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: VI**

Branch: Institutional Elective **Duration: 3 hrs.**

Course Code: 23CH6OEOPR / 22CH6OEOPR **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.
3. Use of statistical tables is permitted.

				CO	PO	Marks
			UNIT - I			
1	a)		Briefly discuss the scope of operation research and enlist its phases.	*CO4*	*PO11*	**08**
	b)		Solve the LPP by graphical method Max Z = 20 x_1+10 x_2 Constraints : x_1+2 $x_2 \leq 40$; $3x_1 + x_2 \geq 40$; $4x_1 + 3x_2 \geq 60$; $x_1, x_2 \geq 0$;	*CO4*	*PO11*	**12**
			OR			
2	a)		A paper mill produces two grade paper namely 40 grams per square meter regular paper (X) and 100 grams per square meter bond paper (Y), due to raw material restrictions, it cannot produce more than 400 tons of grade X and 300 tons of grade Y in a week. There are 160 production hours in a week. It requires 0.2 and 0.4 hours to produce a ton of products X and Y, respectively with corresponding profits of Rs.2000 and Rs.5000 per ton. Formulate the above as a LPP to maximize the profit and find the optimum product mix.	*CO4*	*PO11*	**08**
	b)		Use the graphical method to solve the following linear programming problem. Minimize $Z = 3x_1 + 2x_2$ subject to the constraints are $5x_1 + x_2 \geq 10$; $x_1 + x_2 \geq 6$; $x_1 + 4x_2 \geq 12$; and $x_1, x_2 \geq 0$	*CO4*	*PO11*	**12**
			UNIT - II			
3	a)		The owner of a small machine shop has four mechanics available to assign jobs for the day. Five jobs are offered with expected profit for each mechanic on each job, which are as follows:	*CO4*	*PO11*	**08**

Mechanic \ Job	A	B	C	D	E
1	67	78	50	111	82
2	71	84	61	73	59
3	87	92	111	71	81
4	48	64	87	77	80

			By using the assignment method, find the assignment of mechanics to the job that will result in maximum profit. Which job should be declined?			
		b)	A travelling salesman has to visit five cities. He wishes to start from a particular city, visit each city once and then return to his starting point. The travelling cost (in Rs) to each city from a particular city is given below: To city / From City: A: ∞, 6, 8, 12, 1; B: 2, ∞, 7, 4, 3; C: 5, 3, ∞, 6, 2; D: 7, 8, 4, ∞, 8; E: 1, 2, 7, 5, ∞ What should be the sequence of visit of the salesman so that the cost is minimum? Estimate the cost.	*CO1*	*PO10*	**12**
			OR			
	4	a)	Solve the following assignment problem to minimize the total cost (Rs). The cost of the matrix given below gives the assignment cost when different operators are assigned to various machines A: 30, 25, 33, 35, 36 B: 23, 29, 38, 23, 26 C: 30, 27, 22, 22, 22 D: 25, 31, 29, 27, 32 E: 27, 29, 30, 24, 32	*CO1*	*PO10*	**10**
		b)	Solve the following travelling salesman problem. C_{12}=20, C_{13}=4; C_{14}=10; C_{23}=5; C_{34}=6; C_{25}=10; C_{35}=6; C_{45}=20; Where C_{ij}=C_{ji} and there is no route between i & j if a value for C_{ij} is not shown.	*CO1*	*PO10*	**10**
			UNIT - III			
	5	a)	Determine the initial basic feasible solution for the following transportation problem using NWCR and Vogel's Approximate Method. **Company** / **Retail** (**D1**, **D2**, **D3**, **D4**) / **Supply** **O1**: 11, 13, 17, 14, 250 **O2**: 16, 18, 14, 10, 300 **O3**: 21, 24, 13, 10, 400 **Demand**: 200, 225, 275, 250, 950	*CO2*	*PO2*	**08**
		b)	Determine the initial basic feasible solution for the following transportation problem using MODI Method Destination / Source: P, Q, R, S, Supply A: 21, 16, 25, 13, 11 B: 17, 18, 14, 23, 13 C: 32, 17, 18, 41, 19 Demand: 6, 10, 12, 15	*CO2*	*PO2*	**12**
			OR			

	6	a)	Determine the initial basic feasible solution for the following transportation problem using NWCR. <table><tr><td rowspan="2">Company</td><td colspan="3">Retail</td><td rowspan="2">Supply</td></tr><tr><td>A</td><td>B</td><td>C</td></tr><tr><td>O1</td><td>2</td><td>7</td><td>4</td><td>5</td></tr><tr><td>O2</td><td>3</td><td>3</td><td>1</td><td>8</td></tr><tr><td>O3</td><td>5</td><td>4</td><td>7</td><td>7</td></tr><tr><td>O4</td><td>1</td><td>6</td><td>2</td><td>14</td></tr><tr><td>Demand</td><td>7</td><td>9</td><td>18</td><td>34</td></tr></table>	*CO2*	*PO2*	**08**
		b)	Solve the following transportation problem using Vogel's approximation method (VAM) and find the optimum distribution arrangement and the total costs in the following transportation matrix. <table><tr><td colspan="7">Destination</td></tr><tr><td rowspan="5">Source</td><td></td><td>W1</td><td>W2</td><td>W3</td><td>W4</td><td>Supply</td></tr><tr><td>A</td><td>19</td><td>30</td><td>50</td><td>10</td><td>07</td></tr><tr><td>B</td><td>70</td><td>30</td><td>40</td><td>60</td><td>09</td></tr><tr><td>C</td><td>40</td><td>08</td><td>70</td><td>20</td><td>18</td></tr><tr><td>Demand</td><td>05</td><td>08</td><td>07</td><td>14</td><td></td></tr></table>	*CO2*	*PO2*	**12**
			UNIT - IV			
	7	a)	In a factory, there are five jobs to perform each of which must go through the 3 reactors A, B & C in order ABC. Processing times are given below. Determine a sequence for 5 jobs that will minimize the elapsed time and estimate the total idle time for the machines in this period. <table><tr><td>Job</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>A</td><td>5</td><td>7</td><td>6</td><td>9</td><td>5</td></tr><tr><td>B</td><td>2</td><td>1</td><td>4</td><td>5</td><td>3</td></tr><tr><td>C</td><td>3</td><td>7</td><td>5</td><td>6</td><td>7</td></tr></table>	*CO3*	*PO2*	**10**
		b)	Using the graphical method, calculate the minimum time needed to process jobs 1 and 2 on five machines A, B, C, D and E, i.e. for each machine find the job that should be done first. Also, calculate the total time needed to complete both jobs. <table><tr><td></td><td></td><td colspan="5">Machines</td></tr><tr><td rowspan="2">Job1</td><td rowspan="2">Sequence time (hr.)</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td>6</td><td>8</td><td>4</td><td>12</td><td>4</td></tr><tr><td rowspan="2">Job2</td><td rowspan="2">Sequence time (hr.)</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td>10</td><td>8</td><td>6</td><td>4</td><td>12</td></tr></table>	*CO3*	*PO2*	**10**
			OR			
	8	a)	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 and estimate the idle time for each. <table><tr><td>Job</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>A</td><td>8</td><td>10</td><td>6</td><td>7</td><td>11</td></tr><tr><td>B</td><td>5</td><td>6</td><td>2</td><td>3</td><td>4</td></tr><tr><td>C</td><td>4</td><td>9</td><td>8</td><td>6</td><td>5</td></tr></table>	*CO3*	*PO2*	**12**

	b)	Five jobs each of which must go through the machines A and B in the order AB. Determine the sequence that will minimize the total elapsed time (mins) and estimate the idle time for each **Job** | **1** | **2** | **3** | **4** | **5** | **6** **A** | 1 | 4 | 6 | 3 | 5 | 2 **B** | 3 | 6 | 8 | 8 | 1 | 5	*CO3*	*PO2*	**08**
		UNIT - V			
9	a)	Activities *A, B, H, I* constitute a project. The notation $X < Y$ means that the task *X* must be completed before *Y* is started. With the notation, $A < D$, $A < E$, $B < F$, $D < F$, $C < G$, $C < H$, $F < I$, $G < I$ Draw a graph to represent the sequence of tasks and find the minimum time of completion of the project, when the time (in days) of completion of each task is as follows. The above constraints can be given as in the following table: Activity | A | B | C | D | E | F | G | H | I Time (days) | 8 | 10 | 8 | 10 | 16 | 17 | 18 | 14 | 9	*CO4*	*PO11*	**08**
	b)	The following table shows the jobs of a network along with their time estimates. The time estimates are in days. Job | 1-2 | 1-6 | 2-3 | 2-4 | 3-5 | 4-5 | 5-8 | 6-7 | 7-8 a | 3 | 2 | 6 | 2 | 5 | 3 | 1 | 3 | 4 m | 6 | 5 | 12 | 5 | 11 | 6 | 4 | 9 | 19 b | 15 | 14 | 30 | 8 | 17 | 15 | 7 | 27 | 28 i. Draw the project network. ii. Find the critical path. iii. Find the probability of the project being completed in 31 days.	*CO4*	*PO11*	**12**
		OR			
10	a)	Discuss the differences between PERT and CPM techniques, enumerate on its significance.	*CO4*	*PO11*	**06**
	b)	A small project involves 7 activities, and their time estimates are listed in the following table. Activities are identified by their beginning (*i*) and ending (*j*) node numbers. Activity (i – j) | Estimated duration: Optimistic | Most Likely | pessimistic 1 – 2 | 1 | 1 | 7 1 – 3 | 1 | 4 | 7 1 – 4 | 2 | 2 | 8 2 – 5 | 1 | 1 | 1 3 – 5 | 2 | 5 | 14 4 –6 | 2 | 5 | 8 5 – 6 | 3 | 6 | 15 i. Draw the network diagram of the activities in the project. ii. Find the expected duration and variance for each activity. What is the expected project length? iii. Calculate the variance and standard deviation of the project length. What is probability that the project will be completed within 19 weeks?	*CO4*	*PO11*	**14**

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