S.A.ENGINEERINGCOLLEGE,CHENNAI-600077
(An Autonomous Institution affiliated to Anna University)
DEPARTMENT OF CSBS
MA1406A-OPTIMIZATION TECHNIQUES
QUESTION BANK

PART A

Q.No.	Questions	CO	BT	competence
	UNIT-I LINEAR MODELS			
1.	What do you mean by general LPP? Linear Programming is a mathematical technique for choosing the best alternative from a set of feasible alternatives, in situations where the objective function as well as the restrictions or constraints can be expressed as linear mathematical function.	CO1	BTL-1	Remember
2.	Define Slack, Surplus variables. Slack Variable: If the constraints of a given LPP be $\Sigma a_{ij} x_j \leq$ bi then the non-negative variable Si which are introduced to convert the inequalities to equalities $\Sigma a_{ij} x_j + Si = b_i$ are called slack variables. Surplus variable: If the constraints of a given LPP be $\Sigma a_{ij} x_j \geq b_i$ then the nonnegative variable Si which are introduced to convert the inequality constraints to the equations $\Sigma a_{ij} x_j - Si = b_i$ are called surplus variables.	CO1	BTL-1	Remember
3.	Define non-degenerate solution A basic solution is said to be a non-degenerate basic solution if none of the basic variables is zero	CO1	BTL-1	Remember
4.	Define unbalanced solution and infeasible solution Let there exists a basic feasible solution to a given LPP if for at least one j, for which aij ≤ 0 Zj – Cj is negative, and then there does not exists any optimum solution to this LPP Infeasible solution: If some values of the set of values $x_1,x_2,x_3,x_4 \ldots\ldots x_n$			

	are negative which satisfies the constraints of the LPP is called its infeasible solution.	CO1	BTL-1	Remember
5.	What are the limitations of Graphical method? (1)Problems involving 2 variables can only be solved effectively by this method. (2)Large number of constraints makes the solution difficult.	CO1	BTL-1	Remember
6.	What is meant by an optimal solution Any feasible solution, which optimizes (maximizes or minimizes) the objective function of the LPP is called its optimum solution or optimal solution.	CO1	BTL-1	Remember
7.	Old hens can be bought at Rs.2 each and young ones at Rs.5 each. The old hens lay 3 eggs per week and the young ones lay 5eggs per week, each egg being worth 30 paise. A hen costs Rs.1 per week to feed. A person has only Rs.80 to spend for hens. How many of each kind should he buy to give a profit of more than Rs.6 per week, assuming that he cannot house more than 20 hens. Formulate this as a L.P.P. Max $Z = 0.5 x_2 – 0.1x_1$ Sub to $2x_1 + 5x_2 \leq 80$ $x_1 + x_2 \leq 20$ $0.5x_2 – 0.1x_1 \geq 6$ & $x_1, x_2 \geq 0$	CO1	BTL-1	Remember
8.	Egg contains 6 units of vitamin A per gram and 7 units of vitamin B per gram and cost 12 paise per gram. Milk contains 8 units of vitamin A per gram and 12 units of vitamin B per gram and costs 20 paise per gram. The daily minimum requirement of vitamin A and vitamin B are 100 units and 120 units respectively. Find the optimal product mix. Formulate this problem as a LPP. Let x_1 = number of grams of eggs to be consumed x_2 = number of grams of milk to be consumed The LPP is: Min $Z = 12x_1 + 20x_2$ Subject to	CO1	BTL-2	Understand

	$6x_1 + 8x_2 \geq 100$ $7x_1 + 12x_2 \geq 120$ $x_1, x_2 \geq 0$			
9.	What are the methods used to solve an LPP involving artificial variables and its uses i) Big M method or penalty cost method ii) Two-phase simplex method The purpose of introducing artificial variables is just to obtain an initial basic feasible solution.	CO1	BTL-1	Remember
10.	What are the disadvantages of Big M method over Two-phase method. The Disadvantages of Big M method over Two–phase method: 1. Big M method can be used to find the existence of feasible solution. But it is difficult and many a time one gets confused during computation because of manipulation of constant M. In two–phase method big M is eliminated and calculations will become easy. 2. The existence of big M avoids the use of digital computer for calculations.	CO1	BTL-1	Remember
	UNIT -2-INTEGER PROGRAMMING AND TRANSPORTATION PROBLEMS			
11.	Write down the methods for solving integer linear programming problems. The following method is used to solve both pure and mixed integer programming problem (i) Gomory's cutting plane algorithm or Fractional cut algorithm (ii) Branch and bound method or Search method	CO2	BTL-1	Remember
12.	Mention some important applications of integer programming problem. i. The transportation and assignment problems ii. Product mix problems			

	iii. All allocation problems involving the allocation of men and machine.	CO2	BTL-1	Remember
13.	List different types of Integer programming problems.(or) Can you provide various types of integer programming (i) Pure Integer Programming Problem: In a LPP, if all the variables in the optimal solution are restricted to assume non-negative integer values then it is called a pure integer programming problem. (ii) Mixed Integer Programming Problem: In an LPP, if only some of the variables in the optimal solution are restricted o assume non-negative integer values, while the remaining variables are free to take any non-negative values then it is called a mixed integer programming problem.	CO2	BTL-1	Remember
14.	What do you understand by Transportation problem ? It is a special type of linear programming model in which th goods are shipped from various origins to different destinations. The objective is to find the best possible allocations of goods from various origins to different destinations such that the total transportation cost is minimum.	CO2	BTL-1	Remember
15.	What do you understand by degeneracy in a transportation problem If the number of occupied cells in a m x n transportation problem, is less than (m+n-1) , then the problem is said to be degenerate.	CO2	BTL-1	Remember
16.	How do you convert the maximization problem in to a minimization one ? To solve the maximization problem in to minimization assignment problem, first convert the given maximization matrix in to an equivalent minimization matrix form by multiplying –1 in all the cost elements. Then the problem is a maximization one and can be solved by the usual assignment method.	CO2	BTL-1	Remember

17.	What is traveling salesman problem and what are its objectives ? In this model a salesman has to visit ' n ' cities. He has to start from a particular city, visit each city once and then return to his starting point. The main objective of a salesman is to select the best sequence in which he visited all cities in order to minimize the total distance traveled or minimize the total time.	CO2	BTL-1	Remember
18.	Why assignment problem will always provide degeneracy ? In assignment problem, the allocation is one to one basis therefore, the number of occupied cells in each row and each column will be exactly equal to 1. Hence assignment problem will always provide degeneracy.	CO2	BTL-1	Remember
19.	What do you Understand by resticted assignments ? Explain how should one overcome it ? In assignment problems, it is assured that the performance of all the machines and operators are same. Hence any machine can be assigned to any job. But in practical cases, a machine cannot do all the operations of a job and operator cannot do all kinds of tasks. Therefore a high processing time is assigned to the impossible cell (M or ∞) and then it will be solved by the usual assignment method. In the final assignment the restricted cell will not be present.	CO2	BTL-1	Remember
20.	State the difference between TP & AP <table><tr><td>Assignment</td><td>Transportation</td></tr></table>	CO2	BTL-1	Remember

Allocations are made one to one basis.Therefore only one occupied cell will be Present in each row and each column. Hence the table will be a square matrix.	More than one allocation is possible in each row and each column . Hence it neet not be a square matrix.
It will always provide degeneracy	It will not provide degeneracy
The supply at any row and demand at any column will be equal to 1	The supply and demand may have any positive quantity.

21.	What do you mean by an unbalanced AP? Since the assignment is one to one basis the problem have a square matrix. If the given problem is not a square matrix ie the number of rows and columns are not same then it is called unbalanced assignment problem. To make it a balanced assignment add a dummy row or dummy column and then convert it into a balanced one. Assign zero cost values for the dummy row or column and solve it by usual assignment method.	CO2	BTL-1	Remember
22.	How do you convert an unbalanced transportation problem into a balanced? Any transportation problem is said to be unbalanced if $\sum_{i=1}^{m} a_i \neq \sum_{j=1}^{n} b_j$. i.e., if the total supply is not equal to the total demand. This unbalanced problem can be converted into a	CO2	BTL-1	Remember

<table>
<tr><td></td><td>balanced one by introducing dummy source or dummy destination with zero cost then solve by usual method.</td><td></td><td></td><td></td></tr>
<tr><td>23.</td><td>What is the purpose of MODI method ?
MODI method is the test procedure for optimality involves examination of each unoccupied cell to determine whether or not making an allocation in it reduce the total transportation cost and then repeating this procedure until lowest possible transportation cost is obtained.</td><td>CO2</td><td>BTL-1</td><td>Remember</td></tr>
<tr><td colspan="5"><u>UNIT-III PROJECT SCHEDULING</u></td></tr>
<tr><td>21.</td><td>What do you mean by project ?
A project is defined as a combination of inter-related activities with limited resources(namely, men , machines, materials, money, and time) all of which must be executed in a defined order for its completion.</td><td>CO3</td><td>BTL-1</td><td>Remember</td></tr>
<tr><td>22.</td><td>What are the two basic planning and controlling techniques in a net work analysis?
(i) Critical Path Method (ii) Programme Evaluation and Review Technique.</td><td>CO3</td><td>BTL-1</td><td>Remember</td></tr>
<tr><td>23.</td><td>What are the advantages of CPM and PERT techniques ?
1. It encourages a logical discipline in planning, scheduling and control of projects.
2.It helps to effect considerable reduction of project times and the cost.</td><td>CO3</td><td>BTL-1</td><td>Remember</td></tr>
<tr><td>24.</td><td>What are the difference between PERT AND CPM ?
<table>
<tr><th>S.NO</th><th>CPM</th><th>PERT</th></tr>
<tr><td>1.</td><td>Network is built on the basis of activity</td><td>An event oriented
Network</td></tr>
<tr><td>2.</td><td>Deterministic nature</td><td>Probabilistic nature</td></tr>
</table></td><td>CO3</td><td>BTL-1</td><td>Remember</td></tr>
</table>

	3. One time estimation Three time Estimation			
25.	What is network ? A network is a graphical representation of a project's operations and is composed of all the events and activities in sequence, along with their inter relationship and inter dependencies.	CO3	BTL-1	Remember
26.	What do you mean by an activity in project? An activity represents a job or an individual operation of a project. It consumes, Time, money, resource in doing the work. It will be in between start and end event with arrow.	CO3	BTL-1	Remember
27.	What is event in a network diagram ? An event is the beginning or end of a job or an activity. It represents a specific point in time and does not consume time, money and resources	CO3	BTL-1	Remember
28.	State the rules for network construction**.** i. The starting event and the ending event of an activity are called tail event and head event respectively. ii. The network should have a unique starting node (tail event). iii. The network should have a unique completion node (head event). iv. No activity should be represented by more than one arc in the network.	CO3	BTL-1	Remember
29.	Define the following (i)Optimistic time estimate (ii) Pessimistic time estimate (iii) Most likely time estimate. **Optimistic time estimate** : It is the shortest possible time to perform the activity, assuming that everything goes well. **Pessimistic time estimate** : This is the maximum time that is required to perform the activity, under extremely bad conditions. However, such conditions do not include acts of nature like earth quake, folds etc. It is	CO3	BTL-1	Remember

	the longest of all the three estimates. **Most likely time estimate**. : It is the most often occurring duration of the activity. Statistically, it is the model value of duration of the activity.			
30.	Define Float and Slack. Slack is with respect to an event float is with respect to an activity. In other words, Slack is used with PERT and float with CPM. Float or Slack means extra time over and above its duration which is a non-critical activity can consume without delaying the project.	CO3	BTL-1	Remember
UNIT-IV-CLASSICAL OPTIMISATION THEORY				
31.	Define Non-Linear Programming Problem. Non-Linear programming is the process of solving an optimization problem defined by a system of equalities and inequalities, collectively termed condition, once a set of unknown real variables along with an objective function to be maximized or minimized, where some of the constraints or the objective functions are nonlinear.	CO4	BTL-1	Remember
32.	State the Kuhn-Tucker Conditions. Kuhn-Tucker Conditions(Necessary) (i) $\lambda_i \geq 0, i = 1,2, \dots m$ (ii) $\frac{\partial L}{\partial x_j} = 0, j = 1,2, \dots n$ (First Partial Derivatives) (iii) $\lambda_i(G_i) = 0, i = 1,2, \dots m$ (iv) $G_i(x_1, x_2, \dots\dots x_n) \leq 0, i = 1,2, \dots m$	CO4	BTL-1	Remember
33.	Investigate $f(x) = x^4 + 4x^2$ for maxima and minima? $f(x) = x^4 + 4x^2$ -------------- (1)			

	$f'(x) = 4x^3 + 8x$ --------------(2) $f'(x) = 0$gives $4x^3 + 8x = 0$ ie.,$4x(x^2 + 2) = 0$ $x = 0$ or $x^2 + 2 = 0$ $x^2 + 2 = 0$does not have real solution $\therefore x = 0$is the only stationary (or) extreme value. Now $f''(x) = 12x^2 + 8$ from (2) When $x = 0, f''(0) = 8 > 0$ $x = 0$ minimises $f(x)$and maximum value of $f(x) = f(0) = 0$.	CO4	BTL-2	Understand
34.	What is the condition and order for Newton – Raphson method. Condition for convergence of Newton Raphson method is $\lvert f(x)f''(x)\rvert < \lvert f'(x)\rvert^2$. The rate of convergence in Newton Raphson method is of order 2.	CO4	BTL-1	Remember
35.	State the special cases in Kuhn-Tucker Conditions. (i) For minimization objective with$\leq$ type constraints and maximization objective with$\geq$ type constraints $\lambda_i \leq 0, i = 1,2, \ldots m$ (ii) For minimization objective function with $=$ type constraints,$\lambda_i$is restricted in sign for $i = 1,2, \ldots m$.	CO4	BTL-1	Remember
36.	Define Hessian Matrix? The Hessian of $f(x_1, x_2, \ldots x_n)$ is the $n \times n$ matrix whose i, j^{th} entry is $\frac{\partial^2 f}{\partial x_i \partial x_j}$ .We let $H(x_1, x_2, \ldots x_n)$ denote the value of the Hessian at $(x_1, x_2, \ldots x_n)$.	CO4	BTL-1	Remember

37.	Show that the function $f(x) = x^4 + 6x^2 + 12x$ is convex or concave. Given $f(x) = x^4 + 6x^2 + 12x$ $$\frac{df}{dx} = 4x^3 + 12x + 12$$ $$\frac{d^2f}{dx^2} = 12x^2 + 12$$ Since $\frac{d^2f}{dx^2} > 0$for all values of x, the function is convex.	CO4	BTL-2	Understand
38.	Verify $f(x_1, x_2) = x_1^2 - 3x_1x_2 + 2x_2^2$ is a concave or convex function of R^2. Let $H(x_1, x_2) = \begin{bmatrix} \frac{\partial^2 f}{\partial x_1^2} & \frac{\partial^2 f}{\partial x_1 \partial x_2} \\ \frac{\partial^2 f}{\partial x_1 \partial x_2} & \frac{\partial^2 f}{\partial x_2^2} \end{bmatrix}$ $\therefore H(x_1, x_2) = \begin{bmatrix} 2 & -3 \\ -3 & 4 \end{bmatrix}$. The first principal minors are the diagonal entries of the Hessian (2 and 4). These are positive. But$\lvert H(x_1, x_2) \rvert$ = -1 < 0. Therefore, $f(x_1, x_2)$ is neither concave nor convex functiononR^2.	CO4	BTL-2	Understand
39.	Find an iteration formula for finding the square root of N by Newton's method. $$f(x) = x^2 - N; f'(x) = 2x$$ $$x_{n+1} = x_n - \frac{x_n^2 - N}{2x_n} \Rightarrow x_{n+1} = \frac{1}{2}\left(x_n + \frac{N}{x_n}\right), n = 0,1,2, \dots$$	CO4	BTL-1	Remember
40.	State the methods used to solve NLP with equality constraints. For finding the extreme values of NLPP with equality constraints two methods have been used. They are 1. Jacobian Method	CO4	BTL-1	Remember

	2. Lagrangean Method orLagrangean Multiplier Method.			
39.	What is the advantage of Newton-Raphson method? This method if faster, more reliable and the results are accurate. Requires less number of iterations for convergence. The number of iterationis independent of the size of the system. Suitable for large system.	CO4	BTL-1	Remember
40.	Define Jacobean method J and the Control Matrix C. Let $X = (Y, Z)$when $Y = (y_1, y_2, \dots, y_m)$ and $Z = (z_1, z_2, \dots, z_{n-m})$ are called the dependent and independent variables respectively. The problem is to minimize $Z = f(x)$ subject to $g(x) = 0,$ where $X = (x_1, x_2, \dots, x_n)$ and $g = (g_1, g_2, \dots, g_m)'$ Rewriting the gradient vectors of f and g in terms of y and z. $\nabla f(Y, Z) = (\nabla_y f, \nabla_z f)$ $\nabla g(Y, Z) = (\nabla_y g, \nabla_z g)$ $J = \nabla_y g = \begin{bmatrix} \nabla_y g_1 \\ \nabla_y g_m \end{bmatrix}$ $C = \nabla_z g = \begin{bmatrix} \nabla_z g_1 \\ \nabla_z g_m \end{bmatrix}$ $J_{m*n}$is called the Jacobian matrix and $C_{m,n-m}$ is called the Control matrix.	CO4	BTL-1	Remember
UNIT-V GAME THEORY				
41.	What is meant by Pure Strategy in Game theory. A particular game plan in a deterministic game situation (where a player what other player is going to do), whose objective is to maximize the gain.	CO5	BTL-1	Remember
42.	What are assumption made in Game theory.			

	1) There are finite numbers of competitors (players). 2) The players act reasonably. 3) Every player strives to maximize gains and minimize losses. 4) Each player has finite number of possible courses of action. 5) The choices are assumed to be made simultaneously, so that no player knows his opponent's choice until he has decided his own course of action. 6) The pay-off is fixed and predetermined. 7) The pay-offs must represent utilities.	CO5	BTL-1	Remember
43.	Define: Mixed strategy. When a player is guessing the next move of the opponent, a probabilistic situation is created whose objective is to maximize the expected gain. Thus, a mixed strategy is to select among pure strategies with a fixed probability.	CO5	BTL-1	Remember
44.	State the major limitation of Game theory. The number of players in a game setting must be finite, and all participants are rational and intelligent. Game theory has multiple limitations. For example, the assumption that participants know about their payoff but not other players is unrealistic.	CO5	BTL-1	Remember
45.	Define: Saddle point. Saddle point of a pay-off matrix is that position where the maximum of the row minima coincides with the minimum of the column maxima. For a rectangular game, Maximin of A = Minimax of B is the saddle point of the game.	CO5	BTL-1	Remember
46.	Define Two-person zero-sum game. In a game where there are only two players and the gain of one results in the loss of the other, such that the net gain of both the player is zero.	CO5	BTL-1	Remember
47.	Define Pay-off matrix.			

<table>
<tr><td></td><td>A matrix that shows the payment of each player for a particular strategy after a play or end of the game.</td><td>CO5</td><td>BTL-1</td><td>Remember</td></tr>
<tr><td>48.</td><td>What is Maximin-Minimax principle.
Maximin: The maximizing player lists all his minimum gains from the respective strategies, and selects a strategy which gives the maximum gain out the selected minimum gains.
Minimax: The minimizing player lists all his maximum gains from the respective strategies, and selects a strategy which gives the minimum gain out of the selected maximum gains</td><td>CO5</td><td>BTL-1</td><td>Remember</td></tr>
<tr><td>49.</td><td>Solve the following pay-off matrix:
<table>
<tr><td rowspan="4">Player A</td><td colspan="4">Player B</td></tr>
<tr><td>Strategies</td><td>I</td><td>II</td><td>III</td></tr>
<tr><td>I</td><td>6</td><td>8</td><td>6</td></tr>
<tr><td>II</td><td>4</td><td>12</td><td>2</td></tr>
</table>
Soln:
We shall solve the given pay-off matrix by finding the saddle point,
<table>
<tr><td>Player A</td><td>Player B</td></tr>
</table>
</td><td>CO5</td><td>BTL-2</td><td>Understand</td></tr>
</table>

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<tr>
<td></td>
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<table>
<tr><td></td><td>Strategies</td><td>I</td><td>II</td><td>III</td><td>Row Minimum</td></tr>
<tr><td></td><td>I</td><td>6</td><td>8</td><td>6</td><td>6 Max.</td></tr>
<tr><td></td><td>II</td><td>4</td><td>12</td><td>2</td><td>2</td></tr>
<tr><td></td><td>Column Maximum</td><td>6 Min.</td><td>12</td><td>6 Min.</td><td></td></tr>
</table>
The matrix has two saddle points at (1, 1)and (1, 3). Thus, the solution of game:
(i) Best strategy for player A is I
(ii) Best strategy for player B is I or III
(iii) Value of the game for A is 6 and for B is –6.
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<tr>
<td>50.</td>
<td>
Solve the following pay-off matrix:
<table>
<tr><td rowspan="5">Player A</td><td colspan="6">Player B</td></tr>
<tr><td>Strategies</td><td>I</td><td>II</td><td>III</td><td>IV</td><td>V</td></tr>
<tr><td>I</td><td>9</td><td>3</td><td>1</td><td>8</td><td>0</td></tr>
<tr><td>II</td><td>6</td><td>5</td><td>4</td><td>6</td><td>7</td></tr>
<tr><td>III</td><td>2</td><td>4</td><td>3</td><td>3</td><td>8</td></tr>
</table>
</td>
<td>CO5</td>
<td>BTL-2</td>
<td>Understand</td>
</tr>
</table>

	IV	5	6	2	2	1

Soln:

We shall solve the given pay-off matrix by finding the saddle point,

Player A	Player B						
	Strategies	I	II	III	IV	V	Row Minimum
	I	9	3	1	8	0	0
	II	6	5	4	6	7	4 Max.
	III	2	4	3	3	8	2
	IV	5	6	2	2	1	1
	Column Maximum	9	6	4 Min.	8	8	

The solution for the game:

(i) Best strategy for player A is II

(ii) Best strategy for player B is III

(iii) Value of the game for A is 4 and for B is –4.

51. Find a range of values of a and b for which the following pay-off matrix will a saddle point at (2, 2) position.

<table>
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<table>
<tr><td rowspan="5">Player A</td><td colspan="4">Player B</td></tr>
<tr><td>Strategies</td><td>I</td><td>II</td><td>III</td></tr>
<tr><td>I</td><td>2</td><td>4</td><td>5</td></tr>
<tr><td>II</td><td>10</td><td>7</td><td>b</td></tr>
<tr><td>III</td><td>4</td><td>a</td><td>6</td></tr>
</table>
Soln:
Finding the row minimum and column maximum of the given pay-off matrix,
<table>
<tr><td rowspan="6">Player A</td><td colspan="5">Player B</td></tr>
<tr><td>Strategies</td><td>I</td><td>II</td><td>III</td><td>Row minimum</td></tr>
<tr><td>I</td><td>2</td><td>4</td><td>5</td><td>2</td></tr>
<tr><td>II</td><td>10</td><td>7</td><td>b</td><td>7</td></tr>
<tr><td>III</td><td>4</td><td>a</td><td>6</td><td>4</td></tr>
<tr><td>Column</td><td>10</td><td>7</td><td>6</td><td></td></tr>
</table>
</td>
<td>CO5</td>
<td>BTL-2</td>
<td>Understand</td>
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</table>

	Maximum				

Now, given (2,2) is a saddle point, for row 2, 7 will be the minimum then b > 7. In the second column, 7 will be the maximum, then a < 7. If b = 7, then also (2,2) is a saddle point. But if b = 7, then (2, 3) will also be a saddle point.

∴ the range of values for a and b are a ≤ 7 and b > 7.

52. Solve the following pay-off matrix:

Player A	Player B		
	Strategy	I	II
	I	1	5
	II	4	2

Soln:

The matrix have no saddle points, thus solving by the method of odds

Player A	Player B			
	Strategy	I	II	Odds
	I	1	5	|4 – 2| = 2

CO5	BTL-2	Understand

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<table>
<tr><td></td><td>II</td><td>4</td><td>2</td><td>|1 – 5| = 4</td></tr>
<tr><td></td><td>Odds</td><td>|5 – 2| = 3</td><td>|1 – 4| = 3</td><td></td></tr>
</table>
Value of game, V = [1 × 2 + 4 × 4]/[2 + 4] = 18/6 = 3
Probabilities of selecting strategies:
<table>
<tr><td>Probability of strategies →</td><td>I</td><td>II</td></tr>
<tr><td>Players ↓</td><td></td><td></td></tr>
<tr><td>A</td><td>1/3</td><td>2/3</td></tr>
<tr><td>B</td><td>1/2</td><td>1/2</td></tr>
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<td></td>
<td>PART-B</td>
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<tr>
<td>1.</td>
<td>A firm produces 3 products. These products are processed on 3 different machines. The time required to manufacture one unit of each of the 3 products and the daily capacity of the 3 machines are given below:</td>
<td>CO1</td>
<td>BTL-4</td>
<td>Analyze</td>
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<tr>
<td></td>
<td>It is
<table>
<tr><td rowspan="2">Machine</td><td colspan="3">Time per unit (minutes)</td><td rowspan="2">Machine Capacity (Minutes/day)</td></tr>
<tr><td>Product1</td><td>Product2</td><td>Product3</td></tr>
<tr><td>M₁</td><td>2</td><td>3</td><td>2</td><td>440</td></tr>
<tr><td>M₂</td><td>4</td><td>-</td><td>3</td><td>470</td></tr>
<tr><td>M₃</td><td>2</td><td>5</td><td>-</td><td>430</td></tr>
</table>
required to determine the number of units to be manufactured for each product daily. The profit per unit for product 1,2 and 3 is Rs4, Rs3, Rs6 respectively. It is assumed that all the amounts produced are consumed in the market. Formulate the mathematical model for the problem and solve the LPP by graphical method.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Garden Ltd. Has two product Rose and Lotus. To produce one unit of Rose, 2 units of material X and 4 units of material Y are required. To produce one unit of Lotus, 3 units of material X and 2 units of material Y are required. At least 16 units of each material must be used in order to meet the committed sales of Rose and Lotus Cost per unit of material X and material Y are Rs. 2.50 per unit and Rs.0.25 per unit respectively.
You are required:
(i)To formulate mathematical model
(ii)To solve it for the minimum cost(Graphically)</td>
<td>CO1</td>
<td>BTL-4</td>
<td>Analyze</td>
</tr>
<tr>
<td>3.</td>
<td>Solve by Graphical method
Maximize z = $100x_1+80x_2$ Subject to
$5x_1+20x_2\le 50,$
$8x_1+2x_2\ge 16,$
$3x_1-2x_2\ge 6,$
$x_1,x_2\ge 0$</td>
<td>CO1</td>
<td>BTL-5</td>
<td>Evaluate</td>
</tr>
<tr>
<td>4.</td>
<td>A television company operates 2 assembly sections, section A and section B. Each section is used to assemble the components of 3 types of</td>
<td></td>
<td></td>
<td></td>
</tr>
</table>

<table>
<tr>
<td></td>
<td>televisions : Colour, standard and Economy. The expected daily production on each section is as follows :
<table>
<tr><th>T.V Model</th><th>Section A</th><th>Section B</th></tr>
<tr><td>Colour</td><td>3</td><td>1</td></tr>
<tr><td>Standard</td><td>1</td><td>1</td></tr>
<tr><td>Economy</td><td>2</td><td>6</td></tr>
</table>
The daily running costs for 2 sections average Rs.6000 for section A and Rs.4000 for section B .It is given that the company must produce at least 24 colours, 16 standard and 40 Economy TV sets for which an order is pending. Formulate this as a L.P.P so as to minimize the total cost.</td>
<td>CO1</td>
<td>BTL-4</td>
<td>Analyze</td>
</tr>
<tr>
<td>5.</td>
<td>Solve the following LPP by graphical method.
Minimize Z = $20x_1 + 10x_2$ Subject to
$x_1 + 2x_2 \le 40$
$3x_1 + x_2 \ge 30$
$4x_1 + 3x_2 \ge 60$
$\& \; x_1, x_2 \ge 0$</td>
<td>CO1</td>
<td>BTL-5</td>
<td>Evaluate</td>
</tr>
<tr>
<td>6.</td>
<td>Solve by Simplex Method:
Maximize Z = $4x_1 + 10x_2$
sub to $2x_1 + x_2 \le 50$
$2x_1 + 5x_2 \le 100$
$2x_1 + 3x_2 \le 90$
$x_1, x_2 \ge 0$</td>
<td>CO1</td>
<td>BTL-3</td>
<td>Apply</td>
</tr>
<tr>
<td>7.</td>
<td>Solve by Simplex Method:
Maximize Z = $2x_1 + x_2$
sub to $3x_1 + x_2 \ge 3$
$4x_1 + 3x_2 \ge 6$</td>
<td>CO1</td>
<td>BTL-3</td>
<td>Apply</td>
</tr>
</table>

	$x_1 + 2x_2 \geq 2$ $x_1,x_2 \geq 0.$			
8.	Solve by Simplex Method: Maximize $Z = 3x_1 + 6x_2 + 3x_3$ Sub to $3x_1 + 4x_2 + x_3 \leq 3$ $x_1 + 3x_2 + x_3 \leq 1$ $x_1, x_2, x_3 \geq 0.$	CO1	BTL-3	Apply
9.	Solve by Simplex Method : Minimize $Z = 8x_1 – 2x_2$ Sub to $-4x_1 + 2x_2 \leq 1$ $5x_1 – 4x_2 \leq 3$ $x_1, x_2 \geq 0.$	CO1	BTL-3	Apply
10.	Use Big-M OR Penalty Method to solve Maximize $Z = 3x_1 + 2x_2$ Sub to $2x_1 + x_2 \leq 2$ $3x_1 + 4x_2 \geq 12$ $x_1,x_2 \geq 0.$	CO1	BTL-5	Evaluate
11.	Use Big-M OR Penalty Method to solve Minimize $Z = 4x_1 + 3x_2$ Sub to $2x_1 + x_2 \geq 10$ $-3x_1 + 2x_2 \leq 6$ $x_1 + x_2 \geq 6$ & $x_1,x_2 \geq 0.$	CO1	BTL-5	Evaluate
12.	Use Two-phase method to solve			

	Maximize Z = $5x_1 + 8x_2$ Sub to $3x_1 + 2x_2 \geq 3$ $x_1 + 4x_2 \geq 4$ $x_1 + x_2 \leq 5$ & $x_1, x_2 \geq 0$.	CO1	BTL-5	Evaluate
	UNIT -2			
11.	Use Branch and Bound technique to solve the following Max $z = x_1 + 4x_2$ Subject to $2x_1 + 4x_2 \leq 7$, $5x_1 + 3x_2 \leq 15$ & $x_1, x_2 \geq 0$ and integers			
12.	Use Branch and Bound method to solve the following Max $z = 2x_1 + 3x_2$ Subject to $6x_1 + 5x_2 \leq 25$, $x_1 + 3x_2 \leq 10$ & $x_1, x_2 \geq 0$ and integers			
13.	Use Branch and Bound method to solve the following Max $z = 3x_1 + 4x_2$ Subject to $7x_1 + 16x_2 \leq 52$, $3x_1 - 2x_2 \leq 18$ & $x_1, x_2 \geq 0$ and integers			
14.	Obtain the initial solution for the following TP using NWCR, LCM, VAM	CO2	BTL-4	Analyze

		Destination			
		A	B	C	Supply
Source	1	2	7	4	5
	2	3	3	1	8
	3	5	4	7	7
	4	1	6	2	14
	Demand	7	9	18	34

15. Solve the Transportation Problem where the cell entries denote the unit transportation costs.

		Destination				
		A	B	C	D	Supply
Source	P	5	4	2	6	20
	Q	8	3	5	7	30
	R	5	9	4	6	50
	Demand	10	40	20	30	100

CO2

BTL-4

Analyze

16. Find the minimum transportation cost.

		Warehouse				
		D1	D2	D3	D4	Supply
Factory	F1	19	30	50	10	7
	F2	70	30	40	60	9
	F3	40	8	70	30	18
	Demand	5	8	7	14	

CO2

BTL-4

Analyze

17. Solve the Transportation Problem using Vogel’s approximation method.

<table>
<tr>
<td></td>
<td>
<table>
<tr><td rowspan="6">Source</td><td colspan="6">Destination</td></tr>
<tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>Supply</td></tr>
<tr><td>1</td><td>11</td><td>20</td><td>7</td><td>8</td><td>50</td></tr>
<tr><td>2</td><td>21</td><td>16</td><td>20</td><td>12</td><td>40</td></tr>
<tr><td>3</td><td>8</td><td>12</td><td>8</td><td>9</td><td>70</td></tr>
<tr><td>Demand</td><td>30</td><td>25</td><td>35</td><td>40</td><td></td></tr>
</table>
</td>
<td>CO2</td>
<td>BTL-5</td>
<td>Evaluate</td>
</tr>
<tr>
<td>18.</td>
<td>Solve the following Transportation Problem to maximize the profit.
<table>
<tr><td rowspan="6">Source</td><td colspan="6">Destination</td></tr>
<tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>Supply</td></tr>
<tr><td>1</td><td>40</td><td>25</td><td>22</td><td>33</td><td>100</td></tr>
<tr><td>2</td><td>44</td><td>35</td><td>30</td><td>30</td><td>30</td></tr>
<tr><td>3</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>
</td>
<td>CO2</td>
<td>BTL-5</td>
<td>Evaluate</td>
</tr>
<tr>
<td>19.</td>
<td>Solve the following unbalanced TP.
<table>
<tr><td rowspan="6">FROM</td><td colspan="5">TO</td></tr>
<tr><td></td><td>1</td><td>2</td><td>3</td><td>Supply</td></tr>
<tr><td>1</td><td>5</td><td>1</td><td>7</td><td>10</td></tr>
<tr><td>2</td><td>6</td><td>4</td><td>6</td><td>80</td></tr>
<tr><td>3</td><td>3</td><td>2</td><td>5</td><td>15</td></tr>
<tr><td>Demand</td><td>75</td><td>20</td><td>50</td><td></td></tr>
</table>
</td>
<td>CO2</td>
<td>BTL-3</td>
<td>Apply</td>
</tr>
<tr>
<td>20.</td>
<td>A travelling salesman has to visit 5 cities. He wishes to start from a particular city, visit each city once and then return to his starting point. Cost of going from one city to another is shown below. You are required to find the least cost route.</td>
<td>CO2</td>
<td>BTL-4</td>
<td>Analyze</td>
</tr>
</table>

<table>
<tr>
<td></td>
<td>

To City

$$\text{From City}\quad \begin{array}{cc} & \begin{array}{ccccc} A & B & C & D & E \end{array} \\ \begin{array}{c} A \\ B \\ C \\ D \\ E \end{array} & \begin{bmatrix} \infty & 4 & 10 & 14 & 2 \\ 12 & \infty & 6 & 10 & 4 \\ 16 & 14 & \infty & 8 & 14 \\ 24 & 8 & 12 & \infty & 10 \\ 2 & 6 & 4 & 16 & \infty \end{bmatrix} \end{array}$$

</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>
Solve the Assignment problem:
<table>
<tr><td rowspan="7">Tasks</td><td colspan="6">Men</td></tr>
<tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr>
<tr><td>I</td><td>1</td><td>3</td><td>2</td><td>8</td><td>8</td></tr>
<tr><td>II</td><td>2</td><td>4</td><td>3</td><td>1</td><td>5</td></tr>
<tr><td>III</td><td>5</td><td>6</td><td>3</td><td>4</td><td>6</td></tr>
<tr><td>IV</td><td>3</td><td>1</td><td>4</td><td>2</td><td>2</td></tr>
<tr><td>V</td><td>1</td><td>5</td><td>6</td><td>5</td><td>4</td></tr>
</table>
</td>
<td>CO2</td>
<td>BTL-4</td>
<td>Analyze</td>
</tr>
<tr>
<td>22.</td>
<td>
Solve the Assignment problem:
<table>
<tr><td rowspan="7">Jobs</td><td colspan="6">Machine</td></tr>
<tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr>
<tr><td>A</td><td>11</td><td>17</td><td>8</td><td>16</td><td>20</td></tr>
<tr><td>B</td><td>9</td><td>7</td><td>12</td><td>6</td><td>15</td></tr>
<tr><td>C</td><td>13</td><td>16</td><td>15</td><td>12</td><td>16</td></tr>
<tr><td>D</td><td>21</td><td>24</td><td>17</td><td>28</td><td>26</td></tr>
<tr><td>E</td><td>14</td><td>10</td><td>12</td><td>11</td><td>15</td></tr>
</table>
</td>
<td>CO2</td>
<td>BTL-5</td>
<td>Evaluate</td>
</tr>
<tr>
<td>23.</td>
<td>A company is faced with the problem of assigning 4 machines to different jobs (one machine to one job only). The profits are estimated as follows.</td>
<td></td>
<td></td>
<td></td>
</tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><td rowspan="8">Job</td><td colspan="5">Machine</td></tr>
<tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td></tr>
<tr><td>1</td><td>3</td><td>6</td><td>2</td><td>6</td></tr>
<tr><td>2</td><td>7</td><td>1</td><td>4</td><td>4</td></tr>
<tr><td>3</td><td>3</td><td>8</td><td>5</td><td>8</td></tr>
<tr><td>4</td><td>6</td><td>4</td><td>3</td><td>7</td></tr>
<tr><td>5</td><td>5</td><td>2</td><td>4</td><td>3</td></tr>
<tr><td>6</td><td>5</td><td>7</td><td>6</td><td>4</td></tr>
</table>
Solve the problem to maximize the profit.
</td>
<td>CO2</td>
<td>BTL-4</td>
<td>Analyze</td>
</tr>
<tr>
<td>24.</td>
<td>Write the algorithm for Hungarian method.</td>
<td>CO2</td>
<td>BTL-3</td>
<td>Apply</td>
</tr>
<tr>
<td>25.</td>
<td>There are four machines in a machine shop. On a particular day the shop got Orders for executing five jobs (A, B, C, D & E). the expected profit for each job on each job on machine is as follows:
<table>
<tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td>A</td><td>32</td><td>41</td><td>57</td><td>18</td></tr>
<tr><td>B</td><td>48</td><td>54</td><td>62</td><td>34</td></tr>
<tr><td>C</td><td>20</td><td>31</td><td>81</td><td>57</td></tr>
<tr><td>D</td><td>71</td><td>43</td><td>41</td><td>47</td></tr>
<tr><td>E</td><td>52</td><td>29</td><td>51</td><td>50</td></tr>
</table>
Find the optimal assignment of job to machines to maximize the profit. Which job should be rejected.
</td>
<td>CO2</td>
<td>BTL-5</td>
<td>Evaluate</td>
</tr>
<tr>
<td colspan="5">UNIT-III</td>
</tr>
<tr>
<td>26.</td>
<td>Draw the network from the following activity and find the critical path and total duration of project.</td>
<td></td>
<td></td>
<td></td>
</tr>
</table>

Activity	**Immediate Predecessors**	**Duration (weeks)**
A	-	3
B	-	8
C	A	9
D	B	6
E	C	10
F	C	14
G	C, D	11
H	F, G	10
I	E	5
J	I	4
K	H	1

CO2 BTL-5 Evaluate

27. A project consists of the following activities. Draw the project network. Find the critical path and corresponding project completion time.

Activity	A	B	C	D	E	F	G	H	I	J
Immediate Predecessor	-	-	A, B	A, B	B	C	D	F, G	F, G	E, H
Duration (weeks)	4	3	2	5	6	4	3	7	4	2

CO2 BTL-5 Evaluate

28. A project schedule has the following characteristics

Activity	1-2	1-3	2-4	3-4	3-5	4-9	5-6	5-7	6-8	7-8	8-10	9 1
Time (Hrs.)	4	1	1	1	6	5	4	8	1	2	5	7

(i) Construct the network and compute TF ,FF, IF.

(ii) Find the minimum time of completing the project

(iii) Critical Path.

CO2 BTL-3 Apply

29\.

A project schedule has the following characteristics:

Activity	1 – 2	1 – 4	1 – 7	2 – 3	3 – 6	4 – 5	4 – 8	5 – 6	6 – 9	7 - 8	8 - 9
Duration	2	2	1	4	1	5	8	4	3	3	5

(i) Construct the network and compute TF, FF, IF.

(ii) Find the minimum time of completing the project

(iii) Critical Path.

CO2

BTL-5

Evaluate

30\.

A project has the following activities and other characteristics:

Time estimates (in weeks)

Activity	Preceding activity	Most Optimistic	Most Likely	Most Pessimistic
A	-	4	7	16
B	-	1	5	15
C	A	6	12	30
D	A	2	5	8
E	C	5	11	17
F	D	3	6	15
G	B	3	9	27
H	E, F	1	4	7
I	G	4	19	28

i. Draw the PERT network diagram.

ii. Identify the critical path.

iii. Prepare the activity schedule for the project.

iv. Determine the mean project completion time.

v. Find the probability that the project is completed in 36 weeks.

CO2

BTL-4

Analyze

31\.

Consider the data of project summarized as follows.

Activity	A	B	C	D	E	F	G	H	I	J

Immediate Predecessor		-	-	-	A	A	A	B, C	C	D	E, G
Duration (weeks)	a	4	1	2	1	1	1	1	4	2	6
	m	4	2	5	4	2	5	2	4	2	7
	b	10	9	14	7	3	9	9	4	8	8

(i) Construct the project Network
(ii) Find the expected duration and variance of each activity
(iii) Find the critical path and project completion time
(iv) What is the probability of completing project on or before 35 weeks

CO2 BTL-4 Analyze

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32. The following table shows the jobs of network along with their time estimates.

Activity	A	B	C	D	E	F	G	H
Immediate Predecessor	-	-	-	A	B	C	D, E	F, G
Optimistic Time	1	1	2	1	2	2	3	1
Pessimistic Time	7	7	8	1	14	8	15	3
Most Likely time	1	4	2	1	5	5	6	2

(i) Draw the network
(ii) Calculate the project length.
(iii) What duration will have 95% confidence for project completion?

CO2 BTL-4 Analyze

<table>
<tr><td></td><td>(iv) If the average duration for activity F increased to 14 days what will be its effect on the expected project completion time which will have 95% confidence</td><td></td><td></td><td></td></tr>
<tr><td>33.</td><td>The following table indicates the details of a project. The duration are in days. “a” refers to optimistic time, “m” refers to most likely time and “b” refers to pessimistic time duration.
i. Draw the network.
ii. Find the Critical path.
iii. Determine the expected standard deviation of the completion time.
<table>
<tr><th>Activity</th><th>1 – 2</th><th>1 – 3</th><th>1 – 4</th><th>2 – 4</th><th>2 – 5</th><th>3 – 4</th><th>4 – 5</th></tr>
<tr><td>a</td><td>2</td><td>3</td><td>4</td><td>8</td><td>6</td><td>2</td><td>2</td></tr>
<tr><td>m</td><td>4</td><td>4</td><td>5</td><td>9</td><td>8</td><td>3</td><td>5</td></tr>
<tr><td>b</td><td>5</td><td>6</td><td>6</td><td>11</td><td>12</td><td>4</td><td>7</td></tr>
</table></td><td>CO2</td><td>BTL-4</td><td>Analyze</td></tr>
<tr><td>34.</td><td>The following table shows the jobs of network along with their time estimates.
<table>
<tr><th>Job</th><th>1 - 2</th><th>7 - 8</th><th>2 - 3</th><th>3 - 5</th><th>5 - 8</th><th>6 - 7</th><th>4 - 5</th><th>2 - 4</th><th>1 - 6</th></tr>
<tr><td>Optimistic Time</td><td>3</td><td>4</td><td>6</td><td>5</td><td>1</td><td>3</td><td>3</td><td>2</td><td>2</td></tr>
<tr><td>Pessimistic Time</td><td>15</td><td>28</td><td>30</td><td>17</td><td>7</td><td>27</td><td>15</td><td>8</td><td>14</td></tr>
<tr><td>Most Likely</td><td>6</td><td>19</td><td>12</td><td>11</td><td>4</td><td>9</td><td>6</td><td>5</td><td>5</td></tr>
</table></td><td>CO2</td><td>BTL-5</td><td>Evaluate</td></tr>
</table>

<table>
<tr>
<td></td>
<td>
<table>
<tr><td>time</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
(i) Draw the network
(ii) Calculate the project length and its variance
(iii) Find the earliest and latest event time for all the activities.
(iv) Find the expected variance of the project length
</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35.</td>
<td>
The following table shows the jobs of network along with their time estimates.
<table>
<tr><td>Job</td><td>1-2</td><td>1-6</td><td>2-3</td><td>2-4</td><td>3-5</td><td>4-5</td><td>6-7</td><td>5-8</td><td>7-8</td></tr>
<tr><td>Optimistic Time</td><td>1</td><td>2</td><td>2</td><td>2</td><td>7</td><td>5</td><td>5</td><td>3</td><td>8</td></tr>
<tr><td>Pessimistic Time</td><td>7</td><td>5</td><td>14</td><td>5</td><td>10</td><td>5</td><td>8</td><td>3</td><td>17</td></tr>
<tr><td>Most Likely time</td><td>13</td><td>14</td><td>26</td><td>8</td><td>19</td><td>17</td><td>29</td><td>9</td><td>32</td></tr>
</table>
(i) Draw the network
(ii) Calculate the project length.
(iii) Find the probability that the project is completed in 40 days and 35 days
(iv) Find the earliest and latest event time for all the activities.
(v) Find the expected variance of the project length.
</td>
<td>CO2</td>
<td>BTL-5</td>
<td>Evaluate</td>
</tr>
<tr>
<td>36.</td>
<td>
A Project has the following characteristic
<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></tr>
<tr><td>Predecessors</td><td>-</td><td>A</td><td>A</td><td>B</td><td>B</td><td>D, E</td><td>D</td><td>C, F,G</td></tr>
<tr><td>Duration (Days)</td><td>2</td><td>4</td><td>8</td><td>3</td><td>2</td><td>3</td><td>4</td><td>8</td></tr>
</table>
</td>
<td>CO2</td>
<td>BTL-5</td>
<td>Evaluate</td>
</tr>
</table>

Draw the network of the project. Summarize the CPM calculation and determine the Critical Path.

36. The following table shows the jobs of network along with their time estimates.

Job	A	B	C	D	E	F	G
Predecessor	-	A	A	B	C, D	-	E, F
Optimistic Time	2	6	5	5	3	3	1
Pessimistic Time	8	12	17	11	9	21	7
Most Likely time	5	9	14	8	6	12	4

(i) Draw the network

(ii) Calculate the project length.

(iii) Find the probability that the project is completed in 4 days earlier than expected, not more than 4 days later than expected

(iv) If the project due date is 30 days, find the probability of meeting the due date.

CO2 BTL-3 Apply

UNIT-IV

37 Determine the extreme points

$$f(x) = x_1^2 + 3x_2^2 + 5x_1x_3^2$$
$$g_1(x) = x_1x_3 + 2x_2 + x_2^2 - 11 = 0$$
$$g_2(x) = x_1^2 + 2x_1x_2 + x_3^2 - 14 = 0 \quad \text{with}$$

feasible point $X^0 = (1,2,3)$

13 CO 4 BTL-4

38 Find the maxima or minima of the function

$f(x) = x_1 + 2x_3 + x_2x_3 - x_1^2 - x_2^2 - x_3^2.$

13 CO 4 BTL-4

39 Solve the following using Jacobean method.

13 CO 4 BTL-4

	Minimize $f(z) = x_1^2 + x_2^2 + x_3^2$ Subject to $g_1(x) = x_1 + x_2 + 3x_3 - 2 = 0$ $g_2(x) = 5x_1 + 2x_2 + x_3 - 5 = 0$			
40	Solve the Non-linear programming problem by Lagrangean Method $\text{Minimize}, Z = x_1^2 + x_2^2 + x_3^2$ Subject to the constraints $4x_1 + x_2^2 + 2x_3 = 14,$ $x_1, x_2, x_3 \geq 0$.	13	CO 4	BTL-4
41	Solve the Non-linear programming problem by Lagrangean Method $\text{Maximize}, Z = 4x_1 - x_1^2 + 8x_2 - x_2^2$ Subject to the constraints $x_1 + x_2 = 2$ $x_1, x_2 \geq 0$.	13	CO 4	BTL-4
42	Solve the Non-linear programming problem using the Lagrangean method. Optimize, $Z = 4x_1^2 + 2x_2^2 + x_3^2 - 4x_1x_2$ Subject to the constraints $X_1 + x_2 + x_3 = 15$ $2x_1 - x_2 + 2x_3 = 20$ $x_1, x_2, x_3 \geq 0$.	15	CO 4	BTL-4
43	Solve the NLP by using Kuhn-Tucker Conditions $\text{Max } Z = 8x_1 + 10x_2 - x_1^2 - x_2^2$ Subject to the constraints $3x_1 + 2x_2 \leq 6$ $x_1, x_2 \geq 0$	15	CO 4	BTL-4
44	Solve the NLP by using Kuhn-Tucker Conditions $\text{Min } Z = -x_1^2 + 2x_2^2 + 3x_3^2$ Subject to the constraints $x_1 - x_2 - 2x_3 \leq 12$ $x_1 + 2x_2 - 3x_3 \leq 0.8$	15	CO 4	BTL-4

	$x_1, x_{2,} x_3 \geq 0$			
45	Using Jacobian Method Max $= 2x_1 + 3x_2$ Sub to $x_1 + x_2 + x_3 = 5$ $x_1 + x_2 + x_4 = 3$ $x_1, x_2, x_3, x_4 \geq 0$	13	CO 4	BTL-4
46	Solve the non-linear programming problem by Kuhn-Tucker Condition Minimize $f(x) = x_1^2 + x_2^2 + x_3^2$ Subject to $g_1(x) = 2x_1 + x_2 - 5 \leq 0$ $g_2(x) = x_1 + x_2 - 2 \leq 0$ $g_3(x) = 1 - x_1 \leq 0$ $g_4(x) = 2 - x_2 \leq 0$ $g_5(x) = -x_3 \leq 0$	13	CO 4	BTL-4
UNIT-V				
47	Solve the following 3 x 3 game. Player B Player A $\begin{bmatrix} 3 & -1 & -3 \\ -3 & 3 & -1 \\ -4 & -3 & 3 \end{bmatrix}$	13	CO 5	BTL-4
48	Solve the game whose payoff matrix is given by $\begin{bmatrix} 1 & 3 & 1 \\ 0 & -4 & -3 \\ 1 & 5 & -1 \end{bmatrix}$.	13	CO 5	BTL-4
49	Solve the game whose payoff matrix is given by $\begin{bmatrix} 1 & 7 & 2 \\ 6 & 2 & 7 \\ 6 & 1 & 6 \end{bmatrix}$.	13	CO 5	BTL-4

50	Solve the game whose payoff matrix is given by $\begin{bmatrix} 1 & 7 & 3 & 4 \\ 5 & 6 & 4 & 5 \\ 7 & 2 & 0 & 3 \end{bmatrix}$	13	CO 5	BTL-4
51	Use Arithmetic method to solve the following 3 x 3 game $\begin{pmatrix} 0 & 1 & 2 \\ 2 & 0 & 1 \\ 1 & 2 & 0 \end{pmatrix}$	13	CO 5	BTL-3
52	A and B play a game in which each has three coins, a 5p, a 10p and a 20p. Each selects a coin without the knowledge of the other's choice. If the sum of the coins is an odd amount, A wins B's coin; If the sum is even B wins A's coin. Find the best strategy for each player and the value of the game.	13	CO 5	BTL-4
53	Using Dominance property solve the following game Player B Player A $\begin{pmatrix} 3 & 2 & 4 & 0 \\ 3 & 4 & 2 & 4 \\ 4 & 2 & 4 & 0 \\ 0 & 4 & 0 & 8 \end{pmatrix}$	13	CO 5	BTL-3
54	Using Dominance property solve the following game Player B Player A $\begin{pmatrix} 1 & 7 & 2 \\ 6 & 2 & 7 \\ 5 & 2 & 6 \end{pmatrix}$	13	CO 5	BTL-3
55	Use the notion of dominance to simplify the rectangular game with the following payoff, and solve it graphically. Player B	13	CO 5	BTL-3

	$\begin{array}{cc} \text{Player A} & \begin{bmatrix} 18 & 4 & 6 & 4 \\ 6 & 2 & 13 & 7 \\ 11 & 5 & 17 & 3 \\ 7 & 6 & 12 & 2 \end{bmatrix} \end{array}$			
56	Solve the following 2x5 graphically $\begin{array}{cc} & \text{Player B} \\ \text{Player A} & \begin{pmatrix} 2 & -1 & 5 & -2 & 6 \\ -2 & 4 & -3 & 1 & 0 \end{pmatrix} \end{array}$	13	CO 5	BTL-4
57	Solve the following 2x5 graphically $\begin{array}{cc} & \text{Player B} \\ \text{Player A} & \begin{pmatrix} 3 & 0 & 6 & -1 & 7 \\ -1 & 5 & -2 & 2 & 1 \end{pmatrix} \end{array}$	13	CO 5	BTL-4
58	Solve the following 6 x 2 graphically $\begin{array}{cc} & \text{Player B} \\ \text{Player A} & \begin{pmatrix} 1 & -3 \\ 3 & 5 \\ -1 & 6 \\ 4 & 1 \\ 2 & 2 \\ -5 & 0 \end{pmatrix} \end{array}$	13	CO 5	BTL-4