Government Polytechnic College
Bargarh

INDUSTRIAL ENGINEERING & MANAGEMENT

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plant location means desiding a suitable location, place, area etc where the unit or factory shall start functioning.

→ The size of the plant as a big roll to play in the sucess or failure of the plant.

→ plant location deals with two activities.

1. selection of a proper geographical area.
2. selecting a perticular size within that reason.

Factor affecting plant location

1. Availbility of row materials.
2. proximaty to market.
3. Transport facilities.
4. Availbility of power, fuel or gas.
5. water supply.
6. Disposal facilities of waste product.
7. climatic and atmospheric condition.
8. Availbility of labour.
9. momentum of establish industry.
10. preference of outstanding bussinessment and govt. subsidy.
11. Township selection.
12. Advantages of rural area.

plant layout

The plant layout is the physical arrangement of buildings, machinary, equipments, work places and other facilities of production in order to process the product in the most efficient manner.

→ According to sansonneti and mallick " It is the placing the write equipment coupled with write place, to permit the processing of a product unit in the most effective manner through the shortest possible distance and in the shortest possible time."

Need of plant layout

Two plant having similar operation may not have identical layout. this may be due to size of plant, nature of process and management calipre.

→ There are design changes in the product.
→ there is an expansion of entreprise.
→ there is purposed variation in the size of department.
→ some new product is to be added to the exiting line.

objective of good plant layout

→ It should provide overal satisfaction to all concerned.
→ material handling and internal transportation from one operation to the next is minimized and efficiently controlled.

→ the production bottlenecks and points of congestion are to be eliminated so that input raw material and semifinished parts move first from one work station to another.

→ It should provide high work in process turnover.

→ It should provides worker convenience, promote job satisfaction and safety for them.

→ It should avoid ~~unnesse~~ unnecessary investment of capital and provide space for future expansion of plant.

Principle of plant layout

→ According to muther there are six basic principle of best layout. These are

1. principle of overall integration

According to this principle the best layout is one which provides integration of production facilities like men, machinery, raw material, supporting activities and any other such factor which result in the best compromise.

2. principle of minimum distance

According to this principle the moment of men and materials should be minimized.

3. principle of flow

The best layout is one which arranges the work station for each process or operation in the same order or a sequence that forms assemble the materials.

4. principle of cubic space utilisation

According to this, space available both in ventrical and horizontal direction is most economically and effectively utilise.

5. principle satisfaction and safety

According to this principle best layout is one which provides satisfaction and safety to all workers concerned.

6. principle of ~~elect~~ flexibility

According to this the best layout which provides flexibility of adoption a new product and rearrangement at a minimum cost and least inconvinience.

process layout / functional layout

→ The process layout is perticularly useful where low volume of production is need.

→ If the product are not standardize, the process layout is more desirable, because it has greater process flexibility than other.

→ In this type of layout the machines are not arranged according to the sequence of operation but are arranged according to the nature or type of operations.

→ This layout is commanly suitable for non respective jobs.

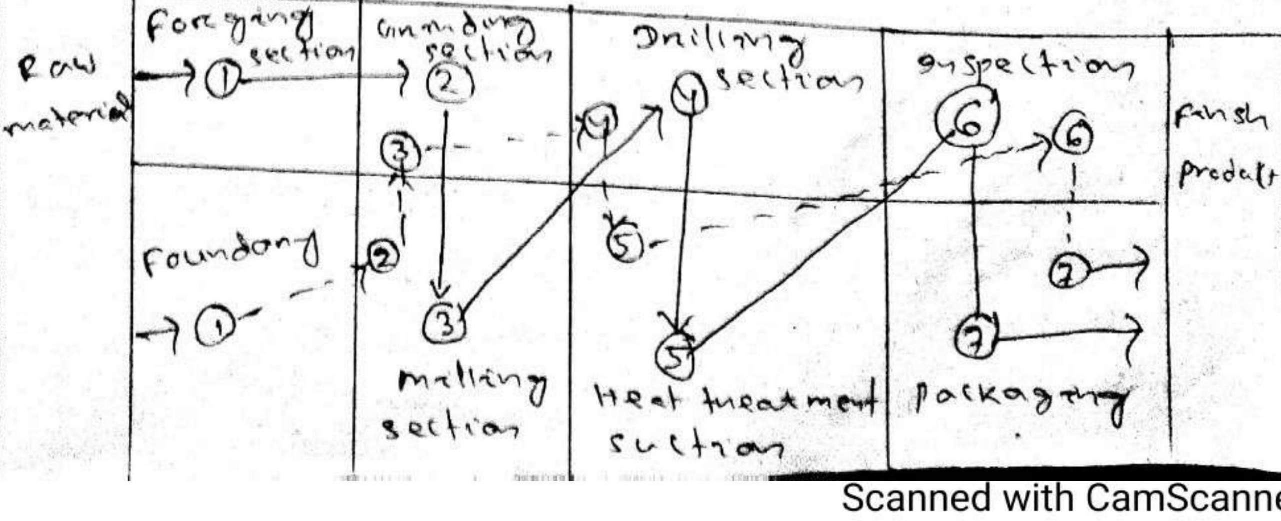
→ same type of operation facilities are grouped together such as lathes will be placed at one placed at one place, all drill machines one at another place and so no on.

Advantages

- It offers better and more efficient suppervision through specification at verious levels.
- There is a greater flexibility in equipment and man. Thus load distribution is easily controlled.
- Greater utilisation of equipment ~~avail~~ available is possible.
- Breakdown of equipment can be easily handled by transferring work to another machining.
- there will be less dublication of machines. Thus total investment in equipment purchage will be reduced.

Disadvantage

- more floor space required.
- production controll is more difficult and more costly.
- Handling and back tracking of material is too much.
- Routing and scheduling is more difficult.



product layout / synthetic layout

→ If all the processing equipment and machines are arrenged according to the sequence of the operation of a product, the layout is called product layout..

→ In this type of layout, only one product or one type of product is produced in an operating area.

→ This product must be standardize and produced in large quantities in order to justify the product layout.

→ the raw material is supplied at the one end of the line and goes from one operation to next quite rapidly with a minimum work in process, storage and material handling.

Advantages

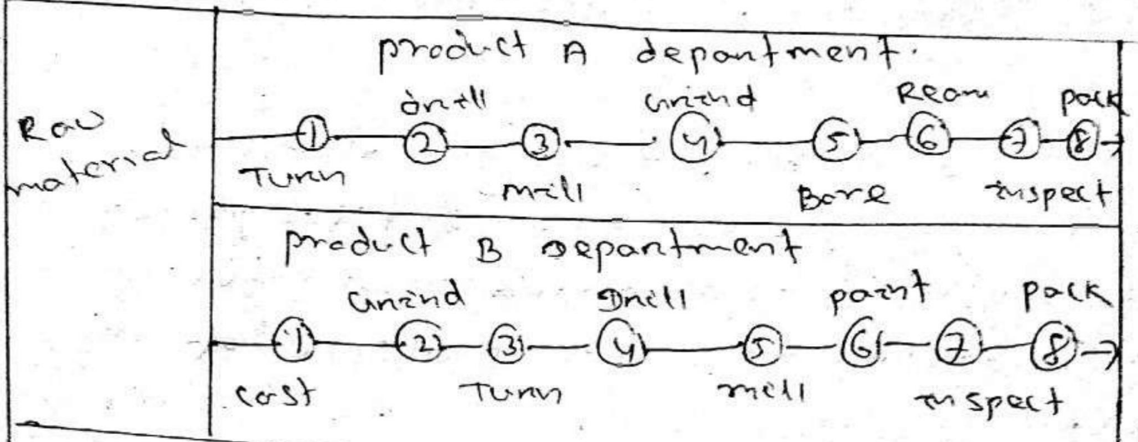
→ It lower the total material handling cost.
→ there is less work in process.
→ Less floor area is occupied by material in transit and for temperary storage.
→ Greater simplicity of production controll.
→ Total producting time is also minimize.

Disadvantages

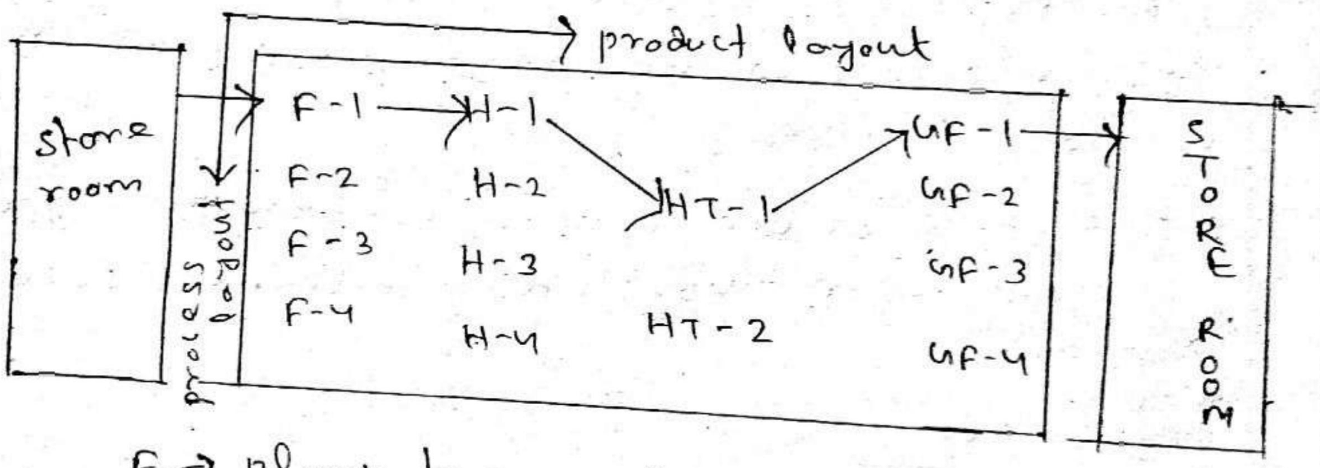
→ No flexibility which is generally required is obtained in this layout.
→ A single machine break down may shoutdown the whole production line.

→ ~~specification~~ specialise and strict supervision is essential.

→ The manufacturing cost increase with a fall in volume of production.



combination layout



F → Blank forging hammers.

H → Hobbing for cutting ~~gre~~ gear teeth.

HT → Heat treatment furnaces.

GF → Gear finishing machines.

→ A combination of process and product layout ~~combination~~ combines the advantages of both type of layouts.

→ more over, these days pure product or process layout are rare. most of the manufacturing sections are arranged in process layout with manufacturing lines occurring here and they are where ever the condition permits.

→ A combination layout is possible where an atom is being made in different types and sizes.

→ In such cases ~~machining~~ machinery is arranged in a process layout but the process grouping is then arranged in a sequence to manufacture very types and sizes of product.

→ The point to note is that, no matter the product varies in size and time, the sequence of operation remains same or similar.

* The above figure shows a combination type of layout for manufacturing different sizes of gear.

Application

→ Files, hacksaw, circular metals saws, wood saws etc can be manufacture on a combination type of layout.

* A combination layout is also useful when no of atoms are produced in same sequence but non of the atoms are to be produced in bulk manner.

Fixed position layout

→ Layout by fixed position of the product is inherent in ship, building, air craft, manufacture, big pressure vessel febrication.

→ In other types of layout discused earlier the product moves past stationary production equipment but in that case men and equipment are moved to the material, which remain at one place and product is complicted at that place where the material lies.

Defination and concept of operation research

→ operation research is the organised application of the monden science, mathmatics and computer technics to complex millitary, hovernment, ~~bisuness~~ business on industrial problems arising in the direction and management of large systems of men, material, moneys and machines..

→ The purpose is to provide the management with explicit quantitative understanding and asselment of complex situation.

→ operation ~~rese~~ research sees the optimum strength of all sphere and thus provides optimum solution to organisational problem.

→ operation aids, insolving, business problems and in planning and investigation of measure operational decision.

Linear programming

Linear programming is powerful mathmetical technique for finding the best use of the limitted resources of a concern.

→ It may be defined as a technique which allocates scarce available resources under condition of centainity in an optimum maner to achieved the company objectives which may be, maximum overall profit on minimum overall cost.

→ Linear programming can be applied effectively only if

1. The objectives can be stated mathematically
2. The resources can be measured as quantities.
3. There are too many alternative solution to be evaluated conveniently.
4. The variable of the problem bear a linear relationship.

A linear programming model may look as under

Maximize $Z = c_1x_1 + c_2x_2 + \dots + c_nx_n$

subjected to condition

$a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + \dots a_{1n}x_n \leq b_1$

$a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + \dots a_{2n}x_n \leq b_2$

$\vdots$

$a_{m1}x_1 + a_{m2}x_2 + a_{m3}x_3 + \dots a_{mn}x_n \leq b_m$

$b_i \geq 0,\ i = 1, 2, 3 \dots m$

$x_j \geq 0,\ j = 1, 2, 3 \dots n$

Graphical method

→ Simple two dimensional linear programming problems can be easily and rapidly solved by this technique.

→ The technique can be easily mastered and shows a visual illustration of the relationships.

→ But as the number of production and constants increase, it is very difficult to show and interpret the ~~relationshi~~ relationships on a simple two dimensional graph.

→ This method can easily be applied with upto 2 variables.

Graphical method a solution of LPP

procedure for solving graphical problem.

1. set up the objective function (which is maximize or minimize)
2. Set up the constraints equation.
3. set up the non-negetivity restrictions.
4. convert the constraints equation into intersept from of a straight line.
5. plot the constraints equations as graphical solution space.
6. Identify the common solution space satisfied by all the equation.
7. consider the corner point of the convex solution space.
8. substitute the corner point into the objective function to get maximum or minimum.

Q1 →

maximize $Z = 12x_1 + 16x_2$ (objective function)

subjected to $10x_1 + 20x_2 \le 120$, $8x_1 + 8x_2 \le 80$ } constraint function

x_1 and $x_2 \ge 0$ (non-negetivity restrictions)

Ans $10x_1 + 20x_2 = 120$ —— (1)

when $x_1 = 0$, $x_2 = 6$

$\Rightarrow 10 \times 0 + 20x_2 = 120$

$20x_2 = 120$

$x_2 = \frac{120}{20} = 6$

x_1	0	12
x_2	6	0

when $x_2 = 0$, $x_1 = 12$

$10x_1 + 20 \times 0 = 120$

$10x_1 = 120$

$\Rightarrow x_1 = 120/10 = 12$

$8x_1 + 8x_2 = 80$ ——— (2)

when $x_1 = 0$, $x_2 = 10$

$\Rightarrow 8 \times 0 + 8x_2 = 80$

$\Rightarrow 8x_2 = 80$

$x_2 = \frac{80}{8} = 10$

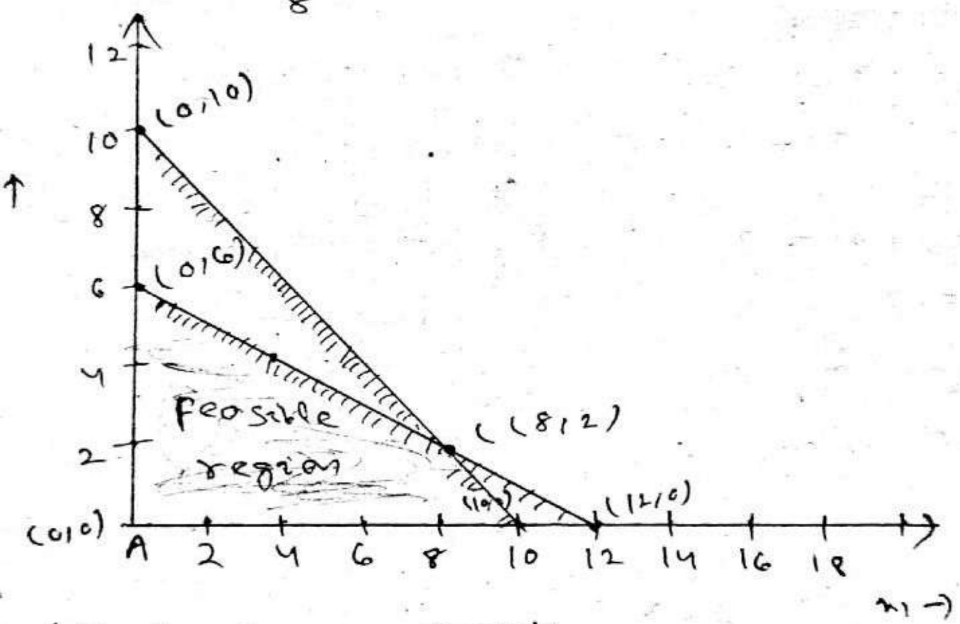
x_1	0	10
x_2	10	0

when $x_2 = 0$, $x_1 = 10$

$8x_1 + 8 \times 0 = 80$

$\Rightarrow 8x_1 = 80$

$\Rightarrow x_1 = \frac{80}{8} = 10$



$10x_1 + 20x_2 = 120$ ——— (1)

$8x_1 + 8x_2 = 80$ ——— (2)

eqn (1) × 8 ⟶ $80x_1 + 160x_2 = 120 \times 8$

eqn (2) × 10 ⟶ $80x_1 + 80x_2 = 800$

$80x_2 = 160$

$x_2 = \frac{160}{80} = 2$

$x_1 = 8$

$Z_A(0,0) = 120 \times 0 + 16 \times 0 = 0$

$Z_B(10,0) = 12 \times 10 + 16 \times 0 = 120$

$Z_C(8,2) = 12 \times 8 + 16 \times 2 = 128$

$Z_D(0,6) = 12 \times 0 + 16 \times 6 = 96$

$\therefore Z_{max} = 128$ at point C (8,2)

Q2 → Maximize $z = 4x_1 + 6x_2$

subject to $x_1 + x_2 \geq 8$

$6x_1 + x_2 \geq 12$

x_1 and $x_2 \geq 0$

Ans

$x_1 + x_2 = 8$ —— (1)

when $x_1 = 0$, $x_2 = 8$

When $x_2 = 0$, $x_1 = 8$

$\Rightarrow x_1 + 0 = 8$

$\Rightarrow x_1 = 8$

x_1	0	8
x_2	8	0

$6x_1 + x_2 = 12$ —— (2)

when $x_1 = 0$, $x_2 = 12$

$\Rightarrow 6 \times 0 + x_2 = 12$

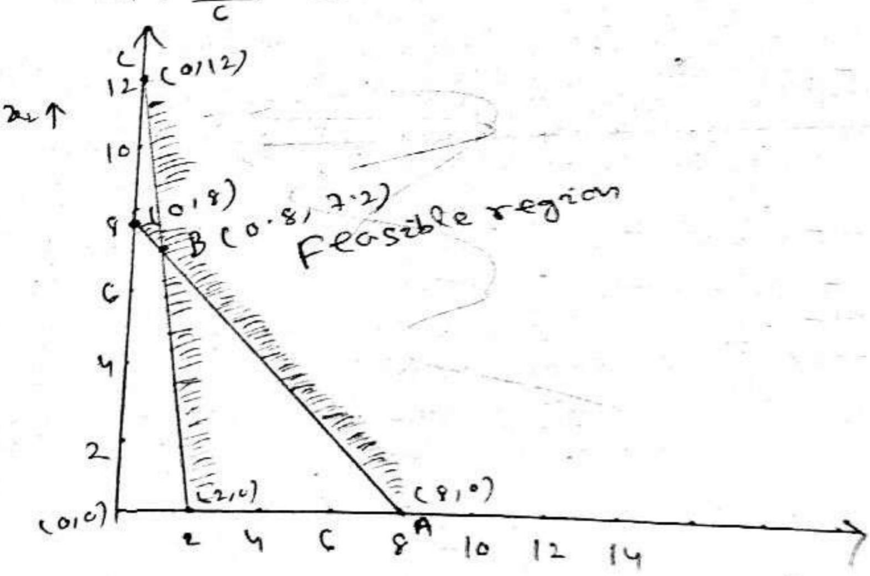
$\Rightarrow x_2 = 12$

When $x_2 = 0$, $x_1 = 2$

$6x_1 + 0 = 12$

$\Rightarrow x_1 = \frac{12}{6} = 2$

x_1	0	2
x_2	12	0



$x_1 + x_2 = 8$ —— (1)

$6x_1 + x_2 = 12$ —— (2)

substracting eqn (2) − eqn (1)

$5x_1 = 4$

$x_1 = \frac{4}{5} = 0.8$

$x_2 = 8 - x_1$

$= 8 - 0.8 = 7.2$

$Z_A(8,0) = 4 \times 8 + 6 \times 0 = 32$

$Z_B(0.8, 7.2) = 4 \times 0.8 + 6 \cdot 7.2 = 46.4$

$Z_C(0,12) = 4 \times 0 + 6 \times 12 = 72$

∴ $Z_{min} = 32$ at point A(8,0).

Q3 → maximize $Z = 100x_1 + 60x_2$

subject to $5x_1 + 10x_2 \leq 50$

$8x_1 + 2x_2 \geq 16$

$3x_1 - 2x_2 \geq 6$

$x_1, x_2 \geq 0$

Ans $5x_1 + 10x_2 = 50$ —— (1)

when $x_1 = 0$, $x_2 = 5$

$\Rightarrow 5 \times 0 + 10x_2 = 50$

$\Rightarrow x_2 = \frac{50}{10} = 5$

when $x_2 = 0$, $x_1 = 10$

$\Rightarrow 5x_1 + 10 \times 0 = 50$

$\Rightarrow 5x_1 = 50$

$\Rightarrow x_1 = \frac{50}{5} = 10$

x_1	0	10
x_2	5	0

$8x_1 + 2x_2 = 16$ —— (2)

when $x_1 = 0$, $x_2 = 8$

$\Rightarrow 8 \times 0 + 2x_2 = 16$

$\Rightarrow 2x_2 = 16$

$\Rightarrow x_2 = \frac{16}{2} = 8$

when $x_2 = 0$, $x_1 = 2$

$\Rightarrow 8x_1 + 2 \times 0 = 16$

$\Rightarrow 8x_1 = 16$

$\Rightarrow x_1 = \frac{16}{8} = 2$

x_1	0	2
x_2	8	0

$3x_1 - 2x_2 = 6$ —— (3)

when $x_1 = 0$, $x_2 = -3$

$\Rightarrow 3 \times 0 - 2x_2 = 6$

$\Rightarrow -2x_2 = 6$

$x_2 = -\frac{6}{2} = -3$

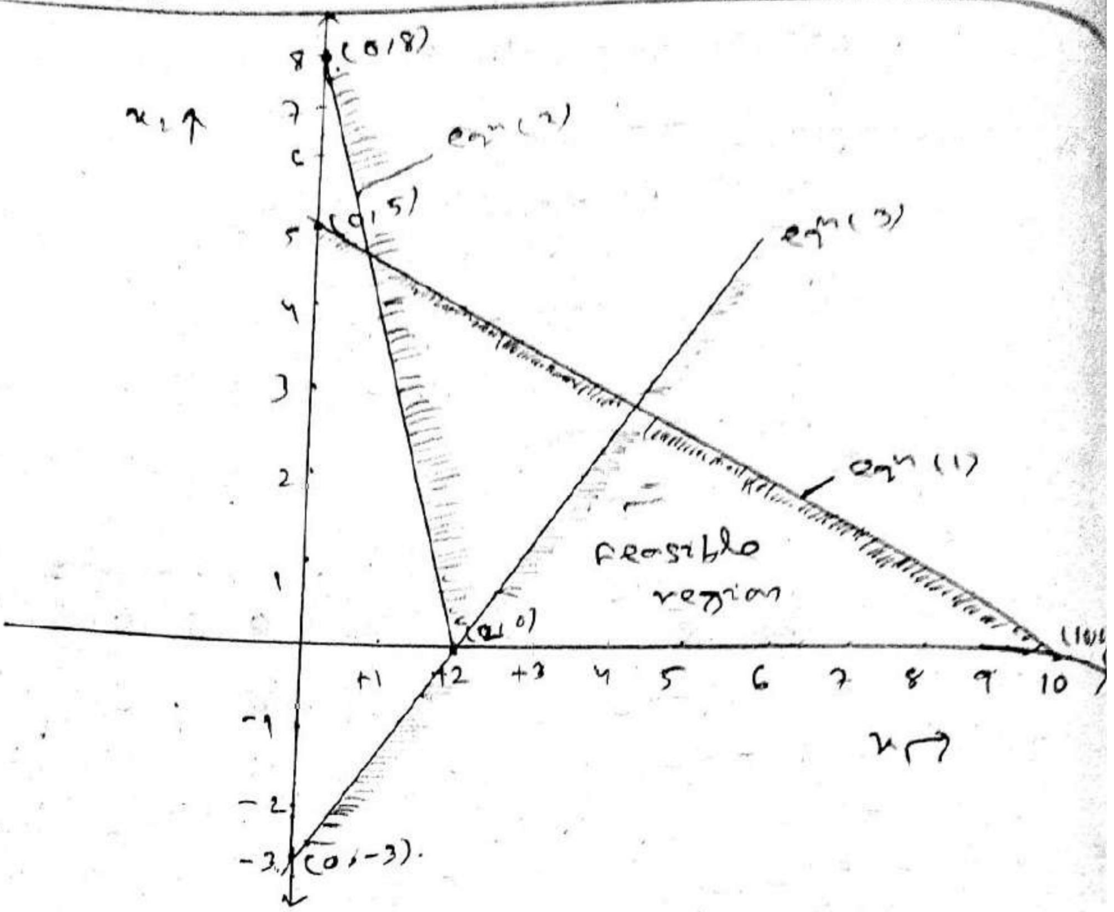
x_1	0	2
x_2	-3	0

when $x_2 = 0$, $x_1 = 2$

$\Rightarrow 3x_1 - 2 \times 0 = 6$

$\Rightarrow 3x_1 = 6$

$\Rightarrow x_1 = \frac{6}{3} = 2$



$5x_1 + 10x_2 = 50$ —— (1)

$3x_1 - 2x_2 = 6$ —— (3)

eqn (1) $\times 1 \rightarrow 5x_1 + 10x_2 = 50$

eqn (3) $\times 5 \rightarrow 15x_1 - 10x_2 = 30$

$20x_1 = 80$

$\Rightarrow x_1 = \frac{80}{20} = 4$

$x_2 = 3$

$Z_A(2,0) = 100 \times 2 + 60 \times 0 = 200$

$Z_B(10,0) = 100 \times 10 + 60 \times 0 = 1000$

$Z_C(4,3) = 100 \times 4 + 60 \times 3 = 580$

$\therefore Z_{max} = 1000$ at point B (10,0)

Q4 ⟶ maximize $Z = 20x_1 + 40x_2$

subject to $x_1 + 4x_2 \le 24$

$3x_1 + x_2 \le 21$

$x_1 + x_2 \le 8$

$x_1, x_2 \ge 0$

Ans $x_1 + 4x_2 = 24$ —— (1)

when $x_1 = 0$, $x_2 = 6$

$\Rightarrow 0 + 4x_2 = 24$

$\Rightarrow x_2 = \frac{24}{4} = 6$

when $x_2 = 0$, $x_1 = 24$

$\Rightarrow x_1 + 4 \times 0 = 24$

$\Rightarrow x_1 = 24$

x_1	0	24
x_2	6	0

$3x_1 + x_2 = 21$ —— (2)

when $x_1 = 0$, $x_2 = 21$

$\Rightarrow 3 \times 0 + x_2 = 21$

$\Rightarrow x_2 = 21$

when $x_2 = 0$, $x_1 = 7$

$3x_1 + 0 = 21$

$x_1 = \frac{21}{3} = 7$

x_1	0	7
x_2	21	0

$x_1 + x_2 = 8$ —— (3)

when $x_1 = 0$, $x_2 = 8$

when $x_2 = 0$, $x_1 = 8$

x_1	0	8
x_2	8	0

Q5 → minimize $Z = 3x_1 + 4x_2$

subject to $5x_1 + x_2 \geq 10$

$x_1 + x_2 \geq 6$

$x_1 + 4x_2 \geq 12$

x_1 and $x_2 \geq 0$

As $5x_1 + x_2 = 10$ —— (1)

when $x_1 = 0$, $x_2 = 10$

$\Rightarrow 5 \times 0 + x_2 = 10$

$\Rightarrow x_2 = 10$

when $x_2 = 0$, $x_1 = 2$

$\Rightarrow 5x_1 + 0 = 10$

$x_1 = \frac{10}{5} = 2$

x_1	0	2
x_2	10	0

$x_1 + x_2 = 6$ —— (2)

when $x_1 = 0$, $x_2 = 6$

$\Rightarrow 0 + x_2 = 6$

when $x_2 = 0$, $x_1 = 6$

x_1	0	6
x_2	6	0

$x_1 + 4x_2 = 12$ ——— (3)

when $x_1 = 0,\ x_2 = 3$

$\Rightarrow 0 + 4x_2 = 12$

$\Rightarrow 4x_2 = 12$

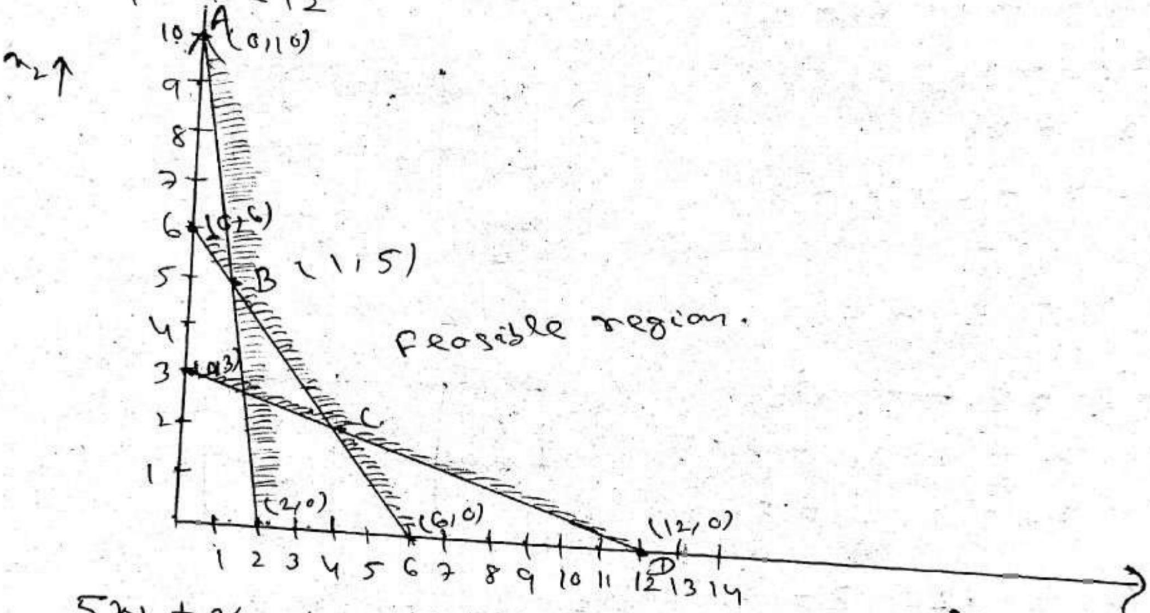
$x_2 = \frac{12}{4} = 3$

x_1	0	12
x_2	3	0

when $x_2 = 0,\ x_1 = 12$

$\Rightarrow x_1 + 4\times 0 = 12$

$\Rightarrow x_1 = 12$



$5x_1 + x_2 = 10$ —— (1)

$x_1 + x_2 = 6$ ——— (2)

$4x_1 = 4$

$\Rightarrow x_1 = \frac{4}{4} = 1$

$x_2 = 5$

Again substracting eq^n (3) − eq^n (2)

$x_1 + x_2 = 6$ ——— (2)

$x_1 + 4x_2 = 12$ ——— (3)

$3x_2 = 6$

$x_2 = \frac{6}{3} = 2$

$x_1 = 4$

$Z_A(0,10) = 3\times 0 + 4\times 10 = 40$

$Z_B(1,5) = 3\times 1 + 4\times 5 = 23$

$Z_C(4,2) = 3\times 4 + 4\times 2 = 20$

$Z_D(12,0) = 3\times 12 + 4\times 0 = 36$

$Z_{min} = 20$ at point C (4,2)

Q6 → maximize $z = 2x + 3y$

subject to $x + y \geq 6$

$2x + y \geq 7$

$x + 4y \geq 8$

$x_1, x_2 \geq 0$

Ans

$x + y = 6$ —— (1)

when $x = 0,\ y = 6$

when $y = 0,\ x = 6$

x	0	6
y	6	0

$2x + y = 7$ —— (2)

when $x = 0,\ y = 7$

$\Rightarrow 2 \times 0 + y = 7$

$y = 7$

when $y = 0,\ x = 3.5$

$\Rightarrow 2x + 0 = 7$

$x = \frac{7}{2} = 3.5$

x	0	3.5
y	7	0

$x + 4y = 8$ —— (3)

when $x = 0,\ y = 2$

$\Rightarrow 0 + 4y = 8$

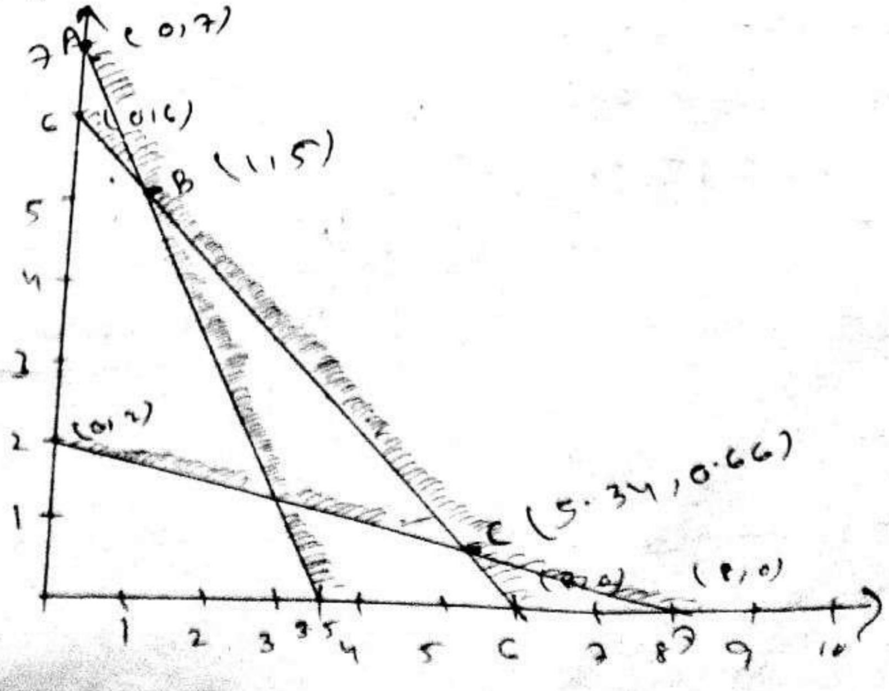
$\Rightarrow y = \frac{8}{4} = 2$

when $y = 0,\ x = 8$

$\Rightarrow x + 4 \times 0 = 8$

$\Rightarrow x = 8$

x	0	8
y	2	0



$x+y=6$ —— (1) Substracting eqn (2) − eqn (1)

$2x+y=7$ —— (2)

$x=1$

$y=5$

$x+y=6$ —— (1)

$x+4y=8$ —— (3)

Substracting eqn (3) − eqn (1)

$3y=2$

$y=\frac{2}{3}=0.66$

$x=5.33$

$Z_A(0,7)=2\times0+3\times7=21$

$Z_B(1,5)=2\times1+3\times5=17$

$Z_C(5.34,0.66)=2\times5.34+3\times0.66=12.66$

$Z_D(8,0)=2\times8+3\times0=16$

$Z_{min}=12.66$ at point $C(5.33, 0.66)$

Q7 → maximize $Z=x+5y$

subject to $5x+6y\leq30$

$3x+2y\leq12$

~~x+t x≥~~ $x, y\geq0$

A) $5x+6y=30$ —— (1)

when $x=0, y=5$

→ $5\times0+6y=30$

→ $y=\frac{30}{6}=5$

when $y=0, x=6$

→ $5x+6\times0=30$

→ $x=\frac{30}{5}=6$

x	0	6
y	5	0

$3x+2y=12$ —— (2)

when $x=0, y=6$

→ $3\times0+2y=12$

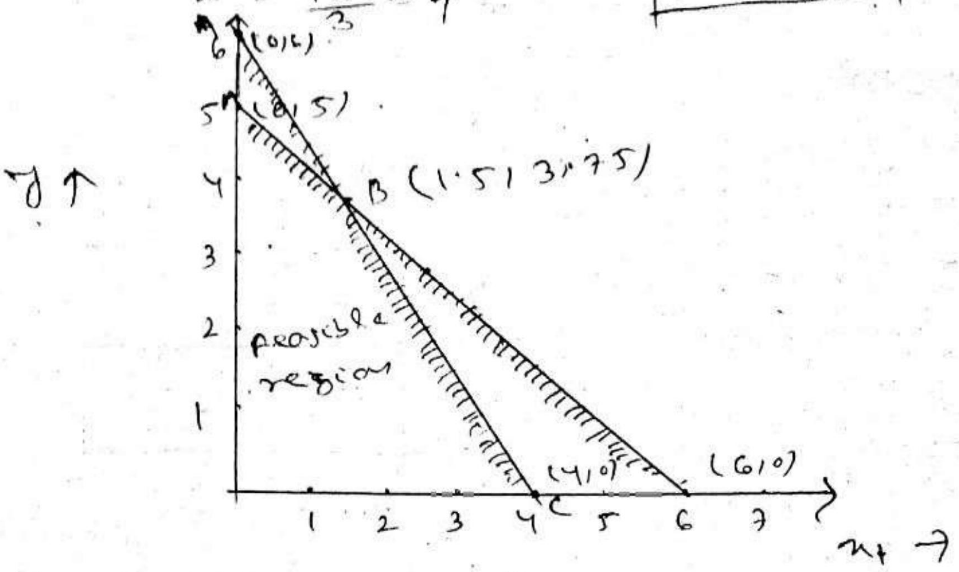
→ $y=\frac{12}{2}=6$

x	0	4
y	6	0

when $y=0$, $x=4$

$3x+0=12$

$x=\frac{12}{3}=4$



$5x+6y=30$ —— (1)

$3x+2y=12$ —— (2)

eqn (1) ×1 → $5x+6y=30$

eqn (2) ×3 → $9x+6y=36$

$4x=6$

$x=\frac{6}{4}=1.5$

$y=3.75$

$z_A(0,5)=0+5\times5=25$

$z_B(1.5,3.75)=1.5+5\times3.75=20.25$

$z_C(4,0)=4+5\times0=4$

$z_{max}=25$ at point A (0,5)

Q8 → maximize $z=5x+6y$

subject to $x+4y\leq 32$

$2x+y\leq 36$

$x,y\geq 0$

Ans $x+4y=32$ —— (1)

when $x=0$, $y=8$

$0+4y=32$

$\Rightarrow y=\frac{32}{4}=8$

When $y=0$, $x=32$

$\Rightarrow x+4\times 0 = 32$

$\Rightarrow x = 32$

x	0	32
y	8	0

$2x+y = 36$ —— (2)

when $x=0$, $y=36$

$\Rightarrow 2\times 0+y = 36$

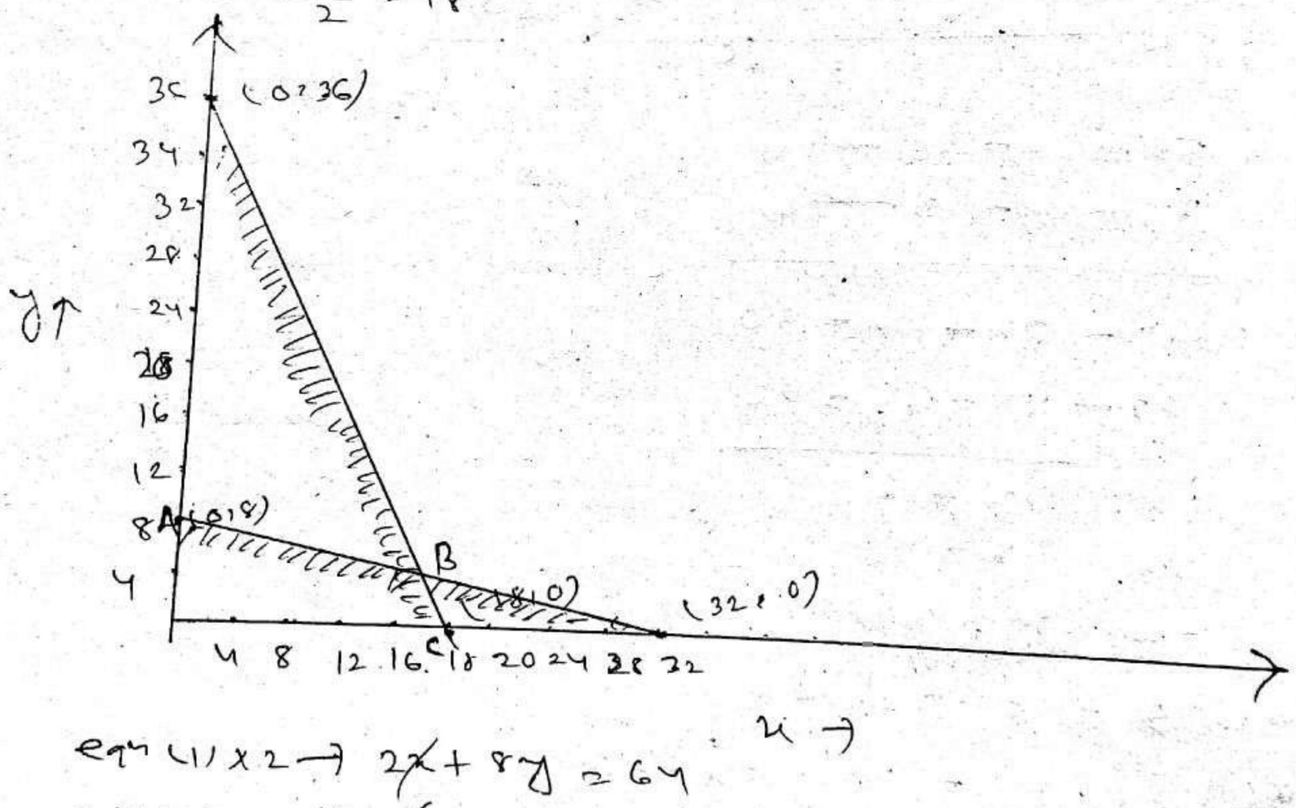
$y = 36$

when $y=0$, $x=18$

$\Rightarrow 2x+0 = 36$

$\Rightarrow x = \frac{36}{2} = 18$

x	0	18
y	36	0



eqn (1) $\times 2 \rightarrow 2x+8y = 64$

eqn (2) $\times 1 \rightarrow 2x+y = 36$

$x = 16$

$y = 4$

$Z_A(0,8) = 5\times 0+6\times 8 = 48$

$Z_B(16,4) = 5\times 16+6\times 4 = 104$

$Z_C(18,0) = 5\times 18+6\times 0 = 90$

$\therefore Z_{max} = 104$ at point $B(16,4)$

Q9 → maximize $Z = 8x + 6y$

subject to $4x + 2y \leq 60$

$2x + 4y \leq 48$

$x, y \geq 0$

Ans $4x + 2y = 60$ —— (1)

when $x = 0$, $y = 30$

$\Rightarrow 4 \times 0 + 2y = 60$

$y = \frac{60}{2} = 30$

when $y = 0$, $x = 15$

$4x + 2 \times 0 = 60$

$x = \frac{60}{4} = 15$

x	0	15
y	30	0

$2x + 4y = 48$ —— (2)

when $x = 0$, $y = 12$

$\Rightarrow 2 \times 0 + 4y = 48$

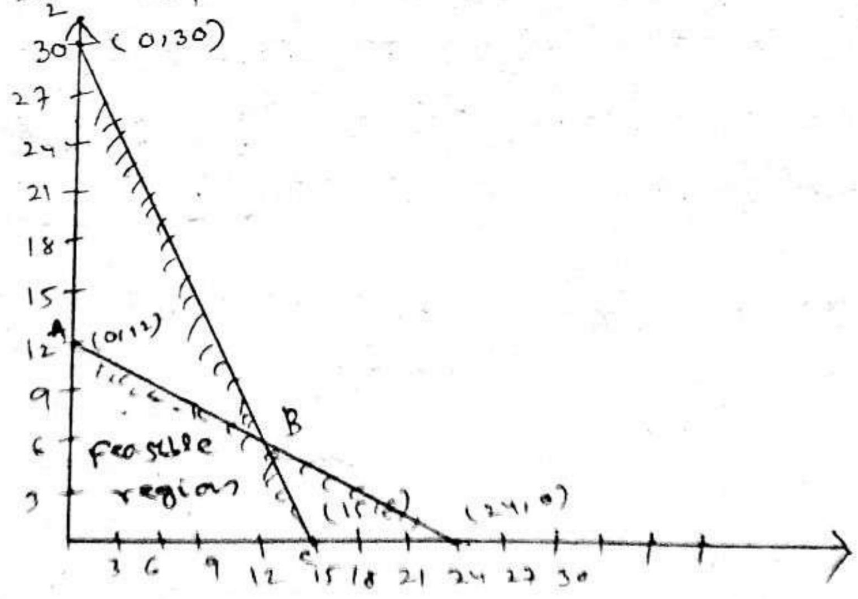
$\Rightarrow y = \frac{48}{4} = 12$

when $y = 0$, $x = 24$

$\Rightarrow 2x + 4 \times 0 = 48$

$\Rightarrow x = \frac{48}{2} = 24$

x	0	24
y	12	0



eqn (1) × 1 = $4x + 2y = 60$

eqn (2) × 2 = $4x + 8y = 96$

$x = 12$

$y = 6$

$Z_A(0,12) = 8\times0 + 6\times12 = 72$

$Z_B(12,6) = 8\times12 + 6\times6 = 132$

$Z_C(15,0) = 8\times15 + 6\times0 = 120$

$Z_{max} = 132$ at point $B(12,6)$

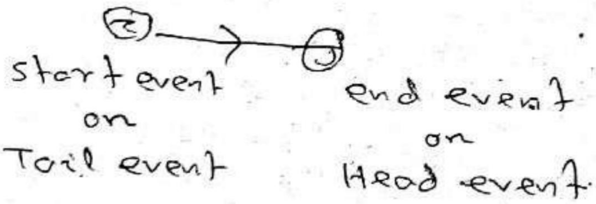
Term related to network planning method

1. Event

An event is a specific instant of time which marks the starts and end of an activity.

→ Event consumes neither time nor resources.

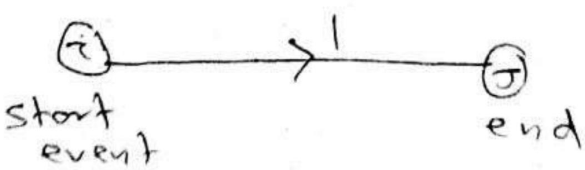
→ It is represented by a circle and event number is written within the circle.



2. Activity

→ Every project consist of a number of job operations or tasks which are called activities.

→ An activity is shown by an arrow (→) and it begins and ~~star~~ ends with an event.



→ ~~a~~ unlike event, an activity consumes time and resources.

→ Activities are classified as

1. critical activity

In a network diagram, critical activities are those which if consume more than there estimated time, the project will be delayed.

→ An activity is called critical if its earlier starts time plus the time taken by it is equal to latest finishing time.

2. Non - critical activities

such activities have provision so that, even if they consume a specified time over and above the estimated time, the project will not be delayed.

3. Dummy activities

when two activities starts at the same instant of time the head events are joined by a dotted arrow and this is known as dummy activities.

→ Dummy activity consumes neither time nor resources.

→ A Dummy activity may be critical activity or non-critical activity.

4. Critical path.

→ It is that sequence of activities which decides the total project duration.

→ A critical path is formed by critical activities.

→ A critical path consumes maximum resources and it is the longest path and consumes minimum time.

5. Duration

Duration is the estimated or actual time required to complete a task.

6. Total project time

It is the time which will be taken to complete a project and is found from the sequence of critical activities.

7. E.S.T (Earliest start time)

→ It is the earliest time at which an activity can start and is calculated by moving from first to last event.

* In case merge event, EST is calculated among all paths and the maximum of it is taken as the EST for the subsequent activity.

8. EFT (Earliest finish time)

It is the earliest time ~~at~~ at which an activity can complited.

EFT = EST + duration of time.

9. LFT (Latest finishing time)

→ It is the maximum time at which an activity is complited.

→ It is calculated by moving backword (we proceed from right to left in the network)

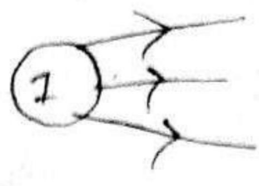
→ In case of brust event LFT are calculated in all paths and minimum of heat taken as LFT for that event.

10. LST (Latest start time)

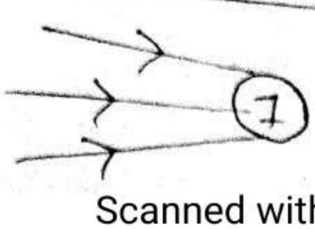
It is the latest possible time by which an activity can start

LST = LFT - duration of time

Brust event



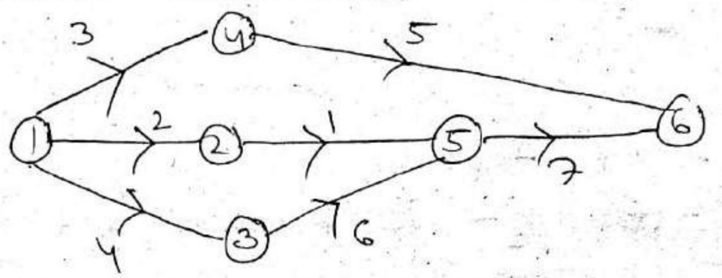
Merge event



Q1→ Find the critical path and construct the network diagram.

Activity	project duration
1-2	2
1-3	4
1-4	3
3-5	6
2-5	1
4-6	5
5-6	7

Ans Network diagram.



∴ path

1-2-5-6	10
1-4-6	8
1-3-5-6	17

∴ Among all the path 1-3-5-6 the longest path on the network and is known as critical path.

Float / slack

→ slack is reference to an event and float is with respect to an activity.

Total float

→ It is the additional time which a non-critical activity can consume without increasing the project duration. However the total float may affect the float in previous and subsequent ~~actitties~~ activities.

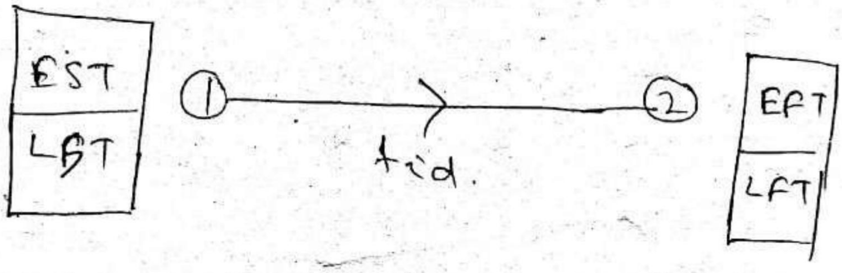
→ Total float may be defined as the difference between LFT and EFT.

Free float

Free float = Total float − Head event slack

Interference float

Independent float = Total float − free float



1) Total float = LFT − EFT

$= (LFT)_2 - [(EST)_1 + t_{ij})]$

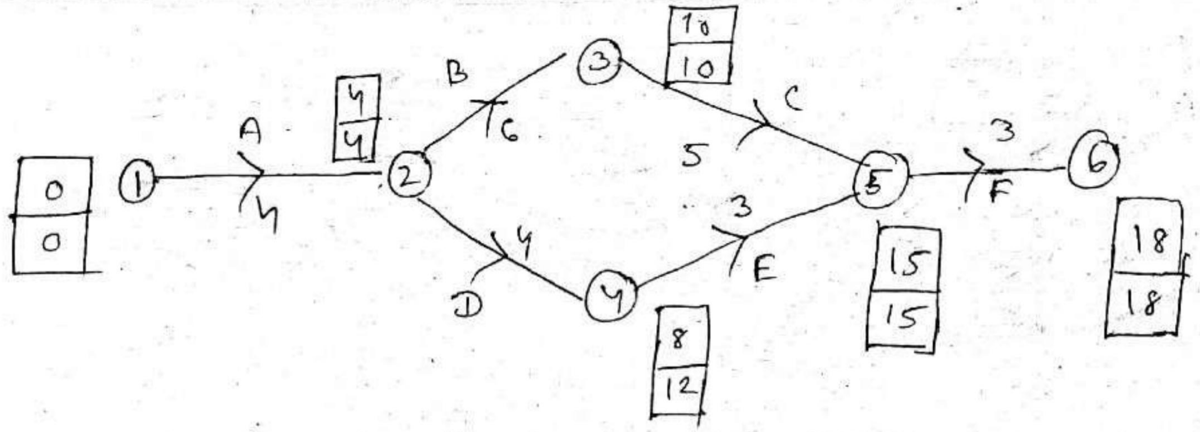
EFT = EST + duration

2) Free float = Total float − Head event slack

= Total float − $(LST - EST)_2$

3) Independent float = Total float − free float.

Q27 A small engineering project consist of 6 activities namely A, B, C, D, E and F with duration of 4, 6, 5, 4, 3 and 3 day respectively. Draw the network diagram and calculate EST, LST, EFT, LFT and floats. Mark the critical path and find total project duration.

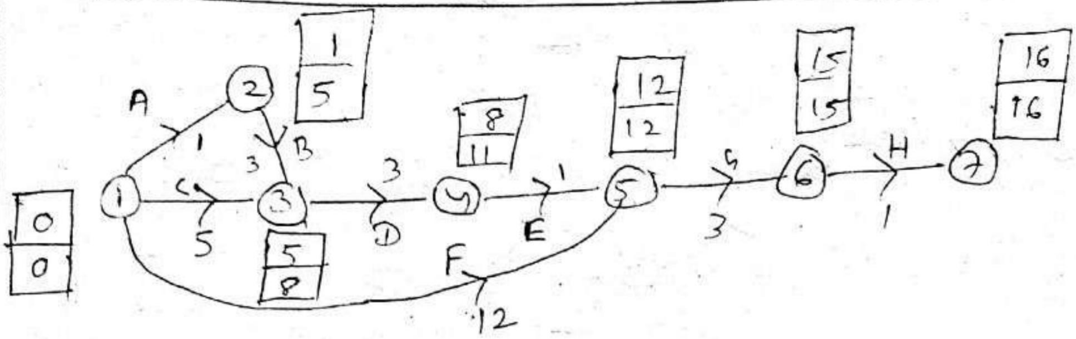


Activity	project duration time (D)	EST	EFT (EFT+D)	LFT	LST LFT-D	Total float	Free float
A	4	0	4	4	0	0	0.
B	6	4	10	10	4.	0	0.
C	5	10	15	15	10	0	0
D	4	4	8	12	8	4	0
E	3	8	11	15	12	.4	4.
F	3	15	18	18	15	0	0

Q3)

Activity	Time duration
1-2 (A)	1
2-3 (B)	3
1-3 (C)	5
3-4 (D)	3
4-5 (E)	1
1-5 (F)	12
5-6 (G)	3
6-7 (H)	1

Draw the network diagram band EST, EFT, EST, LFT



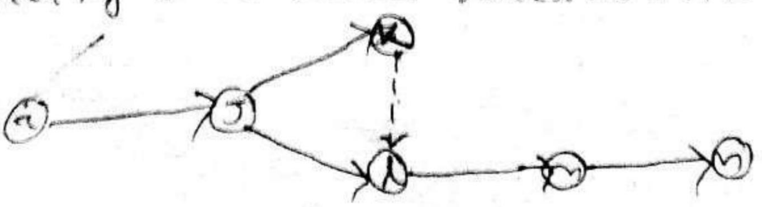
Activity	project duration time	EST	EFT	LFT	LST	Total float	Free float
1-2 (A)	1	0	1	1			
2-3 (B)	3	1	4	5			
1-3 (C)	5	0	5				
3-4 (D)	3	~~8~~ 5	8				
4-5 (E)	1	8	9				
1-5 (F)	12	0	12				
5-6 (G)	3	12	15				
6-7 (H)	1	15	16				

predecessor

If an activity which must be complited before perticular activity starts then it is known as predecessor activity to that perticular activity.

sucessor activity

If an activity (a) can starts only after complition of one more activities say b, c then activity a is called sucessor activity to b and c.



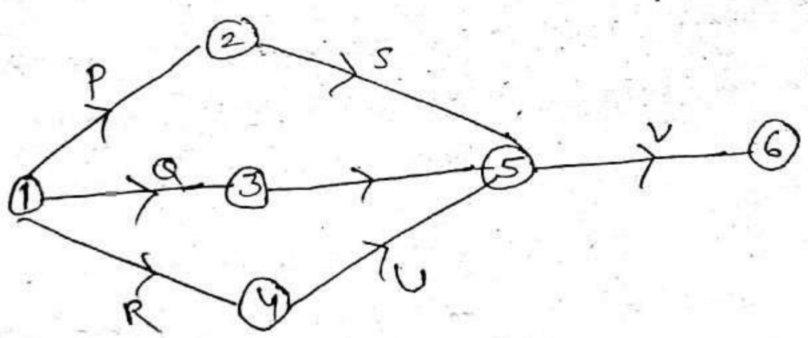
* Activity (i - j) is predecessor activity (j → k), (j → l)

* Activity (J ⟶ k), (J ⟶ l) sucessor activity of (i ⟶ J)

Q4 → A project consist of 7 activities. Activities P, Q, R run simultaneously. The relationship among the various activity is as follows.

Activity	Immediate sucession
P	S
Q	T
R	U

Activity V is the last operation of the project and it is also immediate sucessor to S, T and U. Draw the network ~~dag~~ diagram.



Q5 → Draw the network diagram for the following product.

i) A and B starts cocurently.
ii) C follows A.
iii) D follows A but precidise E
iv) F follows B but precidise ~~H~~ G
v) G follows F but precidise H.
vi) H follows G but precidise E
vii) E and I terminate at the same time.

1. PERT (project evaluation and review technique)

→ PERT stands for project evaluation and review technique.

→ This technique is useful to manage all projects which can splited into activities and having uncertainity with estimation of time of their completion.

→ It must be noted that PERT system involves a probilitistic approach and is best situated for R & D work in which measure uncertainties exists.

→ Thus PERT system is prefered for those operation which are of non-repeatetive nature or in which presize time determination for various activity can not be done.

→ The PERT system uses a network diagram is consisting of events which are to be establish to achieved the project objectives.

Difference between CPM and PERT.

CPM	PERT
→ It stands for critical path method.	→ It stand for project evaluation and review technique.
→ It is activity oriented.	→ It is event oriented.
→ Certainity is associated with CPM.	→ Uncertainity is associated with PERT.
→ It uses one time estimate to evaluate project duration time.	→ It uses three times of estimate to evaluate project duration time (optimisstic time, pessimisstic time and most likely time.

1. t_o (optimisstic time)

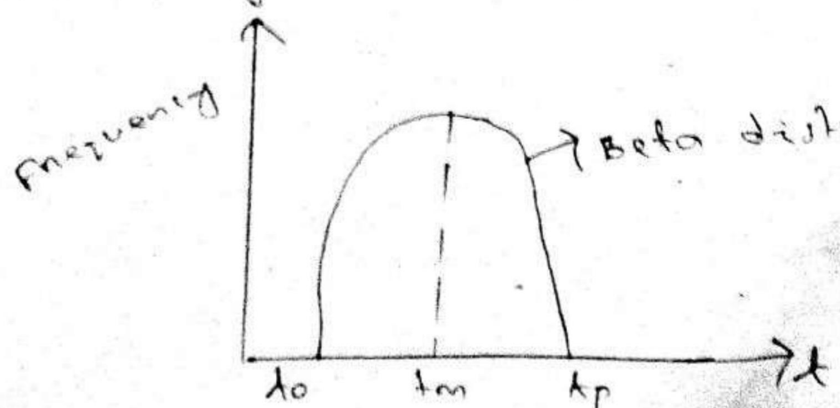
It is the minimum time that is required to complete an activity when every resource is available.

2. t_m (most likely time)

It is the time required on average to complete an activity when a every resource is available.

3. t_p (pesimisstic time)

This is the worst time required to complete an activity when every resource is available.



→ Estimated time $(t_e) = \frac{t_o + 4 \times t_m + t_p}{6}$

→ Standard deviation $= \sigma = \frac{t_p - t_o}{6}$

→ variance $= \sigma^2$.

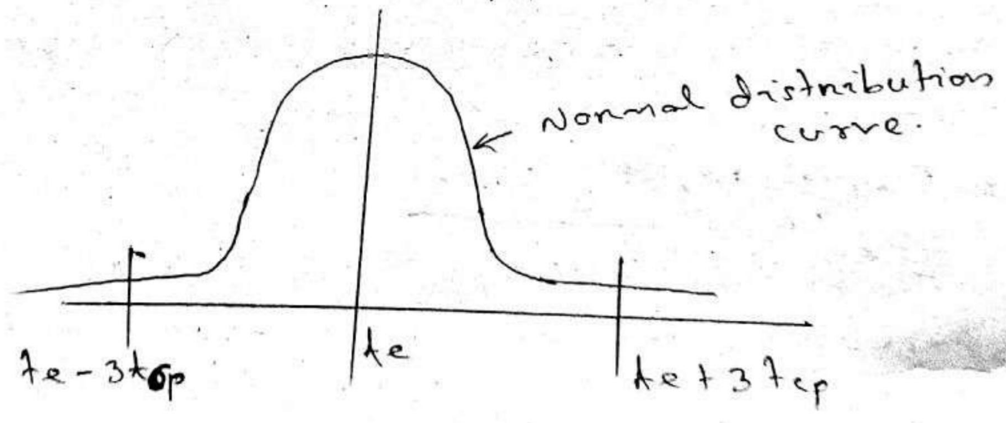
standand deviation

For binding project duration time the varience of critical path should be taken which is sum of varience of activities lying on critical path.

mathmetically,

$$\sigma = \sqrt{\sum \text{varience of critical path}}$$

The project complition time are expected to follow normal distribution.



where,

t_e = estimated time.

t_{cp} = standard deviation on critical path.

The probability of completing a project is given by a formula.

$$\therefore Z = \frac{D - T_e}{\sigma_{cp}}$$

where,

Z = it is belongs to normal distribution curve.

D = Desired completion time.

T_e = critical path time estimate.

σ_{cp} = standard deviation of critical path.

NOTE

case-1

when, $Z=0$, then

probability of complition is 50%.

case-2

when, $Z=1$, then

probability of complition is 84.13%.

case-3

when, $Z=-1$, then

probabilty of complition is 15.87%.

case-4

when, $Z=2$, then

probability of complition is 97.2%.

case-5

when, $Z=-2$, then

probability of complition is 2.8%.

case-6

when, $Z=3$, then

~~probability~~ probability of complition is 99.86%.

case-7

when, $Z=-3$, then

probability of complition is 0.14%.

Q6 → The time estimates for activities of a PERT network is given below.

Activity	t_o	t_m	t_p
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

a) Draw the network and identify all the path.

b) Determine excepted project length.

c) calculate the standard deviation and variant of the project.

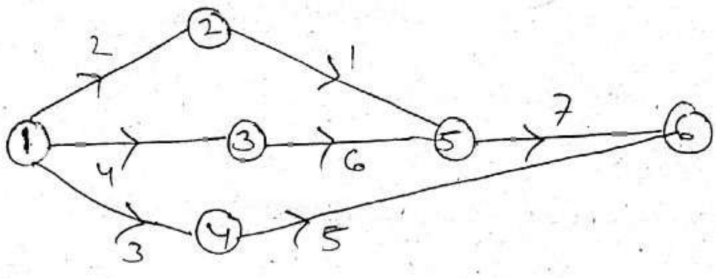
d) what is the probability that the project will be completed.

i) At least 4 weeks earlier than excepted time.

ii) No more than 4 weeks later than excepted time.

Ans :

Activity	t_o	t_m	t_p	$t_e = \frac{t_o + 4 \times t_m + t_p}{6}$	$\sigma = \frac{t_p - t_o}{6}$	σ^2
1-2	1	1	7	2	1	1
1-3	1	4	7	4	1	1
1-4	2	2	8	3	1	1
2-5	1	1	1	1	0	0
3-5	2	5	14	6	2	4
4-6	2	5	8	5	1	1
5-6	3	6	15	7	2	4



path

1-2-5-6	3+7=10
1-3-5-6	4+6+7=17
1-4-6	3+5=8

∴ critical path = expected project duration time = maximum of all the path = 17 weeks.

(d)

(i) $D = 17\text{ weeks} - 4\text{ weeks} = 13\text{ weeks}$

$$Z = \frac{D - T_e}{\sigma_{cp}}$$

$$\Rightarrow \sigma_{cp} = \sqrt{\sigma_{1-3}^2 + \sigma_{3-5}^2 + \sigma_{5-6}^2}$$

$$\Rightarrow \sigma_c = \sqrt{1+4+4} = 3$$

So $Z = \frac{13-17}{3} = -\frac{4}{3} = -1.33$

From the table showing area under normal distribution curve the value corresponding to -1.33 is 0.4082, the probability is 0.5 - 0.4082 = 0.0918

(ii) $D = 17\text{ weeks} + 4\text{ weeks}$

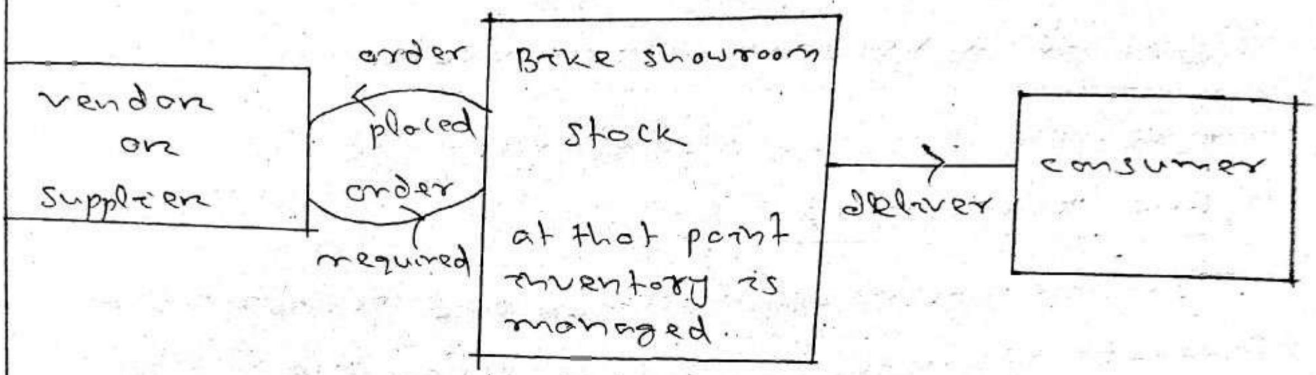
$D = 21\text{ weeks}$

$$Z = \frac{21-17}{3} = \frac{4}{3} = 1.33$$

. probability of completion time = 0.9082

Inventory

Inventory means any kind of stock of raw material and which is to be used in future.



→ Inventory is a detailed list of those movable items which are necessary to manufacture a product and to maintain the equipment and machinary in goods working order.

objective of inventory control

→ The objectives are to minimized investment in inventory.

→ to minimized the service levels to the farms costmer and its own operating department.

→ smooth and on interprited products and hence, no stock out.

→ utilisation of working capital.

→ Helps in minimizing loss due to deterioration, obsolescence damange.

→ Aliminate the possibility of duplicate ordering.

→ Improvement in costmer relationship because of timely delivery of goods and services.

Defination of inventory control

Inventory control may be defined as the scientific method of finding out how much stock should be maintained in order to meet the production demmonds and be able to provide right type of material at right time in the right quantities and at compititative process.

Types of inventory classification

→ inventory may be classified as follows

1. Raw inventories

They include, raw material and semifinished product supplied by another form and which raw items for the present industry.

2. In process inventories

They are semifinished goods at various stages of manufacturing cycle.

3. Finished inventories

They are finished goods lying in stock rooms and waiting to dispatch.

Indirect inventories

They included lubricants and other items like spear parts needed for proper operation, repair and maintainess during manufacturing cycle.

involved in inventory

ondering cost

cost incurred for placing and receiving an order.

→ ordering cost include transportation cost, labour charges etc.

Ex ordering cost per unit = Rs 100/ordering

→ total ordering cost per year o/year = No. of order in a year into ordering cost per unit.

Holding or carrying cost.

material cost

This is the cost of any item.

→ Total material cost = no. of item × price of item per unit.

ordering cost

Cost involve for placing and recieving an order.

→ This also known as procurement cost.

~~west~~ Let ordering cost = C_o = Rs 100/order.

cost involve in ordering cost.

→ Transportation cost.

→ Loading and unloading cost.

→ inspection cost.

carrying cost / holding cost.

cost involve in carrying or holding the product till consumed.

unit = C = Rs 100/unit/year

cost involve in holding cost.

→ space cost.

→ worker cost.

→ Electricity cost.

→ intrest on capital invested.

C_p = unit cost of the product

= Rs 1000/unit

i = rate of intrest per annum

= 10%.

$$C = \frac{C_p \times i}{100} = \frac{1000 \times 10}{100} = \text{Rs } 100/\text{unit}/\text{year}$$

Basic E.O.Q model

Assumption

→ Instant and infinite replenishment.

→ No shortage allow.

→ Lead time should be zero.

Aim → Total cost should be minimum.

Anual demand = D unit/year.

ordering cost/order = D_o

Holding cost or carrying cost = C = $\frac{C_p \times i}{100}$

C_p = unit cost of the product.

i = rate of intrest per annum.

Q = quantity of order placed.

Total cost/year = ordering cost/year + holding cost/year + material cost.

ordering cost/year = ordering cost/year

= Number of orders/year × ordering cost/order

⇒ O.C/year = $\frac{D}{Q} \times C_o$

→ Inventory carrying cost/year = C.C/year

= Avg. inventory × unit carrying cost/year

= $\frac{\text{max. inventory} + \text{min. inventory}}{2}$ × unit carrying cost/year

= $\frac{Q + 0}{2} \times C$

⇒ C.C/year = $\frac{Q}{2} \times C$

→ material cost = Annual demand × unit cost of the product

$= D \times C_p$.

→ Total cost/year $= \frac{D}{Q} \times C_o + \frac{Q}{2} \times C + D \times C_p$

For minimum of total cost/year, $\frac{d(T.C)}{dQ} = 0$

$$\Rightarrow \frac{d}{dQ}\left[\frac{D}{Q} \times C_o + \frac{C}{Q} \times C + D \times C_p\right] = 0$$

$$\Rightarrow -\frac{D}{Q^2} \times C_o + \frac{C}{2} = 0$$

$$\Rightarrow \frac{D}{Q^2} \times C_o = \frac{C}{2}$$

$$\boxed{\Rightarrow Q = \sqrt{\frac{2 \cdot D \cdot C_o}{C}}}$$

Q1 → The rate of consumption of a perticular item is 20 unit/year. The cost of procurement (placing on order and recieving the goods) per order is Rs 40. The unit cost is 100 rupees. The inventory carrying cost is 0.16 %. and it depends upon the average stock. Determine E.O.Q

2. No of orders per years.

A) <u>Given data</u>

Rate of consumption in a year / annual demand $= D = 20$ units/year

ordering cost / order $= C_o =$ Rs 40.

unit cost of product $= C_p =$ Rs 100/-

rate of intrest $= 0.16$ %.

Holding cost $= \frac{C_p \times i}{100} = 100 \times 0.16 = 16$

$$E.O.Q = \sqrt{\frac{2D\,C_o}{C}}$$

$$= \sqrt{\frac{2 \times 20 \times 40}{16}} = 10 \text{ unit}$$

2. No. of orders/year $= \frac{D}{Q} = \frac{20}{10} = 2$ unit/year.

Q27 A manufactures requires revets at an approximately constant rate of 2500 kgs/year. The cost of revet is Rs 40/kg. The companies purchase manager estimates that the carrying cost of inventory is 10%/year. procurement cost in Rs 200/order. Determine EOQ
2. No. of orders/year.
3. Total cost of inventory.

A: Given data

Annual consumption $= D = 2500$ kg
ordering cost $= C_o = 200$/order.
unit cost $= C_p =$ Rs 40
rate of intrest = inventory carrying rate = 10%.
holding/carrying cost/year $= C$

$$C = \frac{C_p \times i}{100} = \frac{40 \times 10}{100} = 4 \text{ units}$$

1. $EOQ = \sqrt{\frac{2 \cdot D \cdot C_o}{C}} = \sqrt{\frac{2 \times 2500 \times 200}{4}} = 500$ kg

2. No. of orders/year $= \frac{D}{Q} = \frac{2500}{500} = 5$ unit/year

3. Total cost = ordering cost + holding cost + material cost

$$= \frac{D}{Q} \times C_o + \frac{Q}{2} \times C + D \times C_p$$

$= \frac{2500}{500} \times 200 + \frac{500}{2} \times 4 + 2500 \times 40$

$= 102000$ /-

Q3→ Given that

1) Anual uses, U = 60 units

2) procurement cost, p = Rs 15/order.

3) cost/piece, C = Rs 100

4) cost of carrying inventory i, a percentage including expandature on absolesience, takes, insuranle, detorration etc = 10%.

calculate EOQ and No. of orders/year.

As Annual consumption/uses, D = 60 units.

ordering cost/order = Co = 15

unit cost of the product, Cp = 100/-

i = rate of intrest per anum = cost of carrying inventory in terms of percentage = 10%.

1. Holding cost/anum, $C = \frac{Cp \times i}{100} = \frac{100 \times 10}{100} = 10$

so

$EOQ = \sqrt{\frac{2 D C_0}{C}} = \sqrt{\frac{2 \times 60 \times 15}{10}} = 13.41$ units.

2. No. of order $= \frac{D}{Q} = \frac{60}{13.41} = 4.47 \simeq 5$ unit.

Q4→ The rate use of a perticular row material from stores is 20 units/year. The cost of placing and recieving an order is Rs 40. The cost of each unit is Rs 100. The cost of carrying inventory in percentage per year is ~~0.6~~ 0.16. Determine the EOQ and no. of ordering per year.

A1 Anual uses , $D = 20$ unit

ordering cost per order $= C_o =$ Rs 40

unit of the product $= C_p = 100/-$

rate of intrest per anum in percentage $= i = 0.16$

→ holding cost / anum $= C_p \times i = 100 \times 0.16 = 16$

Sol

$$E.O.Q = \sqrt{\frac{2 D C_o}{C}} = \sqrt{\frac{2 \times 20 \times 40}{16}} = 10 \text{ unit}$$

2. No of order / anum $= \frac{D}{Q} = \frac{20}{10} = 2$ unit / anum.

E.O.Q (Economic order quantity)

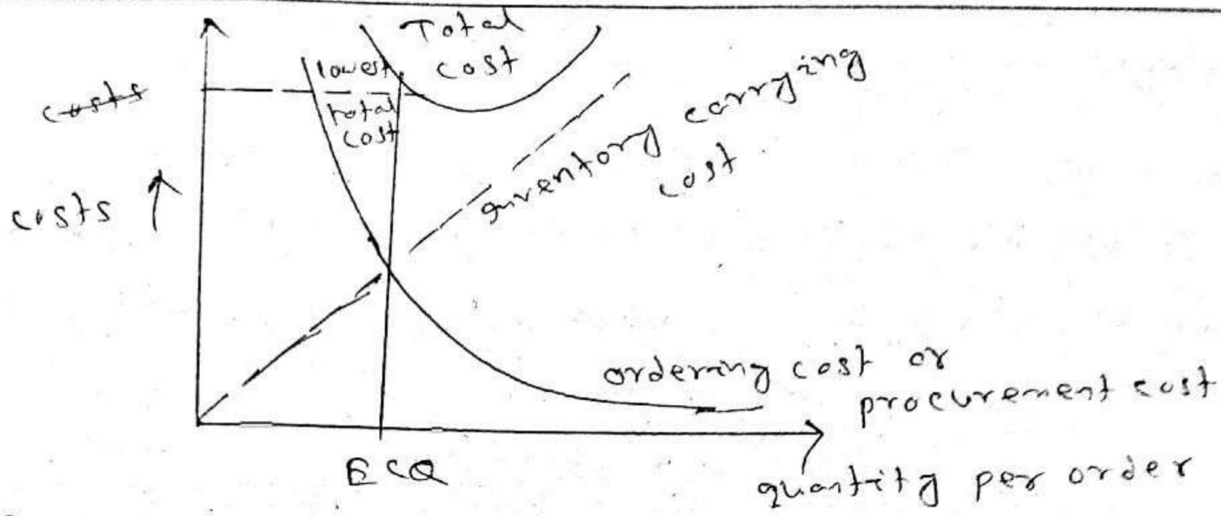
Economic order quantity is one which permits lowest cost per unit and is most advantageous.

* The amount of material procure or quantity produced during one production run by an enterprise is known as lot size.

→ The quantity to be ordered depends upon a no. of factor . It is evident that with increase in inventory size , expendature of storage , detoriation and absolescence etc. is likely to increase where as expandature or setting up of the plant , procurement of material etc will decrease.

→ Thus with lot size there are two set of factors having opposite contribution towards expandature.

→ The lot size for which total cost per period is minimum is known as economic lot size or economic order quantity.



E.O.Q

EOQ is that size of order which minimizes total annual (or other time period as determined by individual firms) cost of carrying inventory and cost of ordering under the assumed condition of certainity of annual demmand.

Inventory control technique

A items
- → High value low quantity.
- → constant control on strict control

B items
- → med. value
- → medium quanty
- → control according to your need.

C items
- → Low value high quantity.
- → less control

ABC analysis (Always better control analysis)

→ ABC analysis help segregating the items from one another and tells how much valued the items is and controlling it to what extent is in the interest of the organisation.

procedurial steps

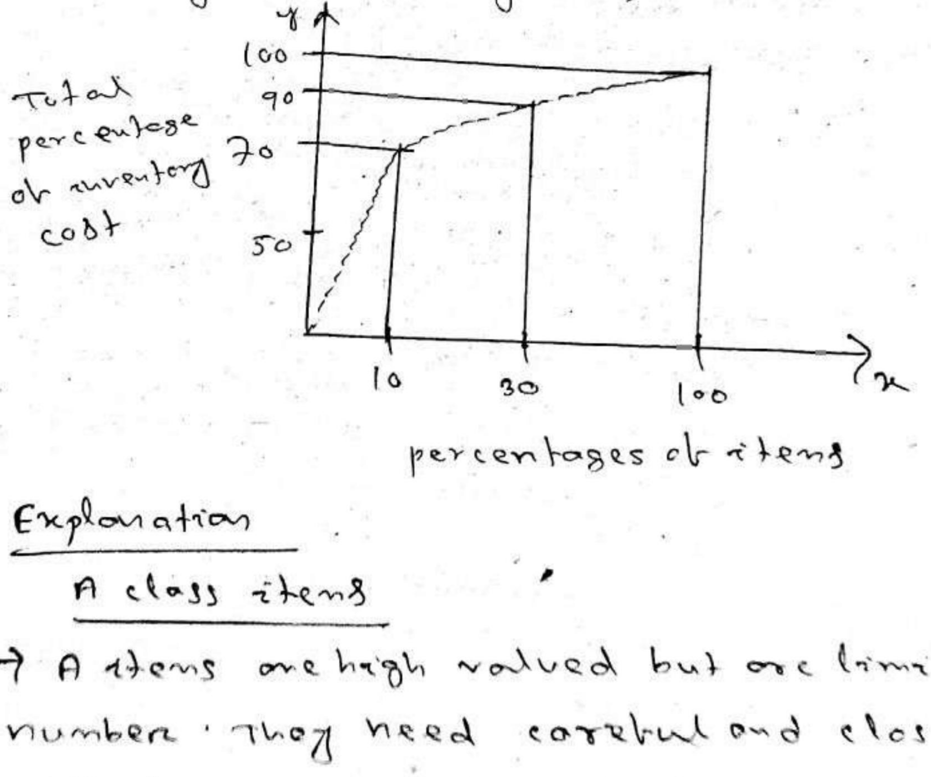
→ identify all the items used in an industry

→ List all the items as per their value.

→ count the number of high valued, medium valued, and low valued items.

→ Find the percentages of high, medium and low valued items. High valued items normally contribute for 70% of total cost and medium and low valued items are 20% and 10% of total cost respectively.

→ A graph can be ploted between percentages of items (on x axis) and percentage of total inventory cost (on y axis).



Explanation

A class items

→ A items are high valued but are limitted or few in number. They need careful and close inventory control.

→ maximum and minimum limits and ~~recorder~~ reorder point is set for A items.

→ A detailed record of their received and issues should be kept and proper handling and storage facilities should be provided for them.

→ Generally A items generally accounts for 70% of total inventory cost and they constitute about 10% of total item.

B class items

→ B items are medium valued and their number lies in between A and C items.

→ Such items need moderate control but more important than C items.

→ They are purchased on the basis of past requirements, reord of recieved and issues is kept and a procurement order is placed as soon as the quantity touches the reorder point.

→ B items generally accounts for 20% of total inventory cost and constitute about 15-20% of total items.

C items

→ C items are low value but maximum number items.

→ These items donot need any control, rather controlling them is uneconomical

→ they are generally procured just before they banish.

→ No expediting is necessary, no records are normally kept and a safety stocks of 3 months or even more can be purchased at an instant.

→ C items generally accounts for 10-5% of total inventory cost and they constitute about 70-75% of total items.

Q57 Usha coporation has got the demmand for perticular parts at 10000 units per year. The cost per unit is Rs 2 and its cost rupees 36 to place an order and the process delivery. The inventory corrying cost is estimated as 9% of average inventory investment. Determine EOQ

2. optimum no. of order to be placed per anum.

3. minimum total cost of inventory per anum.

Ans

Anual demmand, D = 10000 units

unit cost of the product, Cp = 2

ordering cost / order, Co = 36

rate of intrest, i = 9%

So

$$C = \frac{Cp \times i}{100} = \frac{2 \times 9}{100} = 0.18$$

1. $$E.O.Q = \sqrt{\frac{2 \times D \times C_o}{C}}$$

$$= \sqrt{\frac{2 \times 10000 \times 36}{0.18}} = 2000 \text{ unit / order.}$$

2. No. of order per anum $= \frac{D}{Q} = \frac{10000}{2000} = 5$ unit

3. Total cost $= \frac{D}{Q} \times C_o + \frac{Q}{2} \times C + D \times Cp$

$$= \frac{10000}{2000} \times 36 + \frac{2000}{2} \times 0.18 + 10000 \times 2$$

= Rs 20360

Function of inventory

→ Inventory shocks as cushions

Against shocks due to demand./ supplier fluctuation. , it separates different manufacturing operation from one another and make them independent so that each operation can be performed economically.

→ Inventory, necessary evil for any enterprise

→ The invested capital remains ideal till the shocks are not consumes for smooth working of the organisation is not possible without inventory, so it is a ~~necessary~~ necessacity.

→ Further it has been observed that costs of not having inventory are actually greater that cost of having them. Thus inventory is a necessary evil.

→ Inventory provides production economics

→ purchase is desired quantity nullifies the effect of change in price on supplier.

→ stocks brings economy in purchase of various input due to discount on bulk purchase.

→ maintainace smooth and efficient production flow

→ It maintainance smooth and efficient production flow thus keeps a process continuous.

→ creation of motivational effect in decision making.

→ It creates motivational effect in decision and policy making.

(c) maximize $Z = 12x + 24y$

subject to : $x + 4y \leq 20$

$3x + y \leq 15$

$x, y \geq 0$

Ans

$x + 4y = 20$ —— (1)

when $x = 0$, $y = 5$

$\Rightarrow 4y = 20$

$y = \frac{20}{4} = 5$

when $y = 0$, $x = 20$

$x = 20$

x	0	20
y	5	0

$3x + y = 15$ —— (2)

when $x = 0$, $y = 15$

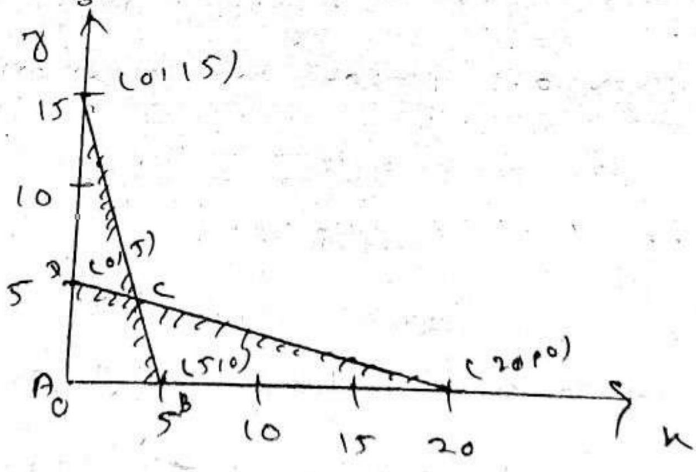
$\Rightarrow 3 \times 0 + y = 15$

when $y = 0$, $x = 5$

$3x = 15$

$x = \frac{15}{3} = 5$

x	0	5
y	15	0



From eqn (1) and eqn (2)

$x + 4y = 20$ —— (1)

$3x + y = 15$ —— (2)

So $x = 3.63$

$y = 4.09$

$Z_A(0,0) = 12 \times 0 + 24 \times 0 = 0$

$Z_B(5,0) = 12 \times 5 + 24 \times 0 = 60$

$Z_C(3.63, 4.09) = 12 \times 3.63 + 24 \times 4.09 = 141.72$

$Z_D(0, 5) = 12 \times 0 + 24 \times 5 = 120$

$\Rightarrow \therefore Z_{max} = 141.72$ at point $C(3.63, 4.09)$.

Q7 find the graphical solution of LPP from the following condition.

Minimization, $Z = 60x + 40y$

subject to, $30x + 10y \geq 240$

$10x + 10y \geq 160$

$20x + 60y \geq 480$

$x, y \geq 0$

Ans

$30x + 10y = 240$ ——— (1)

when $x = 0$, $y = 24$

$3 \times 0 + 10y = 240$

$\Rightarrow y = \frac{240}{10} = 24$

when $y = 0$, $x = 8$

$3 \times x + 10 \times 0 = 240$

$x = \frac{240}{30} = 8$

x	0	8
y	24	0

$10x + 10y = 160$

when $x = 0$, $y = 16$

$\Rightarrow 10 \times 0 + 10y = 160$

$y = \frac{160}{10} = 16$

when $y = 0$, $x = 16$

$10 \times x + 10 \times 0 = 160$

$x = \frac{160}{10} = 16$

x	0	16
y	16	0

$20x + 60y = 480$

when $x = 0$, $y = 8$

$\Rightarrow 20 \times 0 + 60y = 480$

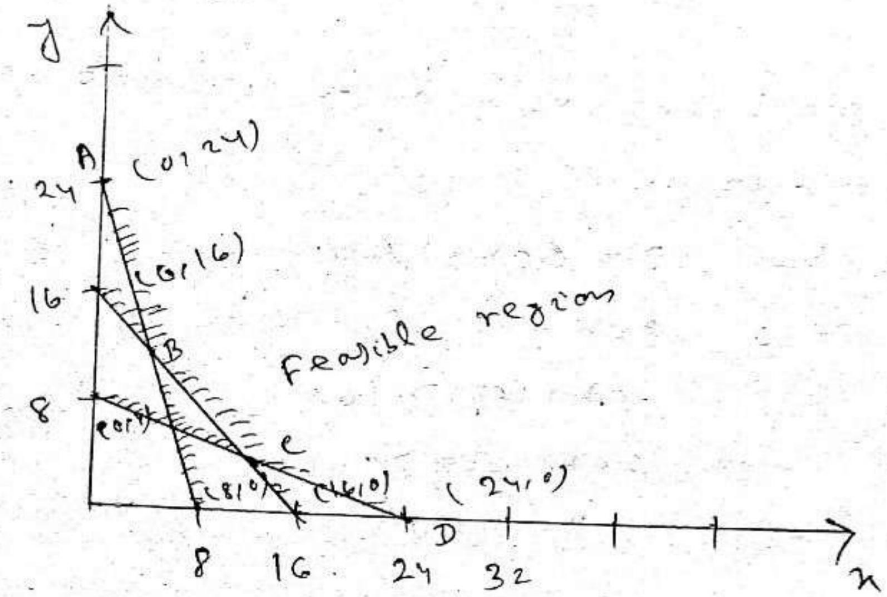
$y = \frac{480}{60} = 8$

x	0	24
y	8	0

When $y = 0$, $x = 24$

$20x + 60 \times 0 = 480$

$x = \frac{480}{20} = 24$



from eqn (1) and eqn (2)

$30x + 10y = 240$ ——— (1)

$10x + 10y = 160$ ——— (2)

$x = 4$, $y = 12$

from eqn (2) and eqn (3).

$10x + 10y = 160$ ——— (3)

$20x + 60y = 480$ ——— (3)

$x = 12$, $y = 4$

$Z_A (0, 24) = 60 \times 0 + 40 \times 24 = 960$

$Z_B (4, 16) = 60 \times 4 + 40 \times 12 = 720$

$Z_C (12, 4) = 60 \times 12 + 40 \times 4 = 880$

$Z_D (24, 0) = 60 \times 24 + 40 \times 0 = 1440$

Z_{min} ~~at~~ = 720 at point B (4, 12).

In mondern industry, equipment and machinary as a very important part of the total productivity ebbort than the case years ago.

→ more over with the development of special purpose and suphisticated machines, equipment and machinary cost a lot of more money and therefore their idle for downtime becomes much more expensive.

→ For this reason it is vitaly important that the plant machinary should be properly maintained.

objective of plant maintainace

→ The objective of the plant maintainace is to achieve minimum break down and to keep the plant is good working condition at the lowest possible cost.

→ machine and other facilities should be kept in a such a condition which permits them to be used at their optimum capacity without any interpretation.

→ The maintainace devision of the ~~facili~~ factory ensures the availability of the machine, buildings and services required by other section of the factory for the performance of ~~the factory~~ their functions at optimum return on investment wheather this investments be in material, machinary on personaly.

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importance of maintarnance

→ The important of plant maintarnce varies with the type of plant and its production.

→ Equipment breakdown leads to an invitable lost of production.

→ An unproperly maintain or neglated plant will sooner or later requine expensive and frequent repair, because with passage of time all machines or other facilities wear out and need to be maintained to function properly.

→ plant maintainace plays a prominent role in production management because plant breakdown creates problems such as loss in production time, resheduling of production, failuer to recover overheads, need for overtime etc.

Responsibility and duty of plant maintaince engineering department.

The different duties, functions and responsibility of the maintainace department are as follows.

1. inspection

inspection is concerned with routing shedule checks of the plant facilities to examine their condition and to check for needed repairs.

→ inspection insure the safe and efficient operation of equipment and machinary.

→ Frequency of inspections depends upon the intensity of use of the equipment.

2. Engineering

→ Engineering involves alteration and improvement in existing equipments and building to minimize breakdown.

+ maintainace department also undertakes engineering and supervision of constructional project that will eventually become part of the plant.

3. maintainace (including preventive maintainace)

→ maintainace of existing equipment.

→ maintainace of existing plants ~~bu~~ building and other facilities such as central stores, road ways, drainage etc.

→ preventive maintainace, preventive breakdown by well conceived plants of inspection, lubrication, adjustments, repair and overhaul.

4. Repair

maintainace department carriage out correlative repairs to alleviate on satisfactory condition found during preventive maintainace inspection.

→ Such a repair is an unscheduled work often of an emergency nature and is necessary to correct break downs.

5. overhaul

overhaul is a planned, ~~sto~~ scheduled reconditioning condition of plant facilities such as machinery etc.

6. construction

In some organisation, maintenance department is provided with equipment and personal and it takes of construction Job also.

7. Salvage

maintainance department may also handle disposition of scrap or surplus materials.

8. Clerical Jobs

maintainance department keeps records of costs, of time progress on Job, administration and supervision of labour coarse, insurance administration, house keeping etc.

Types of maintenance

1. Break down maintenance
2. scheduled "
3. preventive "
4. predictive "

1. Breakdown or corrective maintenance

→ Breakdown maintenance implies that repaires are made after the equipment is out of order and it can not perform its normal function any longer.

ex → Electric motor will not start, A belt is broken etc.

→ After removing the fault the maintenance engineer do not attend the equipment again until another failuer or breakdown occurs.

→ This type of maintenance may be quite justify in small factories which

* are indifferent to the benifits of scheduling.

→ wet seldom demmand in excess of normal operating capacity.

→ Breakdown maintenance practice is economica for those equipments whose downtime and repair cost are less this way than other type of maintenance.

→ Breakdown maintenance involves little administrative work, a few records and a comparatevely small staff.

2. scheduled maintenance

→ scheduled maintenance is a stich-in-time procedure aimed at avoiding breakdowns.

→ Breakdown can be dangerious to life and as far as possible should be minimize.

→ scheduled maintenance practice incoporates, inspections, lubrication, repair and overhaul of certain equipments which if ~~ng~~ neglected can result in breakdown.

→ scheduled maintenance practice is generally followed for overhauling of machines, cleaning of water and other, white washing of ~~bui~~ building etc.

3. preventive maintenance

→ A system of scheduled, planned on preventive maintenance tries to minimize the problem of breakdown maintenance generally it is a stich-in-time procedure.

→ It locates weak spots in all equipments provide them regular inspection and minor repairs thereby reducing the danger of anticipited breakdown.

→ The principle of preventive maintenance is that prevention is better than cure.

* preventive maintenance involves

1. period inspection of equipment and machinary. to uncover conditions that lead to production breakdown and harmful depriciation.

2. ~~keep~~ unkeep of plant equipment to correct such condition which they are still in a miner stage.

Objective of preventive maintenance

→ To minimize the possibility of anticipated production interpretation or measure breakdown.

→ To make plant equipment and machinary always available and ready for use.

→ To maintain the value of equipments and machinary by period inspection, repaires, overhaul etc.

→ To reduce the work content of maintenance jobs.

→ To minimize the optimum productive efficiency of the plant equipment and machinary.

4. Predictive maintenance

→ It is comparatevely a newer maintenance technique.

→ predictive maintenance technique are designed to help determine the condition of inservice equipment in order to estimate when maintenance should be perform.

→ This approach promises cost saving over routine on time based preventive maintenance because tasks are perform only when warranted.

→ It makes use of human senses or other sensitive instruments such as audio gauges, vibration sensors, pressure sensor, temperature sensor and resistance strain gauge to predict troubles before the equipment fails.

→ unusual sounds comming out of a rotating equipment predict a trobule.

Ex → An electric cable excessively hot at one point predict a trobules.

→ predictive maintenance extends the service life of an equipment without fear of failure.

Prepared By

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