SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES (AUTONOMOUS)

QUESTION BANK

Year / Semester: II B.Tech IV Semester **Regulation: R23**

Subject and Code: OPTIMIZATION TECHNIQUES &23BSC242
(Common to CSM, CAI, CSD)

SYLLABUS

UNIT – I: LINEAR PROGRAMMING 09

Nature, Scope & Significance of Optimization – Typical applications. The Linear Programming Problem –Formulation of Linear Programming problem– Limitations of L.P.P– Graphical method, Simplex method– Maximization and Minimization model(exclude Duality problems)– Big-M method and Two-Phase method.

UNIT – II:TRANSPORTATION AND ASSIGNMENT PROBLEM 09

Transportation Problem: Transportation Model– Finding initial basic feasible solutions–Moving towards optimality– Unbalanced Transportation problems– Transportation problems with maximization– Degeneracy.

Assignment Problem: Mathematical formulation of the problem–Solution of an Assignment problem– Hungarian Algorithm– Multiple Solution– Unbalanced Assignment problems– Maximization in Assignment Model.

UNIT – III: SEQUENCING 09

Sequencing: Job sequencing– Johnsons Algorithm for n Jobs and Two machines– n Jobs and Three Machines– n jobs through m machines– Two jobs and m Machines Problems.

UNIT – IV: GAME THEORY 09

Game Theory: Concepts, Definitions and Terminology– Two Person Zero Sum Games–Pure Strategy Games (with Saddle Point)–Principal of Dominance– Mixed Strategy Games (Game without Saddle Point)– Significance of Game Theory in Managerial Application.

UNIT – V: PROJECT MANAGEMENT 09

Project Management: Network Analysis – Objectives –Rules for constructing network diagram– Determining Critical Path – Earliest & Latest Times – Floats - Application of CPM and PERT techniques in Project Planning and Control – PERT Vs CPM. (exclude Project Crashing)

<table>
<tr><th>S.No.</th><th>CO</th><th>Questions</th><th>BT</th></tr>
<tr><td colspan="4">Unit I: (Linear Programming)</td></tr>
<tr><td colspan="4">PART-A (2 marks)</td></tr>
<tr><td>1.</td><td>1</td><td>List out Scope of Optimization Techniques</td><td>L2</td></tr>
<tr><td>2.</td><td>1</td><td>Write any two definitions of Optimization Techniques</td><td>L2</td></tr>
<tr><td>3.</td><td>1</td><td>Define surplus variable</td><td>L1</td></tr>
<tr><td>4.</td><td>1</td><td>Define feasible solution</td><td>L1</td></tr>
<tr><td>5.</td><td>1</td><td>Define infeasible solution</td><td>L1</td></tr>
<tr><td>6.</td><td>1</td><td>Define optimum solution</td><td>L1</td></tr>
<tr><td>7.</td><td>1</td><td>Define unbounded solution</td><td>L1</td></tr>
<tr><td>8.</td><td>1</td><td>Define slack variable</td><td>L1</td></tr>
<tr><td colspan="4">PART-B (10 marks)</td></tr>
<tr><td>1</td><td>1</td><td>Electrical Equipment limited is engaged in the production of power transformers and traction transformers. Both of these categories of transformers pass through three basic manufacturing processes. The power transformer yields a contribution of Rs 50,000/- and a traction transformer yields a contribution of Rs 10,000/-. The time require in terms of hour for each of process and the capacities of the core building shop, assembly shop, and vapor phase drying equipment are as follows.
<table>
<tr><td rowspan="2">Process</td><td colspan="2">Time</td><td rowspan="2">Available Capacity</td></tr>
<tr><td>Power Transformers</td><td>Traction Transformers</td></tr>
<tr><td>Core Preparation</td><td>75</td><td>15</td><td>1000</td></tr>
<tr><td>Core to coil Assembly</td><td>160</td><td>30</td><td>1500</td></tr>
<tr><td>Vapor phase Drying</td><td>45</td><td>10</td><td>750</td></tr>
</table>
Determine the number of power transformers and traction transformers that the manufacturer will produce so that the total contribution is maximum. Formulate the above as a LPP Model.</td><td>L4</td></tr>
</table>

<table>
<tr>
<td>2</td>
<td>1</td>
<td>A Company is producing three products A, B, C with profit contribution of Rs.20, Rs.25, and Rs.15 per unit respectively. The resource requirements per unit of each of the products and total Availability are given below.
<table>
<tr><td>Product</td><td>A</td><td>B</td><td>C</td><td>Total Availability</td></tr>
<tr><td>Man Hours/Unit</td><td>6</td><td>3</td><td>12</td><td>200 Man Hours</td></tr>
<tr><td>Machine Hours/Unit</td><td>2</td><td>5</td><td>4</td><td>350 Machine Hours</td></tr>
<tr><td>Material/Unit</td><td>1kg</td><td>2kg</td><td>1kg</td><td>100kgs</td></tr>
</table>
Formulate the above Information as a LPP Model.</td>
<td>L3</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>Solve the following LPP by using Graphical Method
Maximize $Z=4x+7y$
Subject to constraints
$x+y\leq 60$,
$x\leq 40$,
$Y\leq 40$ and $x, y\geq 0$</td>
<td>L4</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>Minimize $Z=4x+5y$
Subject to constraints
$X+Y\geq 10$,
$2x+5y\geq 35$ and $X, Y\geq 0$.
Solve the above LPP by using Graphical method.</td>
<td>L3</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>Solve the following LPP by using Graphical Method
maximize $Z=6X_1+9X_2$,
Subject to constraints
$X_1+X_2\leq 12$,
$X_1+5X_2\leq 45$,
$3X_1+X_2\leq 30$ and $X_1, X2, \geq 0$.</td>
<td>L5</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>Solve Graphically.
Maximize $Z=40X_1+100X_2$,
subject to the Constraints
$2X_1+X_2\leq 500$,</td>
<td>L4</td>
</tr>
</table>

		$2X_1+5X_2 \leq 1000$ and $X_1, X_2 \geq 0$	
7	**1**	Use simplex method to solve the following LPP. Maximize $Z=3X_1+2X_2$ Subject to constraints $X_1+X_2 \leq 4$, $X_1-X_2 \leq 2$ and $X_1, X_2 \geq 0$.	**L3**
8	**1**	Use simplex method to solve the following LPP Maximize $Z= 6X_1+8X_2$ Subject to the Constraints $5X_1+10X_2 \leq \leq 60$, $4X_1+4X_2 \leq 40$, X_1 and $X_2, \geq 0$.	**L5**
9	**1**	Solve by two-phase method Minimize $Z=12X_1+20X_2$. Subjected to Constraints $6X_1+8X_2 \leq 100$, $7X_1 +12X_2 \leq 120$ and $X_1, X_2, \geq \geq 0$.	**L4**
10	**1**	Solve by Big –M method. Minimize $Z=12X_1+20X_2$. Subjected to Constraints $6X_1+8X_2 \geq 100$, $7X_1 +12X_2 \geq 120$ and $X_1, X_2 \geq 0$.	**L3**
11	**1**	Solve the following LPP by two-phase method Minimize $Z=X_1+X_2$ Subjected to $2X_1+X_2 \geq 4$, $X_1+7X_2 \geq 7$ and $X_1, X_2 \geq 0$.	**L3**

S.No.	**CO**	**Questions**	**BT**
Unit II: (TRANSPORTATION AND ASSIGNMENT PROBLEMS)			
PART-A (2 marks)			
1.	**2**	Define balanced transportation problem	**L1**
2.	**2**	Define unbalanced Transportation problem	**L1**

3.	**2**	What is degeneracy in Transportation Problem?	**L1**
4.	**2**	Write mathematical model of transportation problem	**L2**
5.	**2**	Write mathematical model of Assignment problem	**L2**
6.	**2**	Give any two applications of assignment problem	**L2**

PART-B (10 marks)

1 **2** **L4**

Find the optimum solution to the following transportation problem.

Factory	Ware House				Capacity
	D	E	F	G	
A	1	2	1	4	30
B	3	3	2	1	50
C	4	2	5	9	20
Demand	20	40	30	10	100

2 **2** **L3**

Solve the following transportation problem

Factory	Ware House				Capacity
	W_1	W_2	W_3	W_4	
F_1	11	20	7	8	50
F_2	21	16	10	12	40
F_3	8	12	18	9	70
Demand	30	25	35	40	

3 **2** **L4**

Find an initial basic feasible solution to the following transportation problem using North-west corner rule:

	D_1	D_2	D_3	Availability
O_1	2	7	4	5
O_2	3	3	1	8
O_3	5	4	7	7
O_4	1	6	2	14
Requirements	7	9	18	

4 **2** **L3**

Obtain an initial basic feasible solution to the following transportation problems using the VAM method.

	D_1	D_2	D_3	D_4	Availability
O_1	6	4	1	5	14
O_2	8	9	2	7	16
O_3	4	3	6	2	5
Demand	6	10	15	4	

5 **2** **L5**

Obtain an initial basic feasible solution to the following transportation problem using the Least Cost method.

	D_1	D_2	D_3	Availability
S_1	1	2	6	7
S_2	8	4	2	12

		S_3	3	7	5	11	
		Requirements	10	10	10		

6	**2**	Solve the following transportation problem					**L4**

	D_1	D_2	D_3	D_4	Availability
O_1	5	3	6	4	30
O_2	3	4	7	8	15
O_3	9	6	5	8	10
Demand	10	25	18	7	

7	**2**	Solve the following assignment problem				**L3**

		Jobs			
		J_1	J_2	J_3	J_4
Workers	W_1	10	15	24	30
	W_2	16	20	28	10
	W_3	12	18	30	16
	W_4	9	24	32	18

8	**2**	The assignment costs of four operators to four machines are given in the following table.				**L5**

		Operators			
		I	II	III	IV
Machines	A	10	5	13	15
	B	3	9	18	3
	C	10	7	3	2
	D	5	11	9	7

9	**2**	Three jobs are to be done by 4 machines. Each job can be assigned to one and only one machine. The cost of each job on each machine is given in the following table.				**L4**

		M_1	M_2	M_3	M_4
Job	J_1	18	24	28	32
	J_2	8	13	17	19
	J_3	10	15	19	22

What are the job assignments which will minimize the total cost

10	**2**	Solve the travelling salesman problem with the following cost matrix.				**L3**

		Cities			
		A	B	C	D
C :	A	∞	46	16	40

				B	41	∞	50	40		
				C	82	32	∞	60		
				D	40	40	36	∞		

S.No.	CO	Questions	BT
		Unit III: (SEQUENCING MODELS)	
		PART-A (2 marks)	
1.	**3**	What is job sequencing?	**L1**
2.	**3**	Write the assumptions in sequencing models	**L2**
3.	**3**	What are the various job sequencing models?	**L1**
4.	**3**	What is n-jobs through three machines sequencing	**L1**
5.	**3**	What is the significance of sequencing jobs optimally?	**L1**
6.	**3**	What are the main objectives of job sequencing?	**L1**
		PART-B (10 marks)	
1	**3**	Explain the procedure of the Johonson's algorithm for n jobs and m machines.	**L4**
2	**3**	Find the sequence of jobs that minimizes the total elapsed time to complete the following jobs on two machines. **Jobs** | **1** | **2** | **3** | **4** | **5** | **6** ***Machine A*** | ***3*** | ***12*** | ***5*** | ***2*** | ***9*** | ***11*** ***Machine B*** | ***8*** | ***10*** | ***9*** | ***6*** | ***3*** | ***1***	**L3**
3	**3**	Determine the optimal sequencing to complete the following tasks on two machines. *Task* | *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* | *I* *Machine 1* | *2* | *5* | *4* | *9* | *6* | *8* | *7* | *5* | *4* *Machine 2* | *6* | *8* | *7* | *4* | *3* | *9* | *3* | *8* | *11*	**L4**
4	**3**	Determine the optimal sequencing of the following 7 jobs on two machines. *Jobs* | *1* | *2* | *3* | *4* | *5* | *6* | *7* *Machine 1* | *3* | *12* | *15* | *6* | *10* | *11* | *9* *Machine 2* | *8* | *10* | *10* | *6* | *12* | *1* | *3*	**L3**

5	**3**	Determine the sequence which minimized the total time for processing five jobs on three machines A, B, C. The following table gives the processing times. *Jobs* 1 2 3 4 5 *Machine A* 8 10 6 7 11 *Machine B* 5 6 2 3 4 *Machine C* 4 8 6 5	**L5**
6	**3**	The processing times of six jobs on three machines M1, M2, M3 are given below. *Jobs* M_1 M_2 M_3 *1* *3* *8* *13* *2* *12* *6* *14* *3* *5* *4* *9* *4* *2* *6* *12* *5* *9* *3* *8* *6* *11* *1* *13* Find optimal sequence, total elapsed time and idle time.	**L4**
7	**3**	Solve the following sequencing problem of four jobs on five machines. *Job* / *Machines* M1 M2 M3 M4 M5 *A* 7 5 2 3 9 *B* 6 6 4 5 10 *C* 5 4 5 6 8 *D* 8 3 3 2 6	**L3**
8	**3**	Solve the following sequencing problem. Job / Machines M1 M2 M3 M4 M5 M6 M7 A 20 10 9 4 12 9 40 B 22 8 11 8 10 10 30 C 12 7 10 7 9 12 32 D 30 6 5 6 10 11 28	**L5**
9	**3**	Use the graphical method to minimize the time needed to process the following jobs on the machines shown, i.e. each machine find the job which should be done first. Also calculate the total elapsed time to complete both jobs. Job-1 Sequnce of machine time: A 3, B 4, C 2, D 6, E 2 Job-2 Sequnce of machine time: B 5, C 4, A 3, D 2, E 6	**L4**

10	**3**	Two jobs are to be processed on four machines A, B, C and D. The technological order for these jobs on machines is as follows: Job-1: A B C D; 4 6 7 3 Job-2: D B A C; 4 7 5 8	**L3**

S.No.	**CO**	**Questions**	**BT**
		Unit IV: (Game Theory)	
		PART-A (2 marks)	
1.	**4**	What is a saddle point?	**L1**
2.	**4**	Define the value of the game	**L1**
3.	**4**	What is the optimum strategy for a player?	**L1**
4.	**4**	Define pay-off matrix	**L1**
5.	**4**	What is strategy?	**L1**
6.	**4**	What is dominance property for rows in game theory?	**L1**
7.	**4**	What is two persons zero-sum game?	**L1**
8.	**4**	Define maxmin and minmax principle.	**L1**
		PART-B (10 marks)	
1	**4**	Consider the following payoff matrix with respect to player A and player B and solve it Optimally a. B_1 B_2 B_3 B_4 A_1 20 15 12 35 A_2 25 14 8 10 A_3 40 2 10 15 A_4 -5 4 11 0 b. B_1 B_2 B_3 A_1 20 15 22 A_2 35 45 40 A_3 18 20 25	**L4**

<table>
<tr>
<td>2</td>
<td>4</td>
<td>a. If the following game is determinable find the limits for the value of λ

<table>
<tr><td></td><td>B_1</td><td>B_2</td><td>B_3</td></tr>
<tr><td>A_1</td><td>λ</td><td>6</td><td>4</td></tr>
<tr><td>A_2</td><td>-1</td><td>λ</td><td>-7</td></tr>
<tr><td>A_3</td><td>-2</td><td>4</td><td>λ</td></tr>
</table>

b. If the saddle point is (2,2) in the following payoff matrix find the range of the values p and q

<table>
<tr><td></td><td>B_1</td><td>B_2</td><td>B_3</td></tr>
<tr><td>A_1</td><td>2</td><td>6</td><td>5</td></tr>
<tr><td>A_2</td><td>10</td><td>7</td><td>q</td></tr>
<tr><td>A_3</td><td>5</td><td>p</td><td>8</td></tr>
</table>
</td>
<td>L3</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>Write the algorithm for Game with Mixed Strategies</td>
<td>L4</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Consider the following payoff matrix and solve it Optimally.

<table>
<tr><td></td><td>B_1</td><td>B_2</td></tr>
<tr><td>A_1</td><td>8</td><td>-3</td></tr>
<tr><td>A_2</td><td>-3</td><td>1</td></tr>
</table>
</td>
<td>L3</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>Consider the following 4X4 gme played by players A and B and solve it optimally

<table>
<tr><td></td><td>B_1</td><td>B_2</td><td>B_3</td><td>B_4</td></tr>
<tr><td>A_1</td><td>5</td><td>10</td><td>9</td><td>0</td></tr>
<tr><td>A_2</td><td>6</td><td>7</td><td>8</td><td>1</td></tr>
<tr><td>A_3</td><td>8</td><td>7</td><td>15</td><td>1</td></tr>
</table>
</td>
<td>L5</td>
</tr>
</table>

		A_4 | 3 | 4 | -1 | 4	
6	**4**	Solve the following 3X5 game using Dominance Property **Player B** **1 2 3 4 5** **Player A** 1: **2 5 10 7 2**; 2: **3 3 6 6 4**; 3: **4 4 8 12 1**	**L4**
7	**4**	Write the algorithm for Graphical method for 2 X n and m X 2 games	**L3**
8	**4**	Solve the following game graphically B A: -6 7 / 4 -5 / -1 2 / -2 5 / 7 -6	**L5**
9	**4**	Solve the following game graphically Player-B 1 2 3 4 Player-A 1: 2 1 0 -2; 2: 1 0 3 2	**L4**
10	**4**	Solve the following game Graphical method Player-B 1 2 3 4 5 Player-A 1: 3 0 6 -1 7; 2: -1 5 -2 2 1	**L3**

<table>
<tr><th>S.No.</th><th>CO</th><th>Questions</th><th>BT</th></tr>
<tr><td colspan="4">Unit V: (Project Management)</td></tr>
<tr><td colspan="4">PART-A (2 marks)</td></tr>
<tr><td>1.</td><td>5</td><td>Distinguish between CPM and PERT</td><td>L2</td></tr>
<tr><td>2.</td><td>5</td><td>When do you use dummy activity?</td><td>L1</td></tr>
<tr><td>3.</td><td>5</td><td>Define critical path</td><td>L1</td></tr>
<tr><td>4.</td><td>5</td><td>Write any two applications of CPM/PERT</td><td>L2</td></tr>
<tr><td>5.</td><td>5</td><td>Define float</td><td>L1</td></tr>
<tr><td>6.</td><td>5</td><td>Define Earliest Start Time (EST) and Earliest Finish Time (EFT).</td><td>L1</td></tr>
<tr><td>7.</td><td>5</td><td>State Any Two Rules for Constructing a Network Diagram</td><td>L1</td></tr>
<tr><td>8.</td><td>5</td><td>Define Network Analysis in Project Management</td><td>L1</td></tr>
<tr><td colspan="4">PART-B (10 marks)</td></tr>
<tr><td>1</td><td>5</td><td>Draw a network diagram for the following set of activities:
A<B, C; B<D, E; C<D; D<F; E<G; F<G</td><td>L4</td></tr>
<tr><td>2</td><td>5</td><td>Draw a network diagram for the following set of activities
<table>
<tr><td>Activity</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td><td>H</td><td>I</td></tr>
<tr><td>Immediate predecessor</td><td>-</td><td>-</td><td>-</td><td>A</td><td>B,C</td><td>A</td><td>C</td><td>D,E,F</td><td>D</td></tr>
</table></td><td>L3</td></tr>
<tr><td>3</td><td>5</td><td>. A Project consists of a series of jobs A,B,C,D,E,F,G,H,I such that A<D,E ; B,D<F ; C<G; B<H; F,G< I.
The time of completion of each job is given below:
<table>
<tr><td>Job</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td><td>H</td><td>I</td></tr>
<tr><td>Time (Days)</td><td>23</td><td>8</td><td>20</td><td>16</td><td>24</td><td>18</td><td>19</td><td>4</td><td>10</td></tr>
</table>
Find the critical path and the minimum time required to complete the project.</td><td>L4</td></tr>
</table>

<table>
<tr>
<td>4</td>
<td>5</td>
<td>Find the critical path of the project with the following activitie
<table>
<tr><td>Job</td><td>Time</td><td>Job</td><td>Time</td></tr>
<tr><td>(1,2)</td><td>4</td><td>(5,6)</td><td>4</td></tr>
<tr><td>(1,3)</td><td>1</td><td>(5,7)</td><td>8</td></tr>
<tr><td>(2,4)</td><td>1</td><td>(6,8)</td><td>1</td></tr>
<tr><td>(3,4)</td><td>1</td><td>(7,8)</td><td>2</td></tr>
<tr><td>(3,5)</td><td>6</td><td>(8,10)</td><td>5</td></tr>
<tr><td>(4,9)</td><td>5</td><td>(9,10)</td><td>7</td></tr>
</table>
</td>
<td>L3</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>A project consists of jobs A,B,C,D,E,F,G,H,I such that A<D; A<E; B<F; D<F; C<G;C<H; F<I; G<I.
The time taken for each job is given below:
<table>
<tr><td>Job</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td><td>H</td><td>I</td></tr>
<tr><td>Time (Days)</td><td>8</td><td>10</td><td>8</td><td>10</td><td>16</td><td>17</td><td>18</td><td>14</td><td>9</td></tr>
</table>
Draw the network diagram. Find the critical path and minimum time of completion of the project.</td>
<td>L5</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>Find the critical path of a project having the tasks as given below
<table>
<tr><td>Job</td><td>Time</td><td>Job</td><td>Time</td></tr>
<tr><td>(1,2)</td><td>2</td><td>(5,8)</td><td>5</td></tr>
<tr><td>(2,3)</td><td>7</td><td>(6,7)</td><td>8</td></tr>
<tr><td>(2,4)</td><td>3</td><td>(6,10)</td><td>4</td></tr>
<tr><td>(3,4)</td><td>3</td><td>(7,9)</td><td>4</td></tr>
<tr><td>(3,5)</td><td>5</td><td>(8,9)</td><td>1</td></tr>
<tr><td>(4,6)</td><td>3</td><td>(9,10)</td><td>7</td></tr>
</table>
</td>
<td>L4</td>
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</table>

<table>
<tr>
<td>7</td>
<td>5</td>
<td>A Project consists of the following activities and time estimation.

<table>
<tr><th rowspan="2">ACTIVITY</th><th colspan="3">ESTIMATED DURATION IN WEEKS</th></tr>
<tr><th>OPTIMISTIC</th><th>MOST LIKELY</th><th>PESSIMISTIC</th></tr>
<tr><td>(1,2)</td><td>1</td><td>1</td><td>7</td></tr>
<tr><td>(1,3)</td><td>1</td><td>4</td><td>7</td></tr>
<tr><td>(1,4)</td><td>2</td><td>2</td><td>8</td></tr>
<tr><td>(2,5)</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>(3,5)</td><td>2</td><td>5</td><td>14</td></tr>
<tr><td>(4,6)</td><td>2</td><td>5</td><td>8</td></tr>
<tr><td>(5,6)</td><td>3</td><td>6</td><td>15</td></tr>
</table>

a) Draw the network.
b) Find the expected time and variance for each activity.
c) What is the probability that the project will be completed 4 weeks earlier than the expected time.
d) What is the probability that the project will be completed in 19 weeks?</td>
<td>L3</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
<td>For a certain project the data is given below. Draw the network diagram, identify the Critical path and compute the project duration (in months) and also find the total float.
<table>
<tr><td>Activity</td><td>1-2</td><td>1-4</td><td>1-7</td><td>2-3</td><td>3-6</td><td>4-5</td><td>4-8</td><td>5-6</td><td>6-9</td><td>7-8</td><td>8-9</td></tr>
<tr><td>Time</td><td>2</td><td>2</td><td>1</td><td>4</td><td>1</td><td>3</td><td>8</td><td>4</td><td>3</td><td>3</td><td>5</td></tr>
</table>
</td>
<td>L5</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>A small project is composed of seven activities whose time estimates in weeks are given below. Find the critical path. What is the probability that the project will be completed at least four weeks earlier than expected?
<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>Optimistic time</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>Most likely time</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>Pessimistic time</td><td>7</td><td>7</td><td>8</td><td>1</td><td>14</td><td>8</td><td>15</td></tr>
</table>
</td>
<td>L4</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
<td>Describe the Step-by-step procedure to apply the CPM and PERT methods in project management</td>
<td></td>
</tr>
</table>

Note: L1-Remembering, L2-Understanding, L3-Applying, L4-Analyzing, L5-Evaluating, and L6-Creating