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: VI**
Branch: Institutional Elective **Duration: 3 hrs.**
Course Code: 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. Standard Normal Tables are allowed

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.

			CO	*PO*	Marks
		UNIT – I			
1	a)	Define operations research. List its scope and phases.	*CO1*	*PO2*	**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 $x_1, x_2 \geq 0$	*CO1*	*PO2*	**12**
		OR			
2	a)	Discuss in detail about the classifications of models used in Operations Research.	*CO1*	*PO2*	**10**
	b)	A farmer has a 100 acre farm. He can sell all tomatoes, lettuce or radishes and can get a price of Rs. 1.00 per kg for tomatoes, Rs. 0.75 a heap for lettuce and Rs. 2.00 per kg for radishes. The average yield per acre is 2,000 kg of tomatoes, 3,000 heaps of lettuce and 1,000 kg of radishes. Fertilizers are available at Rs. 0.50 per kg and the amount required per acre is 100 kg each for tomatoes and lettuce and 50 kg for radishes. Labour required for sowing, cultivating and harvesting per acre is 5 man-days for tomatoes and radishes and 6 man-days for lettuce. A total of 400 man-days of labour are available at Rs. 20 per man-day. Formulate this problem as a linear programming model to maximize the farmer's total profit.	*CO1*	*PO2*	**10**
		UNIT – II			
3	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 (table below)	*CO1*	*PO2*	**10**

	E1	**E2**	**E3**	**E4**	**E5**
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

Q. No.		Question	CO	PO	Marks
	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} of there is no route between i & j if a value for C_{ij} is not shown.	CO2	PO3	**10**
		OR			
4	a)	Explain the fundamental differences between the shortest cyclic route model and the shortest acyclic route model in context of assignment problems. Discuss the key application of each model.	CO 2	PO3	**08**
	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 thousand) of each city from a particular city is given below: (see table below) What should be the sequence of visit of the salesman so that the cost is minimum? Estimate the cost.	CO2	PO3	**12**

From City \ To city	A	B	C	D	E
A	∞	2	5	7	1
B	6	∞	3	8	2
C	8	7	∞	4	7
D	12	4	6	∞	5
E	1	3	2	8	∞

UNIT - III

Q. No.		Question	CO	PO	Marks
5	a)	Determine the initial basic feasible solution for the following transportation problem using Vogels Approximate Method	CO3	PO4	**08**

Company	**Retail**				**Supply**
	D1	**D2**	**D3**	**D4**	
O1	11	13	17	14	250
O2	16	18	14	10	300
O3	21	24	13	10	400
Demand	200	225	275	250	950

Q. No.		Question	CO	PO	Marks
	b)	Determine the initial basic feasible solution for the following transportation problem using u-v Method	CO3	PO4	**12**

	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	

OR

Q. No.		Question	CO	PO	Marks
6	a)	Determine the initial basic feasible solution for the following transportation problem using NWCR. Infer the result is non-degenerate or not.	*CO3*	*PO4*	**06**

Company	**Retail**			**Supply**
	A	**B**	**C**	
O1	2	7	4	5
O2	3	3	1	8
O3	5	4	7	7
O4	1	6	2	14
Demand	7	9	18	34

	b)	There are three factories A, B and C, which supply goods to four dealers D1, D2, D3 and D4. The production capacities of these factories are 1,000, 700 and 900 units per month respectively. The requirements from the dealers are 900, 800, 500 and 400 units per month respectively. The per unit return (excluding transportation cost) are Rs. 8, Rs. 7 and Rs. 9 at the three factories. The following table gives the unit transportation costs from the factories to the dealers.	*CO3*	*PO4*	**14**

Factories	Retail			
	D1	D2	D3	D4
A	2	2	2	4
B	3	5	3	2
C	4	3	2	1

Determine the optimum solution to maximize the total returns.

UNIT – IV

7	a)	Determine the optimal sequence of four jobs that minimizes the total elapsed time. Each job of which must go through the machines M_j (j=1, 2, 3, 4 ,5 and 6) in the order M_1, M_2, M_3, M_4, M_5 and M_6 and passing is not allowed. Processing time (in hours) is given below:	*CO4*	*PO6*	**10**

	Machine					
Job	M_1	M_2	M_3	M_4	M_5	M_6
Job A	18	8	7	2	10	25
Job B	17	6	9	6	8	19
Job C	11	5	8	5	7	15
Job D	20	4	3	4	8	12

b) Five jobs each of which must go through the machines A, B in the order AB. Determine the sequence that will minimize the total elapsed time (mins) and estimate the idle time for each

CO4 | PO6 | 10

Job	1	2	3	4	5	6
Machine A	1	4	6	3	5	2
Machine B	3	6	8	8	1	5

OR

8 a) A manufacturing company processes 6 different jobs on two machines A and B. Number of units of each job and its processing times on A and B are given in the following table. Find the optimum sequence, the total minimum elapsed time and idle time for each machine.

CO4 | PO6 | 10

Job Number	No of Unit of each job	Processing time (h)	
		Machine A	Machine B
1	3	5	8
2	4	16	7
3	2	6	11
4	5	3	5
5	2	9	7.5
6	3	6	14

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.

CO4 | PO6 | 10

		Machines				
Job1	Sequence	A	B	C	D	E
	time (h)	6	8	4	12	4
Job2	Sequence	A	B	C	D	E
	time (h)	10	8	6	4	12

UN,,IT – V

9 a) Explain the significance of using PERT/CPM.

CO5 | PO10 | **04**

b) Construct a network diagram for each of the projects whose activities and their precedence relationships are given below.

CO5 | PO10 | **04**

Activity	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**J**	**I**	**J**	**K**
Predecessor	**-**	**-**	**-**	**A**	**B**	**B**	**C**	**D**	**E**	**H, I**	**F,G**

c) The following table shows the jobs of network along with their time estimates.

CO5 | PO10 | **12**

Job	**1-2**	**1-3**	**2-4**	**3-4**	**4-5**	**3-5**
Pessimistic time (t_p)	2	9	5	2	6	8
Most likely time (t_m)	5	12	14	5	6	17
Optimistic time (t_o)	14	15	17	12	12	20

Draw the project network, critical path and find the probability of the project completing in 30 days. Also find the date on which the project manager can complete the project with a probability of 0.90.

OR

	Q. No.		Question	CO	PO	Marks
	10	a)	A small maintenance project consists of the following jobs, whose precedence relationships are given below.	*CO5*	*PO10*	**08**

Job	1-2	1-3	2-3	2-5	3-4	3-6	4-5	4-6	5-6	6-7
Duration (Days)	15	15	3	5	8	12	1	14	3	14

i. Draw an arrow diagram representing the project.
ii. Find the total float for each activity.
iii. Find the critical path and the total project duration.

			Question	CO	PO	Marks
		b)	The Time and cost estimates and precedence relationship of different activities constituting a project are given below.	*CO6*	*PO11*	**12**

Activity	Predecessor activity	Normal		Crash	
		Time (Weeks)	Cost (Rs)	Time (Weeks)	Cost (Rs)
A	None	3	8000	2	9000
B	None	8	600	6	1000
C	B	6	10000	4	12000
D	B	5	4000	2	10000
E	A	13	3000	10	9000
F	A	4	5000	4	5000
G	F	2	1200	1	1400
H	C, E, G	6	3500	4	4500
I	F	2	700	1	800

i. Draw a project network diagram and find the critical path.
ii. If a deadline of 17 weeks is imposed for the completion of the project by the management, identify the activities which can be crashed? Determine the additional cost and the critical activities after crashing the project.

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