



# MANIPAL INSTITUTE OF TECHNOLOGY

## MANIPAL

(A constituent unit of MAHE, Manipal)

### VI Semester B. Tech. Data Science and Engineering

#### End Semester Examination (May 2024)

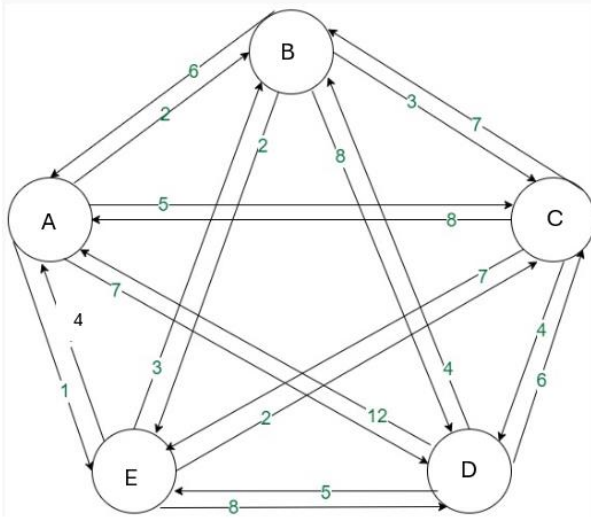
#### SUBJECT: OPERATIONS RESEARCH [HUM 3252]

Duration: 03 Hours

Max. Marks: 50

#### Instructions to Candidates:

- ❖ Assume missing data if any

1A	An electronic company is engaged in the production of two components C1 and C2 used in mobile handsets. Each unit of C1 costs the company Rs.5 in wages and Rs.5 in materials, while C2 costs the company Rs.25 in wages and Rs.15 in materials. The company sells both products in one period of credit terms, but the company's labor and material expenses must be paid in cash. The selling price of C1 is Rs.30 per unit, and C2 is Rs. 70 per unit. Because of the strong monopoly of the company for these products, it is assumed that the company can sell at the prevailing prices as many units as it produces. The company's production capacity is, however, limited by two considerations. First, the company has a limited budget of Rs.4000. Second, the company has, in each period, 2000 units of machine time and 1400 units of assembly time. The production of C1 requires 3 hours of machine time and 2 hours of assembly time, whereas the production of each C2 requires 2 hours of machine time and 3 hours of assembly time. Formulate the problem as an LP model to maximize the profit.	4
1B	For the above problem on the Electronic manufacturing company, write the standard form, generate the basic feasible solution, and identify the incoming and outgoing variables.	3
1C	Generate the optimal solution to determine the number of units of C1 and C2 to be manufactured to maximize the profits.	3
2A	<p>A salesman has been assigned to five cities to promote the products manufactured by his company. He must travel to these cities every week and shall not visit the same city again unless he visits the remaining four cities. Determine the sequence in which the salesman needs to plan his travel to minimize the total distance traveled. The figure below summarizes the distance between the cities.</p> 	5
2B	XYZ company produces two items A & B using three resources. Maximize $Z=4x_1+3x_2$	3

	<p>S.T: <math>1x_1+1x_2\leq 50</math> (Sheet metal) <math>1x_1+2x_2\leq 80</math> (labor) <math>3x_1+2x_2\leq 140</math> (Machine Hours) <math>x_1, x_2\geq 0</math></p> <p>With reference to the optimal simplex table given below, answer the following questions:</p> <table><tr><td></td><td></td><td><math>C_j</math></td><td>4</td><td>3</td><td>0</td><td>0</td><td>0</td></tr><tr><td>Profit</td><td>Basis</td><td>Q</td><td><math>X_1</math></td><td><math>X_2</math></td><td><math>S_1</math></td><td><math>S_2</math></td><td><math>S_3</math></td></tr><tr><td>3</td><td><math>X_2</math></td><td>10</td><td>0</td><td>1</td><td>3</td><td>0</td><td>-1</td></tr><tr><td>0</td><td><math>S_2</math></td><td>20</td><td>0</td><td>0</td><td>-4</td><td>1</td><td>1</td></tr><tr><td>4</td><td><math>X_1</math></td><td>40</td><td>1</td><td>0</td><td>-2</td><td>0</td><td>1</td></tr><tr><td></td><td><math>Z_j</math></td><td>190</td><td>4</td><td>3</td><td>1</td><td>0</td><td>1</td></tr><tr><td></td><td><math>C_j - Z_j</math></td><td></td><td>0</td><td>0</td><td>-1</td><td>0</td><td>-1</td></tr></table> <p>i. A local sheet metal dealer offers to sell 10 units of sheet metal. How much of these the company can buy without affecting the production plan?</p> <p>ii. Workers are demanding a day's leave to attend a local festival. Can this be granted without affecting the production plan? (Assume that the company operates for one eight-hour shift).</p>			$C_j$	4	3	0	0	0	Profit	Basis	Q	$X_1$	$X_2$	$S_1$	$S_2$	$S_3$	3	$X_2$	10	0	1	3	0	-1	0	$S_2$	20	0	0	-4	1	1	4	$X_1$	40	1	0	-2	0	1		$Z_j$	190	4	3	1	0	1		$C_j - Z_j$		0	0	-1	0	-1	
		$C_j$	4	3	0	0	0																																																			
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3	$X_2$	10	0	1	3	0	-1																																																			
0	$S_2$	20	0	0	-4	1	1																																																			
4	$X_1$	40	1	0	-2	0	1																																																			
	$Z_j$	190	4	3	1	0	1																																																			
	$C_j - Z_j$		0	0	-1	0	-1																																																			
2C	<p>With reference to the above question on XYZ company produces two items A &amp; B using three resources and the optimal solution provided thereafter, answer the below question:</p> <p>A neighboring firm requests 10 hours of machine capacity to meet their increased demand. To oblige to this request, can the firm spare 10 hours of machine capacity without affecting the optimal schedule?</p>	2																																																								
3A	<p>A store requires the following monthly quantities of 3 different sizes of refrigerators:</p> <table><tr><td>Size</td><td>A</td><td>B</td><td>C</td></tr><tr><td>No. Required</td><td>16</td><td>24</td><td>15</td></tr></table> <p>The store has received quotations from 4 manufacturers who are able to supply not more than the quantities below (of all sizes combined)</p> <table><tr><td>Manufacturer</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>Max. Supply</td><td>24</td><td>8</td><td>23</td><td>5</td></tr></table> <p>The store estimates that its profit per refrigerator will vary with size and manufacturer, as shown in the following table:</p> <table><tr><td>Size</td><td>A</td><td>B</td><td>C</td></tr><tr><td>1 (Mfg)</td><td>20</td><td>15</td><td>13</td></tr><tr><td>2</td><td>19</td><td>12</td><td>21</td></tr><tr><td>3</td><td>17</td><td>13</td><td>18</td></tr><tr><td>4</td><td>22</td><td>12</td><td>18</td></tr></table> <p>How should the orders be optimally placed? What is the monthly profit for the store? (Use the Maximum Profit Cell method to generate the basic feasible solution and the MODI method to optimize).</p>	Size	A	B	C	No. Required	16	24	15	Manufacturer	1	2	3	4	Max. Supply	24	8	23	5	Size	A	B	C	1 (Mfg)	20	15	13	2	19	12	21	3	17	13	18	4	22	12	18	5																		
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4	22	12	18																																																							
3B	<p>Suppose the demand for size B increases to 30 units monthly, and only manufacturer 2 can increase the supply. By how much could the maximum profit increase? Also, show the optimum allocation to attain this profit.</p>	3																																																								
3C	<p>Suppose the store has already entered into a contract with manufacturer 1 to buy 7 units monthly of size C; what is the maximum sum the store would be willing to pay (per month) to be released from this obligation?</p>	2																																																								

4A	<p>A city corporation has decided to carry out road repairs on the main four arteries of the city. The government has agreed to make a special grant of Rs.50 lakhs towards the cost with the condition that the repairs are done at the lowest cost and quickest time. The corporation has floated tenders, and five contractors have sent in their bids. To expedite the work, one road will be awarded to one contractor.</p> <table><tr><th rowspan="7">Contractor</th><th rowspan="2"></th><th colspan="4">Cost of Road Repairs (Rs. Lakh)</th></tr><tr><th>R<sub>1</sub></th><th>R<sub>2</sub></th><th>R<sub>3</sub></th><th>R<sub>4</sub></th></tr><tr><td>C<sub>1</sub></td><td>9</td><td>14</td><td>19</td><td>15</td></tr><tr><td>C<sub>2</sub></td><td>7</td><td>17</td><td>20</td><td>19</td></tr><tr><td>C<sub>3</sub></td><td>9</td><td>18</td><td>21</td><td>18</td></tr><tr><td>C<sub>4</sub></td><td>10</td><td>12</td><td>18</td><td>19</td></tr><tr><td>C<sub>5</sub></td><td>10</td><td>15</td><td>21</td><td>16</td></tr></table> <p>a. Find the best way of assigning the repair work to the contractors and costs.</p> <p>b. If it is necessary to seek supplementary grants, what should be the amount sought?</p> <p>c. Which of the contractors will be unsuccessful in his bid?</p>	Contractor		Cost of Road Repairs (Rs. Lakh)				R <sub>1</sub>	R <sub>2</sub>	R <sub>3</sub>	R <sub>4</sub>	C <sub>1</sub>	9	14	19	15	C <sub>2</sub>	7	17	20	19	C <sub>3</sub>	9	18	21	18	C <sub>4</sub>	10	12	18	19	C <sub>5</sub>	10	15	21	16	4
Contractor				Cost of Road Repairs (Rs. Lakh)																																	
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	C <sub>5</sub>	10	15	21	16																																
4B	<p>A caterer in charge of serving meals for the next four days needs the following number of clean napkins at the beginning of each day.</p> <table><tr><td>Day:</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>Napkins Required:</td><td>110</td><td>210</td><td>190</td><td>100</td></tr></table> <p>He has three alternatives to satisfy the demand:</p> <ol style="list-style-type: none"><li>Buy new napkins at Rs.10 each.</li><li>Send soiled napkins to a 24-hour service laundry for cleaning at the cost of Rs. 2 each.</li><li>Send soiled napkins to a 48-hour service laundry at a cost of Re. 1 each.</li></ol> <p>A napkin cleaned via a 24-hour laundry is available the very next day after it was last used and a napkin cleaned via 48-hour service laundry is available on the second day. Formulate the problem as a transportation model.</p>	Day:	1	2	3	4	Napkins Required:	110	210	190	100	3																									
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Napkins Required:	110	210	190	100																																	
4C	<p>A company has two grades of inspectors, 1 and 2, who are assigned to a quality control inspection. It is required that at least 2000 pieces be inspected per 8-hour day. Grade 1 inspector can check pieces at the rate of 40 per hour with an accuracy of 97 percent. Grade 2 inspector checks at the rate of 30 pieces per hour with an accuracy of 95 percent. The wage rate of a Grade 1 inspector is Rs. 5 per hour, while that of a Grade 2 inspector is Rs. 4 per hour. An error made by an inspector costs Rs.3 to the company. There are only nine Grade 1 inspectors and eleven Grade 2 inspectors available in the company. The company wishes to assign work to the available inspectors to minimize the total cost of the inspection. Formulate the problem as an LP model.</p>	3																																			
5A	<p>Customers start arriving at 10:00 AM at a supermarket’s check-out area every ten minutes with their baskets of groceries, vegetables, and other essential commodities. The time required to generate the bill and receive the payment for these customers is randomly distributed and depends upon the size of the basket and the number of items to be billed. The billing time distribution is as depicted below.</p> <table><tr><td>Billing time (minutes)</td><td>1</td><td>1.5</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Probability</td><td>0.12</td><td>0.21</td><td>0.36</td><td>0.19</td><td>0.07</td><td>0.05</td></tr></table> <p>Develop a Monte-Carlo Simulation worksheet for ten arrivals and calculate the average waiting time for customers at the check-out counter and the average idle time of the check-out clerk.</p>	Billing time (minutes)	1	1.5	2	3	4	5	Probability	0.12	0.21	0.36	0.19	0.07	0.05	4																					
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	Use the following Random Numbers: 54, 24, 21, 45, 46, 84, 77, 12, 5, 68	
<b>5B</b>	Explain the different configurations of servers in a queuing system with suitable examples.	<b>3</b>
<b>5C</b>	A television repairman finds that the time spent on his job has an exponential distribution with a mean of 30 minutes. If he repairs the sets in the order in which they came in, and the arrival of the sets follows a Poisson distribution approximately with an average rate of 10 per 8-hour day, what is the repairman's expected idle time each day? How many jobs are ahead of the average set just brought in?	<b>3</b>

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