III B. Tech I Semester Regular/Supplementary Examinations, October/November - 2019
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) What are the different phases of OR?   [2M]
   b) Describe the transportation problem with its mathematical formulation.   [3M]
   c) State some of the simplest replacement policies.   [2M]
   d) What is rectangular game?   [3M]
   e) Classify inventory?   [2M]
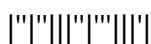   f) Explain Bellman's principles of optimality.   [2M]

PART –B   (56 Marks)

2. a) A company manufactures three products namely X, Y and Z. Each product requires processing on three machines turning, milling and grinding. Product X requires 10 hours of turning, 5 hours of milling and 1 hour of grinding. Product Y requires 5 hours of turning, 4 hours of milling and 2 hours of grinding. In the coming planning period, 2700 hours of turning, 2200 hours of milling and 500 hours of grinding are available. The profit contribution of X, Y and Z are Rs.10, Rs.15 and Rs. 20 per unit respectively. Find the optimal product mix to maximize the profit.   [7M]

   b) Use the graphical method to solve the problem: [7M]
   Maximize $Z = 10x_1 + 20x_2$
   Subject to $X_1 + 2X_2 \leq 15$
   $\qquad\qquad X_1 + X_2 \leq 12$
   $\qquad\qquad 5X_1 + 3X_2 \leq 45$
   $\qquad\qquad X_1, X_2 \geq 0.$

3. a) A product is produced by 4 factories F_1, F_2, F_3 and F_4. Their unit production costs are Rs. 2, 3, 1 and 5 respectively. Production capacity of factories is 50, 70, 30 and 50 respectively. The product is supplied to 4 stores S_1, S_2, S_3 and S_4. The requirements which are 25, 35, 105 and 20 respectively. Unit costs of transportation are given below: [8M]

Factories/stores	S_1	S_2	S_3	S_4
F_1	2	4	6	11
F_2	10	8	7	5
F_3	13	3	9	12
F_4	4	6	8	3

   Find optimum transportation cost.

   b) Give the generalized mathematical formulation of an assignment problem.   [6M]

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4. a) Describe the various types of replacement situations.   [6M]
    b) Find the cost period individual-replacement of an installation of 400 lightening   [8M]
        bulbs given below
        i) Cost of replacing individual bulb is Rs. 4.
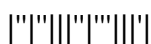   ii) Conditional probability of failure is given below

Week number	0	1	2	3	4
Conditional probability	0	1/10	1/3	2/3	0

5. a) Reduce the following (2 x n) game to (2 x 2) game by graphical method and hence   [7M]
        solve.

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

    b) Discuss about waiting line applications.   [7M]

6. a) Discuss about significance of inventory.   [7M]
    b) A stockiest purchase an item at the rate of Rs. 20 per unit from a manufacturer.   [7M]
        1000 units of the item are required per year. What should be the order quality per
        unit if the cost per unit rose is Rs.15 and the inventory charges per year are 20%?

7. a) Define simulation. What are the advantages and disadvantages of simulation?   [6M]
    b) Use dynamic programming to solve LPP.   [8M]
        $$\text{Max } Z = 4x + 3y$$
        Subject to. $x+y \leq 400$
        $2x+3y \leq 700$
        $x_1, y \geq 0.$

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PART –A   (14 Marks)

1. a) What are the applications of OR.   [2M]
    b) With the reference to the transportation problem define the following: [2M]
       i) Optimal solution; ii) Basic feasible solution.
    c) Differentiate between individual and group replacement.   [2M]
    d) Explain the characteristics of waiting line models.   [3M]
    e) Discuss about the significance of inventory.   [3M]
    f) What are the applications of dynamic programming?   [2M]

PART –B   (56 Marks)

2. Use graphical method to solve the following: [14M]
    Maximize $z = x_1 + x_2/2$
       Subject to $3x_1 + 2x_2 \leq 12$
                  $5x_1 \leq 10$, $x_1 + x_2 \leq 18$
                  $-x_1 + x_2 \geq 4$; $x_1, x_2 \geq 0$.

3. a) Find the optimal solutions for the following transportation problem to minimize   [7M]
       the total cost:

       Warehouse

		W$_1$	W$_2$	W$_3$	Supplies
	P$_1$.	7	6	9	20
Plants:	P$_2$.	5	7	3	28
	P$_3$.	4	5	8	17
Demands:		21	25	19	

    b) 5 machines are to be assigned for 5 jobs. The cost of assigning each job to each   [7M]
       machine is given in the following matrix. Which machine to be assigned to which
       job to minimize the total cost of assignment?

Jobs/ Machines	J$_1$	J$_2$	J$_3$	J$_4$	J$_5$
M$_1$	11	17	8	16	20
M$_2$	9	7	12	6	15
M$_3$	13	16	15	12	16
M$_4$	21	24	17	28	26
M$_5$	14	10	12	11	15

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4. a) The initial cost of a machine is Rs.7100 and the scrap values Rs. 100. The cost found from experience are as follows: [7M]

Year	1	2	3	4	5	6	7	8
Maintenance	200	300	500	700	1000	1300	1700	2100

When should be the machine replaced?

b) The maintenance cost and resale value per year of a machine whose purchase price is Rs. 9000 is given below: [7M]

Year	1	2	3	4	5	6	7	8
Maintenance cost Rs.	900	1200	1600	2100	2800	3700	4700	5900
Resale value Rs.	4000	2000	1200	600	500	400	400	400

When should be machine replaced?

5. a) Explain the characteristics of waiting lines. [8M]

b) Find the ranges of value of P and Q which will render the entry (2, 2) a saddle point for the game. [6M]

		Player B		
		2	4	5
Player A		10	7	Q
		4	P	6

6. a) Explain about i) ABC analysis; ii) VED analysis. [8M]

b) Describe the EOQ problem with one price break. [6M]

7. a) Define simulation. Discuss about limitations of simulation. [7M]

b) Solve the following LPP by using dynamic programming: [7M]

Minimize $Z = x_1 + 3x_2 + 4x_3$

Subject to. $2x_1 + 4x_2 + 3x_3 \geq 60$

$3x_1 + x_2 + 3x_3 \geq 90$

$x_1, x_2, x_3 \geq 0.$

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III B. Tech I Semester Regular/Supplementary Examinations, October/November - 2019
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PART –A   (14 Marks)

1. a)   Explain duality principle.   [2M]
    b)   When does degeneracy occur in transportation problem?   [2M]
    c)   What are the conditions recommended for the replacement of a machine with a   [2M]
        new one when you already have an old one?
    d)   Which competitive situation is called a game?   [3M]
    e)   What are the consequences of over inventory and under inventory situations?   [3M]
    f)   What do you understand by (M/M/1):(α/FCFS). Explain the terms.   [2M]

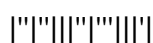## PART –B   (56 Marks)

2.   Solve the given problem by using Big-M method: [14M]
     Maximize $z = -2x_1 - x_2$
     Subject to constraints $3x_1 + x_2 = 3$
                            $4x_1 + 3x_2 \geq 6$
                            $x_1 + 2x_2 \leq 4$
                            $x_1, x_2 \geq 0.$

3. a)   Find the sequence that minimizes the total time required in performing the   [7M]
       following jobs on three machines in order A-B-C as shown in the below table.
       Also find the total elapsed time.

Jobs

		1	2	3	4	5	6
Machines	A	8	3	7	2	5	1
	B	3	4	5	2	1	6
	C	8	7	6	9	10	9

    b)   We have 5 jobs each of which must go through the machines A, B and C in the   [7M]
       order A-B-C. Determine sequence for job that will minimize the total elapsed
       time and idle time for each machine.

Processing time in hours

		1	2	3	4	5
	A	5	7	6	9	5
Job Number	B	2	1	4	5	3
	C	3	7	5	6	7

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4. a) Explain how the theory of replacement is used in the problem of replacement of   [7M]
        items that fail completely?
    b) The initial price of an equipment is Rs. 4000. The running cost (RC) varies as   [7M]
        shown below.

Year	1	2	3	4	5	6	7
RC (Rs.)	300	400	600	9000	1200	1600	2000

        Taking a discount rate of 0.8 find out the optimum replacement interval.

5. a) State some of the important distributions of arrival intervals and service time.   [7M]
    b) A self service store employee has one cashier at its counter. Nine customers   [7M]
        arrive on an average every five minutes while the cashier can serve 10
        customers in 5 minutes. Assuming poison distribution for arrival rate. Find
        i) Average number of customers in the system.
        ii) Average number of customers in queue.
        iii) Average time a customer spends in the system.
        iv) Average time a customer waits before served.

6. a) Discuss about stochastic models of inventory.   [7M]
    b) A manufacturing company uses certain part at a constant rate of 5000 units per   [7M]
        year. Each unit costs Rs. 3 and the company personnel estimates that it's cost
        Rs. 50 to place an order, the carrying cost of inventory is estimated to be
        Rs. 20 per year. Find the optimum size of each order and minimum yearly
        costs.

7. a) What is dynamic programming and discuss about applications and limitations   [7M]
        of dynamic programming.
    b) Explain about Monte-Carlo simulation.   [7M]

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PART –A　　　　　　　　　　　　　　　　　　　　　　　(14 Marks)

1. a) What is the significance of simplex method while solving LPP? [2M]
   b) What are the assumptions made in sequencing problem? [2M]
   c) What are the causes for replacing a machine? [2M]
   d) Define the following i) pure strategy; ii) mixed strategy; iii) saddle point. [3M]
   e) Define i) purchase cost; ii) ordering cost; iii) carrying cost. [3M]
   f) What are the different phases of simulation? [2M]

PART –B　　　　　　　　　　　　　　　　　　　　　　　(56 Marks)

2. a) What are the essential characteristics of OR? Describe them. [4M]

   b) Use Big M graphical method to solve the following: [10M]
   Maximize $z = 3x_1 + 2x_2 + x_3$
   　　Subject to $x_1 + x_2 = 7$
   　　　　　　　$2x_1 + x_2 + x_3 \geq 10$
   　　　　　　　$x_1, x_2, x_3 \geq 0.$

3. a) Five jobs 1, 2, 3, 4 and 5 are to be assigned to machines P, Q, R, S and T. The cost [7M] of assigning these jobs to the machines in rupees is given in the following matrix. Determine the optimal assignment, so as to minimize the total cost. Calculate the total cost of optimal assignment.

		Machine			
	P	Q	R	S	T
1	6	7	5	9	4
2	7	5	10	9	6
Job 3	5	4	3	6	5
4	8	3	5	6	4
5	4	7	5	6	6

   b) Find the sequence that minimizes the total time required in performing the following [7M] jobs on 3 machines in the order as shown below:

		Jobs					
		1	2	3	4	5	6
Machines	A	8	3	7	2	5	1
	B	3	4	5	12	1	6
	C	8	7	6	9	10	9

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4. a) Briefly explain, what you mean by individual and group replacement policy in replacement analysis? [7M]

 b) There is a special light bulb that never lasts longer than two weeks. There is a chance of 0.4 that a bulb will fail at the end of first week. There are 100 new bulbs initially. The cost for individual replacement in Rs. 1.50 and cost per bulb for group replacement is Rs. 0.75. Is it cheaper to replace all the bulbs:
 i) Individuality   ii) Every week   iii) Every second week. [7M]

5. a) Explain the following:
 i) Competitive games;   ii) Two person zero sum game. [6M]

 b) Solve the following game using dominance principle: [8M]

	Player B				
		1	2	3	4
Player A	I	19	6	7	5
	II	7	3	14	6
	III	12	8	18	4
	IV	8	7	13	-1

6. a) Suppose that demand for a product is 40 units per month and the items are withdrawn at a constant rate. The setup cost each time a production run is undertaken to replenish inventory is Rs. 200. The product cost is Rs. 15 per item and the inventory holding cost is Rs. 4 per item per month.
 i) Assuming shortages are not allowed, determine how often to make a production run and what size it should be?
 ii) If shortages are allowed but cost Rs. 40 per item per month, determine how often make a production run and what size it should be? [7M]

 b) Describe the EOQ problem with multiple price breaks. [7M]

7. a) With the help of a single server queuing model having inter arrival and service times constantly 1.5 minutes and 4 minutes respectively. Explain discrete simulation techniques taking 15 minutes has a simulation period. Find the average waiting time and percentage of ideal time of facility of a customer. Assume that initially the system is empty and the first customers arrives at time t=0. [7M]

 b) Solve the following LPP using dynamic programming technique: [7M]
 Maximize z=5x+9y
 Subject to. $-x+3y \leq 3$
 $5x+3y \leq 27$
 x, y $\geq$ 0.

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III B. Tech I Semester Supplementary Examinations, October/November - 2020

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PART – A   **(14 Marks)**

1	a)	What is its significance in Simplex method of solving LPP?	[2M]
	b)	Give the mathematical formulation of an assignment problem.	[3M]
	c)	What are the situations which make the replacement of items necessary?	[2M]
	d)	Define a saddle point in a game.	[2M]
	e)	Write the mathematical equation for EOQ.	[3M]
	f)	Write the advantages and disadvantages of simulation.	[2M]

PART – B   **(56 Marks)**

2 a) State different types of models used in operation research. Explain any two in detail.   [7M]

  b) Solve the linear programming problem: [7M]

$$\text{Max } Z = 3X_1 + 2X_2$$
$$\text{Subjected to } 4X_1 + 3X_2 \le 12$$
$$4X_1 - X_2 \le 8$$
$$X_1, X_2 \ge 0.$$

3 a) Give the generalized mathematical formulation of an assignment problem. Give a comparative study of transportation problem and assignment problem.   [7M]

  b) Find the Total cost using North-west corner method. Also find the optimal solution.   [7M]

	W1	W2	W3	W4	Capacity
F1	95	105	80	15	12
F2	115	180	40	30	7
F3	195	180	95	70	5
Requirement	5	4	4	11	

4 a) Discuss in brief, replacement procedure for the items that deteriorate with time.   [7M]

  b) A truck owner finds from his past records that the maintenance cost per year of a truck whose purchase price is Rs.8000, are given below: [7M]

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

Determine at what time it is profitable to replace the truck?

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5 a) Explain the theory of dominance in the solution of rectangular games.   [7M]
   b) At what average rate a clerk at a super market work in order to ensure a probability of   [7M]
       0.90 that the customer will not have to wait longer than 12 minutes? It is assumed
       that there is only one counter to which customers arrive in a Poisson fashion at an
       average rate of 15 per hour. The length of service by the clerk has an exponential
       distribution.

6 a) What are costs that are involved in carrying inventory? Explain them in detail.   [7M]
   b) A stockist purchases an item at the rate of Rs. 40 per piece from a manufacturer.   [7M]
       2,000 units of the item are required per year. What should be the order quantity per
       order if the cost per order is Rs.15 and the inventory charges per year are 20 per cent?

7 a) Solve the following LPP by dynamic programming: [8M]
       $$\text{Minimize } Z = x_1 + 3x_2 + 4x_3$$
       $$\text{Subject to }\quad 2x_1 + 4x_2 + 3x_3 \geq 60,$$
       $$3x_1 + x_2 + 3x_3 \geq 90$$
       $$x_1, x_2, x_3 \geq 0.$$
   b) What are advantages of simulation? Explain Monte-Carlo simulation.   [6M]

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

III B. Tech I Semester Supplementary Examinations, August-2021
OPERATIONS RESEARCH
(Mechanical Engineering)

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PART – A   (14 Marks)

1. a) State the general linear programming problem (LPP) and put it in the standard form.   [2M]

   b) Give the mathematical formulation of transportation problem.   [2M]

   c) Discuss briefly the various types of replacement problems.   [2M]

   d) Name a few applications of queuing in mechanical engineering.   [3M]

   e) Discuss the significance of inventory.   [3M]

   f) Distinguish between mathematical models and simulation models.   [2M]

PART – B   (56 Marks)

2. a) Write the advantages, limitations and applications of linear programming.   [6M]

   b) Use Penalty method to maximize $z = 3x_1 - x_2$ [8M]
   Subject to the constraints $2x_1 + x_2 \geq 2$;
   $x_1 + 3x_2 \leq 3$;
   $x_2 \leq 4$
   $x_1, x_2 \geq 0$.

3. a) There are five jobs each of which must go through the machines A, B and C in the order ABC. Determine the sequence that will minimize the total elapsed time.   [10M]

Job No	1	2	3	4	5
Machine A	5	7	6	9	5
Machine B	2	1	4	5	3
Machine C	3	7	5	6	7

   b) Briefly explain the Vogel's Approximation Method.   [4M]

4. a) Briefly explain what you mean by "individual and group replacement policy" in Replacement Analysis.   [6M]

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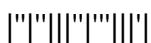
b) Find the cost period of individual replacement of an installation of 300 lighting bulbs, given the following: [8M]
i) Cost of replacing individual bulb is Rs. 3
ii) Conditional probability of failure is given below:

Week number:	0	1	2	3	4
Conditional probability of failure:	0	1/10	1/3	2/3	0

5. a) How do you classify the queuing models? Explain.   [7M]

b) Write the assumptions made in game theory. Solve the following game graphically.   [7M]

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

6. a) Derive EOQ with the assumption involved in.   [7M]

b) A manufacturer purchases items in lots of 800 units which is a four months requirement. The cost per unit is Rs. 100 and the ordering cost is Rs. 120 per patch order. The inventory carrying cost is estimated as 20% of the average inventory investment.   [7M]
     i)   Determine the annual variable cost managing the inventory.
     ii)   How much saving can be obtained from the EOQ purchases?

7. a) Discuss the applications of dynamic programming.   [7M]

b) Why simulation is used? Write the typical applications of simulation.   [7M]
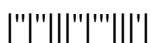
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III B. Tech I Semester Regular/Supplementary Examinations, March - 2021
OPERATIONS RESEARCH
(Mechanical Engineering)

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2. Answer **ALL** the question in **Part-A**
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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,   [6M]
       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 $X_1, X_2, X_3 \geq 0$.

   b) Define the following terms: i) Alternate optimal solution, ii) Unbounded solution,   [8M]
       iii) Infeasible solution, iv) Artificial Variable .

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   [6M]
       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?

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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SET - 2

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) 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: [7M]
   Maximize $Z=3X_1+2X_2$ Subjected to $4X_1+3X_2\leq12$, $4X_1+X_2\leq 8$, $4X_1-X_2\leq8$, and $X_1, X_2 \geq 0$.
   b) Solve the following linear programming problem by-using two-phase simplex   [7M]
   method, Maximize $Z=5X_1+8X_2$ Subject to the constraints $3X_1+2X_2\geq3$, $X_1+4X_2\geq4$, $X_1+ X_2\geq5$ and $X_1, X_2\geq0$.

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

	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   [7M]
   the order of AB. Processing times in hours are as given below. Determine the
   total elapsed time.

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 [7M] 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?

   b) A truck is priced at Rs. 60,000 and running costs are estimated at Rs. 6000 for [7M] 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.

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

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 [7M] 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.

6. a) The Demand of an item is 6000 units' year. Its production rate is 1000 units per [7M] 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.

   b) A company requires 2000 units per month of raw material for its production. [7M] 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.

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

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

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III B. Tech I Semester Regular/Supplementary Examinations, March - 2021
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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   [10M]
       from the dual solution.

   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				
		A	B	C	D	**Supply**
Source	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   [7M]
       method?

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.

b) A truck owner from his past experience estimated that the maintenance cost per year [7M] of a truck whose purchase price is Rs. 1,50,000 and the resale value of truck will be as given below :

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- [7M] person zero-sum game whose payoff matrix is given below:

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 [8M] 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.

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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2. Answer **ALL** the question in **Part-A**
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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   [7M]
       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.
       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   [7M]
       taken by each job on each machine is given below:

	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   [7M]
       the differences between the study of transportation problem and assignment problem.

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   [7M]
       different years are given below:

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   [7M]
       player A and B.

		B				
		I	II	III	IV	V
A	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   [7M]
       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?

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

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   [7M]
       mathematical formulation of a dynamic programming problem.
   b) Discuss the important features of simulation languages.   [7M]

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