

Assignment

1) Basis of Technique used is minimization Technique

2) It can also be done in maximation Technique

3) Various steps in Assignment Problem are

Step 1: Check whether the problem is balanced or unbalanced by checking whether row is equal to column, if unbalanced add dummy column or row to balance the problem

Step 2: Identify Least Number in each row and subtract with all number in that Row.

Step 3: Identify least number of each column and subtract with all number in that column.

Step 4: Check whether solution is reached with zero selection in one row and column, ie. Cover all the zero with minimum number of lines, solution is reached only when selected zeros is equal to number of rows or columns or number of lines is equal to order of matrix.

Step 5: If solution is not reached so maximum sticking

Step 6: Select the least element in within the unstriked Element

Step 7: The element selected above is

- i) Subtracted with all the unstriked element
- ii) Added to all the double striked element (Intersection of two lines)

Step 8: Check the solution

Step 9: If solution is not reached continue with the process from step 5.

Linear Programming

Simplex Method:-

Steps:-

1. Determine the objective function Z. Objective may be maximization or minimization.
2. For maximization problem the constraints would be $\leq$ sign.
For minimization problem the constraints would be $\geq$ sign.
3. Introduce slack variable
For $\leq$ sign – add the slack variable ie. Add S1
For $\geq$ sign – subtract the slack variable and add artificial variable
ie. Subtract S1, add A1.
4. Change the Objective function
For S1 – Add '0S1'
For A1 – Add 'MA1'

5. Simplex table format:-

		Cj						
Quantity	Variable	Const.	X	Y	Z	S1	S2	RR
	S1							
	S2							
		Zj						
		Cj - Zj						

6. Zj is arrived by summation of constant column with X,Y,Z columns
7. Criteria for selecting the key column :-
For Maximization Problem – Highest value of $C_j - Z_j$
For Minimization Problem – Lowest Value of $C_j - Z_j$
8. Divide the Quantity Column with Key column to arrive at RR
9. Criteria for Selecting the Key row :-
For Maximization & Minimization Problem – Lowest Positive RR is selected
10. The Meeting Point is key Element
11. Criteria for deciding the optimal solution
For Maximization Problem – All elements in $C_j - Z_j$ row is negative or zero.
For Minimization Problem – All elements in $C_j - Z_j$ row is positive or zero

Note – For finding whether all the elements in $C_j - Z_j$ row is positive or zero
for minimization problem substitute all the 'M' with highest value.
12. If solution is not reached next table is formed.

13. Input for next table is

First key row in the next table is filled by dividing all the numbers in the key row of the previous table with the key element.

Remaining all the rows is arrived as follows: -

Corresponding previous $\frac{\text{Table row element}}{\text{row in the key column}}$ (Value relating to that * Corresponding element in key row in the 2nd table as filled in previous step)

14. Check the optimal solution, if not reached form the third table.

15. If solution is reached then answer is amount in quantity column corresponding to the variable.

Other Points : -

- We can convert the Minimization Problem into Maximation Problem. This is known as duality.
- We can change the $\geq$ sign to $\leq$ sign to match the problem
E.g. $X + Y \leq 100$
is converted into $-X - Y \geq -100$

Transportation

- The procedure followed is Minimization Procedure
- Problem is generally solved in Vogel's Approximation Method(VAM)
- Steps for the problem is : -
 1. Convert profit matrix into loss matrix.
 2. Balance the problem.
 3. Arrive at Row penalty and column penalty
Row penalty and column penalty is calculated at (2nd least – 1st least) in the corresponding row or column.
 4. Select from the entire Row penalty and column penalty maximum number.
 5. From the entire Row or Column minimum is selected.
 6. Strike the row or column which gets eliminated.
 7. Continue until the entire item in the table is strike.
 8. Write separately Initial solution table.
 9. Check for Degeneracy. Degeneracy occurs when all the elements in the initial solution is equal to (Row + column – 1)
 10. If degeneracy occurs introduce epsilon – 'e'. 'e' is introduced in least independent cell.
 11. Form UV Matrix. It is formed by the element in the original solution corresponding to the element in the Initial solution.
 12. Find unalloted elements in the UV Matrix
 13. Find ΔI_j i.e.(Original Matrix element – Unalloted element found above)
 14. Check for optimal solution ie. All items must be zero or positive.
 15. If not reached select the maximum negative in ΔI_j matrix.
 16. Form a loop and reallocate the solution.
 17. Repeat from step 9.

Notes: -

1. If there is zero in ΔI_j matrix while arriving at optimal solution then there is another solution for the problem.
2. Dummy column can be introduced in profit or loss matrix.

3. If there is penalty/redundancy payment for unsatisfying demand etc. is given then fills the dummy row or column with that amount or fill it with zeros.
4. If there is constraint in the problem first satisfy the constraint and then solve.
5. various other methods for solving the problem is
 - Least cost method
 - North west corner rule
6. Generally VAM method is used

Network Analysis (CPM/PERT)

CPM

- Total float = LS – ES (or) LF – EF
- Free float = Total float – Head event slack
- Independent float = Free float – Tail event slack
- In the diagram Es = Lf in the critical path
- Critical path is the longest duration
- To find the minimum time associated cost (i.e. Additional cost incurred per unit of time saved) following formula is used :-
Crash cost per day (or) Activity cost supply
= $\frac{\text{Crash cost} - \text{Normal cost}}{\text{Normal time} - \text{Crash time}}$
- Interfacing float = It is the part of the total float which causes reduction in the float of the succession activities. In other words it is the portion of activity float which cannot be continued without affecting adversely the float of the subsequent activity or activities.
- Steps in proceeding the problem : -
 1. First find and fill the ES and LF column from the diagram.
 2. Then find LS and EF as follows :-
Ls = Lf – Duration
Ef = Es + Duration
 3. Find total float
 4. Find free float. Wherever total float column has zero free float column is also taken has zero and remaining elements is filled as said above
 5. Find Independent float. Wherever free float column has zero Independent float column is also taken has zero and remaining elements is filled as said above

Notes: -

1. ES = Earliest Start. Indicates earliest time that the given activity can be scheduled
2. EF = Earliest Finish. Time by which the activity can be completed at the earliest.
3. LF = Latest Finish. Latest allowable occurrence time of the head event of the activity.

4. LS = Latest Start.
5. Total duration of the critical path is the maximum time/amount consumed for the activity. This should be crashed with respect to crashing days and crashing cost. This crashing should not change the critical path.

PERT : -

- Expected (or) Average time is found by assigning weights as follows : -
 - 1 for optimistic
 - 4 for Most likely
 - 1 for pessimistic
$$\text{Average time} = \frac{1 \text{ optimistic} + 4 \text{ most likely} + 1 \text{ pessimistic}}{6}$$
- Standard Deviation = $\frac{\sqrt{(\text{Pessimistic time} - \text{Optimistic time})^2}}{6}$
- Variance = (Standard Deviation)²
- Probability of completing the project in N days
 - = $\frac{\text{Required time(N)} - \text{Expected time (critical path duration)}}{\text{Standard Deviation}}$
 - [Nothing but Z = (X - Mean) / Standard deviation]
 - = Y (say)
 - = Find Z(y)
 - = Probability %
 - If required time > Expected time then = 0.5 + Z(Y)
 - If required time < Expected time then = 0.5 - Z(Y)

Learning Curve

Learning is the process of acquiring skill, Knowledge, and ability by an individual. According to learning curve theory the productivity of the worker increases with increase in experience due to learning effect. The learning theory suggests that the best way to master a task is to “learn by doing”. In other words, as people gain experience with a particular job or project they can produce each unit more efficiently than the preceding one.

The speeding up of a job with repeated performance is known as the learning effect or learning curve effect.

The cumulative average time per unit produced is assumed to fall by a constant percentage every time the total output is doubled. So generally learning effect is found in the multiples of 2. If learning curve effect is asked between two even numbers then Learning curve equation is formed ie. Learning curve effect is expressed mathematically as follows:

Learning curve equation =

$$Y = a(x)^{-b}$$

Where Y = Average time per unit
a = Total time for first unit
x = Cumulative number of units manufactured
b = the learning curve index

$$\text{Learning curve index (b)} = \frac{\log (1 - \% \text{ decrease})}{\log 2}$$