2

	500≤Q2 Price /unit (Rs) Rs.10 Rs.900		
17	A shop is about to order some heaters for a forecast spell of cold weather. The shop pays Rs.1000 for each heater and during the cold spell they sell for Rs 2000 each. The demand for the heater declines after the cold spell is ones and any unrold units are sold at Rs.500 previous experience suggests the likely demand for heater is as follows. 	Demand	10	20	30	40	5
---	---	---	---	---	---
Probability	0.20	0.30	0.30	0.10	0. | How many heaters should the shop owner buy?	Understand	7
18	Find the most economic batch quantity of a product on a machine if the production rate of the item on the machine is 300 pieces per day and the demand is uniform at the rate of 150 pieces/day. The set up cost is Rs.300 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?	Remember	2
19	A company that operates for 50 weeks. In a year is concerned about its stocks of copper cable this cost Rs. 240 a meter and there is a demand for 80,000 meters a week. Each replishment costs Rs.1050 for administration and Rs.1650 for delivery while holding costs are estimated at 25% of value hold a year. Assuming no shortages are allowed, what is the optimal inventory, policy for the company? How would this analysis differ if the company wanted to maximize its profits rathen than minimize cost? What is the groups profit if the company sells the cable for Rs.360 a meter.	Understand	7

UNIT-V

. No.	Question	Blooms Taxonomy Level	Course Outcomes
Short Answer Questions		
1	What are the characteristics of a waiting line system?	Understand	7
2	State the arrival characteristics?	Remember	7
3	Define a waiting a line.	Understand	7
4	Discuss waiting line applications.	Remember	3
5	Define customer and server.	Understand	7
6	Expand FIFO, FCFS and LIFO.	Remember	7
7	ExplainFILO and SIRO	Understand	3
8	Define dynamic programming	Remember	7
9	Who developed the technique called dynamic programming?	Understand	7
10	Describe state and stage.	Remember	5
11	Define state variable and decision variable.	Understand	7
12	What is immediate and optimal return ?	Understand	7
13	State Bellman's principle of optimality.	Remember	5
14	What are the applications of dynamic programming?	Understand	7
15	State the examples of dynamic programming.	Remember	7
16	Define simulation	Understand	7
17	What are the types of simulation?	Remember	7
18	Explain the phases of simulation?	Understand	7
19	What are the major limitations of simulation?	Remember	7
20	Explain the advantages of simulation?	Understand	7
21	What are the disadvantages of simulation?	Remember	7
Long Answer Questions		
1	Define the terms Balking, Reneging, Jockeying.	Understand	7

2	Explain the terms single server and multiple server que length and finite and infinite queue length.	Remember	7
3	Define simulation why simulation uses. Give one application area when this technique is used in practice.	Understand	7
4	Explain what factors must be considered when designing simulation experiment. Draw a flow chart to describe the simulation of a simple system.	Remember	7
5	Discuss types of simulations?	Understand	7
6	A road transport company has one reservation clerk on duty at a time. He handles information of bus schedules and makes reservations customers arrive at a rate of 8 per hour and the clerk can, on an average, service 12 customers per hour. After starting your assumptions determine. a. What is the avg number of customer waiting for the service of the clerk b. What is the avg time a customer has to wait before being used?	Remember	7
7	Consider a single semen quering system with poissions input and exponential service times. Suppose that mean arrival rate is 3 calling units per hour, the expected service time is 0.25 hours and the maximum permissible calling units is the system is two. Derive the steady state probability distribution of the number of calling units in the system. And then calculate the expected number in the system.	Understand	7
8	At a railway station only one train is handled at a time. The railway track is sufficient only for two trains to wait while others are given signal to leave the station. Trains arrive at the station at an average rate of 6 per/hours and the railway station can handle them on an average of 12 per/hours. Assuming posission arrivals and exponential service distribution find the steady state probability of the various numbers of trains in the system. also find the average number of trains in the system.	Remember	7
9	Explain the application of Queuing systems?	Understand	7
10	In a departmental store one cashier is there to serve the customers. And the customers pick up their needs by themselves the arrival rate is 9 customers for every 5 minutes and the cashier can serve 10 customers in 5 minutes. Assuming poisions arrival rate and expoertial distribution for service rate. Find a. Average number of customers in the system b. Average number of customers in the queue of average queue length? c. Average time a customer spends in the systems d. Average time a customer waits before being served.	Remember	7
11	Discuss dynamic programming with suitable examples?	Understand	7
12	A television repairman finds that the time spent on his jobs has an exponential distribution with a mean of 30 minutes. If he repairs the sets in the order in which they came in, and if the arrival of sets follows a poission distribution with an approximate average rate of 10 per 8 hour day, what is the repairman's expected idle time each day? How many jobs are ahead of the average, set just brought in?	Remember	7
13	What is simulation? Discuss application of simulation?	Understand	7
14	Discuss the advantages and disadvantages of simulation.	Remember	7
	Analytical Questions		
1	Customers arrive at box office windows being manned by a single individual, according to a poisson input process with a mean rate of 20/hr. the time required to seme a customer has an exponential distribution with a mean of 90 sec. Find the avg waiting time of customers. Also determine the average number of customers in the system and average queue length.	Understand	7
2	A company manufactures around 200 mopeds. Depending upon the availability of raw materials and other conditions. The daily production has been varying from 196 mopeds to 204 mopeds. Whose probability distribution are given below:	Remember	7

Pro/day	196	197	198	199	200	201	202	203	204
Probability	0.05	0.09	0.12	0.14	0.20	0.15	0.11	0.08	0.06

	Finished mopeds are transported to a lorry that can accommodate only 200 mopeds. Random numbers are 82,89,78,24,53,61,18,45,04,23,50,77,54 and 10. Simulate the mopeds waiting.			
3	A bakery keeps stock of a popular brand of cake. Previous experience show the daily demand pattern for the item with associated probabilities as given below:	Understand	7

Daily damand (number)	0	10	20	30	40	50
Probability	0.01	0.20	0.15	0.50	0.12	0.02

use the following sequence of random numbers to simulate the demand for next 10 days.

Random numbers: 25,39,65,76,12,05,73,89,19,49

Also estimate the daily average demand for the cakes on the basis of the simulated data.

| 4 | A firm has a single channel service station with the following arrival and service time probability distributions. | Remember | 7 |

Interarrival time (Minutes)	Probability	Service time minutes	Probability
10	0.10	5	0.08
15	0.25	10	0.14
20	0.30	15	0.18
25	0.25	20	0.24
30	0.10	25	0.22
		30	0.14

The customers arrival at the service station is a random phemomenon and the time between the arrivals varies from 10 to 30 minutes. The service time varies from 5 minute to 30 minutes. The queing process begins at 10 am and proceeds for near ly 8hrs. an arrival immediately goes to the service facility if is free. Otherwise it waits in a queue. The queue discipline is first come first sered. If the attendants wages are Rs.10 per hour and the customers waiting time cost Rs.15 per hour, then would it be an economical proportion to engage a second at tendant?

5	Minimize $z = y_1^2 + y_2^2 + y_3^2$, S.T $y_1 + y_2 + y_3 = 10$, solve using Bellman's principle.	Understand	9
6	Use dynamic programming to solve the following problem Maximize $z = x_1^2 + 2x_2^2 + 4x_3^2$, S.T $x_1 + 2x_2 + x_3 \leq 8$, $x_1, x_2, x_3 \geq 0$	Remember	10
7	Use Bell man's principle of optimality to find the optimum solution to the following problem Minimize $z = y_1^2 + y_2^2 + y_3^2$, S.T $y_1 + y_2 + y_3 \leq 15$, $y_1, y_2, y_3 \geq 0$.	Understand	10

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