REJINPAUL QUESTION BANK

CS6704 -RESOURCE MANAGEMENT TECHNIQUES
QUESTION BANK
VII SEMESTER

SYLLABUS

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UNIT V OBJECT SCHEDULING: 9

Network diagram representation – Critical path method – Time charts and resource leveling – PERT.

TEXT BOOK:

1. H.A. Taha, "Operation Research", Prentice Hall of India, 2002.

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2. Anderson 'Quantitative Methods for Business', 8th Edition, Thomson Learning, 2002.
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UNIT I -LINEAR PROGRAMMING 9

Principal components of decision problem – Modeling phases – LP Formulation and graphic solution –Resource allocation problems – Simplex method – Sensitivity analysis.

1. What is linear programming?

Linear programming is a technique used for determining optimum utilization of limited resources to meet out the given objectives. The objective is to maximize the profit or minimize the resources (men, machine, materials and money)

2. Write the general mathematical formulation of LPP.

1. Objective function

Max or Min $Z = C_1x_1 + C_2x_2 + \ldots .. + C_nx_n$

2. Subject to the constraints

$a_{11}x_1+a_{12}x_2+\ldots\ldots\ldots\ldots+ a_{1n}x_n\ (\leq=\geq)b_1$

$a_{21}x_1+a_{22}x_2+\ldots\ldots\ldots\ldots+ a_{2n}x_n\ (\leq=\geq)b_2$

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$a_{m1}x_1+a_{m2}x_2+\ldots\ldots\ldots\ldots+ a_{mn}x_n\ (\leq=\geq)b_m$

3. Non-negative constraints

$x_1,x_2,\ldots.x_m \geq 0$

3. What are the characteristic of LPP?

- There must be a well defined objective function.
- There must be alternative course of action to choose.
- Both the objective functions and the constraints must be linear equation or inequalities.

4. What are the characteristic of standard form of LPP?

- The objective function is of maximization type.
- All the constraint equation must be of equal type by adding slack or surplus variables
- RHS of the constraint equation must be positive type
- All the decision variables are of positive type

5. What are the characteristics of canonical form of LPP? (NOV '07)

In canonical form, if the objective function is of maximization type, then all constraints are of $\leq$ type. Similarly if the objective function is of minimization type, then all constraints are of $\geq$ type. But non-negative constraints are $\geq$type for both cases.

6. A firm manufactures two types of products A and B and sells them at profit of Rs 2 on type A and Rs 3 on type B. Each product is processed on two machines M1 and M2.Type A requires 1 minute of processing time on M1 and 2 minutes on M2 Type B requires 1 minute of processing time on M1 and 1 minute on M2. Machine M1 is available for not more than 6 hours 40 minutes while machine M2 is available for 10 hours during any working day. Formulate the problem as a LPP so as to maximize the profit. (MAY '07)

Maximize $z = 2x_1 + 3x_2$

Subject tot the constraints:

$x_1 + x_2 \leq 400$

$2x_1 + x_2 \leq 600$

$x_1, x_2 \geq 0$

7. A company sells two different products A and B , making a profit of Rs.40 and Rs. 30 per unit on them,respectively.They are produced in a common production process and are sold in two different markets, the production process has a total capacity of 30,000 man-hours. It takes three hours to produce a unit of A and one hour to produce a unit of B. The market has been surveyed and company official feel that the maximum number of units of A that can be sold is 8,000 units and that of B is 12,000 units. Subject to these limitations, products can be sold in any combination. Formulate the problem as a LPP so as to maximize the profit

Maximize $z = 40x_1 + 30x_2$

Subject tot the constraints:

$3x_1 + x_2 \leq 30{,}000$

$x_1 \leq 8000$

$x_2 \leq 12000$

$x_1 , x_2 \geq 0$

8. What is feasibility region? (MAY '08)

Collections of all feasible solutions are called a feasible set or region of an optimization model. Or A region in which all the constraints are satisfied is called feasible region**.**

9. What is feasibility region in an LP problem? Is ti necessary that it should always be a convex set?

A region in which all the constraints are satisfied is called feasible region. The feasible region of an LPP is always convex set**.**

10. Define solution

A set of variables x1,x2….xn which satisfies the constraints of LPP is called a solution.

11. Define feasible solution? (MAY '07)

Any solution to a LPP which satisfies the non negativity restrictions of LPP's called the feasible solution

12. Define optimal solution of LPP. (MAY '09)

Any feasible solution which optimizes the objective function of the LPP's called the optimal solution

13. State the applications of linear programming

- Work scheduling
- Production planning & production process
- Capital budgeting
- Financial planning
- Blending
- Farm planning
- Distribution
- Multi-period decision problem
  - Inventory model
  - Financial model
  - Work scheduling

14. State the Limitations of LP.

- LP treats all functional relations as linear
- LP does not take into account the effect of time and uncertainty
- No guarantee for integer solution. Rounding off may not feasible or optimal solution.
- Deals with single objective, while in real life the situation may be difficult.

15. What do you understand by redundant constraints?

In a given LPP any constraint does not affect the feasible region or solution space then the constraint is said to be a redundant constraint**.**

16. Define Unbounded solution?

If the feasible solution region does not have a bounded area the maximum value of Z occurs at infinity. Hence the LPP is said to have unbounded solution**.**

17. Define Multiple Optimal solution?

A LPP having more than one optimal solution is said to have alternative or multiple optimal solutions.

18. What is slack variable?

If the constraint as general LPP be <= type then a non negative variable is introduced to convert the inequalities into equalities are called slack variables. The values of these variables are interpretedas the amount of unused resources.

19. What are surplus variables?

If the constraint as general LPP be >= type then a non negative
is introduced to convert the inequalities into equalities are called the surplus variables.

20. Define Basic solution?

Given a system of m linear equations with n variables(m<n).The solution obtained by setting (n-m) variables equal to zero and solving for the remaining m variables is called a basic solution.

21. Define non Degenerate Basic feasible solution?

The basic solution is said to be a non degenerate basic solution if None of the basic variables is zero.

22. Define degenerate basic solution?

A basic solution is said to be a degenerate basic solution if one or more of the basic variables are zero.

23. What is the function of minimum ratio?

- To determine the basic variable to leave
- To determine the maximum increase in basic variable
- To maintain the feasibility of following solution

24. From the optimum simplex table how do you identify that LPP has unbounded solution?

To find the leaving variables the ratio is computed. The ratio is <=0 then there is an unbounded solution to the given LPP.

25. From the optimum simplex table how do you identify that the LPP has no solution?

If atleast one artificial variable appears in the basis at zero level with a +ve value in the Xb column and the optimality condition is satisfied
then the original problem has no feasible solution.

26. How do you identify that LPP has no solution in a two phase method?

If all $Z_j - C_j \leq 0$ & then atleast one artificial variable appears in the optimum basis at non zero level the LPP does not possess any solution.

27. What do you understand by degeneracy?

The concept of obtaining a degenerate basic feasible solution in LPP is known as degeneracy. This may occur in the initial stage when atleast one basic variable is zero in the initial basic feasible solution**.**

28. Write the standard form of LPP in the matrix notation?

In matrix notation the canonical form of LPP can be expressed as

Maximize Z = CX(obj fn.)
Sub to AX <= b(constraints) and X >= 0 (non negative restrictions)
Where C = (C1,C2,…..Cn),

$$A = \begin{matrix} a11 & a12 \ldots.. a1n \\ a21 & a22\ldots.. \; a2n \\ . & \end{matrix} \quad , \quad X = \begin{matrix} x1 \\ x2 \\ . \end{matrix} \quad , \quad b = \begin{matrix} b1 \\ b2 \\ . \end{matrix}$$

. . .
am1 am2…. amn xn bn

29. Define basic variable and non-basic variable in linear programming.

A basic solution to the set of constraints is a solution obtained by setting any n variables equal to zero and solving for remaining m variables not equal to zero. Such m variables are called basic variables and remaining n zero variables are called non-basic variables.

30.Solve the following LP problem by graphical method. (MAY '08)

Maximize $z = 6x_1 + 4x_2$ Subject tot the constraints:
$x_1 + x_2 \leq 5$
$x_2 \geq 8$
$x_1, x_2 \geq 0$

31. Define unrestricted variable and artificial variable. (NOV '07)

- Unrestricted Variable :A variable is unrestricted if it is allowed to take on positive, negative or zero values
- Artificial variable :One type of variable introduced in a linear program model in order to find an initial basic feasible solution; an artificial variable is used for equality constraints and for greater-than or equal inequality constraints

PART – B

1. Use Two – Phase simplex method to solve the following LPP.
Maximize Z = 3X1 + 2 X2
Subject to the constraints
2 X1 + X2 ≤ 2
3 X1 + 4 X2 ≥ 12
X1, X2 ≥ 0.

2. Use Big-M method to solve the following LPP.
Maximize Z = 3X1 - X2
Subject to the constraints
2 X1 + X2 ≥ 2
X1 + 3 X2 ≤ 3
X2 ≤ 4
X1, X2 ≥ 0.

3. Use Big-M method to solve the following LPP.
Minimize Z = 2X1 + X2
Subject to the constraints
3X1 + X2 = 3
4X1 + 3X2 ≥ 6
X1 + 2X2 ≤ 3
X1, X2 ≥ 0.

4. Use Big-M method to solve the following LPP.
Maximize Z = 2X1 + X2 + 3 X3
Subject to the constraints
X1 + X2 + 2X3 ≤ 5
2X1 + 3X2 + 4X3 = 12
X1, X2, X3 ≥ 0.

5. Use Big-M method to solve the following LPP.

Maximize $Z = 2X1 + 3X2 + 4X3$

Subject to the constraints

$3X1 + X2 + 4X3 \leq 600$

$2X1 + 4X2 + 2X3 \geq 480$

$2X1 + 3X2 + 3X3 = 540$

$X1, X2, X3 \geq 0.$

6. Use artificial variable technique to solve the LPP.

Maximize $Z = X1 + 2X2 + 3X3 - X4$

Subject to the constraints

$X1 + 2X2 + 3X3 = 15$

$2X1 + X2 + 5X3 = 20$

$X1 + 2X2 + X3 + X4 = 10$

$X1, X2, X3, X4 \geq 0.$

7. Solve the following LPP by Big-M method

Minimize $Z = 2X1 + 3X2$

Subject to the constraints

$X1 + X2 \geq 5$

$X1 + 2X2 \geq 6$

$X1, X2 \geq 0.$

8. Use Simplex method to solve the LPP

Maximize $Z = 3X1 + 5X2$

Subject to the constraints

$3X1 + 2X2 \leq 18$

$0 \leq X1 \leq 4$

$0 \leq X2 \leq 6$

9. Use simplex method to solve the LPP.

Maximize $Z = 4X1 + 10X2$

Subject to the constraints

$2X1 + X2 \leq 50$

$2X1 + 5X2 \leq 100$

$2X1 + 3X2 \leq 90$ and

$X1, X2 \geq 0.$

10. Use Simplex method to solve the LPP.

Maximize $Z = 15X1 + 6X2 + 9X3 + 2X4$

Subject to the constraints

$2X1 + X2 + 5X3 + 6X4 \leq 20$

$3X1 + X2 + 3X3 + 25X4 \leq 24$

$7X1 + X4 \leq 70$

$X1, X2, X3, X4 \geq 0.$

11. Use graphical method to solve the following LPP.

Maximize $Z = 2X1 + X2$

Subject to the constraints

$X1 + 2X2 \leq 10$

$X1 + X2 \leq 6$

$X1 - X2 \leq 2$
$X1 - 2X2 \leq 1$ and
$X1, X2 \geq 0$.

12. Solve the LPP by graphical Method.
Maximize $Z = 3X1 + 5X2$
Subject to the constraints
$-3X1 +4 X2 \leq 12$
$2X1 - X2 \geq -2$
$2X1 + 3X2 \geq 12$
$X1 \leq 4$
$X2 \geq 2$ and $X1, X2 \geq 0$.

13. Solve by graphically
Maximize $Z = 6X1 + 4X2$
Subject to the constraints
$X1 + X2 \leq 5$
$X2 \geq 8$
$X1, X2 \geq 0$.

14. Solve by graphically
Maximize $Z = 100X1 + 40X2$
Subject to the constraints
$5X1 + 2X2 \leq 1000$
$3X1 + 2X2 \leq 900$
$X1 + 2X2 \leq 500$
$X1, X2 \geq 0$

15. A company produces refrigerator in Unit I and heater in Unit II. The two products are produced and sold on a weekly basis. The weekly production cannot exceed 25 in unit I and 36 in Unit II, due to constraints 60 workers are employed. A refrigerator requires 2 man week of labour, while a heater requires 1 man week of labour, the profit available is Rs. 600 per refrigerator and Rs. 400 per heater. Formulate the LPP problem.

16. A firm manufactures two types of products A and B and sells them at profit of Rs 2 on type A and Rs 3 on type B. Each product is processed on two machines M1 and M2.Type A requires 1 minute of processing time on M1 and 2 minutes on M2 Type B requires 1 minute of processing time on M1 and 1 minute on M2. Machine M1 is available for not more than 6 hours 40 minutes while machine M2 is available for 10 hours during any working day. Formulate the problem as a LPP so as to maximize the profit.

17. A company sells two different products A and B , making a profit of Rs.40 and Rs. 30 per unit on them, respectively. They are produced in a common production process and are sold in two different markets, the production process has a total capacity of 30,000 man-hours. It takes three hours to produce a unit of A and one hour to produce a unit of B. The market has been surveyed and company official feel that the maximum number of units of A that can be sold is 8,000 units and that of B is 12,000 units. Subject to these limitations, products can be sold in any combination. Formulate the problem as a LPP so as to maximize the profit

UNIT-II

UNIT II DUALITY AND NETWORKS **9**

Definition of dual problem – Primal – Dual relation ships – Dual simplex methods – Post optimality analysis – Transportation and assignment model - Shortest route problem

1. Define transportation problem.

It is a special type of linear programming model in which the goods are shipped from various origins to different destinations. The objective is to find the best possible allocation of goods from various origins to different destinations such that the total transportation cost is minimum.

2. Define the following: Feasible solution

A set of non-negative decision values xij (i=1,2,….m; j=1,2…n) satisfies the constraint equations is called a feasible solution.

3. Define the following: basic feasible solution

A basic feasible solution is said to be basic if the number of positive allocations are m+n-1.(m-origin and n-destination).If the number of allocations are less than (m+n-1) it is called degenerate basic feasible solution.

4. Define optimal solution in transportation problem

A feasible solution is said to be optimal, if it minimizes the total transportation cost.

5. What are the methods used in transportation problem to obtain the initial basic feasible solution.

- North-west corner rule
- Lowest cost entry method or matrix minima method
- Vogel's approximation method

6. Write down the basic steps involved in solving a transportation problem.

- To find the initial basic feasible solution
- To find an optimal solution by making successive improvements from the initial basic feasible solution**.**

7. What do you understand by degeneracy in a transportation problem? (NOV '07)

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.

8. What is balanced transportation problem& unbalanced transportation problem?

When the sum of supply is equal to demands, then the problem is said to be balanced transportation problem.

A transportation problem is said to be unbalanced if the total supply is not equal to the total demand.

9. How do you convert an unbalanced transportation problem into a balanced one?

The unbalanced transportation problem is converted into a balanced one by adding a dummy row (source) or dummy column (destination) whichever is necessary. The unit transportation cost of the dummy row/ column elements are assigned to zero. Then the problem is solved by the usual procedure.

10. Explain how the profit maximization transportation problem can be converted to an equivalent cost minimization transportation problem. (MAY '08)

If the objective is to maximize the profit or maximize the expected sales we have to convert these problems by multiplying all cell entries by -1.Now the maximization problem becomes a minimization and it can be solved by the usual algorithm

11. Determine basic feasible solution to the following transportation problem using least cost method. (MAY '09)

	A	B	C	D	SUPPLY
P	1	2	1	4	30
Q	3	3	2	1	50
R	4	2	5	9	20
Demand	20	40	30	10	

12. Define transshipment problems?

A problem in which available commodity frequently moves from one source to another source or destination before reaching its actual destination is called transshipment problems.

13. What is the difference between Transportation problem & Transshipment Problem?

In a transportation problem there are no intermediate shipping points while in transshipment problem there are intermediate shipping points

14. What is assignment problem?

An assignment problem is a particular case of a transportation problem in which a number of operations are assigned to an equal number of operators where each operator performs only one operation, the overall objective is to maximize the total profit or minimize the overall cost of the given assignment.

15. Explain the difference between transportation and assignment problems?

Transportation problems	Assignment problems
1) supply at any source may be a any positive quantity.	Supply at any source will be 1.
2) Demand at any destination may be a positive quantity.	Demand at any destination will be 1.
3) One or more source to any number of destination.	One source one destination.

16. Define unbounded assignment problem and describe the steps involved in solving it?

If the no. of rows is not equal to the no. of column in the given cost matrix the problem is said to be unbalanced. It is converted to a balanced one by adding dummy row or dummy column with zero cost**.**

17. Explain how a maximization problem is solved using assignment model?

The maximization problems are converted to a minimization one of the following method.

(i) Since max z = min(-z)

(ii) Subtract all the cost elements all of the cost matrix from the

Highest cost element in that cost matrix.

18. What do you understand by restricted assignment? Explain how you should overcome it?

The assignment technique, it may not be possible to assign a particular task to a particular facility due to technical difficulties or other restrictions. This can be overcome by assigning a very high processing time or cost (it can be ∞) to the corresponding cell.

19. How do you identify alternative solution in assignment problem?

Sometimes a final cost matrix contains more than required number of zeroes at the independent position. This implies that there is more than one optimal solution with some optimum assignment cost.

20. What is a traveling salesman problem?

A salesman normally must visit a number of cities starting from his head quarters. The distance between every pair of cities are assumed to be known. The problem of finding the shortest distance if the salesman starts from his head quarters and passes through each city exactly once and returns to the headquarters is called Traveling Salesman problem**.**

21. Define route condition?

The salesman starts from his headquarters and passes through each city exactly once.

22. Give the areas of operations of assignment problems?

Assigning jobs to machines.
Allocating men to jobs/machines.
Route scheduling for a traveling salesman.

PART-B

1. How do you convert the unbalanced assignment problem into a balanced one? (MAY ’08)

Since the assignment is one to one basis , the problem have a square matrix. If the given problem is not square matrix add a dummy row or dummy column and then convert it into a balanced one (square matrix). Assign zero cost values for any dummy row/column and solve it by usual assignment method.

1.Find the minimum cost distribution plan to satisfy demand for cement at three	To constmetium sites	Capacity tones/months

cremation sites from available capacities at three cement plants given the following transportation costs(in Rs) per tone of cements moved from plants to sites From				
P1	Rs.300	Rs.360	Rs.425	Rs.600
P2	Rs.390	Rs.340	Rs.310	Rs.300
P3	Rs.255	Rs.295	Rs.275	Rs.1000
Demand tones/months	400	500	800	

2.Solve the following assignments problems

I	II	III	IV	V	
A	10	5	9	18	11
B	13	19	6	12	14
C	3	2	4	4	5
D	18	9	12	17	15
E	11	6	14	19	10

3.Solve the TP where cell entries are unit costs. Use vogel's approriments method to fnd the initial basic solution

D1	D2	D3	D4	D5	AVAI LABL E
O1	68	35	4	74	15	18
O2	57	88	91	3	8	17
O3	91	60	75	45	60	19
O4	52	53	24	7	82	13
O5	51	18	82	13	7	15
Required	16	18	20	14	14	

4.A small garments making units has five tailors stitching five different types of garments all the five tailors are capable of stiching all the five types of garments .the output per day per tailor and the profit(Rs.)for each type of garments are given below.

	2	3	4	5	
A	7	9	4	8	6
B	4	9	5	7	8
C	8	5	2	9	8
D	6	5	8	10	10
E	7	8	10	9	9
PROFIT per garment	2	3	2	3	4

Which type of garments should be assigned to which tailor in order to maximize profit, assuming that there are no others constructs

5. Solve the following TP to maximize profit

	A	B	C	D	SUPPLY
1	40	25	22	33	100
2	44	35	30	30	30
3	38	38	28	30	70
DEMANDS	40	20	60	30	

6. Five workless are available to work with the machines and respective cost associated with each worker –machine assignments is given below.A sixth machine is available to replace one of the existing machines and the associated cost are also given below.

	M1	M2	M3	M4	M5	M6
W1	12	3	6	-	5	8
W2	4	11	-	5	-	3
W3	8	2	10	9	7	5
W4	-	7	8	6	12	10
W5	5	8	9	4	6	-

Determine whether the new machine can be accepet ans also determine optmal assignments and the associated saving in cost

7. Solve the following TP using Vogel's approximation method

	A	B	C	D	SUPPLY
I	6	1	9	3	70
II	11	5	2	8	55
III	10	12	4	7	70
DEMAND	85	35	50	45	

8. Solve the assignment problem

	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	14	10	13	13	12
E	8	12	11	7	13	10

9. Find the IBFS of the following TP by VAM and hence find the optimum solutions

	P	Q	R	SUPPLY
A	5	1	7	10
B	6	4	6	80
C	3	2	5	15
DEMAND	45	20	40	

10. Solve the following assignment problems

	M1	M2	M3	M4
J1	18	24	28	32
J2	8	13	17	18
J3	10	15	19	22

11. Solve the following TP

	D1	D2	D3	D4	SUPPLY
S1	6	1	9	3	70
S2	11	5	2	8	55
S3	10	12	4	7	70
DEMANDS	85	35	50	45	

UNIT-III

INTEGER PROGRAMMING **9**

Cutting plan algorithm – Branch and bound methods, Multistage (Dynamic) programming.

1. Define Integer Programming Problem (IPP)? (DEC '07)

A linear programming problem in which some or all of the variables in the optimal solution are restricted to assume non-negative integer values is called an Integer Programming Problem (IPP) or Integer Linear Programming

2. Explain the importance of Integer programming problem?

In LPP the values for the variables are real in the optimal solution. However in certain problems this assumption is unrealistic. For example if a problem has a solution of 81/2 cars to be produced in a manufacturing company is meaningless. These types of **problems require** integer values for the decision variables. Therefore IPP is necessary to round off the fractional values**.**

3. List out some of the applications of IPP? (MAY '09) (DEC '07) (MAY '07)

- IPP occur quite frequently in business and industry.
- All transportation, assignment and traveling salesman problems are IPP, since the decision variables are either Zero or one.
- All sequencing and routing decisions are IPP as it requires the integer values of the decision variables.
- Capital budgeting and production scheduling problem are PP. In fact, any situation involving decisions of the type either to do a job or not to do can be treated as an IPP.
- All allocation problems involving the allocation of goods, men, machines, give rise to IPP since such commodities can be assigned only integer and not fractional values**.**

4. List the various types of integer programming? (MAY '07)

Mixed IPP
Pure IPP

5. What is pure IPP?

In a linear programming problem, if all the variables in the optimal solution are restricted to assume non-negative integer values, then it is called the pure (all) IPP.

6. What is Mixed IPP?

In a linear programming problem, if only some of the variables in the optimal solution are restricted to assume non-negative integer values, while the remaining variables are free to take any non-negative values, then it is called A Mixed IPP.

7. What is Zero-one problem?

If all the variables in the optimum solution are allowed to take values either 0 or 1 as in 'do' or 'not to do' type decisions, then the problem is called Zero-one problem or standard discrete programming problem.

8. What is the difference between Pure integer programming & mixed integer integer programming.

When an optimization problem, if all the decision variables are restricted to take integer values, then it is referred as pure integer programming. If some of the variables are allowed to take integer values, then it is referred as mixed integer integer programming.

9. Explain the importance of Integer Programming?

In linear programming problem, all the decision variables allowed to take any non-negative real values, as it is quite possible and appropriate to have fractional values in many situations. However in many situations, especially in business and industry, these decision variables make sense only if they have integer values in the optimal solution. Hence a new procedure has been developed in this direction for the case of LPP subjected to additional restriction that the decision variables must have integer values.

10. Why not round off the optimum values in stead of resorting to IP? (MAY '08)

There is no guarantee that the integer valued solution (obtained by simplex method) will satisfy the constraints. i.e. ., it may not satisfy one or more constraints and as such the new solution may not feasible. So there is a need for developing a systematic and efficient algorithm for obtaining the exact optimum integer solution to an IPP.

11. What are methods for IPP? (MAY '08)

Integer programming can be categorized as
(i) Cutting methods
(ii) Search Methods.

12. What is cutting method?

A systematic procedure for solving pure IPP was first developed by R.E.Gomory in 1958. Later on, he extended the procedure to solve mixed IPP, named as cutting plane algorithm, the method consists in first solving the IPP as ordinary LPP.By ignoring the integrity restriction and then introducing additional constraints one after the other to cut certain part of the solution space until an integral solution is obtained**.**

13. What is search method?

It is an enumeration method in which all feasible integer points are enumerated. The widely used search method is the Branch and Bound Technique. It also starts with the continuous optimum, but systematically partitions the solution space into sub problems that eliminate parts that contain no feasible integer solution. It was originally developed by A.H.Land and A.G.Doig.

14. Explain the concept of Branch and Bound Technique?

The widely used search method is the Branch and Bound Technique. It starts with the continuous optimum, but systematically partitions the solution space into sub problems that eliminate parts that contain no feasible integer solution. It was originally developed by A.H.Land and A.G.Doig.

15. Give the general format of IPP?

The general IPP is given by
Maximize Z = CX
Subject to the constraints
$AX \leq b$,
$X \geq 0$ and some or all variables are integer.

16. Write an algorithm for Gomory's Fractional Cut algorithm?

1. Convert the minimization IPP into an equivalent maximization IPP and all the coefficients and constraints should be integers.
2. Find the optimum solution of the resulting maximization LPP by using simplex method.
3. Test the integrity of the optimum solution.

4. Rewrite each X_{Bi}

5. Express each of the negative fractions if any, in the k^{th} row of the optimum simplex table as the sum of a negative integer and a non-negative fraction.

6. Find the fractional cut constraint

7. Add the fractional cut constraint at the bottom of optimum simplex table obtained in step 2.

8. Go to step 3 and repeat the procedure until an optimum integer solution is obtained.

17. What is the purpose of Fractional cut constraints?

In the cutting plane method, the fractional cut constraints cut the unuseful area of the feasible region in the graphical solution of the problem. i.e. cut that area which has no integer-valued feasible solution. Thus these constraints eliminate all the non-integral solutions without loosing any integer-valued solution.

18.A manufacturer of baby dolls makes two types of dolls, doll X and doll Y. Processing of these dolls is done on two machines A and B. Doll X requires 2 hours on machine A and 6 hours on Machine B. Doll Y requires 5 hours on machine A and 5 hours on Machine B. There are 16 hours of time per day available on machine A and 30 hours on machine B. The profit is gained on both the dolls is same. Format this as IPP?

Let the manufacturer decide to manufacture x_1 the number of doll X and x_2 number of doll Y so as to maximize the profit. The complete formulation of the IPP is given by

Maximize $Z = x_1+x_2$

Subject to $2 x_1 + 5 x_2 \leq 16$

$6 x_1+ 5 x_2 \leq 30$

and ≥ 0 and are integers.

19. Explain Gomory's Mixed Integer Method?

The problem is first solved by continuous LPP by ignoring the integrity condition. If the values of the integer constrained variables are integers, then the current solution is an optimal solution to the given mixed IPP. Else select the source row which corresponds to the largest fractional part among these basic variables which are constrained to be integers. Then construct the Gomarian constraint from the source row. Add this secondary constraint at the bottom of the optimum simplex table and use dual simplex method to obtain the new feasible optimal solution. Repeat this procedure until the values of the integer restricted variables are integers in the optimum solution obtained.

20. What is the geometrical meaning of portioned or branched the original problem?

Geometrically it means that the branching process eliminates portion of the feasible region that contains no feasible-integer solution. Each of the sub-problems solved separately as a LPP.

21. What is standard discrete programming problem?

If all the variables in the optimum solution are allowed to take values either 0 or 1 as in 'do' or 'not to do' type decisions, then the problem is called standard discrete programming problem.

22. What is the disadvantage of branched or portioned method?

It requires the optimum solution of each sub problem. In large problems this could be very tedious job.

23. How can you improve the efficiency of portioned method?

The computational efficiency of portioned method is increased by using the concept of bounding. By this concept whenever the continuous optimum solution of a sub problem yields a value of the objective function lower than that of the best available integer solution it is useless to explore the problem any further consideration. Thus once a feasible integer solution is obtained, its associative objective function can be taken as a lower bound to delete inferior sub-problems. Hence efficiency of a branch and bound method depends upon how soon the successive sub-problems are fathomed.

24.What are the condition of branch and bound method

1.The values of the decision variables of the problem are integer

2.The upper bound of the problem which has non-integer values for its decision variables is not greater than the current best lower bound

3. The problem has an infeasible solution

25. What are Traditional approach to solving integer programming problems.

- Feasible solutions can be partitioned into smaller subsets
- Smaller subsets evaluated until best solution is found.
- Method is a tedious and complex mathematical process

PART-B

1. Find the optimum integer solution to the following LPP.

Maximize Z = X1 + X2

Subject to the constraints

$3\ X1 + 2\ X2 \leq 5$

$X2 \leq 2$

$X1, X2 \geq 0$ and are integers.

2. Solve the following ILPP.

Maximize Z = X1 + 2X2

Subject to the constraints

$2\ X2 \leq 7$

$X1 + X2 \leq 7$

$2X2 \leq 11$

$X1, X2 \geq 0$ and are integers.

3. Solve the following ILPP.

Maximize Z = 11X1 + 4X2

Subject to the constraints

$-X1 + 2X2 \leq 4$

$5X1 + 2X2 \leq 16$

$2X1 - X2 \leq 4$

$X1, X2 \geq 0$ and are non negative integers.

4. Solve the integer programming problem.

Maximize Z = 2X1 + 20X2 - 10X3

Subject to the constraints
$2X1 + 20X2 + 4X3 \leq 15$
$6X1 + 20X2 + 4X3 \leq 20$
$X1, X2, X3 \geq 0$ and are integers.

5. Solve the following mixed integer linear programming problem using Gomarian's cutting plane method.

Maximize $Z = X1 + X2$
Subject to the constraints
$3 X1 + 2 X2 \leq 5$
$X2 \leq 2$
$X1, X2 \geq 0$ and X1 is an integer.

6. Solve the following mixed integer programming problem.

Maximize $Z = 7X1 + 9 X2$
Subject to the constraints
$-X1 + 3X2 \leq 6$
$7X1 + X2 \leq 35$
and $X1, X2, \geq 0$, X1 is an integer.

7. Solve the following mixed integer programming problem.

Maximize $Z = 4X1 + 6X2 + 2X3$
Subject to the constraints
$4X1 - 4X2 \leq 5$
$-X1 + 6X2 \leq 5$
$-X1 + X2 + X3 \leq 5$
and $X1, X2, X3 \geq 0$, and X1 , X3 are integers.

8. Use Branch and bound algorithm to solve the following ILPP

Maximize $Z = 11X1 + 4X2$
Subject to the constraints
$-X1 + 2X2 \leq 4$
$5X1 + 2X2 \leq 16$
$2X1 - X2 \leq 4$
$X1, X2 \geq 0$ and are non negative integers

9. Use Branch and bound algorithm to solve the following ILPP

Maximize $Z = X1 + 4X2$
Subject to the constraints
$2X1 + 4X2 \leq 7$
$5X1 + 3X2 \leq 15$
$X1, X2 \geq 0$ and are integers.

10. Use Branch and bound algorithm to solve the following ILPP

Maximize $Z = 2X1 + 2X2$
Subject to the constraints
$5X1 + 3X2 \leq 8$
$X1 + 2X2 \leq 4$
$X1, X2 \geq 0$ and are integers.

UNIT-IV

CLASSICAL OPTIMISATION THEORY

Unconstrained external problems, Newton – Ralphson method – Equality constraints – Jacobean methods – Lagrangian method – Kuhn – Tucker conditions – Simple problems.

PART-A

1. **Discuss the different types of nonlinear programming problems.**
    - Price elasticity
    - Product-mix problem
    - Graphical nillustration
    - Global and local optimum
2. **Explain the application areas of nonlinear programming problems.**
    - Transportation problem
    - Product mix problem
    - NP Problems
3. **State the Lagrangean model.**

    The Lagrangian method usually tracks transiently a large amount of particles. The method starts from solving the transient momentum equation for each particle:

$$\frac{d\vec{u}_p}{dt} = F_D\left(\vec{u} - \vec{u}_p\right) + \frac{\vec{g}\left(\rho_p - \rho\right)}{\rho_p} + \vec{F}_a \qquad (4)$$

4. **What is Newton Ralphson method?**

    Newton and Joseph Raphson, is a method for finding successively better approximations to the roots (or zeroes) of a real-valued function
5. **State the equality constraints.**

    Consider the *equality constrained convex quadratic* minimization problem:

$$\begin{aligned} \text{minimize} \quad & \frac{1}{2}x^\top P x + q^\top x + r \\ \text{subject to} \quad & Ax = b\,, \end{aligned}$$

where $P \in^{n\times n}, P \succeq 0$ and $A \in \mathbb{R}^{p\times n}$. The optimality conditions are:

$$\begin{cases} Ax^* & = b\,, \\ \nabla f(x^*) + A^\top \lambda^* & = 0\,. \end{cases}$$

6. **Define Jacobean method.**

4.4 Jacobean methods

Optimization problem

One of the well known method to solve this system of equations is a Newton – Raphson method, which is one of so called Householder's methods in numerical analysis.

For the function of one variable it is based on the fact that for a differentiable function f(x) we have the following approximation:

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

Similarly, for the system of n functions of n variables:

$$X_{n+1} = X_n - [F'(x_n)]^{-1} F(X_n)$$

$F'(x_n)$,often called Jacobean matrix, is a matrix of first order partial derivatives of all the functions.

7. State the Kuhn-Tucker conditions.

1.Linearity constraint qualification.
2.Linear independence constraint qualification (LICQ):
3.Mangasarian–Fromovitz constraint qualification (MFCQ):
3.Constant rank constraint qualification (CRCQ):
4.Constant positive linear dependence constraint qualification (CPLD):

8. Define nonlinear programming.

Nonlinear programming is the process of solving an optimization problem defined by a system of equalities and inequalities, collectively termed constraints, over a set of unknown real variables, along with an objective function to be maximized or minimized, where some of the constraints or the objective function are nonlinear.

10.**Write the general format of non linear programming**

Let n, m, and p be positive integers. Let X be a subset of Rn, let f, gi, and hj be real-valued functions on X for each i in {1, …, m} and each j in {1, …, p}.

A nonlinear minimization problem is an optimization problem of the form

$$\text{Maximize } f(x_1, x_2, \ldots, x_n),$$

subject to:

$$\begin{aligned} g_1(x_1, x_2, \ldots, x_n) &\leq b_1, \\ \vdots \qquad\qquad & \quad \vdots \\ g_m(x_1, x_2, \ldots, x_n) &\leq b_m, \end{aligned}$$

where each of the constraint functions g_1 through g_m is given. A special case is the linear program that has been treated previously. The obvious association for this case is

$$f(x_1, x_2, \ldots, x_n) = \sum_{j=1}^{n} c_j x_j,$$

11.write the format of Newton Ralphson method

The Newton Raphson method is for solving equations of the form $f(x) = 0$. We make an initial guess for the root we are trying to find, and we call this initial guess x_0.
The sequence $x_0, x_1, x_2, x_3, \ldots$ generated in the manner described below should converge to the exact root.
To implement it analytically we need a formula for each approximation in terms of the previous one, i.e. we need x_{n+1} in terms of x_n.
The equation of the tangent line to the graph $y = f(x)$ at the point $(x_0, f(x_0))$ is

$$y - f(x_0) = f'(x_0)(x - x_0)$$

The tangent line intersects the x-axis when $y = 0$ and $x = x_1$, so

$$-f(x_0) = f'(x_0)(x_1 - x_0)$$

Solving this for x_1 gives

$$x_1 = x_0 - \frac{f(x_0)}{f'(x_0)}$$

and, more generally,

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)} \tag{1}$$

12.What re the optimisation problems

- Constrained optimisation problems
- Un Constrained optimisation problems

PART-B

1. Solve the following non linear programming problem using Langrangean multipliers method.
   Minimize $Z=4X_1^2+2X_2^2+X_3^2-4X_1X_2$

Subject to

$X_1+X_2+X_3=15$

$2X_1-X_2+2X_3=20$

X_1,X_2 AND $X_3 \geq 0$

2. Solve the following non linear programming problem using Kuhn-Tucker conditions.

   Maximize $Z=8X_1+10X_2- X_1^2-X_2^2$

   Subject to

   $3X_1+2X_2\leq 6$

   X_1 and $X_2\geq 0$
3. State and explain the Lagrangean method and steps involved in it with an example.
4. Explain the Kuhn-Tucker method and steps involved in it with an example.
5. Explain the Newton-Raphson method in detail and justify how it is used to solve the non linear equations.

6.What is Jacobian method? Explain the steps how Jacobian matrix is generated

UNIT-V

OBJECT SCHEDULING: 9

Network diagram representation – Critical path method – Time charts and resource leveling – PERT

1. What do you mean by project?

A project is defined as a combination on 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.

2. What are the three main phases of project?

- Planning, Scheduling and Control

3. What are the two basic planning and controlling techniques in a network analysis?

- Critical Path Method (CPM)
- Programme Evaluation and Review Technique (PERT)

4. What are the advantages of CPM and PERT techniques?

- It encourages a logical discipline in planning, scheduling and control of projects
- It helps to effect considerable reduction of project times and the cost
- It helps better utilization of resources like men,machines,materials and money with reference to time
- It measures the effect of delays on the project and procedural changes on the overall schedule**.**

5. What is the difference CPM and PERT

CPM

- Network is built on the basis of activity
- Deterministic nature
- One time estimation

PERT

- An event oriented network
- Probabilistic nature
- Three time estimation

6. What is network?

A network is a graphical representation of a project's operation and is composed of all the events and activities in sequence along with their inter relationship and inter dependencies.

7. What is Event in a network diagram?

An event is specific instant of time which marks the starts and end of an activity. It neither consumes time nor resources. It is represented by a circle.

8. Define activity?

A project consists of a number of job operations which are called activities. It is the element of the project and it may be a process, material handling, procurement cycle etc.

9. Define Critical Activities?

In a Network diagram critical activities are those whose if consumer more than estimated time the project will be delayed.

10. Define non critical activities?

Activities which have a provision such that the event if they consume a specified time over and above the estimated time the project will not be delayed are termed as non critical activities.

11. Define Dummy Activities?

When two activities start at a same time, the head event are joined by a dotted arrow known as dummy activity which may be critical or non critical**.**

12. Define duration?

It is the estimated or the actual time required to complete a trade or an activity.

13. Define total project time?

It is time taken to complete to complete a project and just found from the sequence of critical activities. In other words it is the duration of the critical path**.**

14. Define Critical Path?

It is the sequence of activities which decides the total project duration. It is formed by critical activities and consumes maximum resources and time.

15. Define float or slack? (MAY '08)

Slack is with respect to an event and 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 a non-critical activity can consume without delaying the project.

16. Define total float? (MAY '08)

The total float for an activity is given by the total time which is available for performance of the activity, minus the duration of the activity. The total time is available for execution of the activity is given by the latest finish time of an activity minus the earliest start time for the activity. Thus

Total float = Latest start time – earliest start time.

17. Define free float? (MAY '08)

This is that part of the total float which does not affect the subsequent activities. This is the float which is obtained when all the activities are started at the earliest.

18. Define Independent float? (MAY '07) (MAY '08)

If all the preceding activities are completed at their latest, in some cases, no float available for the subsequent activities which may therefore become critical.

Independent float = free – tail slack.

19. Define Interfering float?

Sometimes float of an activity if utilized wholly or in part, may influence the starting time of the succeeding activities is known as interfering float.

Interfering float = latest event time of the head - earliest event time of the event.

20. Define Optimistic?

Optimistic time estimate is the duration of any activity when everything goes on very well during the project.

21. Define Pessimistic?

Pessimistic time estimate is the duration of any activity when almost everything goes against our will and a lot of difficulties is faced while doing a project.

22. Define most likely time estimation?

Most likely time estimate is the duration of any activity when sometimes thing go on very well, sometimes things go on very bad while doing the project.

24. What is a parallel critical path?

When critical activities are crashed and the duration is reduced other paths may also become critical such critical paths are called parallel critical path.

25. What is standard deviation and variance in PERT network? (NOV '07)

The expected time of an activity in actual execution is not completely reliable and is likely to vary. If the variability is known we can measure the reliability of the expected time as determined from three estimates. The measure of the variability of possible activity time is given by standard deviation, their probability distribution

Variance of the activity is the square of the standard deviation

26. Give the difference between direct cost and indirect cost? (NOV '07)

Direct cost is directly depending upon the amount of resources involved in the execution of all activities of the project. Increase in direct cost will decrease in project duration. Indirect cost is associated with general and administrative expenses, insurance cost, taxes etc. Increase in indirect cost will increase in project duration.

PART-B

1. A project schedule has the following characteristics

Activity	0 – 1	0 – 2	1 – 3	2 – 3	2 – 4	3 – 4	3 – 5	4 – 5	4 - 6	5 - 6
Time	2	3	2	3	3	0	8	7	8	6

(i). Construct Network diagram.

(ii). Compute Earliest time and latest time for each event.

(iii). Find the critical path. Also obtain the Total float, Free float and slack time and Independent float

2.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 - 10
Time	4	1	1	1	6	5	4	8	1	2	5	7

(i). Construct Network diagram

(ii). Compute Earliest time and latest time for each event.

(iii). Find the critical path. Also obtain the Total float, Free float and slack time and Independent float.

3.A small project is composed of seven activities whose time estimates are listed in the table as follows:

Activity	Preceding Activities	Duration
A	----	4
B	----	7
C	----	6
D	A,B	5
E	A,B	7
F	C,D,E	6
G	C,D,E	5

(I). Draw the network and find the project completion time.
(ii). Calculate the three floats for each activity

4.Calculate the total float, free float and independent float for the project whose activities are given below:

Activity	1 – 2	1 – 3	1 – 5	2 – 3	2 – 4	3 – 4	3 – 5	3 – 6	4 - 6	5 - 6
Key	8	7	12	4	10	3	5	10	7	4

Find the critical path also.

5.Draw the network for the following project and compute the earliest and latest times for each event and also find the critical path.

Activity	1 – 2	1 – 3	2 – 4	3 – 4	4 – 5	4 – 6	5 – 7	6 – 7	7 - 8
Immediate Predecessor	---	---	1 – 2	1 – 3	2 – 4	2 – 4 & 3 - 4	4 – 5	4 – 6	6 – 7 & 5 - 7
Time	5	4	6	2	1	7	8	4	

6.The following table lists the jobs of a network with their time estimates:

Job(I, j)	Duration		
	Optimistic (to)	Most likely(tm)	Pessimistic (tp)
1 – 2	3	6	15
1 – 6	2	5	14
2 – 3	6	12	30
2 – 4	2	5	8
3 – 5	5	11	17
4 – 5	3	6	15
6 – 7	3	9	27
5 – 8	1	4	7
7 – 8	4	19	28

(i). Draw the project network.

(ii). Calculate the length and variance of the Critical Path.
(iii). What is the approximate probability that the jobs on the critical path will be completed by the due date of 42 days?
(iv). What due date has about 90 % chance of being met?

7.A small project is composed of 7 activities, whose time estimates are listed in the table below. Activities are identified by their beginning (i) and (j) node numbers.

Job(I, j)	Duration		
	Optimistic (to)	Most likely(tm)	Pessimistic (tp)
1 – 2	1	1	7
1 – 3	1	4	7
1 – 4	2	2	8
2 – 5	1	1	1
3 – 5	2	5	14
4 – 6	2	5	8
5 – 6	3	6	15

(i). Draw the project network and identify all the paths through it.
(ii). Find the expected duration and variance for each activity. What is the expected project length?
(iii). Calculate the variance and standard deviation of the project length. What is the probability that the project will be completed atleast 4 weeks earlier than expected time?

8.The following table lists the jobs of a network along with their time estimates.

Activity	1 – 2	1 – 3	2 – 4	3 – 4	3 – 5	4 – 9	5 – 6	5 – 7	6 – 8	7 - 8	8 – 10	9 - 10
Time	4	1	1	1	6	5	4	8	1	2	5	7

(i). Draw the project network.
(ii). Calculate the length and variance of the critical path after estimating the earliest and latest event times for all nodes.
(iii). Find the probability of completing the project before 41 days?

9. The time estimates (in weeks) for the activities of a PERT network are given below:

Job(I, j)	Duration		
	Optimistic (to)	Most likely(tm)	Pessimistic (tp)
1 – 2	1	1	7
1 – 3	1	4	7
1 – 4	2	2	8
2 – 5	1	1	1
3 – 5	2	5	14
4 – 6	2	5	8
5 – 6	3	6	15

(i). Determine the expected project length.
(ii). Calculate the standard deviation and variance of the project.
(iii). If the project due date is 19 weeks, what is the probability of not meeting the due date?

10.The following table lists the jobs of a network along with their time estimates

Job(I, j)	Duration		
	Optimistic (to)	Most likely(tm)	Pessimistic (tp)
1 – 2	2	5	14
1 – 3	9	12	15
2 – 4	5	14	17
3 – 4	2	5	8
4 – 5	6	6	12
3 – 5	8	17	20

Draw the network. Calculate the length and variance of the critical path and find the probability that the project will be completed within 30 days