U.S.N.										

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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. **Semester: VII**

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

Course Code: 22ME7HSOPR **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.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	CO	PO	Marks
1	a)	Solve the following L.P.P. Max $Z = x_1 + 2x_2 + 3x_3 - x_4$ Subjected to $x_1 + 2x_2 + 3x_3 = 15$ $2x_1 + x_2 + 5x_3 \geq 20$ $x_1 + x_2 + x_3 + x_4 \geq 10$ $x_1, x_2, x_3, x_4 \geq 0$	CO1	PO1 PO2	**10**
	b)	Use Simplex method to solve the following L.P.P. Max $Z = x_1 + 3x_2$ Subjected to $x_1 \leq 5$ $x_1 + 2x_2 \leq 10$ $x_2 \leq 4$ $x_1, x_2 \geq 0$ Plot the feasible region using x_1 and x_2 as coordinates. Follow the solution steps of the simplex method graphically by interpreting the shift from one basic feasible solution to the next in the feasible region.	CO1	PO1 PO2	**10**
		OR			
2	a)	A machine tool company conducts a job-training program for machinists. Trained machinists are used as teachers in the program at a ratio of one for every 10 trainees. The training program lasts for one month. From past experience it has been found that out of 10 trainees hired, only seven complete the program successfully (unsuccessful trainees are released). Trained machinists are also needed for machining and the company's requirements for the next three months are as follows: January – 100, February – 150 & March – 200. In addition, the company requires 250 trained machinists by April. There are 130 trained machinists available at the beginning of the year. Payroll costs per month are: Each trainee Rs.400/-, Each trained machinist (machining or teaching) Rs.700/-, Each trained machinist idle Rs.500/-. Set up a linear programming problem	CO1	PO1 PO2	**10**

			that will produce the minimum cost hiring and training schedule and meet the company's requirements.			
		b)	ABC foods company is developing a low-calorie high-protein diet supplement called Hi-pro. The specifications of Hi-pro have been established by a panel of medical experts. These specifications along with calorie, protein and vitamin content of 3 basic food, are given below:	*CO1*	*PO1* *PO2* *PO4*	**10**

Nutritional Elements	Units of Nutritional Elements (Per 100 gm Serving of Basic Foods)			Basic Food Hi-pro Specifications
	1	2	3	
Calories	350	250	200	300
Proteins	250	300	150	200
Vitamin A	100	150	75	100
Vitamin C	75	125	150	100
Cost per Serving (Rs)	1.50	2.00	1.20	

What quantities of foods 1, 2 and 3 should be used? Formulate this problem as an LP model to minimize cost of serving.

		UNIT - II			
3	a)	Obtain the dual of the given LPP Maximise $Z = 4x_1 + 5x_2$ Subjected to $3x_1 + 2x_2 \leq 20$ $4x_1 - 3x_2 \geq 10$ $x_1 + x_2 = 5$ $x_1 \geq 0$, x_2 unrestricted in sign	*CO2*	*PO1* *PO2* *PO4*	**06**
	b)	Solve the following LPP by dual simplex method Min $Z = 3x_1 + 2x_2 + x_3 + 4x_4$ Subjected to $2x_1 + 4x_2 + 5x_3 + x_4 \geq 10$ $3x_1 - x_2 + 7x_3 - 2x_4 \leq 2$ $5x_1 + 2x_2 + x_3 + 6x_4 \geq 15$ $x_1, x_2, x_3, x_4 \geq 0$	*CO2*	*PO1* *PO2* *PO4*	**14**
		OR			
4	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*	**15**
	b)	Explain the concept of sensitivity analysis in operations research.	*CO2*	*PO1* *PO2* *PO4*	**05**

			UNIT - III			
	5	a)	A manufacturer wants to ship 22 loads of his products as shown below. The matrix gives the kilometers from sources to the destinations. The shipping cost is Rs. 10 per load per kilometer. What shipping schedule be used in order to minimize the total transportation cost?	*CO1*	*PO1* *PO2* *PO4*	**15**
		b)	Differentiate the transportation and assignment models.	*CO1*	*PO1* *PO2* *PO4*	**05**
			OR			
	6	a)	A salesman has to visit five cities A, B, C, D and E. The distances (in hundred km) between the cities are as follows:	*CO3*	*PO1* *PO2* *PO4*	**10**
		b)	An airline company has drawn up a new flight schedule that involves five flights. To assist in allocating five pilots to the flights, it has asked them to state their preference scores by giving each flight a number out of 10. The higher the number, the greater is the preference. A few of these flights are unsuitable to some pilots, owing to domestic reasons. These have been marked with 'x'. What should be the allocation of the pilots to flights in order to meet as many preferences as possible?	*CO3*	*PO1* *PO2* *PO4*	**10**

		Destination					Supply
		D1	D2	D3	D4	D5	
Source	S1	5	8	6	6	3	8
	S2	4	7	7	6	5	5
	S3	8	4	6	6	4	9
	Demand	4	4	5	4	8	

To City

From City	A	B	C	D	E
A	-	17	16	18	14
B	17	-	18	15	16
C	16	18	-	19	17
D	18	15	19	-	18
E	14	16	17	18	-

If the salesman starts from city A and has to come back to city A, which route which route should he select so that the total distance travelled by him is minimized?

		Flight number				
		1	2	3	4	5
Pilot	A	8	2	X	5	4
	B	10	9	2	8	4
	C	5	4	9	6	X
	D	3	6	2	8	7
	E	5	6	10	4	3

<table>
<tr><td></td><td></td><td></td><td colspan="3">UNIT - IV</td><td></td><td></td><td></td></tr>
<tr><td></td><td>7</td><td>a)</td><td>The steel company negotiating with its union for revising wages of the employees. The management, with the help of mediator, has prepared a payoff matrix shown below. Plus sign, represents wage increase, while negative sign stand for wage decrease. The union has also constructed a table which is comparable to that developed by the management. The management does not have the specific knowledge of game theory to select the best strategy or strategies for the firm. You to assist the management assist the management on the problem. What game value and strategies are available to the opposing group?
Additional costs to steel company (Rs)
<table><tr><td>company strategies</td><td colspan="4">Union strategies</td></tr><tr><td></td><td>U1</td><td>U2</td><td>U3</td><td>U4</td></tr><tr><td>C1</td><td>14</td><td>12</td><td>15</td><td>13</td></tr><tr><td>C2</td><td>22</td><td>15</td><td>10</td><td>9</td></tr><tr><td>C3</td><td>20</td><td>16</td><td>8</td><td>8</td></tr><tr><td>C4</td><td>25</td><td>14</td><td>16</td><td>5</td></tr></table></td><td>CO4</td><td>PO1
PO2</td><td>10</td></tr>
<tr><td></td><td></td><td>b)</td><td>In a town there are only two discount stores ABC and XYZ stores run annual pre-Diwali sales. Sales are advertised through local newspapers with the aid of an advertising firm. ABC stores constructed following payoff in unit of Rs 100000. Find the optimal strategies for both stores and the value of the game:
<table><tr><td></td><td colspan="3">Store XYZ</td></tr><tr><td>Store ABC</td><td>B1</td><td>B2</td><td>B3</td></tr><tr><td>A1</td><td>1</td><td>-2</td><td>1</td></tr><tr><td>A2</td><td>-1</td><td>3</td><td>2</td></tr><tr><td>A3</td><td>-1</td><td>-2</td><td>3</td></tr></table></td><td>CO4</td><td>PO1
PO2</td><td>10</td></tr>
<tr><td></td><td></td><td></td><td>OR</td><td></td><td></td></tr>
<tr><td></td><td>8</td><td>a)</td><td>Use the graphical method to 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.
<table><tr><td>Job 1</td><td>Sequence
Time</td><td>A
2</td><td>B
3</td><td>C
4</td><td>D
6</td><td>E
2</td></tr><tr><td>Job 2</td><td>Sequence
Time</td><td>C
4</td><td>A
5</td><td>D
3</td><td>E
2</td><td>B
6</td></tr></table></td><td>CO4</td><td>PO1
PO2</td><td>14</td></tr>
<tr><td></td><td></td><td>b)</td><td>A readymade garment manufacturer has to process 7 items through two stages of production viz., cutting and sewing. The time taken for each of these items at the different stages is given below in appropriate units.</td><td>CO4</td><td>PO1
PO2
PO4</td><td>06</td></tr>
</table>

			<table><tr><td>Item</td><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr><tr><td>Process time</td><td>Cutting</td><td>5</td><td>7</td><td>3</td><td>4</td><td>6</td><td>7</td><td>12</td></tr><tr><td></td><td>Sewing</td><td>2</td><td>6</td><td>7</td><td>5</td><td>9</td><td>5</td><td>8</td></tr></table> a) Find an order in which these items are to be produced through these stages so as to minimize the total processing time. b) Suppose a third stage of production is added, viz., pressing and packing, with the processing time as follows, find an order in which these items are to be produced through these three stages so as to minimize the total processing time. <table><tr><td>Item</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr><tr><td>Pressing and Packing time</td><td>10</td><td>12</td><td>11</td><td>13</td><td>12</td><td>10</td><td>11</td></tr></table>			
			UNIT - V					
	9	a)	A manual stamper currently valued at Rs. 1500/- is expected to last two years. It costs Rs.5000/- per year to operate. An automatic stamper which can be purchased for Rs.4000/- will last five years and can be operated at an annual cost of Rs. 2500/-. If money carries a rate of interest of 8% per annum, determine which stamper should be purchased.	*CO5*	*PO1* *PO2*	**10**
		b)	Suppose a special purpose type of light bulb never lasts longer than three weeks. There is a chance of 0.3 that a bulb will fail at the end of the next week and 0.2 after two weeks. Initially there are 500 bulbs. The cost per bulb for individual replacement is Re.1.5/- and the cost per bulb for group replacement is Rs. 0.8/-. Is it cheapest to replace all the bulbs; i) initially, ii) every week, iii) every second week, and iv) every third week?	*CO5*	*PO1* *PO2*	**10**
			OR					
	10	a)	An electronic chip board contains 10000 components. When any component fails, it is replaced. The cost of replacing a component individually is Re. 1 only. If all are replaced at the same time, the cost per component would be reduced to 35 paise. The percentage of surviving components say S(t) at the end of the month t is as given below. What is the optimal replacement plan and its cost? <table><tr><td>t</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>S(t)</td><td>100</td><td>97</td><td>90</td><td>70</td><td>30</td><td>15</td></tr></table>	*CO5*	*PO1* *PO2*	**14**
		b)	Explain different types of failures and the value of money.	*CO5*	*PO1* *PO2*	**06**

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