DEPARTMENT OF STATISTICS
Operational Research (OR)
DSE-I

1) Operations Research came to existence?

2) Operations Research approach is ______________.

a) Multi-disciplinary
b) Scientific
c) Intuitive
d) Collect essential data

3) A feasible solution to a linear programming problem ______________.

A. Must satisfy all the constraints of the problem simultaneously
B. Need not satisfy all of the constraints, only some of them
C. Must be a corner point of the feasible region.
D. Must optimize the value of the objective function.

4) If any value in XB column of final simplex table is negative, then the solution is ______________.

A. Infeasible
B. Infeasible
C. Bounded
D. No solution

5) For any primal problem and its dual______________.

A. optimal value of objective function is same
B. dual will have an optimal solution iff primal does too
C. primal will have an optimal solution iff dual does too
D. both primal and dual cannot be infeasible

6) The OR technique are not applicable in the _________ situation.

7) An optimal assignment requires that the maximum number of lines which can be drawn through squares with zero opportunity cost should be equal to the number of ______________.

A. Rows or columns
B. Rows and columns.
C. Rows +columns- 1
D. Rows -columns.

8) To proceed with the Modified Distribution method algorithm for solving an transportation problem, the number of dummy allocations need to be added are______________.

A. n
B. n-1
C. 2n-1
D. n-2

9. Select the correct statement

A. EOQ is that quantity at which price paid by the buyer is minimum
B. If annual demand doubles with all other parameters remaining constant, the Economic Order Quantity is doubled
C. Total ordering cost equals holding cost
D. Stock out cost is never permitted

10. Which of the following is not associated with LPP.

A. Proportionality
B. Uncertainty
C. Additively
D. Divisibility.

11. The objective of network analysis is to______________.

A. minimize total project duration
B. minimize total project cost
C. minimize production delays, interruption and conflicts
D. maximize total project duration

12. A constraint in an LPP restricts.

A. Value of objective function
B. Value of a decision variable,
C. Use of variable resource
D. Uncertainty of optimum values.

13. If there is no non-negative replacement ratio in solving a Linear Programming Problem then the solution is ______________.

A. feasible
B. bounded
C. unbounded
D. infinite

14. A constraint in an LPP is expressed as
A. an equation with = sign
B. inequality with ≥ sign
C. inequality with ≤ sign
D. Any of the above.

15. In marking assignments, which of the following should be preferred?
A. Only row having single zero
B. Only column having single zero
C. Only row/column having single zero
D. Column having more than one zero

16. Minimization of objective function in LPP means
A. least value chosen among the allowable decisions
B. greatest value chosen among the allowable decisions
C. both (a) and (b)
D. None of the above.

17. If the order quantity (size of order) is increased, _______________
A. holding costs decrease and ordering costs increase
B. holding costs increase and ordering costs decrease
C. the total costs increase and then decrease
D. storage cost as well as stock-out cost increase

18. _______________ is a mathematical technique used to solve the problem of allocating limited resource among the competing activities
A. Linear Programming problem
B. Assignment Problem
C. Replacement Problem
D. Nonlinear Programming Problem

19. A mixed strategy game can be solved by _______________.
A. Simplex method
B. Hungarian method
C. Graphical method
D. Degeneracy

20. The activity cost corresponding to the crash time is called the _______________.
A. critical time
B. normal time
C. cost slope
D. crash cost

21. A set of feasible solution to a Linear Programming Problem is _______________
A. convex
B. polygon
C. triangle
D. bold

22. In a Linear Programming Problem functions to be maximized or minimized are called _______________.
A. constraints
B. objective function
C. basic solution
D. feasible solution

23. If the primal problem has n constraints and m variables then the number of constraints in the dual problem is _______________.
A. mn
B. m+n
C. m-n
D. m/n

24. The non-basic variables are called _______________.
A. shadow cost
B. opportunity cost

C. slack variable
D. surplus variable

25. Key element is also known as _______________.
A. slack
B. surplus
C. artificial
D. pivot

26. The solution to a transportation problem with m-sources and n-destinations is feasible if the numbers of allocations are _______________.
A. m+n
B. mn
C. m-n
D. m+n-1

27. The allocation cells in the transportation table will be called _______________ cell
A. occupied
B. unoccupied
C. no
D. finite

28. To resolve degeneracy at the initial solution, a very small quantity is allocated in _______________ cell
A. occupied
B. unoccupied
C. no
D. finite

29. The assignment algorithm was developed by _______________ method.
A. Hungarian.
B. Vogel's
C. M0di
D. Traveling Sales Man

30. An assignment problem is a particular case of _______________.
A. transportation Problem
B. assignment Problem
C. travelling salesman problem
D. replacement Problem

31. The coefficient of slack\surplus variables in the objective function are always assumed to be _______________.
A. 0
B. 1
C. M
D. -M

32. Using _______________ method, we can never have an unbounded solution
A. Simplex
B. Dual simplex
C. Big M
D. Modi

33. The number ore
A. 1
B. 2
C. More than 2.

34. if two constraints do not intersect in the positive quadrant of the graph , then
A. One of the constraints is redundant.
B. The solution is infeasible.
C. The solution is unbounded.
D. None of the above.

35. An activity which does not consume neither any resource nor time is known as _______________.
A. predecessor activity
B. successor activity
C. dummy activity
D. activity

36. The general linear programming problem is in standard form, if.
A. The constraints are strict equations.

B. The constraints are inequalities of ≤ type.
C. The constraints are inequalities of ≥ type
D. The decision variables are unrestricted in sign.
E. interference

37. Given a system of m simultaneous linear equations in n unknown (m<n) the number of basic variables will be
A. m
B. n
C. n-m
D. n + m

38. The assignment problem is always a _______________matrix.
A. circle
B. square
C. rectangle
D. triangle

39. The slack variables indicate _______________.
A. Excess resource available.
B. Shortage of resource
C. Nil resource
D. Idle resource

40. If the net evaluation corresponding to any non -basic variable is zero, it is an indication of the existence of an _______________.
A. Initial basic feasible solution
B. Optimum basic feasible solution
C. Optimum solution.
D. Alternate optimum solution.

41. Mathematical model of linear programming problem is important because _______________.
A. it helps in converting the verbal description and numerical data into mathematical expression
B. decision makers prefer to work with formal models
C. it captures the relevant relationship among decision factors
D. it enables the use of algebraic technique

42. While solving a linear programming problem infeasibility may be removed by _______________.
A. adding another constraint
B. adding another variable
C. removing a constraint
D. removing a variable

43. The right hand side constant of a constraint in a primal problem appears in the corresponding dual as _______
A. a coefficient in the objective function
B. a right hand side constant of a function
C. an input output coefficient a left hand side constraint
D. coefficient variable

44. During iteration while moving from one solution to the next, degeneracy may occur when_______________
A. The closed path indicates a diagonal move
B. Two or more occupied cells are on the closed path but neither of them represents a corner of the path.
C. Two or more occupied cells on the closed path with minus sign are tied for lowest circled value.
D. The closed path indicates a rectangle move.

45. Maximization assignment problem is transformed into a minimization problem by_______________.
A. adding each entry in a column from the maximum value in that column
B. subtracting each entry in a column from the maximum value in that column
C. subtracting each entry in the table from the maximum value in that table
D. adding each entry in the table from the maximum value in that table

46. For maximization linear programming problem, the simplex method is terminated when all the net-evaluations are .
A. Negative.
B. Non-negative
C. zero
D. Non-positive

47. Replace an item when_______________.
A. Average cost up to date is equal to the current maintenance cost
B. Average cost up to date is greater than the current maintenance cost
C. Average cost up to date is less than the current maintenance cost.

D. Next year running cost in more than average cost of nth year

48. A necessary and sufficient condition for a basic feasible solution to a minimization LPP to be an optimum is that (for all j).

A. $z_j - c_j \geq 0,$
B. $z_j - c_j \leq 0,$
C. $z_j - c_j = 0,$
D. $z_j - c_j > 0 \text{ or } z_j - c_j < 0,$

49. The transportation problem deals with the transportation of _______________.

A. a single product from a source to several destinations
B. a single product from several sources to several destinations
C. a single product from several sources to a destination
D. a multi -product from several sources to several destinations

50. The minimum number of lines covering all zeros in a reduced cost matrix of order n can be _______________.

A. at the most n
B. at the least n
C. n-1
D. n+1

1.5 MARKS QUESTIONS

1. For a 2.5% increase in order quantity (under fundamental EOQ problem) the total relevant cost would _______________

A. Increase by 2.5%.
B. Decrease by 2.5%.
C. Increase by 0.25%.
D. Decrease by 0.25%.

2. In the basic EOQ model, if the lead time increases from 2 to 4 days, the EOQ will _______________

A. double increase
B. remain constant
C. but not double
D. decrease by a factor of two

3. When the sum of gains of one player is equal to the sum of losses to another player in a game, this situation is known as _______________.

A. two-person game
B. two-person zero-sum game
C. zero-sum game
D. non-zero-sum game

4. In the network, one activity may connect any _______________ nodes

A. 1
B. 2
C. 3
D. 4

5. Graphical method is also known as _______________.

A. Simplex Method
B. Dual Simplex Method
C. Big-M Method
D. Search-Approach Method

6. If the given Linear Programming Problem is in its standard form then primal-dual pair is _______________.

A. symmetric
B. un symmetric
C. square
D. triangle

7. The method used to solve Linear Programming Problem without use of the artificial variable is called ______?

A. Simplex Method
B. Big-M Method
C. Dual Simplex Method
D. Graphical Method

8. When the total demand is equal to supply then the transportation problem is said to be _______________

A. balanced
B. unbalanced
C. maximization
D. minimization

9. For finding an optimum solution in transportation problem _______________ method is used.
A. Simplex
B. Big-M
C. Modi
D. Hungarian

10. Linear Programming Problem is a technique of finding the _______________.
A. optimal value
B. approximate value
C. initial value
D. infeasible value

11. Any solution to a Linear Programming Problem which also satisfies the non- negative notifications of the problem has _______________.
A. solution
B. basic solution
C. basic feasible solution
D. feasible solution

12. At any iteration of the usual simplex method, if there is at least one basic variable in the basis at zero level all $(z_j - c_j \geq 0,$ the current solution is?
A. Infeasible.
B. Unbounded
C. Non-degenerate.
D. Degenerate.

13. A game is said to be strictly determinable if_______________.
A. maximin value equal to minimax value
B. maximin value is less than or equal to minimax value
C. maximin value is greater than or equal to minimax value
D. maximin value is not equal to minimax value

14. The irreducible minimum duration of the project is called _______________.
A. critical time
B. normal time
C. cost slope
D. crash duration

15. The cost of a slack variable is _______________.
A. 0
B. 1
C. 2
D. -1

16. Linear Programming Problem that can be solved by graphical method has _______________.
A. linear constraints
B. quadratic constraints
C. non-linear constraints
D. bi-quadratic constraints

17. If one or more variable vanish then a basic solution to the system is called _______________.
A. non feasible region
B. feasible region
C. degenerate solution
D. basic solution

18. _______________ method is an alternative method of solving a Linear Programming Problem involving artificial variables
A. Simplex Method
B. Big-M Method
C. Dual Simplex Method
D. Graphical Method

19. The role of artificial variables in simplex method is.
A. To aid in finding initial basic feasible solution.

B. To start phases of simplex method.
C. To find shadow prices from the final simplex method
D. None of the above.

20. In a transportation table, an ordered set of_______________ or more cells is said to form a loop
A. 2
B. 3
C. 4
D. 5

21. A Linear Programming Problem have _______________ optimal solution
A. 1
B. 2
C. more than 1
D. more than 2

22. An n-tuple of real numbers which satisfies the constraints of Linear Programming Problem is called _______________
A. solution
B. basic solution
C. basic feasible solution
D. feasible solution

23. Chose the correct statement: A degenerate solution is one that_______________.
A. gives an optimum solution to the Linear Programming Problem
B. gives zero value to one or more of the basic variables
C. yields more than one way to achieve the objective
D. makes use of all available resources

24. At any iteration of the usual simplex method, if there is at least one basic variable in the basis at zero level and all the index numbers are non-negative, the current solution is _______________.
A. basic solution
B. non basic solution
C. degenerate
D. non degenerate

25. For maximization LPP, the objective function co-effieient for an artificial variable is .
A. +M
B. -M
C. +1
D. Zero.

26. In final (optimum) simplex table, if $z_j - c_j = 0$, for at least one non-basic variable, then there will be
A. An unbounded solution.
B. Infeasible solution.
C. Alternative solution
D. Cycling

27. If an optimum solution is degenerate, then.
A. The solution is feasible.
B. There is alternative optimum solution.
C. The solution is of no use to the decision maker
D. None of the above

28. In a network diagram an event is denoted by the symbol _______________.
A. arrow
B. straight line
C. curve
D. circle

29. An _______________ represent the start or completion of some activity and as such it consumes no time
A. activity
B. event
C. slack
D. path

30. If a negative value appears in the solution value (x_B) column of the simplex method , then.
A. The basic solution is optimum.
B. The basic solution is infeasible.
C. The basic solution is bounded.
D. All of the above.

31. The assignment problem will have alternate solutions when the total opportunity cost matrix has _______________

A. at least one zero in each row and column
B. when all rows have two zeros
C. when there is a tie between zero opportunity cost cells
D. If two diagonal elements are zeros.

32. The region common to all the constraints including the non-negativity restrictions is called the _______________.

A. solution space
B. unique solution
C. optimum solution
D. infeasible solution

33. A activity in a network diagram is said to be _______________ if the delay in its start will further delay the project completion time.

A. Forward pass
B. Backward pass
C. Critical.
D. Non-critical.

34. Operation research approach is typically based on the use of _______________.

A. Physical model.
B. Mathematical model.
C. Iconic model.
D. Descriptive model.

35. If an optimum solution is degenerated then.

A. The solution is infeasible
B. There are alternative optimum solutions
C. The solution is of no use to the decision maker.
D. None of the above.

36. If an artificial variable is present in the basic variable column of optimal simplex table, then the problem has _______________ solution.

A. alternative
B. no solution
C. bounded
D. infeasible

37. The dummy source or destination in a transportation problem is added to _______________.

A. satisfy rim conditions
B. prevent solution from becoming degenerate
C. ensure that total cost does not exceed a limit
D. the solution not be degenerate

38. Which of the following methods is used to verify the optimality of the current solution of the transportation problem_______________.

A. Least cost method
B. Vogel's Approximation method
C. Row minima method
D. Modified Distribution method

39. For a salesman who has to visit n cities, following are the ways of his tour plan _______________.

A. n!
B. (n+a)!
C. (n-a)!
D. n

40. Economic order quantity results in _______________

A. equalisation of carrying cost and procurement cost
B. favourable procurement price
C. reduced chances of stock outs
D. minimization of set up cost

41. When we solve a system of simultaneous linear equations by using Two-Phase Simplex Method, the values of decision variables may be.

A. Positive.
B. Negative.
C. Zero.
D. Positive and/or negative.

42. If dual has an unbounded solution, primal has
   A. An unbounded solution
   B. An infeasible solution
   C. A feasible solution
   D. None of the above

43. For any primal and its dual
   A. Optimum value of the objective function is same
   B. Both primal and dual cannot be feasible
   C. Primal will have an optimum solution if and only if dual does too
   D. All of the above

44. The assignment problem is a special case of transportation problem in which _______________.
   A. number of origins are less than the number of destinations
   B. number of origins are greater than the number of destinations
   C. number of origins are greater than or equal to the number of destinations
   D. number of origins equals the number of destinations

45. The dual of the primal maximization LPP having m constraints and n non-negative variable should.
   A. Be a minimization LPP
   B. Have n constraints
   C. and m non-negative variables
   D. Both (a) and (b)
   E. None of the above

46. The time between the placement of an order and its delivery is called as _______________
   A. buffer time
   B. lead time
   C. Economic Order Quantity
   D. capital time

47. Dual simplex method is applicable to these LLP's that start with.
   A. An infeasible solution.
   B. An feasible but optimum solution.
   C. A feasible solution.
   D. A feasible and optimum solution.

48. All of the following may be used to find the EOQ except _______________.
   A. optimal number of days' supply to order
   B. number of orders which minimize ordering costs optimal
   C. number of rupees per order optimal
   D. number of orders per year

49. A feasible solution of a Linear Programming Problem that optimizes the objective function is called _______________
   A. basic feasible solution
   B. optimum solution
   C. feasible solution
   D. solution

50. Charnes method of penalty is called _______________
   A. Simplex Method
   B. Dual Simplex Method
   C. Big-M Method
   D. Graphical Method

TWO MARKS QUESTIONS

1. If the given Linear Programming Problem is in its canonical form then primal-dual pair is which form?
2. All the basis for a transportation problem is?
3. In the transportation table, empty cells will be called as?
4. Which is a completely degenerate form of a transportation problem?
5. While solving a transport problem, the occurrence of degeneracy means that.
6. The coefficient of an artificial variable in the objective function of penalty method are always assumed to be?
7. For any primal have an optimum solution and it's dual.
8. When dual simplex method is applicable to LPP's .
.9. When we use Slack variable?
10. The transport problem deals with the transportation of which type of item?

11. Define critical activity in Network Diagram.
12. The decision variable in OR model are which type?
13. What is the other name of the simplex method?
14. Define degenerate solution.
15. Graphical method of linear programming how much variable are used and why?
16. In the optimal simplex table, Zj-Cj=0 what does it unbounded solution
17. Define operation research.
18) What are the phases of OR
19. If the procurement cost used in the formula to compute EOQ is half of the actual procurement cost, the value of EOQ so obtained?
20. Why Vogel's Approximation method most useful for initial solution for T.P.
21. The initial solution of T.P obtained by which method?
22. Under which condition transportation problem is balanced,
23. How to balance the Transportation problem.
24. How to define model in OR.
25. When the assignment problem is a special case of T.P.
26 Give example of two uses of OR
27. The cost of a surplus variable in objective function?
28. The primal is converted five time of dual what is result?
29. When will a Linear Programming Problem has unbounded solution.
30. What is the other name of OR
31. When we will get an infeasible solution to a LPP.
32. When we will get an alternating solution to a LPP.
33. Define Basic feasible solution.?
34 When can the dual Simplex method be applied?
35. What is meant by degeneracy in a transportation model?
36 What is an unbalanced case in an Assignment model?
37. Define Saddle point?
38. List the methods used to arrive at an initial basic feasible solution in a transportation model.?
39. Define zero sum game?
40. Write a Linear Programming model of the assignment model.
41 Define travelling salesman problem.
42. Define mixed strategy in a game?
43. What is network scheduling?
44. What is spanning tree?
45 Mention the various types of inventory?.
46. Define holding cost and setup cost?
47 Define Lead time of Inventory Control?
48. What is Economic order quantity?
49. Explain the difference between transportation and assignment problems?
50. Define Saddle point in game theory?

LONG TYPE QUESTIONS

1) A firm produces three products. These products are processed on three different machines. The time required manufacturing one unit of each of the three products and the daily capacity of the three machines are given in the table below.

Machine	**Time per unit(Minutes)**			
	Product-1	**Product-2**	**Product-3**	**Machine Capacity(m/d)**
M1	**2**	**3**	**2**	**440**
M2	**4**	**-**	**3**	**30**
M3	**2**	**5**	**-**	**30**

It is required to determine the daily number of units to be manufactured for each product. The profit per unit for product 1, 2 and 3 is Rs. 4, Rs.3 and Rs.6 respectively. It is assumed that all the amounts produced are consumed in the market. Formulate the mathematical (L.P.) model solve it for daily profit.

2) A factory manufactures two products A and B. To manufacture one unit of A, 1.5 machine hours and 2.5 labour hours are required. To manufacture product B, 2.5 machine hours and 1.5 labour hours are required. In a month, 300 machine hours and 240 labour hours are available. Profit per unit for A is Rs. 50 and for B is Rs. 40. Formulate as LPP and solve it.

3) What do you mean by LPP? What are its limitations?

4) Vitamins B1 and B2 are found in two foods F1 and F2. 1 unit of F1 contains 3 units of B1 and 4 units of B2. 1 unit of F2 contains 5 units of B1 and 3 units of B2 respectively. Minimum daily prescribed consumption of B1 & B2 is 50 and 60 units respectively. Cost per unit of F1 & F2 is Rs. 6 & Rs. 3 respectively. Formulate as LPP solve it.

5) Use penalty (or Big-M) method to

maximize $z = 3x1 - x2$

Subject to the constraints

$2x1 + x2 \geq 2$;

$x1 + 3x2 \leq 3$;

$x2 \leq 4$

where $x1, x2 \leq 0$.

6) Use the graphical method to solve the following LP problem.

Minimize $Z = 3x1 + 2x2$

subject to the constraints

$5x1 + x2 \geq 10$,

$x1 + x2 \geq 6$,

$x1 + 4x2 \geq 12$

and $x1, x2 \geq 0$.

7) Solve by simplex Method Maximize $Z=5x1-4x2+3x3$

Subject to

$2x1+x2-6x3= 20$

$6x1+5x2+10x3 \leq 76$

$8x1-3x2+6x3 \leq 50$

$x1, x2, x3 \geq 0$.

8) Solve the following LPP by Graphical method:

Max $Z = 2X1 + 4X2$

Sub to $2X1 + X2 \leq 18$

$3X1 + 2X2 \leq 30$

$X1 + 2X2 \leq 26$

whereas $X1, X2 \geq 0$

9) Find the optimum solution to the transportation problem given in the Table for which the cost, origin-availabilities, and destination-requirements are given.

	D1	**D2**	**D3**	**D4**	**Supply**
O1	**5**	**3**	**6**	**2**	**19**
O2	**4**	**7**	**9**	**2**	**37**
O3	**3**	**4**	**7**	**5**	**34**
Demand	**16**	**18**	**31**	**25**	

10) A company has four sales representatives who are to be assigned to four different sales territories. The monthly sales increase estimated for each sales representative for different sales territories (in lakhs of rupees); are shown in the following table:

Sales Representatives	**Sales Territories**			
	1	**2**	**3**	**4**
A	**200**	**150**	**170**	**220**
B	**160**	**120**	**150**	**140**
C	**190**	**195**	**190**	**200**
D	**100**	**175**	**160**	**190**

11) Briefly explain the Hungarian Method procedure with example.

12) Solve the following game using dominance principle.

	Player-B				
		1	2	3	4
Player A	I	19	6	7	5
	II	7	3	14	6
	III	12	8	18	4
	IV	8	7	13	-1

13) Solve the following transportation problem to maximize profit and give criteria for optimality :

Origin	Destination				Supply
	1	2	3	4	
A	40	25	22	33	200
B	44	35	X	30	60
C	38	38	28	X	140
Demand	100	175	160	190	

14) Consider the problem of assigning five jobs to five persons. The assignment costs are given as follows. Determine the optimum assignment schedule.

Job

Person		1	2	3	4	5
	A	8	4	2	6	1
	B	0	9	5	5	4
	C	3	8	9	2	6
	D	4	3	1	0	3
	E	9	5	8	9	5

15) Five salesmen are to be assigned to five districts. Estimates of sales revenue (in thousands) for each salesman are given as follows:

	A	B	C	D	E
1	32	38	40	28	40
2	40	24	28	21	36
3	41	27	33	30	37
4	22	38	41	36	36
5	29	33	40	35	39

Find the assignment pattern that maximises the sales revenue.

16) Solve the following game

	B1	B2	B3
A1	20	15	22
A2	35	45	40
A3	18	20	25

17) Determine the range of p and q that will make the payoff element a22 as the saddle point of the game with the following matrix .

	B1	B2	B3
A1	2	4	5
A2	10	7	Q
A3	4	P	8

18) A manufacturing company purchases 9000 parts of a machine for its annual requirements, ordering one month usage at a time. Each part costs Rs.20. The ordering cost per order is Rs. 15 and the carrying charges are 15% of the average inventory per year. Suggest a more economic purchasing policy for the company. How much would it save the company per year ?

19) A stockiest purchase an item at the rate of Rs. 20 per unit from a manufacturer 1000 units of the item are required per year. What should be the order quality per unit if the cost per unit rose is Rs.15 and the inventory charges per year are 20%?

20) The network below gives the permissible routes and their lengths in miles between stations of city (node-1) and six other cities (node 2-7)