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**MTECH**  
**(SEM I) THEORY EXAMINATION 2025-26**  
**OPERATIONS RESEARCH**

TIME: 3 HRS

M.MARKS: 70

**Note: 1.** Attempt all Sections. If require any missing data; then choose suitably.

**SECTION A**

**1. Attempt all questions in brief.**

**2 x 7 = 14**

a.	What are constraints in LPP?
b.	What is degeneracy in LPP?
c.	Mention the limitations of Operations Research.
d.	Classify Queuing models.
e.	Distinguish between balanced and unbalanced transportation problem?
f.	What is Mixed Integer Programming Problem?
g.	Describe Pure strategy in game theory.

**SECTION B**

**2. Attempt any three of the following:**

**7 x 3 = 21**

a.	Two product A and B are to be machined on three machine tools, P, Q and R. Product A takes 10 hrs on machine P, 6 hrs on machine Q and 4 hrs on machine R. The product B takes 7.5 hrs on machine P, 9 hrs on machine Q and 13 hrs on machine R. The machining time available on these machine tools, P, Q, R are respectively 75 hrs, 54 hrs and 65 hrs per week. The producer contemplates profit of Rs. 60 per product A, and Rs. 70 per product B. Formulate LP model for the above problem and show the feasible solutions to the above problem? Estimate graphically/ geometrically the optimum product mix for miximizing the profit. Explain why one of the vertics of the feasible region becomes the optimum solution point. (Note: Graph sheet need not be used)																									
b.	A barber shop has space to accommodate only 10 customers. He can serve only one person at a time. If a customer comes to his shop and finds it full, he goes to the next shop. Customers randomly arrive at an average rate $\lambda=10$ per hour and the barber's service time is negative exponential with an average of $1/\mu = 5$ minutes per customer. Find $P_0$ and $P_n$ .																									
c.	Explain the principle of dominance in game theory and solve the following game: <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2" rowspan="2">Player A</th> <th colspan="4">Player B</th> </tr> <tr> <th>B<sub>1</sub></th> <th>B<sub>2</sub></th> <th>B<sub>3</sub></th> <th>B<sub>4</sub></th> </tr> </thead> <tbody> <tr> <th>A<sub>1</sub></th> <td>8</td> <td>10</td> <td>9</td> <td>14</td> </tr> <tr> <th>A<sub>2</sub></th> <td>10</td> <td>11</td> <td>8</td> <td>12</td> </tr> <tr> <th>A<sub>3</sub></th> <td>13</td> <td>12</td> <td>14</td> <td>13</td> </tr> </tbody> </table>	Player A		Player B				B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	B <sub>4</sub>	A <sub>1</sub>	8	10	9	14	A <sub>2</sub>	10	11	8	12	A <sub>3</sub>	13	12	14	13
Player A				Player B																						
		B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	B <sub>4</sub>																					
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A <sub>3</sub>	13	12	14	13																						
d.	Solve the following transportation problem using Vogel approximation method:																									



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		To				
						Supply
From	6	1	9	8	70	
	11	5	2	8	55	
	10	12	4	7	90	
Demand	85	35	50	45		

e. A manufacturer is offered two machines A and B. A is priced at Rs.50,000 and running costs are estimated at Rs.8000 for each of the first five years, increasing by 2000 per year in the sixth and subsequent years. Machine B of the same capacity costs Rs.25,000 but will have running costs of Rs.12000 per year for six years increasing by Rs.2000 per year thereafter. If money is worth 10% per year, which machine should be purchased?

**SECTION C**

3. Attempt any *one* part of the following: 7 x 1 = 7

(a)	Solve by Using VAM Method and North West corner method.																														
	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Origin/Destination</th> <th>D1</th> <th>D2</th> <th>D3</th> <th>D4</th> <th>Supply</th> </tr> <tr> <td>O1</td> <td>11</td> <td>13</td> <td>17</td> <td>14</td> <td>250</td> </tr> <tr> <td>O2</td> <td>16</td> <td>18</td> <td>14</td> <td>10</td> <td>300</td> </tr> <tr> <td>O3</td> <td>21</td> <td>24</td> <td>13</td> <td>10</td> <td>400</td> </tr> <tr> <td>Demand</td> <td>200</td> <td>225</td> <td>275</td> <td>250</td> <td>950</td> </tr> </table>	Origin/Destination	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
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Demand	200	225	275	250	950																										
(b)	<p>Consider the Linear Programming problem (LPP)</p> <p>Maximize <math>4x + 6y</math></p> <p>subject to <math>3x + 2y \leq 6</math></p> <p><math>2x + 3y \leq 6</math></p> <p><math>x, y \geq 0</math></p>																														

4. Attempt any *one* part of the following: 7 x 1 = 7

(a)	<p>Customers arrive at a one-window drive-in bank according to Poisson distribution mean 10 per hour. Service time per customer is exponential with mean five minutes. The space in front of the window including that for the serviced car can accommodate a maximum of three cars. Others can wait outside this space.</p> <p>i) What is the probability that an arriving customer can drive directly to the space in front of the window?</p> <p>ii) What is the probability that an arriving customer will have to wait outside the indicated space?</p> <p>iii) How long is an arriving customer expected to wait before starting service?</p>
(b)	Solve the following mixed integer programming problem. (Use branch and bound method)



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	Max.: $Z = 5X + 6Y$ Subject to: $X + Y \leq 5$ $4X + 7Y \leq 28$
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5. Attempt any *one* part of the following:

7 x 1 = 7

(a)	Find the initial basic feasible solution of the following transportation problem using North West corner method																																			
	<table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th></th> <th>A<sub>1</sub></th> <th>B<sub>1</sub></th> <th>C<sub>1</sub></th> <th>D<sub>1</sub></th> <th>E<sub>1</sub></th> <th>Supply</th> </tr> </thead> <tbody> <tr> <th>Origin A</th> <td>2</td> <td>11</td> <td>10</td> <td>3</td> <td>7</td> <td>4</td> </tr> <tr> <th>B</th> <td>1</td> <td>4</td> <td>7</td> <td>2</td> <td>1</td> <td>8</td> </tr> <tr> <th>C</th> <td>3</td> <td>9</td> <td>4</td> <td>8</td> <td>12</td> <td>9</td> </tr> <tr> <th>Requirement</th> <td>3</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td></td> </tr> </tbody> </table>		A <sub>1</sub>	B <sub>1</sub>	C <sub>1</sub>	D <sub>1</sub>	E <sub>1</sub>	Supply	Origin A	2	11	10	3	7	4	B	1	4	7	2	1	8	C	3	9	4	8	12	9	Requirement	3	3	4	5	6	
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(b)	State the major limitations of the game theory. What are the assumptions made in the theory of game?																																			

6. Attempt any *one* part of the following:

7 x 1 = 7

(a)	Define saddle point and solve the game whose pay-off matrix is																				
	<table style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td colspan="4" style="text-align: center;">Player B</td> </tr> <tr> <td style="text-align: center;">Player A</td> <td style="border: 1px solid black; padding: 5px;">-5</td> <td style="border: 1px solid black; padding: 5px;">3</td> <td style="border: 1px solid black; padding: 5px;">1</td> <td style="border: 1px solid black; padding: 5px;">20</td> </tr> <tr> <td></td> <td style="border: 1px solid black; padding: 5px;">5</td> <td style="border: 1px solid black; padding: 5px;">5</td> <td style="border: 1px solid black; padding: 5px;">4</td> <td style="border: 1px solid black; padding: 5px;">6</td> </tr> <tr> <td></td> <td style="border: 1px solid black; padding: 5px;">-4</td> <td style="border: 1px solid black; padding: 5px;">-2</td> <td style="border: 1px solid black; padding: 5px;">0</td> <td style="border: 1px solid black; padding: 5px;">-5</td> </tr> </table>		Player B				Player A	-5	3	1	20		5	5	4	6		-4	-2	0	-5
	Player B																				
Player A	-5	3	1	20																	
	5	5	4	6																	
	-4	-2	0	-5																	
(b)	Explain the Gomory's Cutting Plane Algorithm for all Integer Programming Problem.																				

7. Attempt any *one* part of the following:

7 x 1 = 7

(a)	A truck is priced at Rs.60,000 and running costs are estimated at Rs. 6000 for each of the first four years, increasing by Rs.2000 per year in the fifth and subsequent years. If the money is worth 10 percent per year, when the truck should be replaced. Assume that the truck will eventually be sold for scrap at a negligible price.
(b)	The cost of a new machine is Rs. 5000. The maintenance cost of the nth year is given by $C_n = 500(n-1)$ , $n=1, 2, \dots$ . Suppose money is worth 5 percent per year, after how many years will it be economical to replace the machine?