SWAMI VIVEKANANDA SCHOOL OF

ENGINEERING & TECHNOLOGY

LECTURE NOTE

INDUSTRIAL ENGINEERING MANAGEMENT

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Jay hanuman Date - 6.02.2017

concept & Factors governing For Plant Location

Plant is a place where men, material, machinary equipment etc are brought together For manufacturing different Product and plant location means we have to decide a suitable place that can proper suitable For manufacturing different product

→ And this plant location involves to measure activities

(i) To select proper Geographic Reason.

(ii) selecting a specific side with in the Reason.

→ Plant Location plays measure role in the design or production system.

(i) Getting suitable Raw material

(ii) processing Raw material to Finish good.

(iii) And these Finish product to distribution to the customers.

Various Factor affects in the plant location

(1) Nearness to Raw material

(2) Transport Facilities

(3) Labour Availability

(4) Nearness to market

(5) power availability

(6) Financial & other Aids

(7) Availability of water

(8) climate condition

Date- 9.1.2017

① Nearness to Raw material

It will reduce the cost of transporting Raw material from the vendors ends to the plant

→ Those plants which consume the raw material in bulk, or raw material is heavy is cheap and the looses of a good amount of its weight during processing the (Sawmills) are must be located close to the source of raw material.

② Transportation Facilited

→ A lot of money is spend both the transporting Raw material and to the Finish goods.

→ also it is depend upon the size of Raw materials and Finish the goods For a suitable method For transportation like Road, Rail, water or air is selected and accordingly plant location is to be decided.

③ Nearness to market

It will be reduce cost of transportation and as well as the chance of Finished products getting damage and spoiled on the way.

④ Availability of Labour

A stable labour force, of right kind of the anticipated size, and all the reasonable mates and with its proper attitude towards the work.

⑤ Availability of Fuel and power

(Because of wide spread use of electrical power), In most cases Fuel and coal are to be necessary to the industry.

→ Even them steel industries are located near to the sources of Fuel and to cut down the Fuel transportion cost.

⑥ Availability of water

Water is used For drinking purpose and sanitary purpose and also it is very much necessary For chemical industries

⑦ Climatic condition

In climate condition that the region of does not present much problem with the development in the Field of heating, ventilation and air conditioning, that's can control to the climates needs. For money.

⑧ Financial and others Aids

certain states give Aids how low Feed money, machinery etc to attract the industry.

⑨ Land

The shape of the size, cost, obstacles drainage, and other facilities.

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Plant Layout

Plant layout means the disposition of facilities just like equipments, Rawmaterial and manpower.

→ Plant layout begins with the design of factory building and goes upto the location and movement of the worktable.

→ All the facilities like tools, workers and fixtures etc are given a proper place, indeciding the place of the equipments and that can operated by supervision and also a engineers.

Objectives of a good plant Layout

(1) Material handling and transportation minimised and efficiently control

(2). Work station are design suitably and properly.

(3) Suitable place to allocated to Production centres and service centre

CHART

(4) The movement made by the workers to be minimised.

(5) Plant maintenance is simplier or easier.

(6) There is the utilisation of cubic space. (Length, breath, height etc)

(7) There is increase Flexibility for changes of product design.

(8) Working conditions are stay safer and better and also improve.

(9) There are improve work methods and reduce production cycle times.

(10) A good layout permits materials to move through the plant and desire speed with the lowest cost.

Principle of plant Layout

For the guidance of plant layout engineers having been developed or made so many principles, considerable care & skill is required in designing a good plant layout.

→ The research of the work is being continue in order to develop a scientific approach for the solving plant layout problem.

① Integration

It means the integration of production centre facilities like workers, machenary, Rawmaterial etc in a logical

and balanced manner.

(b) → Maximum movements and material handling

The number of movements of workers and materials should be minimised, it is a better to transport materials in bulk. optimisation

(c) Smooth and continuous Flow

→ it means conjection points & conjection back tracking should be removed by proper line balancing technique.

Date - 13.01.17

(d) cubic space and utilisation

→ Using the floor space of a room, and of the ceiling height. it also utilised.

→ The more materials can be accomodation in the same room.

(e) → Safe and improved environment

This can produce well ventilised and free from dust, and noise, fumes, and other hazardous condition desirably increases the operating efficiency.

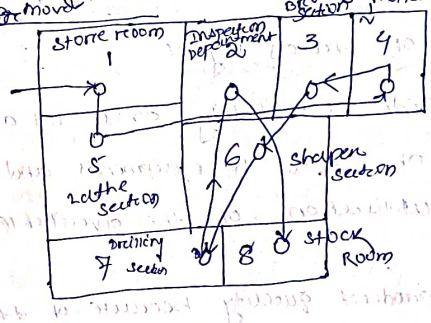
(f) Flexibility

→ In automotive and other industries where models of products changes often sometime, then it can better to permit all possible Flexibility in the layout.

→ The machinery is arranged in such way that the changes of the production process can be achieved at the least cost.

Process Layout

Showing product



(1) Store room

(2) ~~Lathe section~~ Inspection

(3) Broaching section

(4) Milling section

(5) ~~Lathe section~~

(6) shaper section

(7) Drill section

(8) Stock Room

→ It is also known as Functional Layout and it is characterised by keeping similar machines or similar operation or similar function at one location.

→ In other word all lathes will be at one place, all milling machine at another place and ~~so~~ so on.

→ This type of layout is generally employed for industries and engaged job order production and non repetere kind of manufacturing or manufacturing activities.

Date - 19.01.17

Advantages of process layout

(i) → Wide flexibility exist on alligment allotment of work to equipments and workers.

(ii) → Better utilisation of the available equipment.

(iii) → Better product quality because of the supervision and workers rightly attuned to the one type of machine and operation.

(iv) → comparatively less number of machine are to be needed, thus involving reduce the capital investment.

(v) → ~~Varieties~~ Verieties of types of job commong as different job orders that make the work more intresting for the workers.

Dis advantages (when compared with product layout)

(i) → Production control becomes difficult.

(ii) → work in process inventory large.

(iii) → Automater material handling is extremely difficult.

(iv) → Complistion of same product take more time.

(v) → Raw material has to travel largeer distance for being proceed to finish the good.

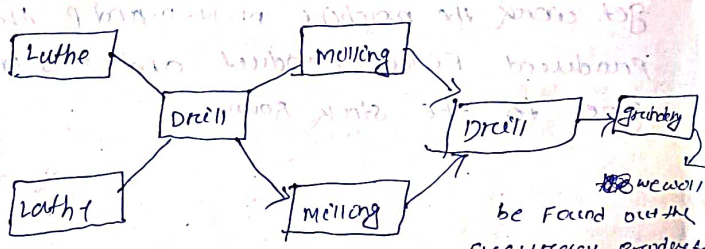
(vi) → It needs more inspection.

Product Layout

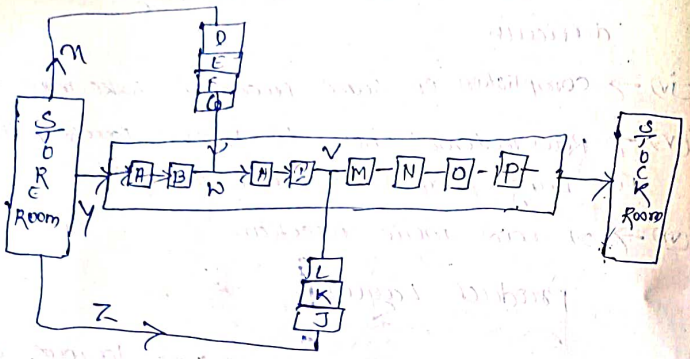
It is also known as line layout or sequencing layout, it emplise that various operation on raw material are performed in sequence and machines are placed along the production flow line.

→ And this machines are arranged in the sequence in which the flow of Raw materials will be operated ~~upon~~ up on.

→ This type of layout is preferred for continuous production. i.e involving the continuous flow of Raw materials towards the finished the product stage.



~~We~~ we will be found out the accuracy products or goods.



→ Raw materials From the stone room is Feed to the 3 lines. Just like x, y, z and materials on x line proceeds on machine D-E-F-G, and materials on y Line proceeds on machine A,B Then materials on Z Line proceeds on machine J, K, L.

→ ~~All~~ Meets the material y and x Lines are assembled then the product produced 'B'. Another part Z Line produce the main product 'B' after that the total assembly get coarse the machine M-N-O-and P then produced Final product and this product goes to the stock Room.

Advantages of product Layout Date - 19.01.17

→ With-in less time it can produce more product and also completion of the product.

→ Less skill workers can easily serve this type of operation.

→ Better co-ordination and simple production planning and control.

→ Smooth and continuous work Flow.

Dis-advantages of the product Layout compare to the process Layout

→ One machine in the line will be Fails, it may Lead to shut down the complete ~~the~~ production Line.

→ In this product layout process similar type of job or goods can not be production at a time

→ product Layout involves highly investment ~~investment~~ capital cost.

→ Specify product determines the layout that can change in product involves ~~major~~ changes the Layout Flexibility is considerable Reduces.

COMBINATION LAYOUT

→ A combination of process and product Layout combines the advantages of both type of Layouts. (process and product).

→ Most of the manufacturing ~~section~~ are arrange in process Layout with product Layout manufacturing Lines occurring Here and there condition will permit.

→ A combination layout is possible where an item is being made in different type and sizes.

→ In such cases machinary is arrange in a process layout but the process grouping (A group of number of similare machines) is then arranged in a sequense to manufacture various type and size of product.

→ Examples

Cheers, Files, Hacksaw, Woodsaws, circulare metal saw.

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2nd chapter

Date: 21.01.2017

OPERATION RESEARCH

Concept of optimisation

An a Industrialist has a two industries (A and B) at different location, He is intrested to send the finished good five different station.

There are several alternate ways of accomplishing this tasks, From industry A can send F_1, F_2, F_3, F_4 and F_5 number of goods to each of the five station. or B can send N_1, N_2, N_3, N_4 and N_5 number of goods to each station. or any other goods.

And similarly the industry B.

The point at which of the several alternated will be based and most favourable.

→ It is the one for which industries has to pay the minimum transportation charges.

Such problems are solved by the use of optimisation techniques.

→ This optimisation technique belongs to Linear programming Problems. (LPP).

DUE-23.02.2014

Methods of Optimisation

(a) → Search
(b) Differential calculus
(c) Statical Statistical method
(d) calculation of variation
(e) Linear programming → This linear programming also follows 3 method.
   (1) Graphical method
   (2) Transportation method
   (3) Simplest method.
(f) Queuing methods or Theory
(g) Dynamic programming
(h) Hill climbing

Application of optimisation

Some of the process to which optimisation is applicable are load allocation problem, → component selection, dynamic load sharing, dynamic terminal value problem etc.

(A)

PERT CHART

OPERATION RESEARCH

INTRODUCTION

Historically the term operation Research originated during second worldwar armed → when U.S.A and Britain forcess sought the Assistance of the scientist to solve the complex and very difficult strategical ~~and tactical~~ problems of war like making mines harmless or increase the efficiency of anti-sub-marine aerial warfare etc

→ But still now operation research used in different type of busines problems and in planning and investigation of measures operational decision.

→ A Few application of operation research that can belongs to
   (1) Locating Factories and to minimise transportation cost.
   (2) Work allocation to machines for minimising production time and cost.
   (3) Inventory problems
   (4) Material handling
   (5) Dealing with waiting time
   (6) Equipment Replacement
   (7) Dividing Advertising budget.
   (8) Traffic control
   (9) Petro-chemical mixer

(10) Municipal and Hospital Administration.

(11) Marketing

Definition and concept of Operation Research

→ Operation Research takes in to consideration of a particular view and particular kind of operation and this operation Research is the organised application of modern science, mathematics, and computer techniques to complex military, government, business or industrial problems. that the arriving in the direction and mangement of large system of men, material, money and machines.

Methodology of operation Research

Various steps involves are the Following:

(1) Understand actual real situations, captures the same and defined the problems.

(2) Then formulate the mathematical model.

A model is of great help in Facilitating the investigations of operation and operation Research expressed a problem by a model. This model covers the relationship of the variables, Generally two types of model are employed: This model which takes the form of electronic circuitry or it may be a mechanical system. The

Symbolic model is in the form of matrix, a graph or an equation.

(3) Develop a mathematical solution (Data is supply to the model, information is compared, and results are analise to find the mathematical solution for uncertainty points.).

(4) Interpret the solution and prepare the information in such form of meaningful intelligent and quantitative.

(5) Implement decission to the real situation.

(6) Verify the Result

Linear programming

Linear programming is one of the classical operation Research technique, and this technique previously used in military section. But presently it is used in so many business section. And its funds allocation like Crude oil distribution to refinery, Product distribution.

→ Thats can may be maximum overall profit or overall cost

→ Linear programming can be applied effectly only if, (i) The objective can be started mathematically

(2) Resources can be measured as quantities. (Number, weight etc)

(3) There are too many alternate solution to ever be evaluated conventionally.

(4) The variable of the problems bears a Linearity. (Straight Line relationship) that can change is one variable produce proportionate changes in the other variable.

→ Other words doubling the units of sources will double the profit.

→ The linear programming model may be look at

maximize

$$Z = c_1x_1 + c_1x_2 + c_1x_3 + \dots + c_nx_n$$

Subjects to conditions

$$a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + \dots + a_{2n} \leq b_1$$

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

$$\vdots$$

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

$$b_2 \geq 0, \quad i = 1,2,3$$

$$x_j \geq 0, \quad j = 1,2,3$$

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Example

GRAPHICAL METHOD

→ A Furniture manufacturer makes two products x_1 and x_2 namely chairs and table. Then each chair contributes a profit of 20 Rupees and a table that of 40 Rupees.

→ Chairs and table from Raw materials to Finish product are process in 3 section. S_1, S_2, S_3. In section S_1 each chair ~~in section~~.

x_1 Requires 1 hours and each table x_2 requires 4 hours of processing.

→ In section S_2 each chair requires 3 hours and each table 1 hour.

→ And section S_3 the times are 1 and 1 hour respectively. The manufacturer wants to optimise his profits of section S_1, S_2 S_3 can be availed for not more than 24, 21, and 8 hours respectively.

Answer

$$Z = Z_{max} = c_1x_1 + c_2x_2 + \dots + c_n$$

$$Z_{max} = 20x_1 + 40x_2 \quad (i)$$

$$x_1 + 4x_2 \leq 24 \quad -- (1)$$

$$3x_1 + x_2 \leq 21 \quad -- (2)$$

$$x_1 + x_2 \leq 8 \quad -- (3)$$

c_i is constraint

Answer

$Z_{max} = 20x_1 + 40x_2$

$x_1 + 4x_2 \leq 24$

$3x_1 + x_2 \leq 21$

$x_1 + x_2 \leq 8$

$x_1, x_2 \geq 0$

GRAPH

1st step

$x_1 + 4x_2 = 24$

$3x_1 + x_2 = 21$

$x_1 + x_2 = 8$

2nd step

$x_1 + 4x_2 = 24$

Let $x_1 = 0, \quad x_2 = 6$

$x_2 = 0, \quad x_1 = 24$

∴ co-ordinates are (0, 6) (24, 0)

again $3x_1 + x_2 = 21$

Let $x_1 = 0, \quad x_2 = 21$

$x_2 = 0, \quad x_1 = 7$

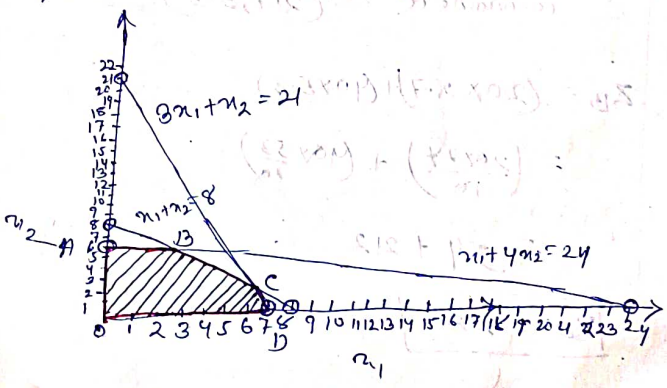
∴ co-ordinates = (0, 21), (7, 0)

again $x_1 + x_2 = 8$

Let $x_1 = 0, \quad x_2 = 8$

$x_2 = 0, \quad x_1 = 8$

∴ co-ordinates = (0, 8) (8, 0)



From graph we find the feasible region as OABCD.

$Z_O = 0$

$Z_A = 20x_1 + 40x_2$

$= 20\times0 + 40\times6$

$= 0 + 240 = 240$

$Z_D = 20x_1 + 40x_2$

$= 20\times7 + 40\times0$

$= 140$

For finding out Z_B we have to solve the two equation as

$x_1 + x_2 = 8$

$2x_1 + 4x_2 = 24$

$\Rightarrow -2x_2 = -16$

$\Rightarrow x_2 = \frac{16}{3} = 5.3$

$\therefore x_1 = 8 - \frac{16}{3} = \frac{24-16}{3} = \frac{8}{3} = 2.7$

$\therefore$ co-ordinate is $(2.7, 5.3)$

$Z_B = (20\times2.7) + (40\times5.3)$

$= \left(\frac{20\times27}{10}\right) + \left(40\times\frac{53}{10}\right)$

$= 54 + 212$

$\boxed{Z_B = 266}$

For finding out the Z_C we have to solve the two equation as

$3x_1 + x_2 = 21$

$x_1 + x_2 = 8$

$\Rightarrow 2x_1 = 13$

$\Rightarrow \boxed{x_1 = 6.5}$

$\Rightarrow x_2 = 8 - 6.5 = 1.5$

$\Rightarrow \therefore$ co-ordinate $= (6.5, 1.5)$

$Z_C = 20\times6.5 + 40\times1.5$

$= \left(20\times\frac{65}{10}\right) + \left(40\times\frac{15}{10}\right)$

$= 130 + 60$

$\boxed{Z_C = 190}$

$\therefore Z_{max}$ will be 266.6 (Ans)

Ques

(b) For maximize

$Z_{max} = x + 5y$

S.C.

$5x + 6y \leq 30$

$3x + 2y \leq 12$

$x, y \geq 0$

Solution:

1st step:

Let $5x + 6y = 30$

$3x + 2y = 12$

2nd step

$5x+8y=30$

Let $x=0$, $y=5$

$y=0$, $x=6$

∴ The co-ordinates are $(0,5)$, $(6,0)$

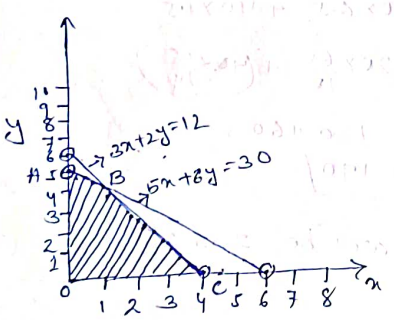
Again

$3x+2y=12$

Let $x=0$, $y=6$

$y=0$, $x=4$

∴ The co-ordinates are $(0,6)$, $(4,0)$



From graph we find feasible region as

OABC.

$Z_O = 0$

$Z_A = x+5y$

$\boxed{Z_A = 25}$

$Z_B = x+5y$

$\boxed{Z_C = 4}$

For finding out Z_B we have to solve the two equation and

$5x+8y=30$ — (i)

$3x+2y=12$ — (ii)

multiply the 5 in equation (ii) & 3 in equation (i)

$\Rightarrow 15x+18y=90$

$15x+10y=60$

(−) (−) (+)

$\Rightarrow 8y=30$

$\Rightarrow y=\frac{30}{8}=\frac{15}{4}=3.75$

Putting the value in equation (ii)

$\Rightarrow 5x+6y=30$

$\Rightarrow 5x+6\times(3.75)=30$

$\Rightarrow 5x=30-\left(6\times\frac{375}{100}\right)$

$\Rightarrow x=\frac{30-(6\times3.75)}{5}$

$\Rightarrow x=\frac{30-22.5}{5}=\frac{7.5}{5}=1.5$

∴ $\boxed{x=1.5}$

$\boxed{y=3.75}$

Putting the value in Z_B

$Z_B = x+5y$

$= 1.5+(5\times3.75)$

$= 1.5+18.75$

$\boxed{Z_B = 20.25}$

∴ Z_{max} will be maximum. (Ans)

$\boxed{Z_A = 25}$

(Ans)

Problem

Date- 25.01.2017

Min $Z = 2x + 3y$ when

$x + y \geq 6$

$2x + y \geq 7$

$x + 4y \geq 8$

$x, y \geq 0$

~~Ans~~ Solution

1st step

$x + y = 6$

$2x + y = 7$

$x + 4y = 8$

2nd step

$x + y = 6$

Let $x = 0, y = 6$

$y = 0, x = 6$

∴ co-ordinates are $(0, 6)$ $(6, 0)$

$2x + y = 7$

Let $x = 0, y = 7$

$y = 0, x = 3.5$

∴ co-ordinates are $(0, 7)$ $(3.5, 0)$

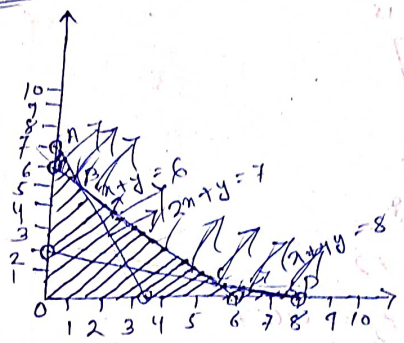
$x + 4y = 8$

$\Rightarrow x = 0, y = 2$

$y = 0, x = 8$

∴ co-ordinates are $(0, 2)$, $(8, 0)$

3rd step



From graph we find reasonable region as OABCD.

$Z_O = 0$

$Z_A = 2x + 3y$

$= 2 \times 0 + 3 \times 7$

$\boxed{Z_A = 21}$

$Z_B = 2x + 3y$

$= 2 \times 8 + 3 \times 0$

$\boxed{Z_D = 16}$

We calculate Z_B

$x + y = 6$

$2x + y = 7$

$\Rightarrow \boxed{x = 1}$

putting the value $x = 1$ in eq (i)

$\Rightarrow \boxed{y = 5}$

$Z_B = 2x + 3y$

$= 2 + 15$

$\boxed{Z_B = 17}$

Z_C we have

$x + y = 6$

$x + 4y = 8$

$\Rightarrow -3y = -2$

$\Rightarrow y = \frac{2}{3} = 0.667$

$\Rightarrow \boxed{y = 0.667}$

$\therefore \boxed{x = 5.33}$

$\therefore Z_C = 2x + 3y$

$= 2 \times 5.33 + 3 \times 0.667$

$\Rightarrow = 10.66 + 2.001$

$\boxed{Z_C = 12.661}$

$\boxed{\therefore Z_{max} \text{ is } 12.661}$ (Ans)

$Z_{max} = 2x + 5y$

$x \leq 4$

$y \leq 6$

$x + y \leq 8$

$x, y \geq 0$

1st Step

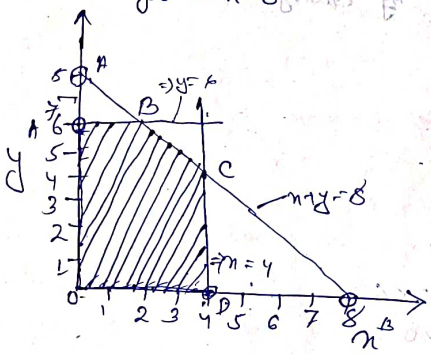
Let $x = 4$ (4, 0) (0, 0)

$y = 6$ (0, 6) (0, 0)

$x + y = 8$

$\Rightarrow$ Let $x = 0 \Rightarrow y = 8$ (0, 8) (8, 0)

$y = 0 \Rightarrow x = 8$



$Z_A = 2x + 5y$

$= 2 \times 0 + 5 \times 8$

$\boxed{Z_A = 40}$

$Z_B = 2x + 5y$

$\boxed{Z_B = 16}$

$\therefore \boxed{Z_{max} = 40}$ (Ans)

From graph we find the feasible region as

OABCD

$Z_O = 0$

$Z_A = 2x + 5y$

$= 2 \times 0 + 5 \times 6$

$\boxed{Z_A = 30}$

$Z_D = 2x + 5y$

$= 2 \times 4 + 5 \times 0$

$\boxed{Z_D = 8}$

we find Z_B by equating

$x + y = 8$

$\Rightarrow y = 6$

$x = 2$

$\therefore y = 6$

$Z_B = 2x + 5y$

$= 2 \times 2 + 5 \times 6$

$= 4 + 30$

$\boxed{Z_B = 34}$

Z_C by eqn

$x + y = 8$

$x = 4$

$y = 4$

$x = 4$

$Z_C = 2x + 5y$

$= 2 \times 4 + 5 \times 4$

$= 8 + 20$

$\boxed{Z_C = 28}$

$\therefore Z_{maximum} = 34$

Date - 28.01.2017

Network theory

Network theory are are developed from the mild stone chart and bar chart. These conventional planning methods, because of they are inhibiting limitation could not be utilised for planning large and complex project.

This network analysis help designing, planning, co-ordinating, controlling and also decision making in order to complete the projects.

This network system which plans, projects both large and small by analysis of project activities, and also this network theory very helpful for different type of construction project.

This network theory should be given properties as regards the resources of men, money, materials and machinary.

They hold following some disadvantages

(i) The effects of changes in schedule, and can not be evaluated with the help of bar chart.

(2) A bar chart neither schedrauding tells the time at which the activities begain and end. note it indicates tolerance in activity timing.

(3) A bar chart doesnot predict satisfactory well in advance with the effects of corrective action can not be taken in time.

(4) A bar chart does not normally indicate work progress, which is very essentially.

(5) A bar chart does not show the continuing inter relationship of the activities, especially of the number of activities is large and they change in time scale and Resources.

Advantages of Network theory.

→ It can helpful for designing, planning controlling which is co-ordinating and also decision making for the project.

This Network theory Follows different techniques (Network Techniques)

① PERT - Programme Evaluation Review Technique

② CPM = Critical path method.

③ RAMS = Resources allocation and multiproject scale scheduling.

④ PEP = Programme evaluation procedure.

⑤ COPAC = Critical operating production allocating control.

⑥ MAP = Manpower allocation procedure.

⑦ GERT = Graphical Evaluation Review Technique.

⑧ PCS = Project control system

⑨ LCS = Least cost scheduling.

Date - 30.01.2017

Terms related to Network planning method

① Event

An event is a specific instant of time which marks the start and end on the activities.

→ Events also consume neither time nor resources.

→ It is represented by a circle and also node.

② Activity

Every Power Projects consist of number of Job operations. are an activities an element of project. and it may be process or material handling or material procurement cycle. Activity are

a) 3 types.

① critical activities

② Non-critical activities

③ Dummy activities.

(a) Critical activities

This type activities are those consumes more than their estimated time, the project will be delay.

(b) Non-critical activities

Such type of activities have provision (Float or Slack) so that, it consumes specified time over the estimated time. This activities will not take be delay.

(c) Dummy activities

In this type of activated starts at the same instant of time. (Always event will be activated at time two activities, just like C&D). But dummy activities does not consume time. It is represented in dotted arrow. or the head events are joined by dotted curves and this dotted arrow is known as, dummy activites.

(3) Critical path

It is the squence of activities, that the decide total project duration. This critical path consumes maximum resources.

→ It is a longest path and also consumes maximum time.

→ It has Zero Float.

Duration

→ Duration is the estimated or actually time required to complete a task or job, or an activity

CHART

Total project time

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

In otherwords it is the duration of critical path.

Earliest Start time (EST)

It is the earliest possible time which an activity can start and is calculated by moving from 1st to last events in a network diagram.

Earliest Finish time (EFT)

It is a earliest possible time at which event can be Finish.

EFT = EST + Duration of that activities.

Latest Finish Time (LFT)

It is calculated by moving backward i.e from last event to 1st event in this network time.

Latest start time (LST)

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

LST → LFT − Duration.

Float or slack

Slack is with reference to an event and Float is with respect to activity.

In otherwords slack is used in PERT and Float is used in CPM, they may be used interchangeable.

→ It may be Float or slack, it maybe spare time, A margin of extra time over and duration which a non-critical activities can consume without delaying the project

→ Float is deference between time available for completing and activities and time necessary to complete the same

$$\text{Total Float} = LST - EST$$
$$\text{or}$$
$$= LFT - EFT$$

Date - 4.02.17

Free Float

→ If all the noncritical activities starts as early as possible, the surplus time is the Free Float.

→ Free Float = EST of Tail Event − EST of Head event − Activity duration.

$$F.F = [EST \text{ of Tail event} - EST \text{ of Head event} - \text{Activity duration}]$$

Independent Float

The use of independent Float of an activities does not change the Float in other activities.

→ Independent Float of found negative is taken as zero. (0)

→ Independent Float = [EST of Tail event (Succeeding) − LFT of head event (Preceding) − Activity duration]

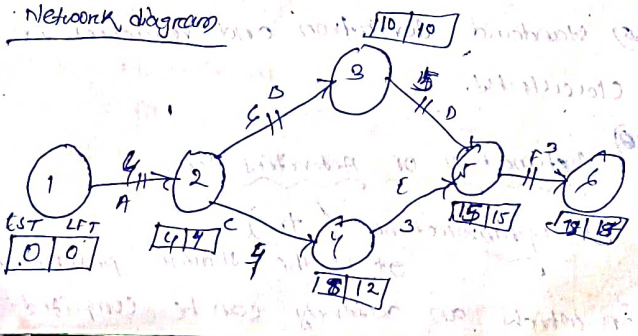
Problem

A small engineering project consist of 6 activities. Namely A, B, C, D, E & F. Duration 4, 6, 5, 4, 3 & 3 days respectively. Draw the network diagram and calculate EST, LST, EFT, LFT. and Floats. Mark the critical paths and find the total project duration.

Date - 7.02.2017

Solution

Network diagram



Sl. No	Activity	Duration	EST	EFT	LST	LFT	Total float	Free float	Critical
1	A	4	0	4	0	4	0	0	0
2	B	6	4	10	4	10	0	0	0
3	C	5	10	15	10	15	0	0	0
4	D	4	4	8	8	12	4	0	0
5	E	3	8	11	12	15	4	4	0
6	F	3	15	18	15	18	0	0	0

PERT

→ PERT planning consists of following steps

(1) The project is broken into different activities.

(2) Activities are arranged in logical sequences.

(3) Draw the Network diagram and event activities are numbered.

(4) Using 3 time estimates, expected time is calculated.

(5) standard deviation and variances is calculated.

(6) Estimation of Activities time

(1) optimistic time (to)

→ It is the shortest possible time in which an activity can be completed.

or everything goes exceptionally well.

(2) Most likely time (tm)

→ It is the time in which the activities is normally ~~accepted~~ expected to complete under normal contingencies.

(3) pessimistic time (tp)

→ It is the time which an activities will take to complete in case of difficulty. (i.e if every thing goes wrong)

→ Expected time can be calculated by given Formula

$$t_e = \frac{t_o + t_p + 4t_m}{6}$$

Standard deviation (S_t)

→ $S_t = \frac{t_p - t_o}{6}$

variance (V_t)

$V_t = [S_t]^2$

Date- 8.02.17

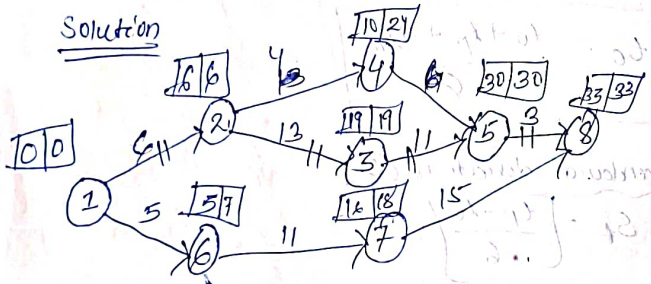
(7) Find the estimated time of the following table also calculate standard divisions and variances.

TABLE

Activity	to	tm	tp
1-2	2	5	14
1-6	2	5	8
2-3	5	11	29
2-4	1	4	7
3-5	5	11	17
4-5	2	5	14
6-7	3	9	27
5-8	2	2	8
7-8	7	13	31

and draw the network diagram and find the critical path method.

Solution



Activity	to	tm	tp	$t_e = \frac{to+tp+4tm}{6}$	$S_t = \frac{tp-to}{6}$	$(S_t)^2$
1-2	2	5	14	6	2	4
1-6	2	5	8	5	1	1
2-3	5	11	29	13	4	16
2-4	1	4	7	4	1	1
3-5	5	11	17	11	2	4
4-5	2	5	14	6	2	4
6-7	3	9	27	11	4	16
5-8	2	2	8	3	1	1
7-8	7	13	31	15	4	16

From the network diagram we find the critical 1-2-3-6-8. and total project duration is 33 days.

(Q) Difference between PERT and CPM ?

PERT	CPM
→ It is a probabilistic model with uncertainty in activity duration. Excepted time is calculation from to, tm, tp.	→ A deterministic model with well known activities, time based on past experiences.
→ It is an event oriented approach.	→ It is an activity oriented approach.
→ PERT uses the words like network diagram, events, and slack	→ CPM uses the words like arrows diagram, node, Float etc.
→ PERT basically does not distinguishes between critical and non critical activities.	→ CPM marks the critical activities.
→ PERT finds application in projects where resources (men, material, money etc) are always made available when required.	→ CPM is employed to those project where minimum overall cost each of primarily importants. There is better utilisation of resources.

→ Example

Differences project, R&D where activity times cannot be ~~reliable~~ reliable predicated

→ Example

Industrial setting, Plant maintenance, civil construction project etc.

3rd chapter

INVENTORY CONTROL

Definaution

→ Inventory is a detailed list of those moveable items which are necessary to manufacture a product. and to maintained the equipment and machinery in good working order.

→ objectives of inventory control

(i) → The objectives of inventory control are given below

(i) To minimize the investment in inventory.

(ii) To maximize the service level to the Firms customers and own operating department

Classificaution of inventory

Inventory may be classified as follows

① Raw inventory
② In-Process inventory
③ Finished inventory
④ Indirect inventory

① Raw inventory

It include raw material, and semi-Finished product supplied by another Firm. and which are raw items of the present industry.

② In process inventory

They are semi Finished goods at various stages of manufacturing cycle.

③ Finished inventory

→ They are the Finished goods lying in stock room and waiting dispatch.

④ Indirect inventory

→ They include Lubricants and other items (spayer parts) needed For proper operation, repair and maintenance during manufacturing cycle.

Date-11.02.2017

Inventory control and its objectives

(i) purchasing of material at an economical price.

(ii) → providing a suitable and secure storage place.

(iii) → providing enough storage space.

(iv) → A definite inventory identification system.

(v) → periodic inventory checkup.

(vi) → upto date and accurate record keeping.

(vii) → Decision of inventory under A, B, and C item.

A good inventory control as the following Advantages

(i) → production target are achieved.

(ii) → one does not face shortage of material.

(iii) → Delay of production schedule is avoid.

(iv) → Accurate delivery date can be achieved.

Function of inventory

(i) → Maintain smooth and efficient flow of production.

(ii) → Keep the process continuously operated.

(iii) → Purchase of desired quantities can be achieved.

→ Separate different operation from one to

→ create motivational effect. That means a person may be tempted to purchase more of inventory are displayed in shelf.

EOQ (Economic order quantity) short song

→ Economic order quantity means how much material may be order at a time.

→ Example - An a industry making bolt with definitely like to know the length of the steel bar to be purchased at any one time. The length of the steel bar is known as economic order quantity.

Different terms used in EOQ

① Maximum Order quantity

It is the upper and maximum limit to which the inventory can be kept in the store at any time

② Minimum quantity

It is the lower or minimum level of inventory which must be store or kept at any time.

③ Standard order or economic purchase inventory

It is the difference between maximum and minimum quantity.

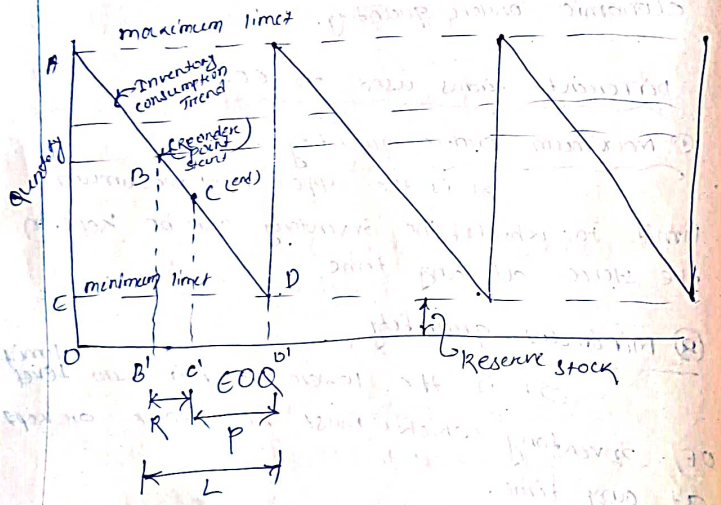
④ Re-order point

→ It indicates that, it is the suitable time to intimate the purchase order. For new material.

⑤ Reserve stock.

Reserve stock will give us the material detect in the inventory in the utilisation of shortages of material.

→ It should not be used if it is used it can be harmful for company.



Date. 14.02.2017

① Inventory procurement cost (P.C)

→ It consist of following costs like

① Receiving quotations
② Processing purchase Requisition
③ Expediting purchase order
④ Receiving materials and inspecting it
⑤ Processing sellers (Vendors) in-voice (बिल)

Note

Procurement cost decreases as the order quantity increases.

② Carrying cost (C.C)

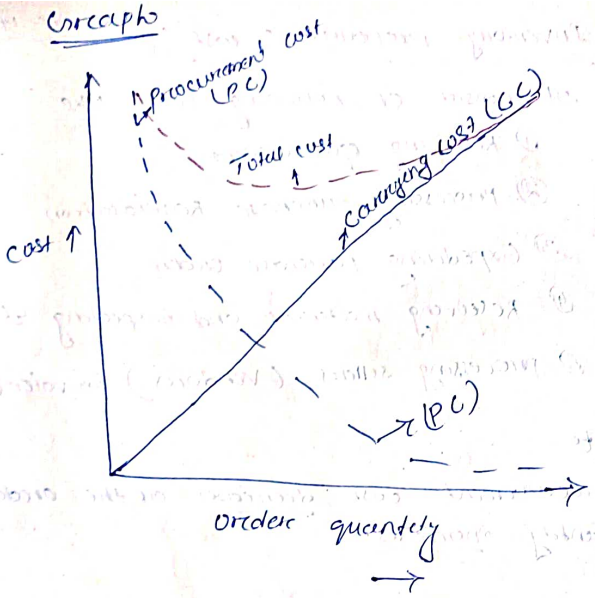
It consist of following costs like

① Interest on capital investment
② cost of storage facility, Records keeping, etc
③ cost involving deterioration and Obsolescences (out dated)

Note

→ As the carrying cost is almost directly proportional to the order size or lot size or order quantity.

Concepts



Method For Finding out EOQ

Let Q = Economic lot size (EOQ)

C = cost of one item

I = cost of inventory in % (Insurance, Obsolences, taxes etc)

P = procurement cost associated with one order.

U = total quantity used per year period (say annually)

Number of purchase orders to be placed. $= \frac{U}{Q}$

Total procurement cost

$$T.P.C = \left(\frac{U}{Q} \times P\right)$$

Average annual inventory

$$A.a.i = \frac{Q}{2}$$

inventory carrying cost =

= Average inventory × cost per item × cost of carrying inventory in %

$$= \frac{Q}{2} \times C \times I$$

Total cost = p.c + c.c

Total cost $= \frac{U}{Q} \times P + \frac{Q}{2} \times C \times I$

Total cost $= UPQ^{-1} + \frac{Q}{2} CI$

To minimise the total cost differentiating it with respect to Q and put = 0

$$\frac{dT}{dQ} = \frac{d}{dQ}\left(UPQ^{-1} + \frac{Q}{2} CI\right) = 0$$

$$\Rightarrow -UPQ^{-2} + \frac{CI}{2} = 0$$

$$\Rightarrow \frac{CI}{2} = \frac{UP}{Q^2}$$

$$\Rightarrow Q^2 = \frac{2UP}{CI}$$

Next

$$Q = \sqrt{\frac{2UP}{CI}}$$

(Ans)

Due - 15.02.17

(*) Problem

Data given

① Annual usage (U) = 60 units

② procurement cost = (P) = Rs 15.00/order

③ cost per price (C) = Rs 100.00

④ cost of carrying inventory in % (I) = 10%
(taxes, insurance)

calculate Q = ?

$$Q = \sqrt{\frac{2PU}{CI}}$$

$$= \sqrt{\frac{2 \times 15 \times 60}{100 \times 0.1}}$$

$$= \sqrt{18 \times 10}$$

$$= \sqrt{180} = 13.41$$

Solution

Let U = Annual usage = 60 units

P = procurement cost = Rs 15/order

C = cost per price = Rs 100.00

I = carrying inventory % = 10% = $\frac{10}{100}$ = 0.1

we know that

$$EOQ = \sqrt{\frac{2UP}{CI}}$$

$$= \sqrt{\frac{2 \times 60 \times 15}{100 \times 0.1}}$$

$$Q = 13.41$$

∴ Q = Economic lot size = 13.41

∴ number of order per year = $\frac{U}{Q}$

$$= \frac{60}{13.41}$$

$$= 4.47 \approx 5$$

hence EOQ or Q = $\frac{60}{5} = 12$

Q = 12

(Ans)

Problem-2

calculate EOQ = ? Data given are

Annual usage (U) = 80 units

procurement cost (P) = Rs 20.00/order

Cost per 10 piece price (C) = Rs. 1000.00

Cost of carrying inventory = 16 %.

Data given

Let Annual usage (U) = 80 units

procurement cost (P) = Rs 20.00/order

Cost per 1 piece = $\frac{1000}{10}$ = 100.00 Rs

Cost of carrying inventory (I) = 16 %.

$$\therefore Q = \sqrt{\frac{2PD}{CI}}$$

$$= \sqrt{\frac{2 \times 200 \times 80}{\frac{100}{5} \times 0.16}}$$

$$\boxed{Q = 14.14}$$

$\therefore$ Number of order per year $= \frac{D}{Q}$

$$= \frac{80}{14.14}$$

$$= 5.65 \simeq 6$$

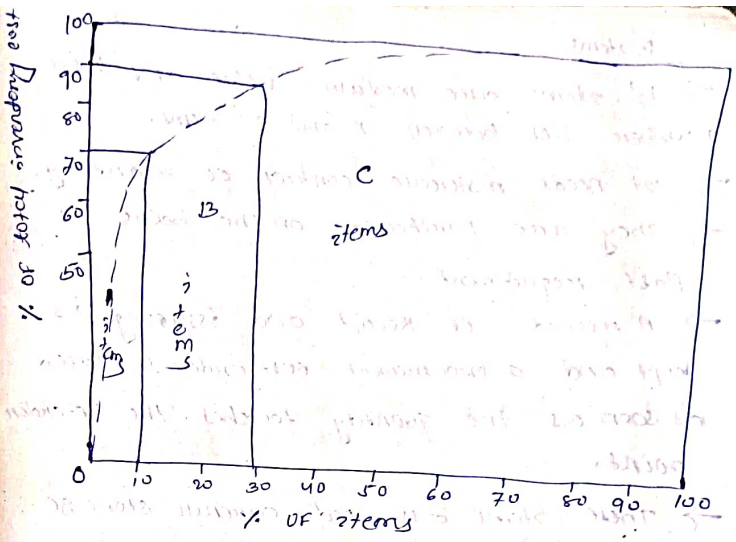
$$\therefore Q = \frac{D}{\text{number of order/year}} = \frac{80}{5} = 16$$

$$\boxed{EOQ = 16}$$

ABC Analysis

→ As the size of the industry increases number of items to be purchased and then to be taken care also increases.

→ ABC Analysis helps seggregating the items from one another and tells how much value the items is and controlling at to what extended in the organisation.



→ ABC Analysis curve given below

A items

→ A item are high value but are limited in number.

→ They need careful and close inventory control.

→ Minimum and maximum limit, Re-order point can be set for 'A' items.

→ A item generally account for 70-80% of total inventory cost

→ And constitute about 10% of total item.

B items

→ 'B' items are medium value and their number lies between A and C items.
→ It needs moderate control of inventory.
→ They are purchased on the basis of past requirement.
→ A record of Receipt and issuing is kept and a procurement cost order is placed as soon as the quantity touches the Re-order point.
→ These items also need careful storage and handling.
→ 'B' item generally accounts for (20-15)% of total inventory cost and constitute about (1.5-20)% of total inventory.

'C' items

→ 'C' item are low value and maximum in number.
→ These items don't need any control, rather controlling them is an economical.
→ These are the least important like Eg: clip, pin, cotton, washer, Rubber band etc.
→ They are generally procured as they finished.
→ C item generally accounts for (5-10)% of total inventory cost and constitute (70-75)% of total inventory.

Chapter-4

Date - 16.02.17

Plant maintenance

① Define the plant maintenance & its objective of plant maintenance.

Ans → Objective of plant maintenance

→ The objective of plant maintenance is to achieve minimum breakdown and to keep the plant in good working condition at the lowest possible price.
→ machines and other facilities should be kept in such a condition which permits them to be used at their optimum (Profit making) capacity without any interruption.
→ Maintenance division of the factory ensures the availability of machine, building, and services required by the other section of the factory for the performance of their functions at optimum return.

Duties, Functions and Responsibility of plant maintenance

→ The different duties, Functions and Responsibilities of plant maintenance are as follows.

(a) Inspection

→ Inspection is concerned with the Routine Schedule. Checks the plant Facilities to examine their condition and to check for needed repair.

→ It ensure the safe and efficient operation of the machine.

→ Frequency of inspection depends upon the intencity of use of machine or equipment.

→ Inspection sytt section makes always improper attwintention

→ Maintenance item received From the vendors and are inspected For their Fitness.

(b) Engineering

Engineering involves at a ulterconstion and improvement existing equipments & building to minimise breakdowns.

→ Engineering and a consulting service to production supervision are also responsibilities of machtenance department.

Date - 18.02.2017

(c) Maintenance (Preventive maintenance)

→ Maintenance of existing plant equipment, plant building, other service Facilities, etc.

(d) Repaire

→ maintenance department carrube out the corrective repair to the machinary.

→ Such a repair is an unschedule work at emergency time.

(e) Overhaul

Overhaul is a planned schedule re-conditioning of plant Facilities such as machinary, building etc.

→ Overhaul involves, replacement, reconditioning, re-assembly etc.

(f) Construction

In some organisation, maintenance department is provided with equipments and personnel and it takes up construction work.

→ Maintenance department handles construction of wood, bricks, steel structures, cement and

electrical installation etc.

⑧ Savage

Maintenance department may also handled the disposition of ~~scrap~~ scrap or surplus material.

→ The collection and disposition of surplus equipments, materials and supplies.

→ Disposition of production scrap

⑨ Clearical Job

Maintenance department keep records cost, time progress of job, transportation facility, electrical installation etc.

① → ~~Generation~~ Generation and distribution of power to other utility

③ → Administration and supervision of labour force (maintenance department)

④ → Insurance Administration

⑤ → House keeping

→ House keeping involves cleaning of building, equipment, toilet, washroom etc

⑥ → pollution and noise control.

TYPES OF PLANT MAINTENANCE ump 7marks

Types of plant maintenance are given below:

① Corrective or breakdown maintenance
② Scheduled maintenance
③ Preventive "
④ Predictive "

Date-21.02.2017

① Corrective or break-down maintenance

→ Corrective or breakdown maintenance implies that the repairs are made after equipment is out of the order and it can not perform its normal function.

→ Example = Electric motor will not starts, belt is broken etc.

→ under such condition, production department calls on the maintenance department to rectify the defects.

→ After removing the fault, maintenance engineer do not attaint the equipment again until another Failure or breakdown occurs.

→ Break down maintenance is economical for those equipment whose down time and repair cost are less.

→ Typical causes of equipment breakdown

(1) Failure to replace worn out part.
(2) Lack of Lubrication
(3) Neglecting cooling system
(4) Indeference towards minor Fault (Neglecting minor Fault such as equipment vibration, unusual sound coming, equipment getting too much heated etc)
(5) External Factors (too low, too high or line voltage, wrongo Fuel)
(6) .

DIS-advantage of break down maintenance

→ Reduction of output
→ Faster plant deforiation
→ Break down maintenance practice can not be employed for those plant items which are ~~cannot~~ be regulated by Statutory provision. Example = cranes, lifts, hoists and pressure vessels etc.

Dear- 22.02.2017

Scheduled maintenance

→ Scheduled maintenance is a stich and time stich-in-time procedure aimed at avoiding breakdown.
→ Breakdown can be dangerious to life and as far as possible should be minimised.
→ Scheduled maintenance procedure involves with inspection, Lubrication, Repair and overhaul of certain equipments which if neglated can result in breakdown.
→ Scheduled maintenance procedure generally followed for overhauling or machines, cleaning of coolers and other tanks, white washing of building etc.

Preventive maintenance

→ Preventive maintenance tries to minimise the problems of breakdown maintenance.
→ It is a stich-in-time procedure.
→ It locates weak spot (such as bearing surface, parts under excessive vibration etc.)
→ in all equipments, provides them regular inspection and minor Repair to reduce unanticipated breakdown.

→ Preventive maintenance involved

(a) Periodic inspection of equipment

(b) upkeep of plant equipment to correct such condition while they are in minor stage.

objective of preventive maintenance

(i) → To minimise the possibility of un anticipated production interruption (breakdown)

(ii) → To make the plant equipment and machinery always available and ready for use.

(iii) → To maintain the optimum productive efficiency of the plant equipment and machinery.

(iv) → To reduce the work content and maintenance job.

(v) → To achieve maximum production at minimum repairing cost.

(vi) → To ensure safety of life of work man.

(vii) → To maintain the operational accuracy of the plant equipment.

Predictive maintenance Date-28.02.2017

It is a newly maintenance technique.

→ It makes use of human senses are other sensitive instruments. such as

(a) audio gauges

(b) vibration analyser

(c) Amplitude meter

(d) Pressure and temperature, and resistance strain gauges to predicte gauge troubles

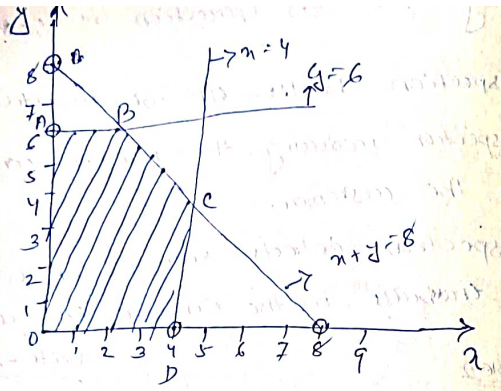
→ Example

(i) An electric cable excessively hot at one point predicts a trouble.

(ii) Simple hand touch can point out many unusual condition and thus predicte a trouble.

→ A predictive maintenance, equipment conditions are measures periodically on a continuous basis and this enables the maintenance work.

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



At point 'A'

$Z_A = 2x + 5y$

$= 5 \times 8$

$Z_A = 40$ (Ans)

At point B

$Z_B = 2x + 5y$

we find x and y value at point 'B'

$y = 6$

$x + y = 8$

$-x = -2$

$\Rightarrow x = 2$

putting the value x in equation (i)

$\Rightarrow y = 8 - 2 = 6$

$\Rightarrow y = 6$

$Z_B = 2x + 5y$

$= 2 \times 2 + 5 \times 6$

$= 4 + 30$

$Z_B = 34$ (Ans)

At point C

we find x and y

$x = 4$ ---(i)

$x + y = 8$ ---(ii)

$-y = -4$

$\Rightarrow y = 4$

putting the value y in equation (i)

$\Rightarrow x + y = 8$

$x = 4$

putting the value x and y at point 'C'

$Z_C = 2x + 5y$

$= 2 \times 4 + 5 \times 4$

$= 8 + 20$

$Z_C = 28$ (Ans)

At point D

$Z_D = 2x + 5y$

$= 2 \times 4 + 5 \times 0$

$Z_D = 8$ (Ans)

$\therefore Z_{maximize} = 34$

At point 'B'.

Ans

Problem

Usha corporation has got the demand for particular parts at 10,000 units per year. The cost per unit is Rs-2 and its cost Rs 36 to place an order and processes delivery. The inventory carrying is estimated as 9% of average inventory investment. Determine

(1) EOQ

(2) optimum number of order to be placed per annum.

(3) Minimum total cost of inventory per annum.

Solution

$U = 10,000$

$C = 2$

$P = 36$

$I = 9\%$

(1) $EOQ = \sqrt{\frac{2PU}{CI}} = \sqrt{\frac{2 \times 36 \times 10,000}{2 \times 0.09}}$

$EOQ = 2000$

$EOQ = \sqrt{\frac{2PU}{CI}} = \sqrt{\frac{2 \times 36 \times 10,000}{2 \times 0.09}}$

$EOQ = 2000$ units

(2) optimum number of order to be placed per annum

$= \frac{U}{Q}$

$= \frac{10,000}{2000}$

$= 5$ Nos (Ans)

(3) Minimum total cost of inventory per annum

$\therefore T.C = M.C + C.C + P.C$ (P.C = Inventory carrying cost)

$= (10,000 \times 2) + \left(\frac{10000}{2000} \times 36\right) + \left(\frac{2000}{2} \times 2 \times \frac{9}{100}\right)$

$T.C = 20360$ Rs (Ans)

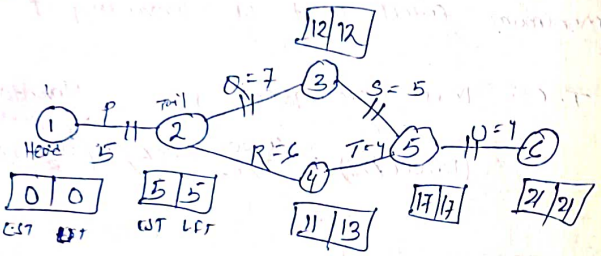
Problem 2

ABC manufacturing company get a demand for particular part 1000 units per year. The cost of unit is Rs-2 and cost 36 to be placed an order to process the delivery. the inventory carrying cost is estimated as 9%.

Problem-3:

A small engineering project consists of 6 activities namely P, Q, R, S, T, U with the duration of 5, 7, 6, 5, 4, 4 days. Draw the network diagram and calculate EST, LST, EFT, LFT, Float. Find the total project duration.

Solution



∴ The total project duration = 21

SL no	Activity	Duration	EST	LST	EFT	LFT	Total Float	Free Float	Independent Float
1	P	5	0	5	0	5	0	0	0
2	Q	7	5	12	5	12	0	0	0
3	R	6	5	11	7	13	2	0	0
4	S	5	12	17	12	17	0	0	0
5	T	4	11	15	13	17	2	2	0
6	U	4	17	21	17	21	0	0	0

Problem-4

$Z_{min} = 600x_1 + 500x_2$

Subject to $3x_1 + x_2 \geq 24$

$x_1 + x_2 \geq 16$

$2x_1 + 6x_2 \geq 48$

$x_1, x_2 \geq 0$

1st step

$3x_1 + x_2 = 24$

$x + x_2 = 16$

$2x_1 + 6x_2 = 48$

2nd step

$3x_1 + x_2 = 24$

Let $x_1 = 0, \quad x_2 = 24$

$x_2 = 0, \quad x_1 = 8$

∴ co-ordinate are $(0, 24)$ $(8, 0)$

$x + x_2 = 16$

Let $x_1 = 0, \quad x_2 = 16$

$x_2 = 0, \quad x_1 = 16$

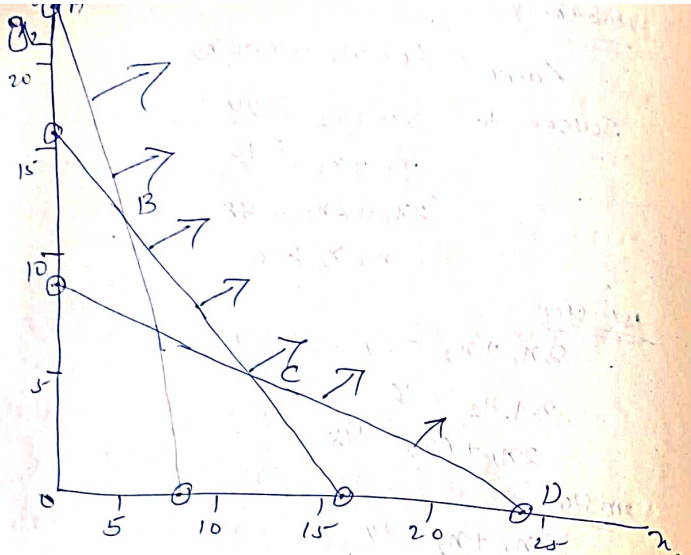
∴ co-ordinate are $(0, 16)$ $(16, 0)$

$2x_1 + 6x_2 = 48$

Let $x_1 = 0, \quad x_2 = 8$

$x_2 = 0, \quad x_1 = 24$

Co-ordinate are = $(0, 8)$ $(24, 0)$



At point A

$Z_A = 600x_1 + 500x_2$

$= 600 \times 0 + 500 \times 24$

$\boxed{Z_A = 12000}$

At point D

$Z_D = 600x_1 + 500x_2$

$= 600 \times 24 + 0$

$\boxed{Z_D = 14400}$

At point 'B'

$3x_1 + x_2 = 24$

$x_1 + x_2 = 16$

$\Rightarrow 2x_1 = 8$

$\Rightarrow \boxed{x_1 = 4}$

putting the value x_1 in eq:

$\Rightarrow x_1 + x_2 = 16$

$\Rightarrow x_2 = 16 - 4 = 12$

$\Rightarrow \boxed{x_2 = 12}$

$\therefore Z_B = 600x_1 + 500x_2$

$= 600 \times 4 + 500 \times 12$

$= 2400 + 6000$

$\boxed{Z_B = 8400}$

Z_C at point C

$\Rightarrow 2x_1 + 12x_2 = 32$

$2x_1 + 6x_2 = 48$

$+4x_2 = +16$

$\Rightarrow \boxed{x_2 = 4}$

$\Rightarrow \boxed{x_1 = 12}$

$\therefore Z_C = 600 \times 12 + 500 \times 4$

$= 7200 + 2000$

$\boxed{Z_C = 9200}$

$\therefore$ minimum at point B $= 8400$ (Marks)

Date - 6.03.2017

Kind of Inspection

① ~~FIOR Inspection~~

1. Floor Inspection
2. Fixed Inspection
3. Key point Inspection
4. Final Inspection

① Floor Inspection

In this inspection, Inspector ~~constantly~~ round on the shop floor from machine to machine and checks samples on the work of various machine operator.

→ It helps catching error during process itself i.e before the final production is ready.

→ It is more effective and desirable because the work need not be transported to the centralised space (Inspection dept.)

② Fixed Inspection

The work is brought at intervals for inspector to check.

→ Fixed inspection discovers defect after the job has been completed.

→ Fixed inspection is used when inspection equipment and tools can not be brought on the soft floor.

→ It is a short of centralised inspection, the workers and Inspector don't come in contact with each other.

Key point Inspection

Every product (more or less) has a key point in its process of manufacture.

→ A key point is a stage beyond which either the product requires an expensive operation or it may not be capable of Rework.

→ Inspection at a key point avoids unnecessary further expenditure on the job.

Final Inspection

→ Final Inspection of the product may be checked at appearance and performance.

→ Many destructive and non-destructive inspection and test method such as tensile, compressive, bending, impact testing, ultrasonic inspection, X-ray, etc are available for final inspection of the product.

→ Final inspection is a centralised inspection and it makes use of special equipment.

Control chart

Date - 7.03.17

Control chart are based on the statistical Sampling theory. in which an adequate sized sample drawn, at random from a lot.

→ control chart purpose and advantage

(i) A control chart indicates whether the process is in control or out of control.

(2) It determines process variability. and detects on usual vibration taking place in a process.

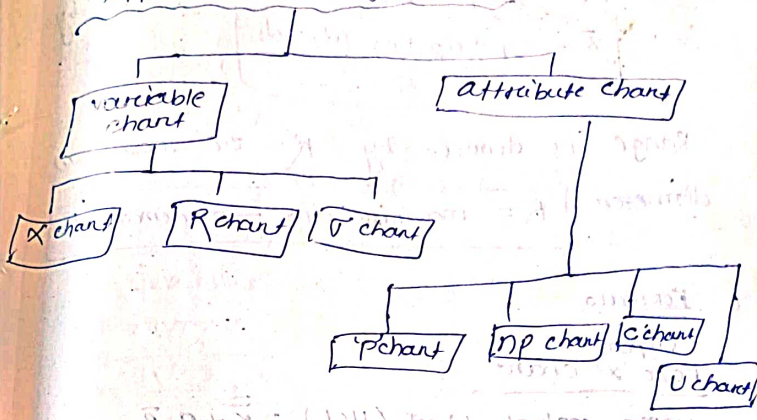
(3) It ensures product quality level.

(4) It can reduce the percentage of Rejection. rejection.

(5) It provides information about the selection of process and setting of tolerance limit.

(6) control chart build up the Reputation of the organisation through customer satisfaction.

TYPES OF CONTROL CHART



'X' chart

→ It shows change in process average. and is affected by change in process variability.

→ It a chart of measure of central tendency.

→ It shows cyclic shifts in the process.

→ It detects steady progres changes like tool wear.

→ It is the most commonly used variable chart.

→ It is used along with R chart.

'R' chart

It control general variability of the process and is affect by change in process variability.

→ It is a chart generally used along with 'x' chart. For example - sample contain 5 items and diameter are d_1, d_2, d_3, d_4 and

As the sample average is denoted by $\bar{x}$.

$$\bar{x} = \frac{d_1 + d_2 + d_3 + d_4 + d_5}{5}$$

Range is denoted by R. i.e maximum diameter

R = maximum dia − minimum dia

Formula

For 'x̄' chart

Upper control limit (UCL) $= \bar{\bar{x}} + A_2 \bar{R}$

Lower control limit (LCL) $= \bar{\bar{x}} - A_2 \bar{R}$

For 'R' chart

Upper control limit (UCL) $= D_4 \bar{R}$

Lower control limit (LCL) $= D_3 \bar{R}$

Example

Sample No	$\bar{x}$	R
1	7.0	2
1	7.5	3
3	8.0	2
4	10.0	2
5	9.5	3
6	11.0	4
7	11.5	3
8	4.0	2
9	3.5	3
10	4.0	2

Draw the x̄ chart & R chart.

Solution

Sample No	$\bar{x}$	R
1	7.0	2
2	7.5	3
3	8.0	2
4	10.0	2
5	9.5	3
6	11.0	4
7	11.5	3
8	4.0	2
9	3.5	3
10	4.0	2
	$\Sigma\bar{x} = 76.0$	

$$\bar{\bar{x}} = \frac{\Sigma \bar{x}}{\text{no of sample}} = \frac{76.0}{10} = 7.6$$

$$\bar{R} = \frac{\Sigma R}{\text{no of samples}} = \frac{26}{10} = 2.6$$

For $\bar{x}$ chart

UCL $= \bar{\bar{x}} + A_2 \bar{R}$

$= 7.6 + (0.58 \times 2.6)$

$= 9.10$

LCL $= \bar{\bar{x}} - A_2 \bar{R}$

$= 7.6 - (0.58 \times 2.6)$

$= 6.09$

For R chart

UCL $= D_4 \bar{R}$

$= 2.11 \times 2.6$

$= 5.486$

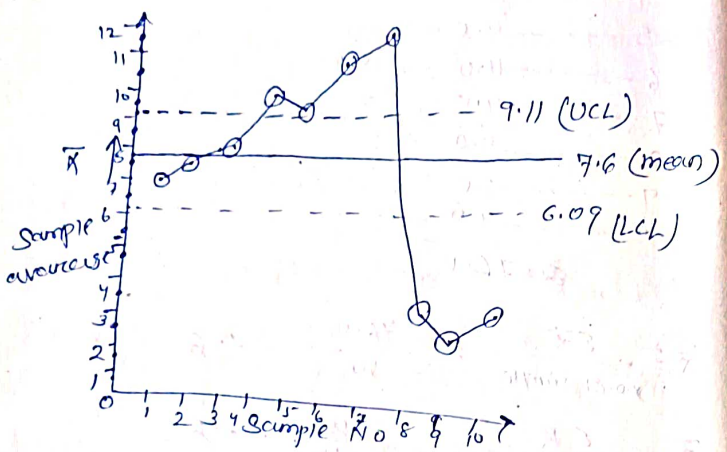
$LCL = D_3 \times \bar{R}$

$= 0 \times 2.6$

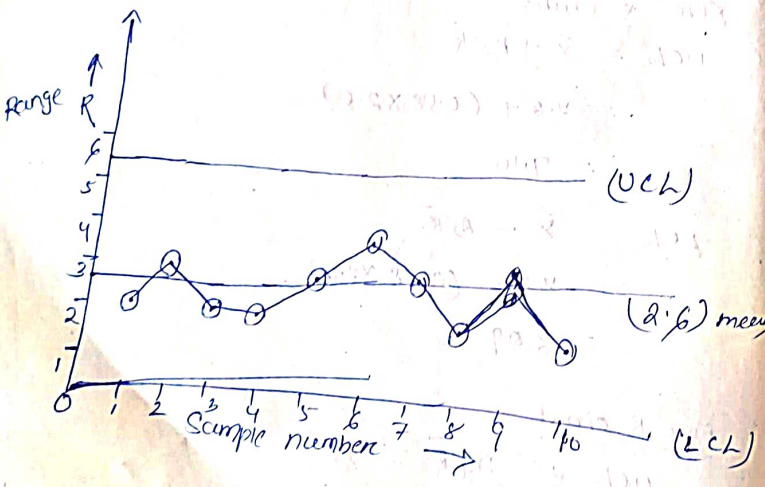
$LCL = 0$

Date - 8.03.2017

$\bar{X}$ chart



$\bar{R}$ chart



p chart

→ It can be Fraction defective chart.

→ Each item is classified as good (Non-defective) or bad (defective).

→ This chart is used to control the general quality of the component and it checks of the Fluctuation in Product quality.

→ It can be used even if sample size is variable (different for all sample)

→ Following example are finding out the procedure of calculation and plotting of 'p' chart.

Date	number of piece inspected (a)	No of defective piece of found (b)	Fraction defective (b/a)	% of defective b/a x100
Nov 4	300	25	0.0834	8.34
Nov 5	300	30	0.0100	10.00
Nov 6	300	35	0.1167	11.67
Nov 7	300	40	0.1333	13.33
Nov 8	300	45	0.1500	15.00
Nov 10	300	35	0.1167	11.67
Nov 11	300	40	0.1333	13.33
Nov 12	300	30	0.1000	10.00
Nov-13	300	20	0.0666	6.66
Nov 14	300	50	0.1666	16.66

For $\bar{p}$ chart

Upper control limit (UCL) $= \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

$LCL = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

where

$\bar{p} = \frac{\text{Total No of defective Found (b)}}{\text{Total No of piece inspected (a)}}$

$= \frac{350}{3000}$

$= 0.116 = 11.6\%$

n = number piece inspected every day

$n = 300$

Therefore

$\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

$= \sqrt{\frac{0.116(1-0.116)}{300}}$

$= 0.0184$

$\therefore UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

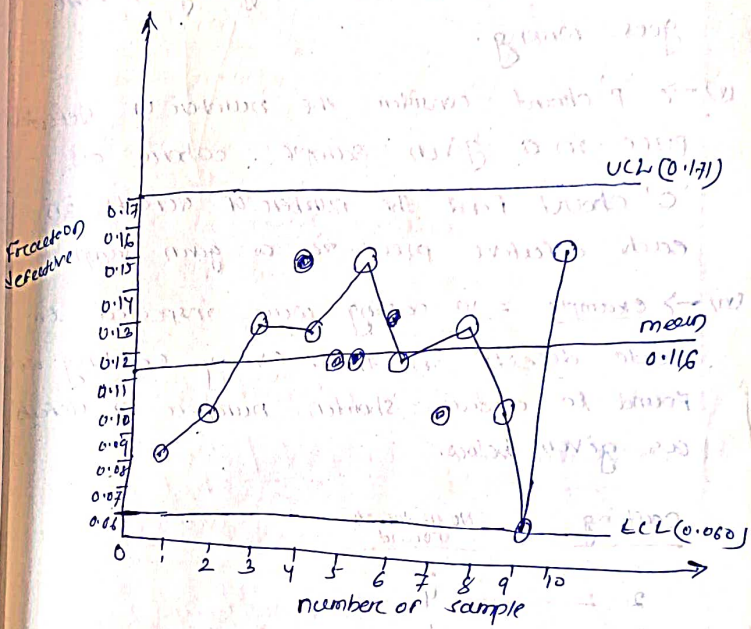
$= 0.116 + 3 \times 0.0184$

$UCL = 0.171$

$LCL = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$

$= 0.116 - (3 \times 0.0184)$

$LCL = 0.0608$



'C' chart

Date - 9.03.2017

It is the control chart in which number of defects in a piece are a sample are ploted.

→ It controls number of defects observed per unit part per sample.

→ Sample size is constant.

(iv) → The chart is used where average number of defects are much less than the number of defects which would occur, otherwise if everything possible goes wrong.

(v) → 'p' chart consider the number of defective piece in a given sample where as 'c' chart find the number of defects in each defective piece in a given sample.

(vi) → Example = 10 casting were inspected to locate defects in them. Every casting was found to contain shorten number of defects as given below.

Casting	No of defects Found
1	2
2	4
3	1
4	5
5	5
6	6
7	3
8	4
9	0
10	7

Plot the C chart ?

Solution

Casting	No of defect Found
1	2
2	4
3	1
4	5
5	5
6	6
7	3
8	4
9	0
10	7
	37

C chart

$UCL = \bar{c} + 3\sqrt{\bar{c}}$

$LCL = \bar{c} - 3\sqrt{\bar{c}}$

where $\bar{c} = \frac{\text{Total number of defects}}{\text{number of samples}}$

$= \frac{37}{10} = 3.7$

$\boxed{\bar{c} = 3.7}$

$\therefore UCL = \bar{c} + 3\sqrt{\bar{c}}$

$= 3.7 + 3\times\sqrt{3.7}$

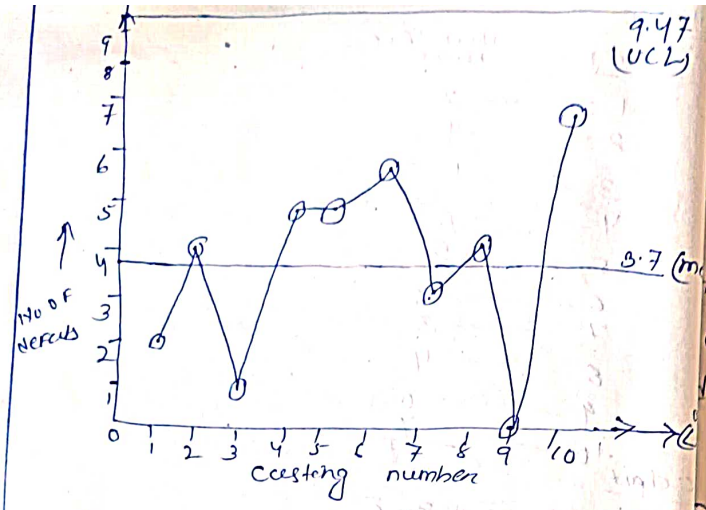
$= 9.47$

$LCL = \bar{c} - 3\sqrt{\bar{c}}$

$= 3.7 - 3\times\sqrt{3.7}$

$= -2.07 \simeq 0$

$\boxed{L.C.L = 0}$



Application of control chart

① → Final assembly (Attribute chart)

② → Manufactured component (shafts, spindle, ball, pin, slotted) (variable chart)

③ → Soldered joints (Attribute chart)

④ → casting (Attribute chart)

⑤ → Defects in component made of glass

⑥ → For study tool wear (variable chart)

⑦ → punch press work, spot welding etc (Attribute chart)

⑧ → In coining material (Attribute or variable chart)

Comparison between attribute and variable chart

① → variable chart involves the measurement of job dimension and an item is accepted or rejected if its dimensions are within our tolerance limit., where as Attribute chart only differentiate between defective and non-defective items without going into measurement of any dimension.

② → variable chart are more detailed and contain more information as compare to attribute chart.

③ → variable chart are relatively expensive because of collecting measure data.

④ → Attribute chart, being based upon go and no go data.

⑤ commonly used charts like $\bar{x}$ and R chart for process control, p chart for analysing fraction defective and c chart for controlling number of defects per piece.

① Define inventory ? and Explain ABC Analysis ? detail ? ?

Ans

→ Inventory is the detail list or those movable item which is used to manufacture a product with efficiently and effectively.

→ The inventory is used or control the
  i) Minimise the cost of investment
  ii) maximise the service centre.

→ The inventory is control by the help of ABC analysis.

'A' item

→ ~~The~~ All the costly item are held together in A item.

→ A inventory are high value and ~~is~~ oriented control. They need carefully and inventory control.

→ The total cost of this item is 70-80%. is required out of 100%.

→ And the ~~amount of~~ total item is 10%.

'B' item

→ In B inventory are medium value.

→ The total item is (15-20) and amount is ~~(20-30)~~ %. (15-20) %.

→ It is moderated control.

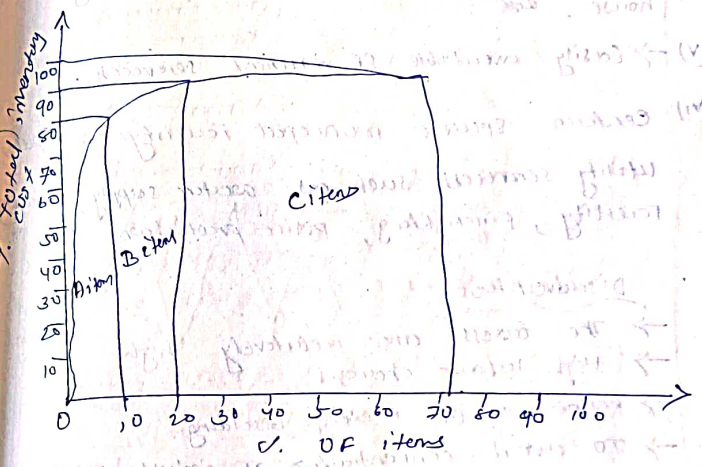
'C' item.

→ In 'C' item are not control.

→ All the item are low value and maximum in number.

→ These items are cotton, Rubber, wooden etc.

→ The total amount is required (5-10)%. and the item is (70-75) %.



(2) Write the advantage and disadvantage of urban location of plant.

Ans

Advantage of urban location of plant.

(i) → Good transportation facilities are easily available.

(ii) → Nearness to the market place.

(iii) → Easily available of skilled labours.

(iv) → Sufficient storage facilities including ware house.

(v) → Easily available of different services.

(vi) Certain specific recreational facility and public utility services such as, water supply, drainage facility, Firefighting, police protection etc.

Disadvantage

→ The taxes are relatively high.

→ High labour charges.

→ Restriction of factory building.

→ To avoid concentration of industries, government restricts the for expanding new branches of new company.

→ Land cost is very high as compare to rural area.

→ The trade union movement is very strong which often result in strikes etc.

(3) Problem

The following table gives the number of missing rivets noted at air craft finally inspection.

Air plane No	No of missing rivets
1	8
2	16
3	14
4	19
5	11
6	15
7	8
8	11
9	21
10	12
11	23
12	16
13	9
14	25
15	15

Find C bar and plot control for c chart. What value of c would you suggest for subsequent period.

Solution

Air plane No	No of missing rivets
1	8
2	16
3	14
4	19
5	11
6	15
7	8
8	11
9	21
10	12
11	23
12	16
13	9
14	25
15	15
	$\sum c = 223$

$\therefore$ $UCL = \bar{c} + 3\sqrt{\bar{c}}$

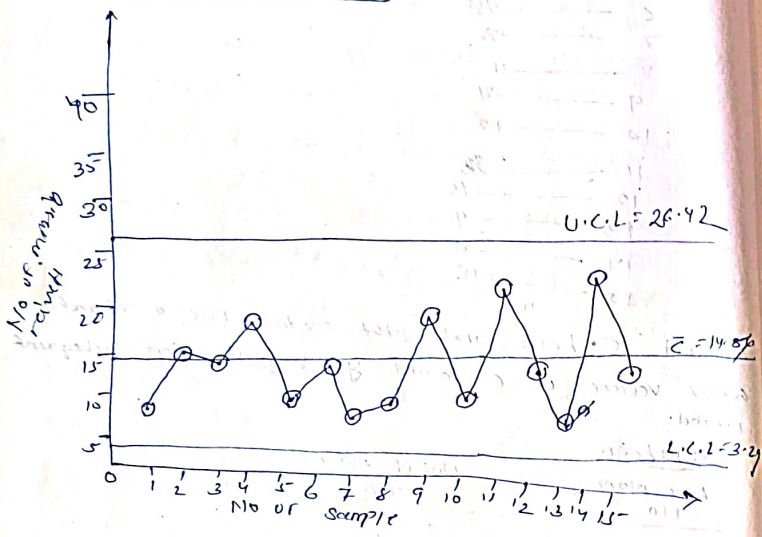
$\therefore$ $\bar{c} = \frac{223}{15} = 14.86$

$U.C.L = 26.42$

$L.C.L = \bar{c} - 3\sqrt{\bar{c}}$

$= 14.86 - 3 \times \sqrt{14.86}$

$L.C.L = 3.29$



Date: 22.03.2017

Total Quality management (TQM)

→ Total quality control is an effective system of integrating quality development, quality maintenance and quality improvement efforts of various groups in an organisation, so as to enable production and services at the most economical level, which allow full customers satisfaction.

→ Total quality control gives stress on prevention of defects rather than setting it right by rectification.

→ The concept of total quality is different from product quality.

→ Total quality can be achieved through total employee involvement.

→ Total Quality Function includes

(i) Development of product satisfication based on needs of users and economical consideration.

(2) Interaction with product design.

(3) Reliability and development testing.

(4) Process capability studies.

(5) Quality control of incoming material.

(6) Interaction with service engineers.

(7) Inspection and testing during manufacturing.

⑦ Training of staff and customer.
⑧ Quality audit
⑨ There are 6 identifiable Phases in achieving total quality control.

(1) comprehension
(2) commitment
(3) Competence
(4) communication
(5) correction
(6) continuance

① comprehension
→ What is quality, it should be determinable and measurable. Eg.

② commitment
Clarify of concepts, and policies, organization effort of.

③ competence
Develop method, tests, procedure to evaluate quality understand the price of product.

④ communication
→ Create awareness, Resolve conflicts, co-ordinate activities

⑤ correction
Solve problem of non-conformance.
→ Plo problems are largely due to lack of knowledge or lack of facility.

⑥ continuance
Maintain its importants and ensure to sustain programmes, Innovation (introducing latest technology)

Definition of TQM
Date - 23.02.2017

→ TQM involves/refers to the total involvement of staff in an organisation together, which includes suppliers, distributors and even customer in bringing about quality satisfaction. by promoting quality cultures. through quality circles.

or

→ TQM is a control of all transformation process of an organisation to best satisfy customers need in the most economical manner.

Principle Objective of TQM

(1) → Meeting the customers requirements.

(2) → Conteneous improvement of Quality at every level, at every place, and at every stage

(3) → To develop Proactive attitude and integrate Problem solving process.

(4) → Bring about a total cultural change in the organisation.

(5) → Focused on conteneus cost reduction. with affordable price.

(6) → Inter link and Integrate various Sub-system in-side the organisation.

Benefits of TQM

(A) → Benefits to customer

(1) Fewer problems with the product or Service

(2) Better customer care.

(3) Greater Satisfaction.

(B) Benefit to company

(1) Better product Quality

(2) Staffs are more motivated and Quality conscious.

(3) Productivity Improvement

(4) Reduce Quality cost

(5) Enhance problem solving capacity

(6) Increase marketing activity

(7) Increased competative position in the Firm.

(8) Improve profitability

(9) Improvement in human relation

(C) Benefit to staff

(1) Empowerment

(2) Enhancement of Job and security

(3) More training and Improvement in skill

(4) Reduce employee grievences.

Date - 24.03.2019

(a) what is the total Quality management ? Is
(b) What are the principles and action of TQM?

Ans. TQM may be defined as creating and organisational culture committed to the continuous improvement of skills, Team work, Process, product and service Quality and customer satisfaction.

→ TQM is a continuous customer improvement Program.

→ Principle and action of TQM

(a) → Objective → continuous Quality improvement at every level, at every place and at every stage.

(b) → Approach → Management involvement and leadership, Team work and action Research.

(c) → Scale → Every one working in the organisation is involved including suppliers and customers.

(d) → Standard → Do it right 1st time every time.

(e) Measure → customer satisfaction Internal and external

(f) Philosophy → Prevention of defects and then ~~two~~ not detection and then correction. (Prevention orientation approach).

(g) Tools → commitment, participation, motivation, Education, and Training, Organisation development Quality system.

(h) JIT Technology (Just-in-time)

→ Just-in-time production is defined as "a philosophy that Focuses attention on eliminating waste and purchasing on manufacturing just enough of the right items Just-in-time".

→ It is a Japanese management philosophy. applied in manufacturing which involves having the right items of the right Quality and Quantity in the right place and at right time.

→ Also JIT is a hand to mouth approach to production. It aims at having the right part at right time in the right Quantity to go into assembly.

→ JIT stands for producing necessary units in necessary quantities at necessary time.

→ The ultimate aim of JIT is to concentrate on 'not less, Respective manufacturing

and has following characteristics.

(i) ISO 9000 can be implemented in any type and size of organisation.

(2) It is independent of product, size and country.

(3) It has International acceptance and recognition.

(4) It ensures improvement in quality.

FIFO - 28.03.2017

$Z_{max} = 3x_1 + 4x_2$

S.C.O $4x_1 + 2x_2 \leq 80$

$2x_1 + 5x_2 \leq 180$

$x_1, x_2 \geq 0$.

Solution

$4x_1 + 2x_2 = 80$ - (i)

$2x_1 + 5x_2 = 180$ - (ii)

1st Step

$4x_1 + 2x_2 = 80$

Let $x_1 = 0, \quad x_2 = 40$

$x_2 = 0, \quad x_1 = 20$

Co-ordinate are (0, 40) (20, 0)

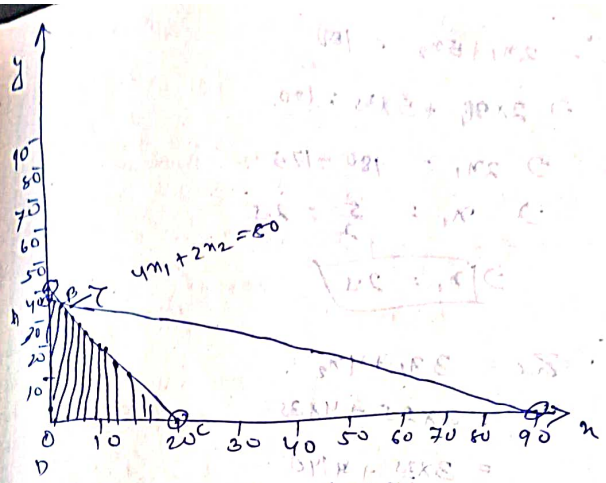
2nd Step

$2x_1 + 5x_2 = 180$

Let $x_1 = 0, \quad x_2 = 36$

$x_2 = 0, \quad x_1 = 90$

(0, 36) (90, 0)



The Feasible Region is ABCO

At point A

$Z_A = 3x_1 + 4x_2$

$= 3 \times 0 + 4 \times 36$

$Z_A = 144$

At point C

$Z_C = 3x_1 + 4x_2$

$= 3 \times 20 + 4 \times 0$

$Z_C = 60$

At point B we find

$4x_1 + 2x_2 = 80$ - (i)

$2x_1 + 5x_2 = 180$ - (ii)

$4x_1 + 2x_2 = 80$

$\times 2 \quad 4x_1 + 10x_2 = 360$

$-8x_2 = -280$

$\Rightarrow x_2 = \frac{280}{8} = 35$

$\therefore 2x_1 + 5x_2 = 180$

$\Rightarrow 2x_1 + 5 \times 35 = 180$

$\Rightarrow 2x_1 = 180 - 175$

$\Rightarrow x_1 = \frac{5}{2} = 2.5$

$\Rightarrow \boxed{x_1 = 2.5}$

$\therefore Z_C = 3x_1 + 4x_2$

$= 3 \times 2.5 + 4 \times 35$

$= 3 \times \frac{25}{10} + 140$

$\boxed{Z_C = 147.5}$

$\therefore \boxed{Z_{max} = 147.5}$ (Ans)

Problem-2

$Z_{max} = 10x_1 + 5x_2$

S.C = $x_1 + x_2 \leq 850$ — (i)

$x_1 \leq 500$ — (ii)

$x_2 \leq 700$ — (iii)

$2x_1 + x_2 \leq 1000$ — (iv)

$x_1, x_2 \geq 0$

Solution

1st eqn

$x_1 + x_2 = 850$

$\Rightarrow x_1 = 0, \quad x_2 = 850$

$x_2 = 0, \quad x_1 = 850$

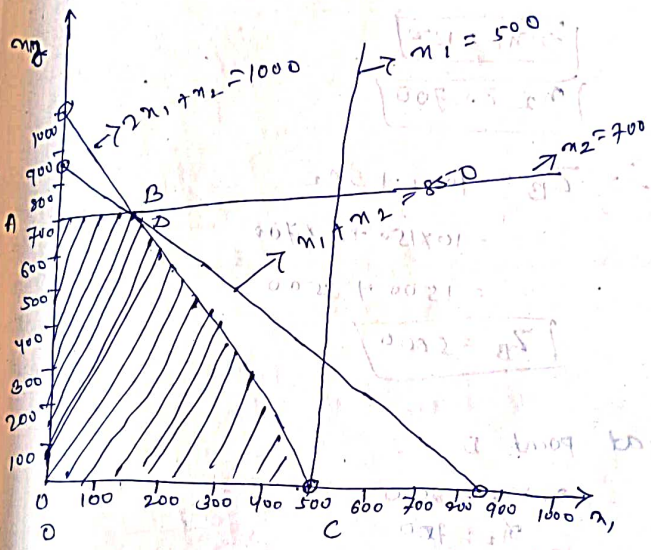
co-ordinates are = (0, 850) (850, 0)

$2x_1 + x_2 = 1000$

$x_1 = 0, \quad x_2 = 1000$

$x_2 = 0, \quad x_1 = 500$

$\therefore$ co-ordinate are (0, 1000) (500, 0)



$\therefore$ Fusicable Region = OABCD

Z_{Max} at point A,

$Z_A = 10x_1 + 5x_2$

$= 10 \times 0 + 5 \times 700$

$\boxed{Z_A = 3500}$

at point C

$Z_C = 10x_1 + 5x_2$

$= 10 \times 500 + 5 \times 0$

$\boxed{Z_C = 5000}$

at point B

$x_1 + x_2 = 850$

$2x_1 + x_2 = 1000$

$\Rightarrow -x_1 = -150$

$\Rightarrow x_1 = 150$

$x_2 = 700$

$\therefore Z_B = 10x_1 + 5x_2$

$= 10 \times 150 + 5 \times 700$

$= 1500 + 3500$

$Z_B = 5000$

at point D

$x_1 + x_2 = 850$

$x_2 = 700$

$\Rightarrow x_1 = 150$

$x_2 = 700$

$\therefore$ at point D

$Z_D = 10x_1 + 5x_2$

$= 10 \times 150 + 5 \times 700$

$= 1500 + 3500$

$Z_D = 5000$

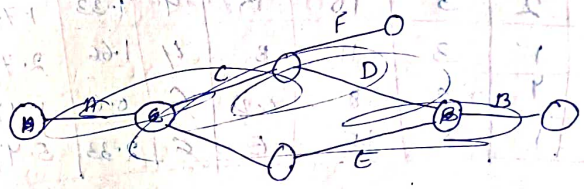
$\therefore Z_{max} = 5000$

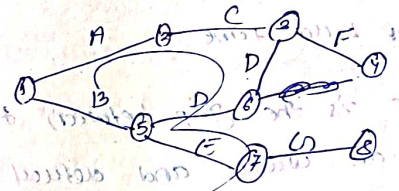
Problem: Consider the following project. Date: 29.03.2017

Activity	Time estimate in weeks			predecessors
	to	tm	tp	
A	3	6	9	None
B	2	5	8	None
C	2	4	6	A
D	2	3	10	B
E	1	3	11	B
F	4	6	8	C, D
G	2	5	15	E

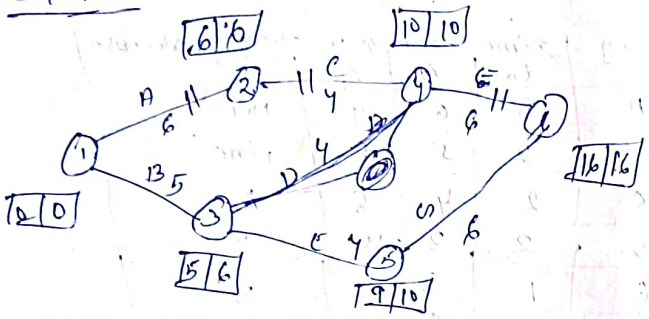
Find the critical paths and standard deviation and Total project duration and variance.

Solution:





Solution



Activity	Time estimated in			predecessor	te	σt	variance (σ²)
	to	tm	tp				
A	3	6	9	None	6	1	1
B	2	5	8	None	5	1	1
C	2	4	6	A	4	0.6	0.44
D	2	3	10	B	4	1.33	1.77
E	1	3	11	B	4	1.66	2.77
F	4	6	8	C, D	6	0.6	0.44
G	1	5	15	E	6	2.33	5.44

Definition of Lead time

Lead time is the gap between the placing of an order and actual arrival of the inventory is known as lead time.

→ If the Lead time is known and is not equal to zero (0), and if the demand is deterministic, all that one require to do is to order in advance by [illegible] equal to the lead time. If the lead time is zero, there is no need to order in advance.

If the lead time is variable which is known only probabilistically, then the question of when to order is more difficult.

Date - 30.03.17

Sixsigma

Sixsigma is a set up techniques and tools for process improvement.

→ It was introduced by Engineer Bill smith while working at motrola in 1986.

→ It seeks impr to improve the quality of output of a process by identifying and removing the causes of defects and minimising variability in manufacturing.

→ It uses a set up quality management methods. and creates a special impraststuture of people with in the organisation.

→ Six sigma methods targets to

(1) Reduce process cycle time
(2) Reduce pollution
(3) Reduce cost
(4) Increase customer satisfaction
(5) Increase profit

Features of Six sigma

A clear focus on achieving measurable and quantifiable financial Return.

→ An increase of management leadership and supports.

→ A clear commitment to making decisions on the basis of different data and a statistical method rather than assumption

→ ~~Six sigma comes F used in stat~~

→ Six sigma comes from statistics and is used in statistical quality control, which evaluates process capability.

Benefits ISO -9000

The Followings are the advantages of having ISO -9000 certification

(1) Reduction of multiple assesment by audit as ISO -9000 is sufficient for all assesment.

(2) Management control is better of all the activities are properly documentated.

(3) If an industry having ISO -9000, There is raise in status like a graduated having honours.

(4) Quality assurance in industry like electrical, and pharmaceutical having documents management system acts as a defence against civil claims.

(5) The most important aspect is that For market in europe, the ISO -9000 certification must For a company.

(6) → It helps in motivating the employees and bring a quality culture in to the company.

NACCB = (National Accreditation council For Certification Bodies).

→ NACCB is a organisation For issuing a certificate, of registration, Indicating the organisation FulFilling the requirements of ISO standards.

Date - 04.04.2017

Lean manufacturing

The lean manufacturing is actually a work on eliminating waste From the manufacturing process.

→ That means it is a waste management process.

→ waste is defined as any activity does not add value From the customer Prespective any waste product.

... to research conducted by lean Enter-prise, Fully 60% of production activity in a tipical manufacturing operation have no waste and have no value per customer satisfication.

→ Now days every company used lean manufacturing technique to improve the better product quality.

Defination

Lean manufacturing is a systematic method for elimination of waste with in a manufacturing system.

The original 7 waste are

① Transport

Moving product that are not actually required to perform the processing

② Inventory

→ All component, and work in processed and finished product not in product)

③ Motion

people or equipment moving or working more than is required to perform the processing.

④ Waiting

Waiting for next production step, interruption of production during shift change.

⑤ over process

product design creative activity.

⑥ over production

production ahead of demand

⑦ defects

The above involve in inspecting and fixing defects.

ISO 14000

ISO 14000 series of environmental management standards are indended to assist and organisational manage the environmental effect of their business practice.

→ ISO 14000 series is similar to ISO 9000 series.

→ The propose of ISO 9000 is a Quality management programme ISO 14000 hells with the management of environmental effects of an orga

→ ISO 14000 standard assist to a com in confirming to environmental regulation.