SIDDHARTH INSTITUTE OF ENGINEERING & TECHNOLOGY:
PUTTUR (AUTONOMOUS)
Siddharth Nagar, Narayanavanam Road – 517583

Subject with Code: OPERATIONS RESEARCH (25MB9013)

Regulation: R25

Year & Sem: I MBA & II-Sem

Course & Branch: MBA

UNIT - I

INTRODUCTION TO OR

1	**a)**	Define Operations Research. Discus the scope of Operations Research.	**[L1][CO1]**	**[6M]**
	b)	Explain the various methods of solving a Linear Programming Problem (LPP).	**[L2][CO1]**	**[6M]**
2		Solve the following Liner Programming Problem (LPP) by using Graphical Method. *Minimize* $Z = 20X_1 + 10X_2$ Subject to constraints $X_1 + 2X_2 \le 40$, $3X_1 + X_2 \ge 30$, $4X_1 + 3X_2 \ge 60$ X_1 *and* $X_2 \ge 0$	**[L3][CO2]**	**[12M]**
3		Solve the following LP problem using Simplex method. *Maximize* $Z = X_1 + X_2 + 3X_3$ Subject to constraints $3X_1 + 2X_2 + X_3 \le 3$, $2X_1 + X_2 + 2X_3 \le 2$, X_1 *and* $X_2 \ge 0$	**[L3][CO2]**	**[12M]**
4		Define the following: (i) Basic variable (ii)Artificial variable (iii) Slack variable (iv)Feasible solution (v) Optimal solution	**[L1][CO1]**	**[12M]**
5		Solve the following Liner Programming Problem (LPP) by using Graphical Method. *Maximize* $Z = 12X_1 + 16X_2$ Subject to constraints $10X_1 + 20X_2 \le 120$, $8X_1 + 8X_2 \le 80$ X_1 *and* $X_2 \ge 0$	**[L3][CO2]**	**[12M]**
6		Solve the following Liner Programming Problem (LPP) by using Graphical Method. *Minimize* $Z = 2X_1 + 3X_2$ Subject to constraints $X_1 + X_2 \ge 6$, $7X_1 + X_2 \ge 14$, X_1 *and* $X_2 \ge 0$	**[L3][CO2]**	**[12M]**

7		Solve the following LP problem using Simplex method. *Maximize* $Z = 6X_1 + 8X_2$ Subject to constraints $5X_1 + 10X_2 \leq 60$, $4X_1 + 4X_2 \leq 40$, X_1 *and* $X_2 \geq 0$	**[L4][CO2]**	**[12M]**
8		A company manufactures two products P_1 and P_2. Each product uses lathe and milling machine. The processing time per unit of P_1 on the lathe is 5 hours and on the milling machine is 4 hours. The processing time per unit of P_2 on the lathe is 10 hours and on the milling machine is 4 hours. The maximum number of hours available per week on the lathe and the milling machine are 60 hours and 40 hours respectively. Also the profit per unit of selling P_1 and P_2 are Rs.6.00 and Rs. 8.00 respectively. Formulate a linear programming model to determine the production volume of each of the products such that the total profit is maximized.	**[L6][CO2]**	**[12M]**
9		Solve the following Liner Programming Problem (LPP) by using Graphical Method. *Maximize* $Z = 100X_1 + 80X_2$ Subject to constraints, $5X_1 + 10X_2 \leq 50$, $8X_1 + 2X_2 \geq 16$, $3X_1 - 2X_2 \geq 6$ X_1 *and* $X_2 \geq 0$	**[L3[CO2]**	**[12M]**
10		A manufacturer produces two types of models M1 and M2. Each model of the type M1 requires 4 hours of grinding and 2 hours of polishing; whereas each model of the type M2 requires 2 hours of grinding and 5 hours of polishing. The manufacturer has 2 grinders and 3 polishers. Each grinder works 40 hours a week and each polisher work for 60 hours a week. Profit on M1 model is Rs.3 and on model M2 is Rs.4. whatever is produced in a week is sold in the market. How should the manufacturer allocate his production capacity to the two types of models so that he may make the maximum profit in a week?	**[L6][CO2]**	**[12M]**

UNIT - II

TRANSPORTATION AND ASSIGNMENT PROBLEMS

<table>
<tr><td>1</td><td></td><td>What are the types of Transportation Problem? Explain them with suitable examples.</td><td>[L1][CO3]</td><td>[12M]</td></tr>
<tr><td>2</td><td></td><td>Explain the steps involve in Northwest corner cell method to find the initial basic feasible solution for a transportation problem.</td><td>[L2][CO3]</td><td>[12M]</td></tr>
<tr><td>3</td><td></td><td>Solve the following problem of assigning 4 workers to 4 activities. The time required by each of them (in minutes) to perform each of the activities are as follows.
Workers
Activities
<table><tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>A</td><td>14</td><td>12</td><td>15</td><td>15</td></tr><tr><td>B</td><td>21</td><td>18</td><td>18</td><td>22</td></tr><tr><td>C</td><td>14</td><td>17</td><td>12</td><td>14</td></tr><tr><td>D</td><td>6</td><td>5</td><td>3</td><td>6</td></tr></table></td><td>[L3][CO3]</td><td>[12M]</td></tr>
<tr><td>4</td><td></td><td>Solve the following Assignment problem using Hungarian method. The matrix entries represent processing times in hours.
Operator
Job
<table><tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>1</td><td>9</td><td>11</td><td>14</td><td>11</td><td>7</td></tr><tr><td>2</td><td>6</td><td>15</td><td>13</td><td>13</td><td>10</td></tr><tr><td>3</td><td>12</td><td>13</td><td>6</td><td>8</td><td>8</td></tr><tr><td>4</td><td>11</td><td>9</td><td>10</td><td>12</td><td>9</td></tr><tr><td>5</td><td>7</td><td>12</td><td>14</td><td>10</td><td>14</td></tr></table></td><td>[L4][CO3]</td><td>[12M]</td></tr>
<tr><td>5</td><td></td><td>Determine an initial basic feasible solution to the following transportation problem using Northwest corner cell method.
Destination
<table><tr><td></td><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>Supply</td></tr><tr><td></td><td>1</td><td>3</td><td>1</td><td>7</td><td>4</td><td>300</td></tr><tr><td>Source</td><td>2</td><td>2</td><td>6</td><td>5</td><td>9</td><td>400</td></tr><tr><td></td><td>3</td><td>8</td><td>3</td><td>3</td><td>2</td><td>500</td></tr><tr><td></td><td>Demand</td><td>250</td><td>350</td><td>400</td><td>200</td><td></td></tr></table></td><td>[L4][CO3]</td><td>[12M]</td></tr>
</table>

6		Find an initial basic feasible solution to the following transportation problem using Least cost cell method. To From 1 2 3 Supply 1: 2 7 4 — 5 2: 3 3 1 — 8 3: 5 4 7 — 7 4: 1 6 2 — 14 Demand: 2 9 18	**[L4][CO3]**	**[12M]**
7		Determine an initial basic feasible solution to the following transportation problem using Vogel's approximation method. Warehouses Factory W1 W2 W3 W4 Capacity F1: 10 30 50 10 — 7 F2: 70 30 40 60 — 9 F3: 40 8 70 20 — 18 Requirement: 5 8 7 14	**[L2][CO3]**	**[12M]**
8		Solve the following assignment problem using Hungarian method. The matrix entries represent the processing times in hours: **Operator** **Job** | | 1 | 2 | 3 | 4 | 5 | |---|---|---|---|---|---| | A | 9 | 11 | 14 | 11 | 7 | | B | 6 | 15 | 13 | 13 | 10 | | C | 12 | 13 | 6 | 8 | 8 | | D | 11 | 9 | 10 | 12 | 9 | | E | 7 | 12 | 14 | 10 | 14 |	**[L3][CO3]**	**[12M]**
9		Discuss the steps of Hungarian method to solve the assignment problem.	**[L2][CO3]**	**[12M]**

10		Solve the following Assignment Problem.	**[L4][CO3]**	**[12M]**

Operator

Job	1	2	3	4	5
A	10	12	15	12	8
B	7	16	14	14	11
C	13	14	7	9	9
D	12	10	11	13	10
E	8	12	15	11	15

UNIT - III

SEQUENCING

<table>
<tr><td>1</td><td></td><td>Define job sequencing and explain its methods of solution.</td><td>[L2][CO4]</td><td>[12M]</td></tr>
<tr><td>2</td><td></td><td>What are the steps involved in the problems with n jobs through 2 machines.</td><td>[L1][CO4]</td><td>[12M]</td></tr>
<tr><td>3</td><td></td><td>There are 5 jobs, each of which must go through the two machines A and B in the order AB. Processing time are given below:
<table>
<tr><td>Job</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Machine-A</td><td>5</td><td>1</td><td>9</td><td>3</td><td>10</td></tr>
<tr><td>Machine-B</td><td>2</td><td>6</td><td>7</td><td>8</td><td>4</td></tr>
</table>
Calculate the total Elapsed time and also Idle time.</td><td>[L2][CO4]</td><td>[12M]</td></tr>
<tr><td>4</td><td></td><td>Find the sequence that minimizes the total elapsed time (in hours) required to complete the following tasks on 2 machines.
<table>
<tr><td>Job</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td>Machine-A</td><td>2</td><td>5</td><td>4</td><td>9</td><td>6</td><td>8</td><td>7</td><td>5</td><td>4</td></tr>
<tr><td>Machine-B</td><td>6</td><td>8</td><td>7</td><td>4</td><td>3</td><td>9</td><td>3</td><td>8</td><td>11</td></tr>
</table>
Calculate the total Elapsed time and also Idle time.</td><td>[L4][CO4]</td><td>[12M]</td></tr>
<tr><td>5</td><td></td><td>There are five jobs (namely 1,2,3,4 and 5), each of which must go through machines A, B and C in the order ABC. Processing Time (in hours) are given below:
<table>
<tr><td>Job</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>Machine-A</td><td>5</td><td>7</td><td>6</td><td>9</td><td>5</td></tr>
<tr><td>Machine-B</td><td>2</td><td>1</td><td>4</td><td>5</td><td>3</td></tr>
<tr><td>Machine-C</td><td>3</td><td>7</td><td>5</td><td>6</td><td>7</td></tr>
</table>
Calculate the total Elapsed time and also Idle time.</td><td>[L1][CO4]</td><td>[12M]</td></tr>
<tr><td>6</td><td></td><td>There are 9 jobs each of which has to go through the machine A and B in the order AB. Processing times in hours are given as
<table>
<tr><td>Job</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td></tr>
<tr><td>Machine-A</td><td>5</td><td>3</td><td>12</td><td>15</td><td>6</td><td>10</td><td>11</td><td>9</td><td>5</td></tr>
<tr><td>Machine-B</td><td>6</td><td>8</td><td>10</td><td>10</td><td>6</td><td>12</td><td>1</td><td>3</td><td>7</td></tr>
</table>
Calculate the total Elapsed time and also Idle time.</td><td>[L1][CO4]</td><td>[12M]</td></tr>
</table>

7		There are five jobs (namely 1,2,3,4 and 5), each of which must go through machines A, B and C in the order ABC. Processing Time (in minutes) are given below: **Job** 1 2 3 4 5 **Machine-A** 6 16 14 10 8 **Machine-B** 8 10 2 4 6 **Machine-C** 14 18 10 12 20 Calculate the total Elapsed time and also Idle time.	**[L1][CO4]**	**[12M]**
8		There are 56jobs, each of which must go through the two machines A and B in the order AB. Processing time are given below: **Job** **1** **2** **3** **4** **5** **6** **Machine-A** 2 5 4 3 2 1 **Machine-B** 6 8 1 2 3 5 Calculate the total Elapsed time and also Idle time.	**[L4][CO3]**	**[12M]**
9		What are the steps involved in the problems with *n* jobs through 3 machines.	**[L1][CO4]**	**[12M]**
10		Ten jobs are required to be processed on two machines M1 and M2 in the order, M1 followed by M2. Processing times are given below. Determine the optimal sequence(s) and evaluate the total elapsed time. **Job** **J_1** **J_2** **J_3** **J_4** **J_5** **J_6** **J_7** **J_8** **J_9** **J_{10}** **M_1** 7 8 10 3 7 4 5 8 5 6 **M_2** 4 2 6 6 5 7 2 6 7 6	**[L4][CO4]**	**[12M]**

UNIT - IV

GAME THEORY

<table>
<tr><td>1</td><td>a)</td><td>Find the optimum strategies for the players in the following games.
<table><tr><td colspan="2"></td><td colspan="3">Player B</td></tr><tr><td colspan="2"></td><td>1</td><td>2</td><td>3</td></tr><tr><td rowspan="3">Player A</td><td>1</td><td>25</td><td>20</td><td>35</td></tr><tr><td>2</td><td>50</td><td>45</td><td>55</td></tr><tr><td>3</td><td>58</td><td>40</td><td>42</td></tr></table></td><td>[L4][CO5]</td><td>[6M]</td></tr>
<tr><td></td><td>b)</td><td>Define the following terminologies of game theory.
(i) Players (ii) Strategy (iii) Saddle point (iv) Value of the game (v) Two-person zero-sum game (vi) Dominance property</td><td>[L2][CO5]</td><td>[6M]</td></tr>
<tr><td>2</td><td>a)</td><td>Find the optimum strategies of the players in the following game.
<table><tr><td colspan="2"></td><td colspan="3">Player B</td></tr><tr><td colspan="2"></td><td>1</td><td>2</td><td>3</td></tr><tr><td rowspan="3">Player A</td><td>1</td><td>30</td><td>20</td><td>40</td></tr><tr><td>2</td><td>55</td><td>50</td><td>60</td></tr><tr><td>3</td><td>60</td><td>30</td><td>40</td></tr></table></td><td>[L4][CO5]</td><td>[6M]</td></tr>
<tr><td></td><td>b)</td><td>Discuss the steps involving in game with pure strategies.</td><td>[L2][CO5]</td><td>[6M]</td></tr>
<tr><td>3</td><td></td><td>Players A and B play a game in which each player has three coins (20p, 25p and 50p). Each of them selects a coin without the knowledge of the other person. If the sum of the values of the values of the coins in an even number, A wins B’s coin. If that sum is an odd number, B wins A’s coin.
a) Develop a payoff matrix with respect to player A
b) Find the optimal strategies for the players.</td><td>[L6][CO5]</td><td>[12M]</td></tr>
<tr><td>4</td><td>a)</td><td>Discuss the steps involving in game with mixed strategies.</td><td>[L2][CO5]</td><td>[6M]</td></tr>
<tr><td></td><td>b)</td><td>Find the optimum strategies of the players in the following game.
<table><tr><td colspan="2"></td><td colspan="3">Player B</td></tr><tr><td colspan="2"></td><td>1</td><td>2</td><td>3</td></tr><tr><td rowspan="3">Player A</td><td>1</td><td>10</td><td>5</td><td>20</td></tr><tr><td>2</td><td>65</td><td>50</td><td>40</td></tr><tr><td>3</td><td>55</td><td>25</td><td>30</td></tr></table></td><td>[L4][CO5]</td><td>[6M]</td></tr>
<tr><td>5</td><td>a)</td><td>Discuss the algorithm for m × 2 game in Graphical Method.</td><td>[L2][CO5]</td><td>[6M]</td></tr>
</table>

	b)	Consider the following payoff matrix with respect to Player A and solve it optimally. Player A / Player B: 1 → 9, 7; 2 → 5, 11	**[L2][CO5]**	**[6M]**
6	**a)**	Discuss the algorithm for $2 \times n$ game in Graphical Method.	**[L2][CO5]**	**[6M]**
	b)	Solve by graphical method. Player A / Player B: 1 → 4, -1, 0; 2 → -1, 4, 2	**[L3][CO5]**	**[6M]**
7		The following table represents the payoff matrix with respect to player A. Solve it optimally using Dominance Property. Player A / Player B: 1 → 4, 6, 5, 10, 6; 2 → 7, 8, 5, 9, 10; 3 → 8, 9, 11, 10, 9; 4 → 6, 4, 10, 6, 4	**[L4][CO5]**	**[12M]**
8		Consider the following payoff matrix with respect to player A and solve it optimally. Player A / Player B: 1 → 3, 0, 6, -1, 7; 2 → -1, 5, -2, 2, 1	**[L3][CO5]**	**[12M]**
9		Consider the following payoff matrix with respect to player A and solve it optimally. Player A / Player B: 1 → 1, 3; 2 → 3, 1; 3 → 5, -1; 4 → 6, -6	**[L4][CO5]**	**[12M]**

<table>
<tr><td>10</td><td>a)</td><td>Write the rules for determining saddle point.</td><td>[L1][CO5]</td><td>[6M]</td></tr>
<tr><td></td><td>b)</td><td>Consider (two person zero sum) game matrix which represents payoff to the Player A. find the optimal strategy if any.
<table>
<tr><td colspan="2"></td><td colspan="3">Player B</td></tr>
<tr><td colspan="2"></td><td>1</td><td>2</td><td>3</td></tr>
<tr><td rowspan="3">Player A</td><td>1</td><td>-3</td><td>-2</td><td>6</td></tr>
<tr><td>2</td><td>2</td><td>0</td><td>2</td></tr>
<tr><td>3</td><td>5</td><td>-2</td><td>-4</td></tr>
</table></td><td>[L4][CO5]</td><td>[6M]</td></tr>
</table>

UNIT - V

PROJECT MANAGEMENT

<table>
<tr><td>1</td><td>a)</td><td>Define Project. What are the steps involved in CPM?</td><td>[L2][CO6]</td><td>[6M]</td></tr>
<tr><td></td><td>b)</td><td>Find the Critical Path for the following problem.

<table><tr><td>Activity</td><td>1 - 2</td><td>1 - 3</td><td>2 - 4</td><td>3 - 4</td><td>4 - 5</td></tr><tr><td>Duration</td><td>6</td><td>2</td><td>4</td><td>3</td><td>4</td></tr></table></td><td>[L4][CO6]</td><td>[6M]</td></tr>
<tr><td>2</td><td></td><td>Draw the network and identify the critical path for the following activities.
<table><tr><td>Activity</td><td>1-2</td><td>1-3</td><td>2-3</td><td>2-5</td><td>3-4</td><td>3-6</td><td>4-5</td><td>4-6</td><td>5-6</td><td>6-7</td></tr><tr><td>Duration</td><td>15</td><td>15</td><td>3</td><td>5</td><td>8</td><td>12</td><td>1</td><td>14</td><td>3</td><td>14</td></tr></table></td><td>[L1][CO6]</td><td>[12M]</td></tr>
<tr><td>3</td><td></td><td>Find the critical path for the following data.
<table><tr><td>Activity</td><td>1 - 2</td><td>1 - 3</td><td>2 - 4</td><td>2 - 5</td><td>3 - 4</td><td>4 - 5</td></tr><tr><td>Duration</td><td>8</td><td>2</td><td>4</td><td>6</td><td>5</td><td>4</td></tr></table></td><td>[L2][CO6]</td><td>[12M]</td></tr>
<tr><td>4</td><td></td><td>Draw the Network diagram, find critical path, EST, EFT, LST, LFT.
<table><tr><td>Activity</td><td>1 - 2</td><td>1 - 3</td><td>2 - 4</td><td>3 - 4</td><td>2 - 5</td><td>4 - 5</td></tr><tr><td>Duration</td><td>13</td><td>12</td><td>2</td><td>8</td><td>15</td><td>2</td></tr></table></td><td>[L4][CO6]</td><td>[12M]</td></tr>
<tr><td>5</td><td></td><td>The time estimates in weeks for the activities of a PERT network are given below.
<table><tr><td>Activity</td><td>1 – 2</td><td>1 – 3</td><td>1 – 4</td><td>2 – 5</td><td>3 – 5</td><td>4 – 6</td><td>5 – 6</td></tr><tr><td>To</td><td>1</td><td>1</td><td>2</td><td>1</td><td>2</td><td>2</td><td>3</td></tr><tr><td>Tm</td><td>1</td><td>4</td><td>2</td><td>1</td><td>5</td><td>5</td><td>6</td></tr><tr><td>Tp</td><td>7</td><td>7</td><td>8</td><td>1</td><td>14</td><td>8</td><td>15</td></tr></table>a) Draw a Project Network.
b) Determine the expected project length.
c) Calculate the standard deviation and variance of the project length.</td><td>[L1][CO6]</td><td>[12M]</td></tr>
<tr><td>6</td><td></td><td>Determine the total, Free and Independent Float and identify critical path.
<table><tr><td>Activity</td><td>1-2</td><td>2-3</td><td>2-4</td><td>3-5</td><td>3-6</td><td>4-5</td><td>4-7</td><td>5-8</td><td>6-8</td><td>7-8</td></tr><tr><td>Duration</td><td>2</td><td>8</td><td>10</td><td>6</td><td>3</td><td>3</td><td>7</td><td>5</td><td>2</td><td>8</td></tr></table></td><td>[L1][CO6]</td><td>[12M]</td></tr>
<tr><td>7</td><td></td><td>Draw the network, identify the critical path and total project duration for the following activities.
<table><tr><td>Activity</td><td>1-2</td><td>1-3</td><td>2-4</td><td>3-4</td><td>3-5</td><td>4-9</td><td>5-6</td><td>5-7</td><td>6-8</td><td>7-8</td><td>8-10</td><td>9-10</td></tr><tr><td>Duration</td><td>4</td><td>1</td><td>1</td><td>1</td><td>6</td><td>5</td><td>4</td><td>8</td><td>1</td><td>2</td><td>5</td><td>7</td></tr></table></td><td>[L1][CO6]</td><td>[12M]</td></tr>
</table>

<table>
<tr><td>8</td><td>a)</td><td>Write a note on CPM.</td><td>[L1][CO6]</td><td>[6M]</td></tr>
<tr><td></td><td>b)</td><td>Explain Steps in PERT.</td><td>[L1][CO6]</td><td>[6M]</td></tr>
<tr><td>9</td><td></td><td>A project consists of the following activities and time estimates.
<table>
<tr><td>Activity</td><td>1 – 2</td><td>2 – 3</td><td>1 – 4</td><td>2 – 5</td><td>2 - 6</td><td>3 – 6</td><td>4 – 7</td><td>5 – 7</td><td>6 - 7</td></tr>
<tr><td>To</td><td>3</td><td>2</td><td>6</td><td>2</td><td>5</td><td>3</td><td>3</td><td>1</td><td>2</td></tr>
<tr><td>Tm</td><td>15</td><td>14</td><td>30</td><td>8</td><td>17</td><td>15</td><td>27</td><td>7</td><td>8</td></tr>
<tr><td>Tp</td><td>6</td><td>5</td><td>12</td><td>5</td><td>11</td><td>6</td><td>9</td><td>4</td><td>5</td></tr>
</table></td><td>[L1][CO6]</td><td>[12M]</td></tr>
<tr><td>10</td><td></td><td>Explain the three time estimates used in PERT.</td><td>[L1][CO6]</td><td>[12M]</td></tr>
</table>

Prepared by:

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