Code No: R1631034 **R16** SET - 1

III B. Tech I Semester Regular/Supplementary Examinations, March - 2021

OPERATIONS RESEARCH

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**

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PART – A (14 Marks)

1 a) Define model and explain the importance of model in LPP. [2M]
b) Discuss about total elapsed time sequencing. [2M]
c) Explain about group replacement. [2M]
d) Define saddle point and without saddle point game. [3M]
e) Define economic order quantity and its influencing parameters. [3M]
f) Explain the application of simulation to inventory problems. [2M]

PART – B (56 Marks)

2 a) Solve the linear programming problem using two-phase simplex method, maximize $Z=10X_1+6X_2+2X_3$ subject to constraints $-X_1+X_2+X_3 \geq 1$, $3X_1+X_2+X_3 \geq 2$ and $X_1, X_2, X_3 \geq 0$. [6M]
b) Define the following terms: i) Alternate optimal solution, ii) Unbounded solution, iii) Infeasible solution, iv) Artificial Variable . [8M]

3 a) Find the transportation cost for the following by using row-minima method. [10M]

	A	B	C	D	E	F	G	Supply
A	5	6	4	3	7	5	4	7000
B	9	4	3	4	3	2	1	4000
C	8	4	2	5	4	8	3	10000
Demand	1500	2000	4500	4000	2500	3500	3000	

b) Solve the following unbalanced assignment and calculate the assignment cost. [4M]

	A	B	C	D	E
A	30	39	31	38	40
B	43	37	32	35	38
C	34	41	33	41	34
D	39	36	43	32	36
E	32	49	35	40	37
F	36	42	35	44	42

4 a) A truck owner finds from his past experience that the maintenance costs per year of a truck whose purchase price is Rs. 80,000 are as given below. Determine at which time it is profitable to the replace the truck? [6M]

Year	1	2	3	4	5	6	7	8
Maintenance cost	10000	13000	17000	22000	29000	38000	48000	60000
Resale price	40000	20000	12000	6000	5000	4000	4000	4000
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b) A fleet owners finds from his past records that the cost per year of running a vehicle, whose purchase price is Rs. 100000. [8M]

Year	1	2	3	4	5	6	7
Running cost	10000	12000	14000	18000	23000	32000	36000
Resale value	60000	30000	15000	7500	4000	4000	4000

Thereafter, running cost increases by Rs.4000, but resale value remains const Rs.4000. At what age is replacement is due?

5 a) Consider the payoff matrix of player A as shown below and solve it optimally using graphical method: [7M]

	A	B	C	D	E
A	3	0	6	-1	7
B	-1	5	-2	2	1

b) Customers arrive at a box office window being manned by a single individual according to a Poisson input process with a mean rate of 30 per hour. The time required to serve a customer has an exponential distribution with a mean of 90 seconds. Find the average waiting time of a customer. Also determine the average number of customers in the system and average queue length. [7M]

6 a) An engineering company consumes electrodes at the rate of 600 electrodes per month. The cost of one packet containing 12 electrodes is Rs. 48. The cost of placing an order and processing the delivery comes out to be Rs. 24 per order. The inventory carrying cost is 16% of average inventory investment. Determine the EOQ and total variable cost of managing the inventory. [7M]

b) A stockiest has to supply 12,000 units of a product per year to his customer. The demand is fixed and unknown and the shortage cost is assumed to be infinite. The inventory holding cost is Rs 0.20 per unit per month and the ordering cost per order is Rs 350. Determine the optimum lot size, optimum scheduling period, minimum total variable yearly cost. [7M]

7 a) Solve the following problem by dynamic programming: [7M]
Minimize $Z= 2X_1+3X_2+20X_3$, subject to $X_1+X_2+X_3=12$, $X_1,X_2,X_3 \geq 0$.

b) What is the need of simulation? How can you use Monte Carlo simulation for industrial problems? Give examples. [7M]

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PART – A (14 Marks)

1. a) List the characteristics of operations research. [2M]
   b) Define initial basic feasible solution for transportation problem. [2M]
   c) Discuss about failure theories in replacement. [2M]
   d) What are the operating characteristics of queuing theory? [3M]
   e) Explain various costs in inventory. [3M]
   f) What is the importance of state and stage variables in dynamic programming? [2M]

PART – B (56 Marks)

2. a) Solve the following linear programming problem by using simplex method: Maximize $Z=3X_1+2X_2$, Subjected to $4X_1+3X_2 \leq 12$, $4X_1+X_2 \leq 8$, $4X_1-X_2 \leq 8$, and $X_1, X_2 \geq 0$. [7M]
   b) Solve the following linear programming problem by-using two-phase simplex method**,** Maximize $Z=5X_1+8X_2$ Subject to the constraints $3X_1+2X_2 \geq 3$, $X_1+4X_2 \geq 4$, $X_1+X_2 \geq 5$ and $X_1, X_2 \geq 0$. [7M]

3. a) Find an initial basic feasible solution to the following transportation problem using Vogel's approximation technique: [7M]

	I	II	III	IV	Availability
A	7	2	5	5	30
B	4	4	6	5	15
C	5	3	2	2	10
D	4	-1	4	2	20
Requirement	20	25	15	15	

   b) There are seven jobs, each of which has to go through the machines A and B in the order of AB. Processing times in hours are as given below. Determine the total elapsed time. [7M]

Job	1	2	3	4	5	6	7
Machine A	3	12	15	6	10	11	9
Machine B	8	10	10	6	12	1	3
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4. a) A company is planning to replace an equipment by a new equipment whose first cost is Rs. 1,00,000. The operating and maintenance cost of the equipment during its first year of its operation is Rs. 10,000 and it increases Rs. 2000 every year thereafter. The resale value of the equipment at the end of the first year is Rs. 65,000 and it decreases by Rs. 10,000 every year thereafter. Find the economic life time of the equipment by assuming there is no interest rate on the operation and maintenance? [7M]

   b) A truck is priced at Rs. 60,000 and running costs are estimated at Rs. 6000 for each of the first four years, increased by Rs. 2000 per year in the fifth and subsequent years. If money worth 10% per year, when should the truck be replaced? Assume that truck will eventually be sold for scrap at negligible price. [7M]

5. a) Consider the following Payoff matrix of players and solve it optimally using graphical method and calculate strategies for player A and B and game value. [7M]

3	6	8	4	4
-7	4	2	10	2

   b) A self service store employs one cashier at its cash counter. 9 customers are arriving on an average every 5 minutes, while the cashier can serve 10 customers in 5 minutes. Assuming the Poisson distribution for arrival rate and exponential distribution for service time, find: i) Average number of customers in the system, ii) Average number of customers in the queue, iii) Average time a customer spends in the system, iv) Average time a customer waits before being served?, v) Explain about characteristics of game theory. [7M]

6. a) The Demand of an item is 6000 units' year. Its production rate is 1000 units per month. The carrying cost is Rs. 50/unit/year and the set-up cost is Rs. 2000 per set-up. The shortage cost is Rs. 1000 per unit year. Find the following parameters of the inventory system: i) Economic batch quantity, ii) Maximum inventory, iii) Maximum stock out, iv) Cycle time, v) Production and consumption time, vi) Consumption time, vii) Shortage time, viii) Production and consumption time satisfying back order. [7M]

   b) A company requires 2000 units per month of raw material for its production. The cost of placing an order is Rs. 100 per order. The inventory carrying cost is 10% per year per unit of purchase inventory. The company maintains a safety stock of 20 days requirements. If purchase price of raw material is Rs. 25 per unit, determine: i) Economic order quantity, ii) Minimum cost per year, iii) Maximum and minimum inventories. [7M]

7. a) Define dynamic programming. List and explain the terminologies of dynamic programming problem. Write the applications of dynamic programming. [7M]

   b) Explain about Monte Carlo simulation and state its merits. [7M]

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Code No: R1631034 **R16** SET - 3

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PART – A (14 Marks)

1 a) What are the advantages and limitations of LP problem? [2M]

b) What is meant by an optimality test in a transportation problem? [2M]

c) Describe the various replacement situations. [2M]

d) Write the differences between the pure strategy and mixed strategy in a game. [3M]

e) Describe the basic characteristics of an inventory system. [3M]

f) What are the demerits of dynamic programming? [2M]

PART – B (56 Marks)

2 a) Use the duality principle to solve the following L.P.P and find the solution of primal from the dual solution. [10M]

Minimize $z = 4x_1 + 2x_2 + 3x_3$
subjected to: $x_1 + 4x_3 > 5$
$2x_1 + 3x_2 + x_3 > 4$ and
$x_1, x_2, x_3 > 0$.

b) Discuss the limitations of Simplex method. [4M]

3 a) Find the minimum transportation cost for the data given below: [7M]

	Destination					
Source		A	B	C	D	**Supply**
	1	1	2	3	4	6
	2	4	3	2	0	8
	3	0	2	2	1	10
	Demand	4	6	8	6	

b) What is the unbalanced Assignment problem? How is it solved by the Hungarian method? [7M]

4 a) Explain how the theory of replacement is used in the following problems: [7M]
i) Replacement of items whose maintenance cost varies with time.
ii) Replacement of items that fail completely.
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b) A truck owner from his past experience estimated that the maintenance cost per year of a truck whose purchase price is Rs. 1,50,000 and the resale value of truck will be as given below : [7M]

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Maintenance cost	10000	50000	20000	25000	30000	40000	45000	50000
Resale Price	130000	120000	115000	105000	90000	75000	60000	50000

Determine at which time it is profitable to replace the truck.

5 a) Obtain the optimal strategies for both players and the value of the game for two-person zero-sum game whose payoff matrix is given below: [7M]

Player A	Player B	
	B1	B2
A1	-6	7
A2	4	-5
A3	-1	-2
A4	-2	5
A5	7	6

b) What are the assumptions made in the theory of games? [7M]

6 a) Write short notes on VED analysis. [6M]

b) A stockiest has to supply 400 units of a product every Monday to his customers. He gets the product at Rs. 50 per unit from the manufacturer. The cost of ordering and transportation from the manufacturer is Rs.75 per order. The cost of carrying inventory is 7.5% per year of the cost of the product. Find: i) the economic lot size ii) the total optimal cost. [8M]

7 a) Use dynamic programming to solve the linear programming problem: [8M]
Max $Z = 3X + 2Y$
Subject to $X + Y \leq 300$
$2X + 3Y \leq 800$ and $X, Y \geq 0$.

b) Discuss how you apply Simulation to an inventory problem? [6M]

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PART – A **(14 Marks)**

1 a) What are the steps in operations research? [2M]
b) Explain the use of Vogel's approximate method. [2M]
c) Discuss briefly the various types of replacement problems. [2M]
d) How do you represent a queue mathematically? [3M]
e) Explain the significance of EOQ. [3M]
f) What are the pre-requisites for applying dynamic programming? [2M]

PART – B **(56 Marks)**

2 a) What is duality principle? Explain. [7M]
b) A company is manufacturing two different types of products, A and B. Each product has to be processed on two machines M_1 and M_2. Product A requires 2 hrs on machine M_1 and 1 hr on machine M_2, product B requires 1 hr on machine M_1 and 2 hrs on machine M_2. The available capacity of machine M_1 is 104 hrs and that of machine M_2 is 76 hrs. Profit per unit for product A is Rs. 6 and that for B is Rs.11. [7M]
i) Formulate the problem
ii) Find out the optimal solution by Simplex method.

3 a) Six jobs are to be processed on two machines A and then on machine B. Time in hours taken by each job on each machine is given below: [7M]

	Jobs					
	1	**2**	**3**	**4**	**5**	**6**
Machine A	5	3	2	10	12	6
Machine B	3	2	5	11	10	7

Determine the optimum sequence of jobs that minimizes the total elapsed time to complete the jobs and compute the minimum time.
b) Describe the generalized mathematical formulation of an assignment problem. Write the differences between the study of transportation problem and assignment problem. [7M]

4 a) State some of the simple replacement policies and explain with examples. [7M]
b) The initial cost of an item is Rs. 6000 and maintenance and resale cost (in Rs.) for different years are given below: [7M]

Year	1	2	3	4	5	6	7	8
Resale Cost (Rs.)	4000	2000	1200	600	500	400	400	400
Maintenance cost(Rs.)	1000	1300	1700	2200	2900	3800	4800	6000

When should be the item replaced?
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5 a) The payoff matrix of a game is given below. Find the solution of the game to the player A and B. [7M]

		B				
A		I	II	III	IV	V
	I	-2	0	0	5	3
	II	3	2	1	2	2
	III	-4	-3	0	-2	6
	IV	5	3	-4	2	-6

b) A company has two manufacturing shops and two tool cribs one for each shop. Both tool cribs handle identical tools, gauges and measuring instruments. The device time is negative exponentially distributed with a mean if 3 minutes per workman. Arrival of the workman follows Poisson distribution with a mean of 15 per hour. The production manager feels that if tool cribs are combined for both shops, efficiency will improve and waiting time in the queue will reduce. Do you agree with this opinion? [7M]

6 a) Find the optimal order quantity, when we are given D=600 units per year, ordering cost = Rs. 800, and cost of carrying one rupee into inventory for a year = Rs. 0.20, with the range of quantity as: [7M]

Quantity	**Unit Cost (Rs.)**
$0 \leq Q_1 \leq 500$	0.39
$500 \leq Q_2 \leq 1000$	0.29
$1000 \leq Q_3$	0.28

b) Describe the basic characteristics of an inventory system. [7M]

7 a) State the Bellman's principle of optimality in dynamic programming and give a mathematical formulation of a dynamic programming problem. [7M]

b) Discuss the important features of simulation languages. [7M]

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