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DEPARTMENT OF MANAGEMENT STUDIES

QUESTION BANK

II SEMESTER

1915201– APPLIED OPERATIONS RESEACH

Regulation – 2019

Academic Year 2019 - 2020

Prepared by

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DEPARTMENT OF MANAGEMENT STUDIES QUESTION BANK

SUBJECT : 1915201 – APPLIED OPERATIONS RESEARCH

SEM / YEAR : II Semester / I Year

UNIT – I – INTRODUCTION TO LINEAR PROGRAMMING (LP)

SYLLABUS: Introduction to applications of operations research in functional areas of management. Linear Programming-formulation, solution by graphical and simplex methods, Special cases. Dual simplex method. Principles of Duality. Sensitivity Analysis.

PART- A

S.NO	QUESTIONS	BT LEVEL	COMPETENCE
1.	Define Operations Research (OR).	Level 1	Remembering
2.	Differentiate between Simplex and Big M Method	Level 2	Understanding
3.	How do you show your understanding unbounded solution?	Level 3	Applying
4.	Categorize the forms of LPP.	Level 4	Analysing
5.	Discuss why is two phase method is better than Big M method?	Level 5	Evaluating
6.	Interpret the usage of Sensitivity Analysis in LPP.	Level 6	Creating
7.	What are the assumptions and requirements of LPP?	Level 1	Remembering
8.	Compare Dual Simplex and Duality.	Level 2	Understanding
9.	Identify the Advantages of duality.	Level 3	Applying
10.	What do you think about Infeasible solution?	Level 4	Analysing
11.	How will you solve LPP graphically?	Level 5	Evaluating
12.	Conclude your understanding on the mathematical formulation of LPP.	Level 6	Creating
13.	Define basic variables and artificial variables.	Level 1	Remembering
14.	Compare Slack variable & Surplus Variable.	Level 2	Understanding
15.	Give some example for the role of Surplus variable & Slack Variable in the simplex method	Level 3	Applying
16.	How would you apply Artificial variable?	Level 4	Analysing
17.	What is Big M Method?	Level 1	Remembering
18.	Distinguish simplex and Big M method	Level 2	Understanding
19.	What do you mean by Duality? List the Rules for primal and dual.	Level 1	Remembering
20.	What is Shadow price?	Level 1	Remembering

PART- B

S.NO	QUESTIONS	BT LEVEL	COMPETENCE																
1.	Maximise $Z=3x+4y$ subject to $2x+5y \leq 60$, $4x+2y \leq 40$. $x, y > 0$. Solve by Graphical Method (i) Plot the graph (ii) Which one is the best solution?	(8) (5)	Level 1 Remembering																
2.	Min $Z= 20x_1+10 x_2$ subject to $x_1+2x_2 \leq 40$, $3x_1+x_2 \geq 30$, $4x_1+3x_2 \geq 60$, $x_1, x_2 \geq 0$. Solve by Graphical Method, (i) Plot the graph (ii) Predict the value of x & y.	(8) (5)	Level 2 Understanding																
3	Max $Z= 5x_1+4x_2$ subject to $x_1-2x_2 \leq 1$, $x_1+2x_2 \geq 3$, $x_1, x_2 \geq 0$. Solve Graphically. Which one is the best solution?		Level 3 Applying																
4.	A Plant Manufacturer 2 Product A & B. The Profit Contribution of each product has been estimated as Rs.300 for product A and Rs.400 for Product B. Each Product passes through 3 departments of the plant. The time required for each product and total time available in each department is as follows. <table border="1"> <thead> <tr> <th>Department</th><th>Hours Required Product A</th><th>Hours Required Product B</th><th>Available Hours during month</th></tr> </thead> <tbody> <tr> <td>I</td><td>2</td><td>3</td><td>1600</td></tr> <tr> <td>II</td><td>3</td><td>2</td><td>1500</td></tr> <tr> <td>III</td><td>1</td><td>1</td><td>700</td></tr> </tbody> </table> The company has a contract to supply atleast 300 units of Product B per month. Formulate the LPP (i) (ii) Solve through Graphical Method	Department	Hours Required Product A	Hours Required Product B	Available Hours during month	I	2	3	1600	II	3	2	1500	III	1	1	700	(5) (8)	Level 4 Analysing
Department	Hours Required Product A	Hours Required Product B	Available Hours during month																
I	2	3	1600																
II	3	2	1500																
III	1	1	700																
5.	Solve the following LPP by graphical method. Maximize $Z= 3x_1+2x_2$ Subject to $-2x_1+x_2 \leq 1$, $x_1 \leq 2$, $x_1+x_2 \leq 3$ and $x_1, x_2 \geq 0$		Level 5 Evaluating																

6.	(i)	Max $Z = 1000x_1 + 4000x_2 + 5000x_3$ Subject to $3x_1 + 3x_3 \leq 22$, $x_1 + 2x_2 + 3x_3 \leq 14$, $3x_1 + 2x_2 \leq 14$ & $x_1, x_2 \geq 0$	(5)	Level 6	Creating																									
		Develop a Simplex Table																												
	(ii)	Analyse and find the value of x_1, x_2 ?	(8)																											
7.		Analyze the following LPP by Simplex Method: Min $Z = -10y_1 - 15y_2 - 20y_3$ Subject to $2y_1 + 4y_2 + 6y_3 \leq 24$, $3y_1 + 9y_2 + 6y_3 \leq 30$, & $y_1, y_2, y_3 \geq 0$.		Level 1	Remembering																									
	(i)	Develop a Simplex Table	(5)																											
	(ii)	Solve and find the value of y_1, y_2 and y_3	(8)																											
8.		Solve By Graphical Method Minimize $Z = 40x_1 + 24x_2$ Subject to, $20x_1 + 50x_2 \geq 4,800$ $80x_1 + 50x_2 \geq 7,200$ $x_1, x_2 \geq 0$		Level 2	Understanding																									
9.		Solve the following LPP by simplex method: Minimize $Z = 8x_1 - 2x_2$ Subject to $-4x_1 + 2x_2 \leq 1$, $5x_1 - 4x_2 \leq 3$, and $x_1, x_2 \geq 0$		Level 3	Applying																									
10.		Solve the following LPP by simplex method: Maximize $Z = 3x_1 + 2x_2$ Subject to $2x_1 + x_2 \leq 2$, $3x_1 + 4x_2 \geq 12$, $x_1, x_2 \geq 0$		Level 4	Analyzing																									
11.		Review the LPP and solve by simplex method Max $Z = 25x + 10y$ Subject to the constraints $x + 0.5y \leq 20$ $x + y \leq 50$ $x, y \geq 0$		Level 1	Remembering																									
12.		A firm produces three products. These products are processors on 3 different machines. The time required for manufacturing one unit of cost of the products and the daily capacity of the three machines is given in the table below. Analyse and find the optimum solution. <table border="1"><thead><tr><th>Machine</th><th>Time/Unit (Minutes)</th><th>Time/Unit (Minutes)</th><th>Time/Unit (Minutes)</th><th>Machine Capacity Min /Day</th></tr><tr><th></th><th>Product 1</th><th>Product 2</th><th>Product 3</th><th></th></tr></thead><tbody><tr><td>M1</td><td>2</td><td>8</td><td>2</td><td>940</td></tr><tr><td>M2</td><td>4</td><td>-</td><td>8</td><td>970</td></tr><tr><td>M3</td><td>2</td><td>5</td><td>-</td><td>430</td></tr></tbody></table> It is required to determine the daily no. of units to be manufactured for each product. The profit for unit for	Machine	Time/Unit (Minutes)	Time/Unit (Minutes)	Time/Unit (Minutes)	Machine Capacity Min /Day		Product 1	Product 2	Product 3		M1	2	8	2	940	M2	4	-	8	970	M3	2	5	-	430		Level 2	Understanding
Machine	Time/Unit (Minutes)	Time/Unit (Minutes)	Time/Unit (Minutes)	Machine Capacity Min /Day																										
	Product 1	Product 2	Product 3																											
M1	2	8	2	940																										
M2	4	-	8	970																										
M3	2	5	-	430																										

		product 1,2,3 is Rs.4, Rs.8, Rs.6 respectively. It is assumed that all the amount produced are consumed in the market			
13.		Using dual simplex method, solve and find the optimum solution for the given LPP. Maximize $Z = 6x_1 + 4x_2 + 4x_3$ Subject to $3x_1 + x_2 + 2x_3 \geq 2$ $2x_1 + x_2 - x_3 \geq 1$ $-x_1 + x_2 + 2x_3 \geq 1$ & $x_1, x_2, x_3 \geq 0$		Level 4	Analysing
14.		Evaluate by using dual simplex method and solve the LPP. Minimize $Z = 2x_1 + x_2$ Subject to $3x_1 + 2x_2 \geq 3$ $4x_1 + 3x_2 \geq 6$ $x_1 + x_2 \leq 5$ & $x_1, x_2 \geq$	(5)	Level 1	Remembering
	(i)	Determine the dual simplex table			
	(ii)	Find the value of x_1, x_2	(8)		

PART - C			
S.No	Questions	BT LEVEL	COMPETENCE
1.	Max $Z = 300x + 400y$ subject to $2x + 3y \leq 1600$, $3x + 2y \leq 1500$, $x + y \leq 700$, $y \geq 300, x, y \geq 0$ Solve by Graphical Method, choose the value of x & y which maximizes profit.	Level 1	Remembering
2.	Solve the following LPP by graphical method. Minimize $Z = 6000x_1 + 4000x_2$ Subject to $3x + x_2 \geq 40$, $x_1 + 2.5x_2 \geq 22$ $3x_1 + 3x_2 \geq 40$ and $x_1, x_2 \geq 0$	Level 2	Understanding
3.	Develop a Simplex Table and Solve Max $Z = 3x_1 + 2x_2$, Subject to $x_1 + x_2 \leq 4$, $x_1 - x_2 \leq 2$, $x_1, x_2 \geq 0$.	Level 3	Applying
4.	Solve by using Simplex Method. Maximize $Z = 3x + 5y$ Subject to the constraints $x + y \leq 60$ $x \leq 40$ $y \leq 30$ $x, y \geq 0$	Level 1	Remembering

UNIT - II LINEAR PROGRAMMING EXTENSIONS

SYLLABUS: Transportation Models (Minimizing and Maximizing Problems) – Balanced and unbalanced Problems – Initial Basic feasible solution by N-W Corner Rule, Least cost and Vogel's approximation methods. Check for optimality. Solution by MODI /. Case of Degeneracy. Trans-shipment Models. Assignment Models (Minimising and Maximising Problems) – Balanced and Unbalanced Problems. Solution by Hungarian and Branch and Bound Algorithms. Travelling Salesman problem.

PART - A

S.NO	QUESTIONS	BT LEVEL	COMPETENCE																														
1.	Define Transportation & Transshipment.	Level 1	Remembering																														
2.	Differentiate balanced transportation problem & Unbalanced Transportation Problem.	Level 2	Understanding																														
3.	How would you show your understanding on unbalanced transportation problem?	Level 3	Applying																														
4.	Categorize the Phases of transportation model.	Level 4	Analysing																														
5.	Construct the basic feasible solution for the following transportation problem. <table border="1"><tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>SUPPLY</td></tr><tr><td>1</td><td>2</td><td>3</td><td>11</td><td>7</td><td>6</td></tr><tr><td>2</td><td>1</td><td>0</td><td>6</td><td>1</td><td>1</td></tr><tr><td>3</td><td>5</td><td>8</td><td>15</td><td>9</td><td>10</td></tr><tr><td>DEMAN D</td><td>7</td><td>5</td><td>3</td><td>2</td><td></td></tr></table>		1	2	3	4	SUPPLY	1	2	3	11	7	6	2	1	0	6	1	1	3	5	8	15	9	10	DEMAN D	7	5	3	2		Level 5	Evaluating
	1	2	3	4	SUPPLY																												
1	2	3	11	7	6																												
2	1	0	6	1	1																												
3	5	8	15	9	10																												
DEMAN D	7	5	3	2																													
6	Interpret the need for Optimum solution in transportation.	Level 6	Creating																														
7.	What do you mean by Least cost method (LCM)?	Level 1	Remembering																														
8.	Compare Vogel approximation method (VAM) & Least Cost Method.	Level 2	Understanding																														
9.	How do you represent a travelling salesman problem through mathematical formulation?	Level 3	Applying																														
10.	Analyse the rules of travelling salesman Problem.	Level 4	Analysing																														
11.	Discuss the meaning of Assignment	Level 5	Evaluating																														
12.	Compare Balanced assignment problem & Unbalanced Assignment Problem.	Level 6	Creating																														
13.	What example can you give for Unbalanced assignment problem?	Level 1	Remembering																														
14.	How will you resolve degeneracy in Transportation Problem?	Level 2	Understanding																														
15.	Classify transportation problem.	Level 3	Applying																														

16.	Examine the Steps in Hungarian algorithm.	Level 4	Analysing
17.	What is Branch and bound algorithm in Assignment?	Level 1	Remembering
18.	Compare Assignment and transportation Problem.	Level 2	Understanding
19.	What do you mean by Travelling Salesman Problem?	Level 1	Remembering
20.	What is Restricted Assignment?	Level 1	Remembering

S.NO	QUESTIONS	BT LEVEL	COMPETENCE																																				
1.	Solve and find the Transportation Problem and Which method will you select if you want to Minimize Cost? <table><tr><td></td><td colspan="4">Destination</td><td>Supply</td></tr><tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td></td></tr><tr><td>I</td><td>21</td><td>16</td><td>25</td><td>13</td><td>11</td></tr><tr><td>II</td><td>17</td><td>18</td><td>14</td><td>23</td><td>13</td></tr><tr><td>III</td><td>32</td><td>27</td><td>18</td><td>41</td><td>19</td></tr><tr><td>Demand</td><td>6</td><td>10</td><td>12</td><td>15</td><td></td></tr></table>		Destination				Supply		1	2	3	4		I	21	16	25	13	11	II	17	18	14	23	13	III	32	27	18	41	19	Demand	6	10	12	15		Level 1	Remembering
	Destination				Supply																																		
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Demand	6	10	12	15																																			
2.	Find the Initial Basic Feasible solution for following TP. Using NW Rule, LCM, and VAM. Which method will you select if you want to Minimize Cost? <table><tr><td></td><td>D1</td><td>D2</td><td>D3</td><td>Supply</td></tr><tr><td>S1</td><td>7</td><td>3</td><td>2</td><td>2</td></tr><tr><td>S2</td><td>2</td><td>1</td><td>3</td><td>3</td></tr><tr><td>S3</td><td>3</td><td>4</td><td>6</td><td>5</td></tr><tr><td>Demand</td><td>4</td><td>1</td><td>5</td><td>10</td></tr></table>		D1	D2	D3	Supply	S1	7	3	2	2	S2	2	1	3	3	S3	3	4	6	5	Demand	4	1	5	10	Level 2	Understanding											
	D1	D2	D3	Supply																																			
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S2	2	1	3	3																																			
S3	3	4	6	5																																			
Demand	4	1	5	10																																			

3.	Analyze the transportation problem with unit transportation costs,demand, and supply as given below: <table><tr><td></td><td colspan="4">Destination</td><td rowspan="2">Supply</td></tr><tr><td>Source</td><td>D1</td><td>D2</td><td>D3</td><td>D4</td></tr><tr><td>S1</td><td>6</td><td>1</td><td>9</td><td>3</td><td>70</td></tr><tr><td>S2</td><td>11</td><td>5</td><td>2</td><td>8</td><td>55</td></tr><tr><td>S3</td><td>10</td><td>12</td><td>4</td><td>7</td><td>70</td></tr><tr><td>Demand</td><td>85</td><td>35</td><td>50</td><td>45</td><td></td></tr></table> Apply VAM for Initial solution.		Destination				Supply	Source	D1	D2	D3	D4	S1	6	1	9	3	70	S2	11	5	2	8	55	S3	10	12	4	7	70	Demand	85	35	50	45		(5)	Level 3	Applying													
	Destination				Supply																																															
Source	D1	D2	D3	D4																																																
S1	6	1	9	3	70																																															
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Demand	85	35	50	45																																																
	(ii) Construct the final Solution by using MODIMethod.	(8)																																																		
4.	Analyze & solve the following transportation problem to maximize profit. <table><tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>Supply</td></tr><tr><td>1</td><td>15</td><td>51</td><td>42</td><td>33</td><td>23</td></tr><tr><td>Source 2</td><td>80</td><td>42</td><td>26</td><td>81</td><td>44</td></tr><tr><td>3</td><td>90</td><td>40</td><td>66</td><td>60</td><td>33</td></tr><tr><td>Demand</td><td>23</td><td>31</td><td>16</td><td>30</td><td>100</td></tr></table>		A	B	C	D	Supply	1	15	51	42	33	23	Source 2	80	42	26	81	44	3	90	40	66	60	33	Demand	23	31	16	30	100	(5)	Level 4	Analysing																		
	A	B	C	D	Supply																																															
1	15	51	42	33	23																																															
Source 2	80	42	26	81	44																																															
3	90	40	66	60	33																																															
Demand	23	31	16	30	100																																															
	(i) Examine Initial solution using VAM.																																																			
	(ii) Analyze and find out the final Solution by using MODI Method.	(8)																																																		
5.	Solve the following transportation problem using Vogel's method Factory↓ Warehouse →Available <table><tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td></td></tr><tr><td>1</td><td>9</td><td>12</td><td>9</td><td>6</td><td>9</td><td>10</td><td>5</td></tr><tr><td>2</td><td>7</td><td>3</td><td>7</td><td>7</td><td>5</td><td>5</td><td>6</td></tr><tr><td>3</td><td>6</td><td>5</td><td>9</td><td>11</td><td>3</td><td>11</td><td>2</td></tr><tr><td>4</td><td>6</td><td>8</td><td>11</td><td>2</td><td>2</td><td>10</td><td>9</td></tr><tr><td></td><td>4</td><td>4</td><td>6</td><td>2</td><td>4</td><td>2</td><td></td></tr></table> Requirement→		A	B	C	D	E	F		1	9	12	9	6	9	10	5	2	7	3	7	7	5	5	6	3	6	5	9	11	3	11	2	4	6	8	11	2	2	10	9		4	4	6	2	4	2		(5)	Level 5	Evaluating
	A	B	C	D	E	F																																														
1	9	12	9	6	9	10	5																																													
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3	6	5	9	11	3	11	2																																													
4	6	8	11	2	2	10	9																																													
	4	4	6	2	4	2																																														
6.	(i) Solve the transportation problem and decide using VAM for initial solution.	(5)	Level 6	Creating																																																

	(ii)	Evaluate using NWC and Least Cost method for initial solution?	(8)																																												
		<table><tr><td></td><td colspan="4">Destination</td><td>Supply</td></tr><tr><td>I</td><td>2</td><td>1</td><td>25</td><td>13</td><td>11</td></tr><tr><td>II</td><td>1</td><td>1</td><td>14</td><td>23</td><td>13</td></tr><tr><td>III</td><td>3</td><td>2</td><td>18</td><td>41</td><td>19</td></tr><tr><td>Demand</td><td>6</td><td>1</td><td>22</td><td>15</td><td></td></tr></table>		Destination				Supply	I	2	1	25	13	11	II	1	1	14	23	13	III	3	2	18	41	19	Demand	6	1	22	15																
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7.		Maximize profit from the following transportationproblem. <table><tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>Supply</td></tr><tr><td>I</td><td>40</td><td>25</td><td>22</td><td>33</td><td>100</td></tr><tr><td>SourceII</td><td>44</td><td>35</td><td>30</td><td>30</td><td>30</td></tr><tr><td>III</td><td>38</td><td>38</td><td>28</td><td>30</td><td>70</td></tr><tr><td>Demand</td><td>40</td><td>20</td><td>60</td><td>30</td><td></td></tr></table>		A	B	C	D	Supply	I	40	25	22	33	100	SourceII	44	35	30	30	30	III	38	38	28	30	70	Demand	40	20	60	30			Level 1	Remembering												
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III	38	38	28	30	70																																										
Demand	40	20	60	30																																											
	(i)	How will you convert maximization problem to minimization. Find the maximum profit	(8)																																												
	(ii)	Explain stepping stone method for checking the solution for optimality transportation problems.	(5)																																												
8.		A company has one surplus truck in each of the cities A, B, C, D, & E and one deficit trucks in each of the cities 1,2,3,4,5,6. The distance between the cities in kms is shown in the matrix below. Can you select the assignment of trucks from cities in surplus to cities in deficiency .so that total distance covered by the vehicles is minimum? <table><tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>A</td><td>12</td><td>10</td><td>15</td><td>22</td><td>18</td><td>8</td></tr><tr><td>B</td><td>10</td><td>18</td><td>25</td><td>15</td><td>16</td><td>12</td></tr><tr><td>C</td><td>11</td><td>10</td><td>3</td><td>8</td><td>5</td><td>9</td></tr><tr><td>D</td><td>6</td><td>4</td><td>10</td><td>13</td><td>13</td><td>12</td></tr><tr><td>E</td><td>8</td><td>12</td><td>11</td><td>7</td><td>13</td><td>10</td></tr></table>		1	2	3	4	5	6	A	12	10	15	22	18	8	B	10	18	25	15	16	12	C	11	10	3	8	5	9	D	6	4	10	13	13	12	E	8	12	11	7	13	10		Level 2	Understanding
	1	2	3	4	5	6																																									
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B	10	18	25	15	16	12																																									
C	11	10	3	8	5	9																																									
D	6	4	10	13	13	12																																									
E	8	12	11	7	13	10																																									
9.		Consider the problem of assigning five jobs to five persons. The assignment costs are given as follows: PERSONS↓JOBS → <table><tr><td></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>4</td><td>2</td><td>6</td><td>1</td></tr><tr><td>B</td><td>0</td><td>9</td><td>5</td><td>5</td><td>4</td></tr><tr><td>C</td><td>3</td><td>8</td><td>9</td><td>2</td><td>6</td></tr><tr><td>D</td><td>4</td><td>3</td><td>1</td><td>0</td><td>3</td></tr></table>		1	2	3	4	5	A	8	4	2	6	1	B	0	9	5	5	4	C	3	8	9	2	6	D	4	3	1	0	3		Level 3	Applying												
	1	2	3	4	5																																										
A	8	4	2	6	1																																										
B	0	9	5	5	4																																										
C	3	8	9	2	6																																										
D	4	3	1	0	3																																										

		<table><tr><td>E</td><td>9</td><td>5</td><td>8</td><td>9</td><td>5</td></tr></table>	E	9	5	8	9	5																								
E	9	5	8	9	5																											
		Determine the optimum assignment schedule.																														
10.		The assignment cost of assigning any one operator to any one machine is given in the following table. MACHINE↓OPERATORS → <table><tr><td></td><td>I</td><td>II</td><td>III</td><td>IV</td></tr><tr><td>A</td><td>10</td><td>5</td><td>13</td><td>15</td></tr><tr><td>B</td><td>3</td><td>9</td><td>18</td><td>3</td></tr><tr><td>C</td><td>10</td><td>7</td><td>3</td><td>2</td></tr><tr><td>D</td><td>5</td><td>11</td><td>9</td><td>7</td></tr></table> Find the optimal assignment by Hungarian method.		I	II	III	IV	A	10	5	13	15	B	3	9	18	3	C	10	7	3	2	D	5	11	9	7		Level 4	Analysing		
	I	II	III	IV																												
A	10	5	13	15																												
B	3	9	18	3																												
C	10	7	3	2																												
D	5	11	9	7																												
11.		A machine shop purchased a drilling machine and two lathes of different capacities. The Positioning of the machines among 4 possible locations on the shop floor is important forms the standard of materials handling. Given the cost estimate per unit time of materials below, find the optimum location of the machines. LOCATIONS <table><tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>Lathe 1</td><td>12</td><td>9</td><td>12</td><td>9</td></tr><tr><td>Drill</td><td>15</td><td>Not suitable</td><td>13</td><td>20</td></tr><tr><td>Lathe 2</td><td>4</td><td>8</td><td>10</td><td>6</td></tr></table>		1	2	3	4	Lathe 1	12	9	12	9	Drill	15	Not suitable	13	20	Lathe 2	4	8	10	6		Level 1	Remembering							
	1	2	3	4																												
Lathe 1	12	9	12	9																												
Drill	15	Not suitable	13	20																												
Lathe 2	4	8	10	6																												
12.		Solve the assignment problem for maximization given profit matrix(profit in rupees). <table><tr><td colspan="5">Machines</td></tr><tr><td></td><td>P</td><td>Q</td><td>R</td><td>S</td></tr><tr><td rowspan="4">JOB</td><td>51</td><td>53</td><td>54</td><td>50</td></tr><tr><td>47</td><td>50</td><td>48</td><td>50</td></tr><tr><td>49</td><td>50</td><td>60</td><td>61</td></tr><tr><td>63</td><td>64</td><td>60</td><td>60</td></tr></table>	Machines						P	Q	R	S	JOB	51	53	54	50	47	50	48	50	49	50	60	61	63	64	60	60		Level 2	Understanding
Machines																																
	P	Q	R	S																												
JOB	51	53	54	50																												
	47	50	48	50																												
	49	50	60	61																												
	63	64	60	60																												

13.	The processing time in hours for the jobs when allocated to the different machines is indicated below. Select the best assignment of the machines for the jobs so that the total processing time is Minimum. <table><tr><td></td><td></td><td colspan="3">Machines</td><td colspan="2"></td></tr><tr><td></td><td></td><td>M1</td><td>M2</td><td>M3</td><td>M4</td><td>M5</td></tr><tr><td rowspan="5">JOB</td><td>J1</td><td>9</td><td>22</td><td>58</td><td>11</td><td>19</td></tr><tr><td>J2</td><td>43</td><td>78</td><td>72</td><td>50</td><td>63</td></tr><tr><td>J3</td><td>41</td><td>28</td><td>91</td><td>37</td><td>45</td></tr><tr><td>J4</td><td>74</td><td>42</td><td>27</td><td>49</td><td>39</td></tr><tr><td>J5</td><td>36</td><td>11</td><td>57</td><td>22</td><td>25</td></tr></table>			Machines							M1	M2	M3	M4	M5	JOB	J1	9	22	58	11	19	J2	43	78	72	50	63	J3	41	28	91	37	45	J4	74	42	27	49	39	J5	36	11	57	22	25		Level 4	Analysing
		Machines																																															
		M1	M2	M3	M4	M5																																											
JOB	J1	9	22	58	11	19																																											
	J2	43	78	72	50	63																																											
	J3	41	28	91	37	45																																											
	J4	74	42	27	49	39																																											
	J5	36	11	57	22	25																																											
14.	For the given travelling salesman problem, Minimize the total cost. <table><tr><td></td><td colspan="5">To</td></tr><tr><td rowspan="5">From</td><td></td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>A</td><td>-</td><td>46</td><td>16</td><td>40</td></tr><tr><td>B</td><td>41</td><td>-</td><td>50</td><td>40</td></tr><tr><td>C</td><td>82</td><td>32</td><td>-</td><td>60</td></tr><tr><td>D</td><td>40</td><td>40</td><td>36</td><td>-</td></tr></table>		To					From		1	2	3	4	A	-	46	16	40	B	41	-	50	40	C	82	32	-	60	D	40	40	36	-		Level 1	Remembering													
	To																																																
From		1	2	3	4																																												
	A	-	46	16	40																																												
	B	41	-	50	40																																												
	C	82	32	-	60																																												
	D	40	40	36	-																																												
	(i) Observe the above travelling salesman problem and find out minimize the cost per cycle.	(8)																																															
	(ii) Find whether path is satisfied.	(5)																																															

PART - C

S.No	Questions	Marks	BT Level	Competence
1.	Assume that you are an OR specialist. Identify the procedure for each of the following Method to the employees in order to help them achieve solution to Transportation Problems. a Northwest Corner Cell Method	(3)	Level 1	Remembering
	b Least Cost cell Method	(4)		
	c Vogel's Approximation Method	(4)		
	d U V Method.	(4)		

2.

Solve the following transportation problem, in which a_i is the availability at Origin

O_i and b_j is the requirement at the destination D_j and cell entries are unit costs of transportation from any origin to any destination:

	D1	D2	D3	D4	D5	a_i
O1	4	7	3	8	2	4
O2	1	4	7	3	8	7
O3	7	2	4	7	7	9
O4	4	8	2	4	7	2
b_j	8	3	7	2	2	

Predict the allocation to minimize the cost.

Level 2

Understanding

3.

A company has a team of 4 Salesman and the company wants to do in 4 districts. Considering the capabilities of salesmen and nature of the district, the company has estimated the profit per day in Rs. For each salesmen in each district as follows.

	District s			
Salesmen	1	2	3	4
A	16	10	14	11
B	14	11	15	15
C	15	15	13	12
D	13	12	14	15

Develop the best assignment schedule and analyze the total cost.

Level 3

Applying

4.

Five operators have to be assigned to Five Machines. The assignment costs are given in the table below.

	Machine				
	I	II	III	IV	V
Operator					
A	5	5	-	2	6
B	7	4	2	3	4
C	9	3	5	-	3
D	7	2	6	7	2
E	6	5	7	9	1

Analyse using Hungarian algorithm & find out the assignment to minimize the cost.

Level 4

Analyzing

UNIT – III – INTEGER PROGRAMMING AND GAME THEORY

SYLLABUS: Integer Programming – Introduction and types - Game Theory-Two-person Zero sum games-Saddle point, Dominance Rule, graphical and LP solutions, Nash Equilibrium

PART - A

S.NO	QUESTIONS	BT LEVEL	COMPETENCE														
1.	What do you mean by integer programming problem?	Level 1	Remembering														
2.	In what respect a mixed IPP differs from pure IPP?	Level 2	Understanding														
3.	What is Nash Equilibrium?	Level 3	Applying														
4.	Classify the different types of strategy.	Level 4	Analysing														
5.	Compile the Characteristics of game.	Level 5	Evaluating														
6.	Can you assess the applications of integer programming?	Level 6	Creating														
7.	Define Game.	Level 1	Remembering														
8.	Compare Mixed Strategy and Pure Strategy.	Level 2	Understanding														
9.	How would you make use of the concept of Game theory in Managerial Decision Making?	Level 3	Applying														
10.	Conclude your understanding about Payoff Matrix.	Level 4	Analysing														
11.	How will you find the optimal strategies and value of the following game? <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td colspan="4" style="text-align: center;">Player B</td></tr> <tr> <td rowspan="3" style="text-align: center; vertical-align: middle;">Player A</td><td></td><td style="text-align: center;">H</td><td style="text-align: center;">T</td></tr> <tr> <td style="text-align: center;">H</td><td style="text-align: center;">2</td><td style="text-align: center;">-1</td></tr> <tr> <td style="text-align: center;">T</td><td style="text-align: center;">-1</td><td style="text-align: center;">0</td></tr> </table>	Player B				Player A		H	T	H	2	-1	T	-1	0	Level 5	Evaluating
Player B																	
Player A		H	T														
	H	2	-1														
	T	-1	0														
12.	Interpret the concept of two person zero sum game.	Level 6	Creating														
13.	What is Saddle point?	Level 1	Remembering														
14.	Compare Dominance Principle of Rows and Columns.	Level 2	Understanding														
15.	Identify the basic assumptions of the Game.	Level 3	Applying														
16.	Conclude the advantages of Game theory.	Level 4	Analysing														
17.	What are the Methods of Matrices?	Level 1	Remembering														

18.	Summarize how graphs and LP solution are used in Game theory.	Level 2	Understanding
19.	What is a Decision Tree?	Level 1	Remembering
20.	Define Dominance principle.	Level 1	Remembering

S.N O		PART - B QUESTIONS	MA RK S	BT LEVEL	COMPETENCE																									
1.	(i)	What do you mean by Pure IPP?	(3)	Level 1	Remembering																									
	(ii)	What do you mean by Mixed IPP?	(5)																											
	(iii)	List out the difference between Pure and Mixed IPP.	(5)																											
2.	(i)	For what value of λ , the game with the following matrix is strictly determined <table><tr><td></td><td>B₁</td><td>B₂</td><td>B₃</td></tr><tr><td>A₁</td><td>λ</td><td>6</td><td>2</td></tr><tr><td>A₂</td><td>-1</td><td>λ</td><td>-7</td></tr><tr><td>A₃</td><td>-2</td><td>4</td><td>λ</td></tr></table>		B ₁	B ₂	B ₃	A ₁	λ	6	2	A ₂	-1	λ	-7	A ₃	-2	4	λ	(8)	Level 2	Understanding									
		B ₁	B ₂	B ₃																										
A ₁	λ	6	2																											
A ₂	-1	λ	-7																											
A ₃	-2	4	λ																											
(ii)	Write down the assumptions of game theory.	(5)																												
3.	(i)	Solve the game whose pay-off matrix is given by <table><tr><td></td><td>B₁</td><td>B₂</td><td>B₃</td></tr><tr><td>A₁</td><td>1</td><td>3</td><td>1</td></tr><tr><td>A₂</td><td>0</td><td>-4</td><td>-3</td></tr><tr><td>A₃</td><td>1</td><td>5</td><td>-1</td></tr></table>		B ₁	B ₂	B ₃	A ₁	1	3	1	A ₂	0	-4	-3	A ₃	1	5	-1	(8)	Level 3	Applying									
		B ₁	B ₂	B ₃																										
A ₁	1	3	1																											
A ₂	0	-4	-3																											
A ₃	1	5	-1																											
(ii)	Explain the concept of Nash Equilibrium.	(5)																												
4.		Analyze the Value of the game graphically <table><tr><td></td><td>B1</td><td>B2</td></tr><tr><td>A1</td><td>4</td><td>4</td></tr><tr><td>A2</td><td>2</td><td>7</td></tr><tr><td>A3</td><td>5</td><td>3</td></tr><tr><td>A4</td><td>6</td><td>2</td></tr></table>		B1	B2	A1	4	4	A2	2	7	A3	5	3	A4	6	2		Level 4	Analysing										
	B1	B2																												
A1	4	4																												
A2	2	7																												
A3	5	3																												
A4	6	2																												
5.		What inference can be made using Dominance Principle to reduce the following game and estimate the game value? <table><tr><td></td><td>B1</td><td>B2</td><td>B3</td><td>B4</td></tr><tr><td>A1</td><td>3</td><td>2</td><td>4</td><td>0</td></tr><tr><td>A2</td><td>3</td><td>4</td><td>2</td><td>4</td></tr><tr><td>A3</td><td>4</td><td>2</td><td>2</td><td>0</td></tr><tr><td>A4</td><td>2</td><td>1</td><td>6</td><td>3</td></tr></table>		B1	B2	B3	B4	A1	3	2	4	0	A2	3	4	2	4	A3	4	2	2	0	A4	2	1	6	3		Level 5	Evaluating
	B1	B2	B3	B4																										
A1	3	2	4	0																										
A2	3	4	2	4																										
A3	4	2	2	0																										
A4	2	1	6	3																										

6.		How would you evaluate the following game whose Pay-Off matrix is Given Below? 9 3 1 8 0 6 5 4 6 7 2 4 3 3 8 5 6 2 2 1		Level 6	Creating																								
7.		Two players A&B match coins. If the coins match then A wins one unit value, if the coins do not match then B wins one unit of value.		Level 1	Remembering																								
	(i)	Determine pay-off matrix which strategy is to be chosen	(5)																										
	(ii)	Find the value of game.	(8)																										
8.		Predict the Value of the Game given above Pay OffMatrix. <table><tr><td></td><td colspan="4">Player B</td></tr><tr><td></td><td>B1</td><td>B2</td><td>B3</td><td></td></tr><tr><td rowspan="3">Player A</td><td>A1</td><td>-2</td><td>5</td><td>-3</td></tr><tr><td>A2</td><td>1</td><td>3</td><td>5</td></tr><tr><td>A3</td><td>-3</td><td>-7</td><td>11</td></tr></table>		Player B					B1	B2	B3		Player A	A1	-2	5	-3	A2	1	3	5	A3	-3	-7	11		Level 2	Understanding	
	Player B																												
	B1	B2	B3																										
Player A	A1	-2	5	-3																									
	A2	1	3	5																									
	A3	-3	-7	11																									
9.		Apply graphical analysis to Solve the game. <table><tr><td>A/ B</td><td>B1</td><td>B2</td><td>B3</td><td>B4</td></tr><tr><td>A1</td><td>3</td><td>3</td><td>4</td><td>0</td></tr><tr><td>A2</td><td>5</td><td>4</td><td>3</td><td>7</td></tr></table>	A/ B	B1	B2	B3	B4	A1	3	3	4	0	A2	5	4	3	7		Level 3	Applying									
A/ B	B1	B2	B3	B4																									
A1	3	3	4	0																									
A2	5	4	3	7																									
10.		Solve the following game by graphical method. <table><tr><td></td><td></td><td colspan="3">Player B</td><td></td></tr><tr><td></td><td></td><td>1</td><td>2</td><td>3</td><td></td></tr><tr><td></td><td>1</td><td>6</td><td>4</td><td>3</td><td></td></tr><tr><td>Player A</td><td>2</td><td>2</td><td>4</td><td>8</td><td></td></tr></table>			Player B						1	2	3			1	6	4	3		Player A	2	2	4	8			Level 4	Analysing
		Player B																											
		1	2	3																									
	1	6	4	3																									
Player A	2	2	4	8																									
11.		A and B play a Match(Game) in which each has 3 coins 5 paise, 10 paise and 20 paise. Each player selects a coin without the knowledge of others choice. IF the sum is even, B wins A's Coin. If sum is Odd, A wins B's coin.		Level 1	Remembering																								
	(i)	How will you find the pay-off matrix ?	(5)																										
	(ii)	Find the Best Strategy & value of the Game.	(8)																										
12.		Consider the Pay Off Matrix of player A as shown in the table below and solve it optimally using the graphical method . <table><tr><td></td><td colspan="5">Player B</td></tr><tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td></td></tr><tr><td rowspan="2">Player A</td><td>1</td><td>3</td><td>6</td><td>8</td><td>4</td></tr><tr><td>2</td><td>-7</td><td>4</td><td>2</td><td>10</td></tr></table>		Player B						1	2	3	4		Player A	1	3	6	8	4	2	-7	4	2	10		Level 2	Understanding	
	Player B																												
	1	2	3	4																									
Player A	1	3	6	8	4																								
	2	-7	4	2	10																								

13.	Analyze the Game Graphically: <table><tr><td></td><td colspan="2">Player A</td></tr><tr><td>Player A</td><td>B1</td><td>B2</td></tr><tr><td>A1</td><td>-3</td><td>1</td></tr><tr><td>A2</td><td>5</td><td>3</td></tr><tr><td>A3</td><td>6</td><td>-1</td></tr><tr><td>A4</td><td>1</td><td>4</td></tr><tr><td>A5</td><td>2</td><td>2</td></tr><tr><td>A6</td><td>0</td><td>-5</td></tr></table> (i) Plot the graph (ii) Analyse and find the value of the game.		Player A		Player A	B1	B2	A1	-3	1	A2	5	3	A3	6	-1	A4	1	4	A5	2	2	A6	0	-5		Level 4	Analysing																		
	Player A																																													
Player A	B1	B2																																												
A1	-3	1																																												
A2	5	3																																												
A3	6	-1																																												
A4	1	4																																												
A5	2	2																																												
A6	0	-5																																												
		(5)																																												
		(8)																																												
14.	Which one is the best strategy using Dominance Principle? <table><tr><td></td><td>B1</td><td>B2</td><td>B3</td><td>B4</td><td>B5</td><td>B6</td></tr><tr><td>A1</td><td>4</td><td>2</td><td>0</td><td>2</td><td>1</td><td>1</td></tr><tr><td>A2</td><td>4</td><td>3</td><td>1</td><td>3</td><td>2</td><td>2</td></tr><tr><td>A3</td><td>4</td><td>3</td><td>7</td><td>-5</td><td>1</td><td>2</td></tr><tr><td>A4</td><td>4</td><td>3</td><td>4</td><td>-1</td><td>2</td><td>2</td></tr><tr><td>A5</td><td>4</td><td>3</td><td>3</td><td>-2</td><td>2</td><td>2</td></tr></table>		B1	B2	B3	B4	B5	B6	A1	4	2	0	2	1	1	A2	4	3	1	3	2	2	A3	4	3	7	-5	1	2	A4	4	3	4	-1	2	2	A5	4	3	3	-2	2	2		Level 1	Remembering
	B1	B2	B3	B4	B5	B6																																								
A1	4	2	0	2	1	1																																								
A2	4	3	1	3	2	2																																								
A3	4	3	7	-5	1	2																																								
A4	4	3	4	-1	2	2																																								
A5	4	3	3	-2	2	2																																								

PART-C

S.No	Questions	BT Level	Competence																						
1.	Using Dominance property Solve. <table><tr><td></td><td colspan="4">B</td></tr><tr><td rowspan="4">A</td><td></td><td>I</td><td>II</td><td>IIIIV</td></tr><tr><td>1</td><td>-5</td><td>3</td><td>1 20</td></tr><tr><td>2</td><td>5</td><td>5</td><td>4 6</td></tr><tr><td>3</td><td>-4</td><td>-2</td><td>0 -5</td></tr></table>		B				A		I	II	IIIIV	1	-5	3	1 20	2	5	5	4 6	3	-4	-2	0 -5	Level 1	Remembering
	B																								
A		I	II	IIIIV																					
	1	-5	3	1 20																					
	2	5	5	4 6																					
	3	-4	-2	0 -5																					
2.	Examine the 2 * n Game by the Method of Sub Game: <table><tr><td></td><td>B1</td><td>B2</td><td>B3</td></tr><tr><td>A1</td><td>1</td><td>3</td><td>11</td></tr><tr><td>A2</td><td>8</td><td>5</td><td>2</td></tr></table>		B1	B2	B3	A1	1	3	11	A2	8	5	2	Level 2	Understanding										
	B1	B2	B3																						
A1	1	3	11																						
A2	8	5	2																						

3.		In a game of matching coins with 2 players, A wins 1 unit value when there are 2 heads, wins nothing when there are 2 tails and loses $\frac{1}{2}$ unit value when there are one head and one tail. Develop Pay Off matrix and value of the game.		Level 3	Applying																				
4.	i	Assume you have to choice of 3 strategies for advertising and you have one major	(5)	Level 4	Analysing																				
	ii	Analyse the theory on Two-person sum games competitor with 3 strategies.																							
	iii	What are the assumptions of Game?																							
		Find value of game.	(5)																						
		<table><tr><td></td><td>B1</td><td>B2</td><td>B3</td><td></td></tr><tr><td>A1</td><td>80</td><td>70</td><td>60</td><td></td></tr><tr><td>A2</td><td>90</td><td>80</td><td>100</td><td></td></tr><tr><td>A3</td><td>40</td><td>30</td><td>40</td><td></td></tr></table>		B1	B2	B3		A1	80	70	60		A2	90	80	100		A3	40	30	40				
	B1	B2	B3																						
A1	80	70	60																						
A2	90	80	100																						
A3	40	30	40																						

UNIT - IV INVENTORY MODELS, SIMULATION AND DECISION THEORY

SYLLABUS: Inventory Models – EOQ and EBQ Models (With and without shortages), Quantity Discount Models. Decision making under risk – Decision trees – Decision making under uncertainty. Monte-carlo simulation.

PART - A

S.NO	QUESTIONS	BT LEVEL	COMPETENCE
1.	Define inventory.	Level 1	Remembering
2.	Classify the Forms of inventory.	Level 2	Understanding
3.	Identify the Objectives/significance of inventory model.	Level 3	Applying
4.	Highlight the importance of Reorder level.	Level 4	Analysing
5.	Discuss the concept of Lead time.	Level 5	Evaluate
6.	Interpret the Types of stock replenishment.	Level 1	Remembering
7.	List the Basic inventory models.	Level 2	Understanding
8.	Compare Ordering Cost and Carrying Cost.	Level 3	Applying
9.	Identify when shortage cost and stock out cost arises?	Level 5	Evaluating
10.	Analyze why safety stock is maintained.	Level 1	Remembering
11.	Discuss the concept of Quantity Discount Model.	Level 2	Understanding
12.	Interpret the meaning of EOQ & EBQ.	Level 3	Applying
13.	What are random and pseudo random numbers?	Level 4	Analysing
14.	Explain Monte Carlo Method.	Level 5	Evaluating
15.	Summarize the concept of EMV.	Level 1	Remembering
16.	What inference can you make about holding cost ?	Level 2	Understanding

17.	What is Shortage Cost?	Level 3	Applying
18.	Classify and explain the various conditions under which decisions are made.	Level 1	Remembering
19.	What is meant by the following terms in inventory management: i) Carrying cost ii) shortage costs	Level 2	Understanding
20.	What is Decision theory? List the problems that can be solved by Simulation.	Level 3	Applying

S.NO	PART - B QUESTIONS		Marks	BT LEVEL	COMPETENCE
1.		Alpha industry needs 5400 units per year of a bought out component which will be used in its main product. The ordering cost is Rs.250 per order and the carrying cost per unit per year is Rs.30.		Level 1	Remembering
	(i)	Which is the best order quantity?	(8)		
	(ii)	Find the number of order per year and Frequency of orders?	(5)		
2.		A stockiest has to supply 12000 units of a product per year to his customer. Demand is fixed and known. Shortage cost is assumed to be infinite. Inventory holding cost is 20 paise per unit per month. Ordering Cost is Rs. 250 and purchase price is Rs.10 per unit.		Level 2	Understanding
	(i)	Estimate the EOQ	(8)		
	(ii)	Find the Frequency of orders and total inventory cost.	(5)		
3.		ABC manufacturing company purchases 9000 parts of a machine for its annual requirement. Each part costs Rs.20. The ordering cost per order is Rs.15 and the carrying charges are 15% of the average inventory per year. Apply EOQ formulae and find out EOQ, No of orders, Total Inventory Cost and total cost.		Level 3	Applying

4.	(i)	Demand for an item in a company is 18,000 units per year. The company can produce the items at a rate of 3000 units per month. The Cost of one setup is Rs.500 and the holding cost of one unit per month is 15 paise. Shortage cost of one unit is Rs.20 per year. Analyze and find the optimum manufacturing quantity.	(8)	Level 4	Analysing							
	(ii)	Find the number of shortages and frequency of Production run.	(5)									
5.		A company has a demand of 12000 units/year for an item and it can produce 2000 units per month. The cost of one setup is Rs.400 and the holding cost/unit/month is 15 paise. Select the optimum lot size and total cost per year assuming the cost of 1 unit as Rs.4. Find EBQ, the number of set ups & total cost.		Level 5	Evaluating							
6.	(i)	Find the optimal order quantity for a product when the annual demand for the product is 500 units. The Cost of storage per unit per year is 10% of the unit cost. Ordering cost per order is Rs. 180. Determine EOQ	(8)	Level 6	Creating							
	(ii)	Evaluate the Total Cost	(5)									
		The unit cost are given below: <table><tr><th>Quantity</th><th>Unit Cost(Rs.)</th></tr><tr><td>$0 < Q_1 < 500$</td><td>25</td></tr><tr><td>$500 \leq Q_2 \leq 1500$</td><td>24.80</td></tr><tr><td>$1500 \leq Q_3 < 3000$</td><td>24.60</td></tr><tr><td>$3000 \leq Q_4$</td><td>24.40</td></tr></table>	Quantity			Unit Cost(Rs.)	$0 < Q_1 < 500$	25	$500 \leq Q_2 \leq 1500$	24.80	$1500 \leq Q_3 < 3000$	24.60
Quantity	Unit Cost(Rs.)											
$0 < Q_1 < 500$	25											
$500 \leq Q_2 \leq 1500$	24.80											
$1500 \leq Q_3 < 3000$	24.60											
$3000 \leq Q_4$	24.40											
7.	(i)	Formulate the Optimal order quantity for a product for which the price breaks are as follows	(8)	Level 1	Remembering							
	(ii)	Also find the Total cost. <table><tr><th>Quantity</th><th>Unit Cost(Rs.)</th></tr><tr><td>$0 < Q < 500$</td><td>1000</td></tr><tr><td>$500 \leq Q \leq 750$</td><td>925</td></tr><tr><td>$750 \leq Q$</td><td>875</td></tr></table>	Quantity			Unit Cost(Rs.)	$0 < Q < 500$	1000	$500 \leq Q \leq 750$	925	$750 \leq Q$	875
Quantity	Unit Cost(Rs.)											
$0 < Q < 500$	1000											
$500 \leq Q \leq 750$	925											
$750 \leq Q$	875											

8.		Compute the EOQ and the total variable cost for the following: Annual demand: 25 units Unit price: Rs.2.50 Order cost: Rs.4.00 Storage rate: 1% per year		Level 2	Understand																									
9.		Identify the profit under three states of nature & three decision alternative. <table border="1"><tr><td></td><td></td><td>State of Nature</td><td>State of Nature</td><td>State of Nature</td></tr><tr><td></td><td></td><td>N1</td><td>N2</td><td>N3</td></tr><tr><td>Decision Making</td><td>D1</td><td>150</td><td>250</td><td>300</td></tr><tr><td>Decision Making</td><td>D2</td><td>450</td><td>250</td><td>200</td></tr><tr><td>Decision Making</td><td>D3</td><td>100</td><td>180</td><td>290</td></tr></table> (i) Hurwitz criterion for alpha=0.5 (3) (ii) Laplace condition (5) (iii) Minimax Condition (5)			State of Nature	State of Nature	State of Nature			N1	N2	N3	Decision Making	D1	150	250	300	Decision Making	D2	450	250	200	Decision Making	D3	100	180	290		Level 3	Applying
		State of Nature	State of Nature	State of Nature																										
		N1	N2	N3																										
Decision Making	D1	150	250	300																										
Decision Making	D2	450	250	200																										
Decision Making	D3	100	180	290																										
10.		A Bakery keeps a stock of particular brand of cake. Daily demand of past experience. <table border="1"><tr><td>Daily demand</td><td>0</td><td>15</td><td>25</td><td>35</td><td>45</td><td>50</td></tr><tr><td>Probability</td><td>0.01</td><td>0.15</td><td>0.20</td><td>0.50</td><td>0.12</td><td>0.02</td></tr></table> Consider the following sequence of random numbers. 48 78 9 51 56 77 15 14 68 9 Using this sequence simulate the demand for next 10 days. Find the stock situation if the owner makes 35 cakes every day. Examine the daily average demand.	Daily demand	0	15	25	35	45	50	Probability	0.01	0.15	0.20	0.50	0.12	0.02		Level 1	Remembering											
Daily demand	0	15	25	35	45	50																								
Probability	0.01	0.15	0.20	0.50	0.12	0.02																								
11.		<table border="1"><tr><td>Nature</td><td>Probability</td><td>Don't Expand</td><td>Expand 200</td><td>Expand 400</td></tr><tr><td>High Demand</td><td>0.4</td><td>2500</td><td>3500</td><td>5000</td></tr><tr><td>Medium Demand</td><td>0.4</td><td>2500</td><td>3500</td><td>2500</td></tr><tr><td>Low Demand</td><td>0.2</td><td>2500</td><td>1500</td><td>1000</td></tr></table> Given above is the following pay off matrix. Using EMV criterion . Decide which of the act can be chosen at the best. FindEVPI & EOL.	Nature	Probability	Don't Expand	Expand 200	Expand 400	High Demand	0.4	2500	3500	5000	Medium Demand	0.4	2500	3500	2500	Low Demand	0.2	2500	1500	1000		Level 2	Understanding					
Nature	Probability	Don't Expand	Expand 200	Expand 400																										
High Demand	0.4	2500	3500	5000																										
Medium Demand	0.4	2500	3500	2500																										
Low Demand	0.2	2500	1500	1000																										

12.	A sample of 100 arrivals of customers at a retail sales depot is according to the following distribution. <table><tr><th>Time between arrivals(mins)</th><th>Frequency</th></tr><tr><td>0.5</td><td>2</td></tr><tr><td>1.0</td><td>6</td></tr><tr><td>1.5</td><td>10</td></tr><tr><td>2.0</td><td>25</td></tr><tr><td>2.5</td><td>20</td></tr><tr><td>3.0</td><td>14</td></tr><tr><td>3.5</td><td>4</td></tr><tr><td>4.0</td><td>7</td></tr><tr><td>4.5</td><td>4</td></tr><tr><td>5.0</td><td>2</td></tr></table> Use random numbers and predict the average time between arrivals. 48 78 9 51 56 77 15 14 68 9	Time between arrivals(mins)	Frequency	0.5	2	1.0	6	1.5	10	2.0	25	2.5	20	3.0	14	3.5	4	4.0	7	4.5	4	5.0	2		Level 3	Applying
Time between arrivals(mins)	Frequency																									
0.5	2																									
1.0	6																									
1.5	10																									
2.0	25																									
2.5	20																									
3.0	14																									
3.5	4																									
4.0	7																									
4.5	4																									
5.0	2																									
13.	A departmental store purchases sprays which can be ordered only in lots of 10. Each spray cost Rs.75 and sells at Rs.90 each. Used sprays, however have no salvage value. <table><tr><td>Demand</td><td>10</td><td>20</td><td>30</td><td>40</td><td>50</td></tr><tr><td>Probability</td><td>0.2</td><td>0.35</td><td>0.25</td><td>0.15</td><td>0.05</td></tr></table> The probability distribution obtained from analysis of past sales data is given below. Analyse the payoff table. (i)	Demand	10	20	30	40	50	Probability	0.2	0.35	0.25	0.15	0.05	(5)	Level 4	Analysing										
Demand	10	20	30	40	50																					
Probability	0.2	0.35	0.25	0.15	0.05																					
	(ii) How much quantity should the departmental store buy to maximize its profit?	(8)																								
14.	(i) A company uses annually 50,000 units of an item each costing Rs.1.20. Each order costs Rs.45 and inventory carrying costs are 15% of the annual average inventory value. Find EOQ.	(3)	Level 2	Understanding																						
	(ii) If the company operates 250 days a year and the procurement time is 10 days and safety stock is 500 units, find reorder level, maximum, minimum and average inventory	(10)																								

PART - C

PART - C

S.No		Questions		BT Level	Competence																							
1.		A contractor has to supply 10000 bearings per day to an automobile manufacturer. He finds that when he starts a production run he can produce 25000 bearings per day. The cost of holding a bearing in stock for one year is 2 paise and the set up cost of the production run is Rs.18. How frequently should production run be made and which is the Best Economic Batch Quantity? How much would be the No. of Setup and Total Inventory Cost.		Level 1	Remembering																							
2.		A stockist has to supply 400 units of a product every Monday to his customer. He gets the product at Rs.50 per unit from the manufacturer. The cost of ordering and transportation from the manufacturer is Rs.75 per order. The cost of carrying inventory is 7.5% per year of the cost of product. Predict EOQ, Frequency of orders and Number of Orders, Total Incremental cost and Total Cost.		Level 2	Understanding																							
3.	(i)	Identify the profit under three states of nature & three decision alternative. <table border="1"><tr><td></td><td colspan="4">State of Nature</td></tr><tr><td></td><td></td><td>N1</td><td>N2</td><td>N3</td></tr><tr><td rowspan="4">Decision Making</td><td>D1</td><td>100</td><td>200</td><td>300</td></tr><tr><td>D2</td><td>400</td><td>200</td><td>200</td></tr><tr><td>D3</td><td>200</td><td>160</td><td>390</td></tr></table> Hurwitz criterion for $\alpha=0.5$		State of Nature						N1	N2	N3	Decision Making	D1	100	200	300	D2	400	200	200	D3	200	160	390	(5)	Level 3	Applying
	State of Nature																											
		N1	N2	N3																								
Decision Making	D1	100	200	300																								
	D2	400	200	200																								
	D3	200	160	390																								
	(ii)	Laplace Condition	(5)																									
(iii)	Minimax Condition	(5)																										
4.		An automobile production line turns out about 100 cars a day, but deviation occur owing to many causes. The production is more accurately described by the probability distribution given below; <table border="1"><tr><td>Production/ Day</td><td>Probability</td></tr><tr><td>95</td><td>0.03</td></tr><tr><td>96</td><td>0.05</td></tr><tr><td>97</td><td>0.07</td></tr><tr><td>98</td><td>0.10</td></tr></table>	Production/ Day	Probability	95	0.03	96	0.05	97	0.07	98	0.10		Level 4	Analysing													
Production/ Day	Probability																											
95	0.03																											
96	0.05																											
97	0.07																											
98	0.10																											

		<table><tr><td>99</td><td>0.15</td></tr><tr><td>100</td><td>0.20</td></tr><tr><td>101</td><td>0.15</td></tr><tr><td>102</td><td>0.10</td></tr><tr><td>103</td><td>0.07</td></tr><tr><td>104</td><td>0.05</td></tr><tr><td>105</td><td>0.03</td></tr></table>	99	0.15	100	0.20	101	0.15	102	0.10	103	0.07	104	0.05	105	0.03			
99	0.15																		
100	0.20																		
101	0.15																		
102	0.10																		
103	0.07																		
104	0.05																		
105	0.03																		
		Use the random numbers & find the average demand 48 78 9 51 56 77 15 14 68 9																	

UNIT - V QUEUING THEORY AND REPLACEMENT MODELS

SYLLABUS: Queuing Theory –Single and Multi-Channel models-infinite number of customers and infinite calling resource Replacement Models-Individuals replacement Models (With and without time value of money) – Group Replacement Models.

PART - A

S.NO	QUESTIONS	BT LEVEL	COMPETENCE
1.	Define Queue.	Level 1	Remembering
2.	How do you show your understanding on replacement theory?	Level 2	Understanding
3.	In a bank, 20 customers on an average are served by a cashier in an hour. If the service time has exponential distribution, what is the probability that it will take more than 10 minutes to serve a customer?	Level 3	Applying
4.	Classify the types of Queue.	Level 4	Analysing
5.	How waiting time cost is related to queuing system?	Level 5	Evaluating
6.	Interpret the Characteristics Of Queuing Models.	Level 4	Evaluating
7.	How would you explain consumer behavior in queues?	Level 1	Remembering
8.	Compare Serial and parallel Queue with Examples.	Level 2	Understanding
9.	Classify the types of Replacement model.	Level 3	Applying
10.	Describe Kendall's Notation for identifying a Queue Model with single channel, Poisson arrivals, exponential service unlimited queue and infinite calling population.	Level 4	Analysing
11.	GRP includes IRP .Do You Agree?	Level 5	Evaluating
12.	What is GRP & IRP?	Level 6	Creating

13.	Distinguish between breakdown maintenance and preventive maintenance.	Level 1	Remembering
14.	How do you show your understanding on Little's formula in queuing theory?	Level 2	Understanding
15.	Categorize Queue Discipline.	Level 3	Applying
16.	Develop Kendall's Notation of a Queue.	Level 4	Analysing
17.	What is "Collusion" in Queue Discipline?	Level 1	Remembering
18.	Compare the Queue Length and No. of Customers in the System.	Level 2	Understanding
19.	Distinguish between individual replacement and group replacement?	Level 3	Applying
20.	Describe Kendall's Notation for identifying a Queue Model with two channels, Poisson arrivals, exponential service Unlimited Queue and infinite calling population.	Level 1	Remembering

S.No	PART - B QUESTIONS	Marks	BT LEVEL	COMPETENCE																								
1.	The cost of machine is Rs.16, 00 and scrap value is Rs.1,100. Maintenance Cost form for machine are as follows: <table><tr><th>Year</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th></tr><tr><th>Maintenance cost</th><td>300</td><td>459</td><td>600</td><td>800</td><td>100</td><td>1200</td><td>1500</td><td>2000</td></tr></table> When should the machine be the replaced?	Year	1	2	3	4	5	6	7	8	Maintenance cost	300	459	600	800	100	1200	1500	2000		Level 1	Remembering						
Year	1	2	3	4	5	6	7	8																				
Maintenance cost	300	459	600	800	100	1200	1500	2000																				
2.	The following table gives to cost of spares per year, overhead cost of maintenance per year and resale value of certain equipment whose purchase price is Rs. 50,000: Illustrate when the machine can be replaced. <table><tr><th>Year</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr><tr><th>Cost of Spares</th><td>10000</td><td>12000</td><td>14000</td><td>15000</td><td>17000</td></tr><tr><th>Overhead Maintenance Cost</th><td>5000</td><td>5000</td><td>6000</td><td>6000</td><td>8000</td></tr><tr><th>Resale Value</th><td>40000</td><td>32000</td><td>28000</td><td>25000</td><td>22000</td></tr></table>	Year	1	2	3	4	5	Cost of Spares	10000	12000	14000	15000	17000	Overhead Maintenance Cost	5000	5000	6000	6000	8000	Resale Value	40000	32000	28000	25000	22000		Level 2	Understanding
Year	1	2	3	4	5																							
Cost of Spares	10000	12000	14000	15000	17000																							
Overhead Maintenance Cost	5000	5000	6000	6000	8000																							
Resale Value	40000	32000	28000	25000	22000																							
3.	A Taxi owner estimates from his past records that the cost per year for operating a taxi whose purchase price when new is Rs.60,000 are as follows. <table><tr><th>Age</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr><tr><th>Operating cost</th><td>10000</td><td>12000</td><td>15000</td><td>18000</td><td>20000</td></tr></table> After 5 years the operating cost is Rs.6000 x K, Where “k” is 6,7,8,9,10(age). If the resale value decreases by 10% of	Age	1	2	3	4	5	Operating cost	10000	12000	15000	18000	20000		Level 3	Applying												
Age	1	2	3	4	5																							
Operating cost	10000	12000	15000	18000	20000																							

		purchase price each year, calculate the best time of replacement if time value is not implemented?																														
4.		A cost of a machine is 6100 and its scrap value is Rs. 100. The maintenance Cost from the experience are as follows: <table><tr><td>Year</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></tr><tr><td>Maintenance cost</td><td>100</td><td>250</td><td>400</td><td>600</td><td>900</td><td>1200</td><td>1600</td><td>2000</td></tr></table> (i) Examine the average cost of replacement (ii) Analyze when the asset can be replaced	Year	1	2	3	4	5	6	7	8	Maintenance cost	100	250	400	600	900	1200	1600	2000	(8) (5)	Level 4	Analysing									
Year	1	2	3	4	5	6	7	8																								
Maintenance cost	100	250	400	600	900	1200	1600	2000																								
5.		<table><tr><td>Week</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr><tr><td>Conditional Probability</td><td>0.07</td><td>0.15</td><td>0.25</td><td>0.45</td><td>0.75</td><td>0.9</td><td>1</td></tr></table> IRP Cost is Rs.1.25 per item GRP Cost is Rs.60 Paise Per item. Estimate the IRP Cost (i) (ii) Predict GRP cost and Determine whether GRP or IRP is the Best Policy	Week	1	2	3	4	5	6	7	Conditional Probability	0.07	0.15	0.25	0.45	0.75	0.9	1	(5) (8)	Level 5	Evaluating											
Week	1	2	3	4	5	6	7																									
Conditional Probability	0.07	0.15	0.25	0.45	0.75	0.9	1																									
6.		Machine A Costs Rs.9000. Annual Operating Cost is Rs.200 for the 1st year and then increases by 2000 every year. Determine the best age at which to replace the machine. Assume the machine has no resale value. Machine B Costs Rs.10,000 . Annual operating cost is Rs.400 for the 1st year and then increases by 800 every year. No resale value. You have now a machine of type A which is one year old. Conclude if M/c A can be replaced by M/c B. Is so, When?		Level 6	Creating																											
7.		A manufacturer is offered two machines A and B. A has cost price of Rs.2,500, its running cost is Rs. 400 for each of first years and increased by Rs. 100 every subsequent year, Taking money's value as 10% per year, when machine should be replaced?		Level 1	Remembering																											
8.		The maintenance cost and resale value per year of a machine whose purchase price is Rs.7000 is given below : <table><tr><td>Year</td><td>Operating Cost</td><td>Resale Value</td></tr><tr><td>1</td><td>900</td><td>400</td></tr><tr><td>2</td><td>1200</td><td>2000</td></tr><tr><td>3</td><td>1600</td><td>1200</td></tr><tr><td>4</td><td>2100</td><td>600</td></tr><tr><td>5</td><td>2800</td><td>500</td></tr><tr><td>6</td><td>3700</td><td>400</td></tr><tr><td>7</td><td>4700</td><td>400</td></tr><tr><td>8</td><td>5900</td><td>400</td></tr></table> When should the machine be replaced ?	Year	Operating Cost	Resale Value	1	900	400	2	1200	2000	3	1600	1200	4	2100	600	5	2800	500	6	3700	400	7	4700	400	8	5900	400		Level 2	Understanding
Year	Operating Cost	Resale Value																														
1	900	400																														
2	1200	2000																														
3	1600	1200																														
4	2100	600																														
5	2800	500																														
6	3700	400																														
7	4700	400																														
8	5900	400																														

9.		A truck owner finds from his past experience that the maintenance costs rs.200 for the first year and then increases by rs.2000 every year, The cost of the truck type A is rs.9000. Determine the best age at which to replace the truck. Truck B type cost rs.10000. Annual Maintenance costs are rs.400 and increased by Rs.800 every year. The truck owner now has truck type A which is one year old and should be replaced by Type B and if so when?		Level 3	Applying																											
10.		IRP cost Rs 4/item. GRP cost is 80paise/item. <table><tr><td>Week</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>Probability</td><td>0.09</td><td>0.25</td><td>0.49</td><td>0.85</td><td>0.97</td><td>1</td></tr></table>	Week	1	2	3	4	5	6	Probability	0.09	0.25	0.49	0.85	0.97	1		Level 4	Analysing													
Week	1	2	3	4	5	6																										
Probability	0.09	0.25	0.49	0.85	0.97	1																										
	(i)	Find the IRP cost	5																													
	(ii)	Compare IRP or GRP and conclude which is best.	8																													
11.		A machine owner finds from his past records that the cost per year of maintaining a machine, whose purchase price is Rs.6,000 are as given below. <table><tr><td>Year</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></tr><tr><td>Mainten Ance Cost</td><td>100</td><td>1200</td><td>1400</td><td>1800</td><td>2300</td><td>2800</td><td>3400</td><td>4000</td></tr><tr><td>Resale Price</td><td>3000</td><td>1500</td><td>750</td><td>375</td><td>200</td><td>200</td><td>200</td><td>200</td></tr></table> Find at what age a replacement is due, assuming time value is 10%	Year	1	2	3	4	5	6	7	8	Mainten Ance Cost	100	1200	1400	1800	2300	2800	3400	4000	Resale Price	3000	1500	750	375	200	200	200	200		Level 1	Remembering
Year	1	2	3	4	5	6	7	8																								
Mainten Ance Cost	100	1200	1400	1800	2300	2800	3400	4000																								
Resale Price	3000	1500	750	375	200	200	200	200																								
12.	(i)	Cars arrive at a petrol pump, having one petrol unit, in poisson fashion with an average of 10 cars per hour. The service time is distributed exponentially with a mean of 3 minutes.		Level 2	Understanding																											
	(ii)	PredictAverage number of cars in the system	(3)																													
		Average waiting time in the queue	(3)																													
	(iii)	Average queue length	(3)																													
	(iv)	The probability that the number of cars in the system is	(4)																													
13.		In a public telephone booth, the arrivals are on the average 15 per hour. A call on the average takes 3 minutes. If there is just one phone, Analyse and find: The expected number of callers in the booth at any time.		Level 4	Analysing																											
	(i)		(6)																													
	(ii)	The proportion of the time the booth is expected to be idle	(7)																													

14.		A T.V repairman finds that the time spent on his job has an exponential distribution with mean 30 minutes. If he repairs sets in the order in which they came in and if the arrival of sets is poisson with an average rate of 10 per 8 hour day, how will you calculate the expected idle time day? How much is the queue length and how many TV sets would be in the shop ?		Level 1	Remembering
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PART - C

PART - C																				
S.No		Questions	Marks	BT Level	Competence															
1.		Assume an insurance company has three claims adjusters in its branch office. People with claims against the company are found to arrive in a Poisson fashion, at an average rate of 20 per 8-hour day. The amount of time that an adjuster spends with a claimant is found to have an exponential distribution, with mean service time 40 minutes. Claimants are processed in the order of their appearance. How many hours a week can an adjuster expect to spend with claimants?	(8)	Level 1	Remembering															
	(i)																			
	(ii)	How much time, on the average, does a claimant spend in the branch office?	(7)																	
2.		In a reservation counter with a single server, customer arrive with the inter-arrival time as the exponential distribution with mean 10 minutes. The service time is also assumed to be exponential with mean 8 minutes. Predict the idle time of the server	(5)	Level 2	Understanding															
	(i)																			
	(ii)	The average length of the Queue.	(5)																	
	(iii)	Expected time that a customer spends in the system.	(5)																	
3.		An electronic equipment contains 500 resistors. When any resistor fails, it is replaced. The cost of replacing a resistor individually is Rs.20. If all the resistors are replaced at the same time, the cost per resistor is Rs. 5. The percentage of surviving, S(i) at the end of month i is given below; Apply IRP & GRP & Find which is best. <table border="1"><tr><th>Month I</th><th>0</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr><tr><th>S (i)</th><td>100</td><td>90</td><td>75</td><td>55</td><td>30</td><td>0</td></tr></table>	Month I	0	1	2	3	4	5	S (i)	100	90	75	55	30	0		Level 3	Applying	
Month I	0	1	2	3	4	5														
S (i)	100	90	75	55	30	0														

4.		The failure rates of 1000 street bulbs in a colony are summarized in table: <table><tr><td>End Of Month</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>Probability of failure to Date</td><td>0.05</td><td>0.20</td><td>0.40</td><td>0.65</td><td>0.85</td><td>1.00</td></tr></table> The cost of replacing an individual bulb is Rs.60. If all the bulbs are replaced simultaneously it would cost Rs.25 Per bulb. Any one of the following two options can be followed to replace the bulbs. Replace the bulbs individually when they fail (Individual replacement policy)	End Of Month	1	2	3	4	5	6	Probability of failure to Date	0.05	0.20	0.40	0.65	0.85	1.00		Level 4	Analysing
End Of Month	1	2	3	4	5	6													
Probability of failure to Date	0.05	0.20	0.40	0.65	0.85	1.00													
	(i)		(8)																
	(ii)	Replace all the bulbs simultaneously at fixed intervals and replace the individual bulbs as and when they fail in service during the fixed interval (Group replacement policy). Analyse & find out the optimal replacement policy, i.e., Individual replacement policy or group replacement policy? If group replacement policy is optimal, then find at what equal intervals should all bulbs are replaced?	(7)																