U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**

Branch: Mechanical Engineering **Duration: 3 hrs.**

Course Code: 20ME5DCORE **Max Marks: 100**

Course: Operations Research

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

		UNIT - I	CO	PO	Marks
1	a)	State the conditions required for a LPP to be in standard form. What is a canonical system of equations, explain with an example?	CO1	PO1 PO2	**06**
	b)	Solve the following L.P.P. Max $Z = x_1 + 2x_2 + 3x_3 - x_4$ Subjected to $x_1 + 2x_2 + 3x_3 \leq 15$ $2x_1 + x_2 + 5x_3 \leq 20$ $x_1 + x_2 + x_3 + x_4 = 10$ $x_1, x_2, x_3, x_4 \geq 0$	CO1	PO1 PO2	**14**
		OR			
2	a)	Explain the characteristics of an operations research model.	CO1	PO1 PO2	**10**
	b)	A manufacturing firm produces two machines' parts P1 and P2 of a machine. For this it makes use of milling and grinding machines. The different machining times required for each part, the machining times available on different machines and then profit on each machine part as given below:	CO1	PO1 PO2 PO4	**10**

Machines	Manufacturing time required(min)		Maximum time av per week(min)
	P_1	P_2	
Lathe	10	1.5	2500
Milling machine	4	10	2000
Grinding machine	1	1.5	450
Profit per unit	50	100	

Determine the no of pieces of P_1 and P_2 to be manufactured per week in order to maximize profit. Solve it graphically.

			UNIT - II			
	3	a)	Solve the following L.P.P using revised simplex method. Max $Z = x_1 + 2x_2 + 3x_3 - x_4$ Subjected to $x_1 + 2x_2 + 3x_3 \leq 15$ $2x_1 + x_2 + 5x_3 \leq 20$ $x_1 + x_2 + x_3 + x_4 = 10$ $x_1, x_2, x_3, x_4 \geq 0$	*CO2*	*PO1* *PO2* *PO4*	**10**
		b)	Find the optimal solution by using the revised simplex method. Maximize $Z = x_1 + x_2 + 3x_3$ subject to $3x_1 + 2x_2 + x_3 \leq 3$ $2x_1 + x_2 + 2x_3 \leq 2$ and $x_1, x_2, x_3 \geq 0$	*CO2*	*PO1* *PO2* *PO4*	**10**
			OR			
	4	a)	Find the optimal solution by using the revised simplex method. Max $Z = 2x_1 + x_2$ subject to $3x_1 + 4x_2 \leq 6$ $6x_1 + x_2 \leq 3$ and $x_1, x_2 \geq 0$	*CO2*	*PO1* *PO2* *PO4*	**10**
		b)	Use the dual simplex method to show that the following linear program is infeasible. Max $Z = -4x_1 - 3x_2$ Subjected to $x_1 + x_2 \leq 1$ $-x_2 \leq -1$ $-x_1 + 2x_2 \leq 1$ $x_1, x_2 \geq 0$	*CO2*	*PO1* *PO2* *PO4*	**10**
			UNIT - III			
	5	a)	To simulate interest and provide an atmosphere for intellectual discussion, an engineering faculty decides to hold special seminars on four contemporary topics like ecology, energy, transportation and bioengineering. Such seminars should be held once per week in the afternoons. However, scheduling these seminars (One for each topic, and not more than one seminar per afternoon) has to be done carefully so that the number of students unable to attend is kept minimum. A careful study indicates that the number of students who cannot attend a particular seminar on a specific date is as follows: Find the optimal schedule of seminars.	*CO3*	*PO1* *PO2* *PO4*	**10**

				Ecology	**Energy**	**Transportation**	**Bio-Engg**			
			Monday	50	40	60	20			
			Tuesday	40	30	40	30			
			Wednesday	60	20	30	20			
			Thursday	30	30	20	30			
			Friday	10	20	10	30			
		b)	Solve the travelling salesman problem given by the following data. C_{12} = 20, C_{13} = 4, C_{14} = 10, C_{23} = 5, C_{24} = 6, C_{25} = 10, C_{35} = 6, C_{45} = 20, where $C_{ij} = C_{ji}$ and there is no route between *i* and *j* if the value of C_{ij} is not shown.					*CO1*	*PO1* *PO2* *PO4*	**10**
			OR							
	6		A company purchases a material and stores in warehouses located in the following four cities: Warehouse Location (City) : A B C D Capacity (Tonnes) : 90 50 80 60 The warehouse supplies the material to manufacturing units in three cities that have the following demand: Manufacturing Units : Bharat Janata Redlamp Demand (Tonnes) : 120 100 110 The following railroad shipping costs per tonne (in hundred rupees) have been estimated:					*CO3*	*PO1* *PO2* *PO4*	**20**
				Warehouse location	**Bharat**	**Janata**	**Redlamp**			
				A	7	10	5			
				B	12	9	4			
				C	7	3	11			
				D	9	5	7			
			Because of railroad construction, shipments are temporarily prohibited from Warehouse at city A to Bharat. a) Find the optimum distribution of the materials b) Are there multiple solutions? If so, identify all of them. Use North West Corner rule to start with.							
			UNIT - IV							
	7	a)	Solve the given game.					*CO4*	*PO1* *PO2*	**10**
					Player B					
				Player A	2	-2	4	1		
					6	1	12	3		
					-3	2	0	6		
					2	-3	7	7		

		b)	Minimize the total time needed to process the following jobs on the machine shown. Also calculate the total elapsed time to complete both the jobs. Job 1: Sequence A 3, B 4, C 2, D 6, E 2 Job 2: Sequence B 5, C 4, A 3, D 2, E 6	*CO4*	*PO1* *PO2*	**10**
			OR			
	8	a)	A machine operator has to perform three operations, turning, threading and knurling on a number of different jobs in the same order. The time required to perform these operations (in minutes) on each job is known. Determine the order in which the jobs should be processed to minimize the total time taken. Also find the minimum elapsed time. **Job** / **1** / **2** / **3** / **4** / **5** / **6** Turning: 3, 12, 5, 2, 9, 11 Threading: 8, 6, 4, 6, 3, 1 Knurling: 13, 14, 9, 12, 8, 13	*CO4*	*PO1* *PO2*	**14**
		b)	Solve the following game graphically. Player A / Player B: 1, 2, 3, 11, 4 Player A: 8, 7, 5, 2, -3	*CO4*	*PO1* *PO2* *PO4*	**06**
			UNIT - V			
	9	a)	Machine A costs Rs.9000. Annual operating cost is Rs.200 for the first year and then increases by Rs.2000 every year. Determine the best age to replace the machine. If the optimum replacement policy is followed, what will be the average yearly cost of owning and operating the machine? Machine B costs Rs.10000. Annual operating cost is Rs.400 for the first year and then increases by Rs.800 every year. You now have machine of type A, which is one year old. Should you replace it with B, if so, when?	*CO5*	*PO1* *PO2*	**10**
		b)	The probability P_n of failure just before age 'n' is shown below. If individual replacement costs Rs.12/- and group replacement costs Rs.3/- per item. Find the optimal replacement policy. **n**: 1, 2, 3, 4, 5, 6 **P_n**: 0.1, 0.2, 0.25, 0.25, 0.15, 0.05	*CO5*	*PO1* *PO2*	**10**

<table>
<tr><td></td><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td></td><td>10</td><td>a)</td><td>A company has the option of buying one of the two machines, A and B. Machine A costs Rs. 5 lakhs, and its running and maintenance cost is Rs. 60,000/- for each of the first five years and increases by Rs. 20,000/- per year in the sixth and subsequent years. Machine B has the same capacity as that of A, but costs Rs. 2.5 lakhs only. However, its running and maintenance cost is Rs. 1.2 lakhs per year for the first five years and increases by Rs. 20,000/- per year thereafter. If the money is worth 10 percent per year, which machine should be purchased? What are the optimal replacement periods for each machine? Salvage value is assumed to be nil for both the machines.</td><td>CO5</td><td>PO1
PO2</td><td>12</td></tr>
<tr><td></td><td></td><td>b)</td><td>The following table shows the operating expenditures of running a machine whose capital cost is Rs. 60,000/-. Determine the optimum period of replacement of the machine.
<table>
<tr><th>Year</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr>
<tr><td>Resale value (Rs.)</td><td>42000</td><td>30000</td><td>20400</td><td>14400</td><td>9650</td></tr>
<tr><td>Cost of spares (Rs.)</td><td>4000</td><td>4270</td><td>4880</td><td>5700</td><td>6800</td></tr>
<tr><td>Cost of labour (Rs.)</td><td>14000</td><td>16000</td><td>18000</td><td>21000</td><td>25000</td></tr>
</table></td><td>CO5</td><td>PO1
PO2</td><td>08</td></tr>
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