LECTURE NOTES
ON
INDUSTRIAL ENGINEERING
6TH SEMESTER,
(TH-1)
(6th semester MECHANICAL ENGINEERING)

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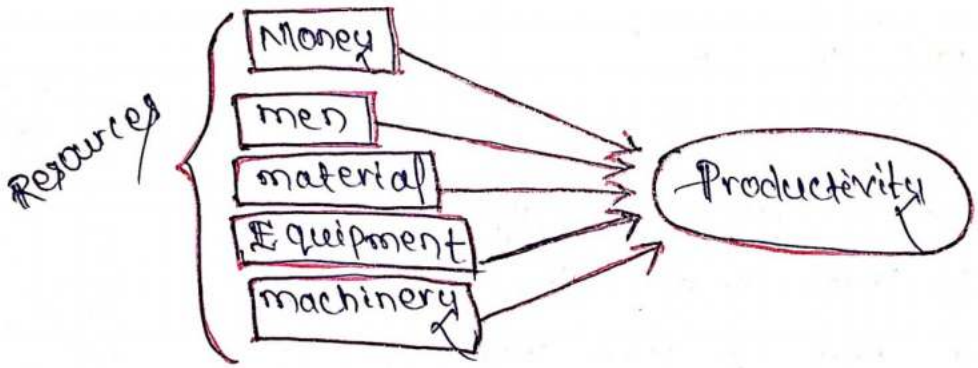
Industrial Engg :-

→ Introduction)

→ The americal institute of industrial engineers (AIIE) has defind the theoritical consept of industrial engg. as, concerned with design, improvement & installation of integrated system of peoples, materials, equipment & energy.

→ Industrial engginering is going to play a pivotal role in increasing the productivity. In other words it is that engineering approach to the detailed analysis of the use & cost of the resources of an organisation.

→ The main resources are men, money, materials, equipment & machinery.



CH-1 -> PLANT LOCATION & LAYOUT <-

Introduction

→ A plant is a space where all the resources like men, money, material, equipment, machinary etc are brought together for manufacturing products.

→ Plant location means deciding a suitable location, area, place etc where the plant or factory will start ~~functning~~. functoning.

→ Plant location involves two measure activities -

(i) to select a proper geographical region.

(ii) to choose a suitable sites within region.

Plant Location Problem :-

1 → selection Region.
2 → selection of a particular site.
3 → conditions that demand city location.
4 → conditions demanding rural location.
5 → conditions that demand sub urban location.

Factors affecting Plant Location :-

① Nearness to raw materials :- It will reduce the cost of transporting raw material from the vendors end to the plant like sugar, cement, Jute & cotton textiles.

② Transport Facilities :- A lot of money is spent both in transporting the raw material & the finished goods. Speedy transport facilities, that ensure timely supply of raw materials to the company & finished goods to the customers, There are time basic modes of physical transportation, air, road, rail, water & Pipe line.

③ Availability of Labour :- Suitable labour force of right time of adiquate size & at resonable rates with its proper attitude towards work are a few factors which govern plant location to measure extent.

④ Nearness to market :- It also reduces the cost of transpotation as well as the changes of the finish products.

⑤ Availability of fuel & power :- Steel industries or steel plants are located near source of fuel (coal, diesel) to cut down fuel transpotation costs. Electric power should remain available contineously in proper quantity & at resonable rates.

⑥ Availablity of water :- Depending on the nature of the plant water should be available in adiquative quantity & should be proper quantity in essential Paper & chemical plant.

⑦ Climatic cond' :- Climate greatly influence human efficiency & behaviour. Textile mills require humidity with the developments in the field of heating, ventilating & air conditioning, Climate of the region doesn't present much problem occurs control of Climates needs money.

(8) Financial & other aids :- Certain states give aids as loans, feed money, funding, built of sheds to attracked industrialies.

(9) Land :- Area, the shape of site, topography, cost drainage & other facilities, the probability of floods, earthquakes etc. influence the selection of plant location.

(10) Supporting industries :- All industries will not make all the components & parts by it self & it subcontracts the work to venders.

(11) Social intrafactures :- Availability of community facilities like (a) Housing facilities
(b) Educational facilities
(c) Medical facilities
(d) Internate facilities & so on are tobe consider.

(12) Law & taxation :- The policies of the state & local bodies concerning labour laws, safety its arethe factors that demand attentation.

* PLANT LAYOUT :-

→ Plant Layout means the disposition of the various facilities like equipments, materials, manpowers etc & services of the plant within the area of the site selected previously.

→ Plant layout is a plan of an optimum arrangement of facilities including personal, operating equipment, storage space, material handling equipment & all other supporting services along with the design of best structure to contain all these facilities.

*) objectives of plant layout :-

1 → Materials handling & transpotation is minimize.
2 → Work stations are designed suitabely & properly.
3 → Suitable places are alocated to production centers & service centers.
4 → Movements made by the workers are minimized.
5 → Delay time of semifinished products is minimized.
6 → Working conditions are safer, better & improved
7 → Increased flexibility of changes in product design & for future expansion.
8 → Plant maintanance is simpler.
9 → Increased productivity & better product quality with reduced capital cost.
10 → A good plant layout permits materials to move through the plant at the desired speed with the lower cost.

Principle of plant layout :-

*) Principle of integration :-

→ A good plant lay out is one that integrates men, materials machines & supporting services. In order to get the optimum utilization of resources & max^m effectiveness.

*) Principle of smooth & continuous flow :-

→ A good layout makes the materials to move in forward direction towards the completion stage.

*) Principle of Minimum movements & material handling :-

→ The facilities should be arranged such that the total distances travelled by the men & the materials should be minimum.

It is better to transport materials in bulk rather than small amounts.

*) Principle of cubic space utilization :-

→ The good layout utilizes both horizontal & vertical space. Besides using the floor space of a room. The ceiling height is also utilized. Boxes & bags containing raw materials or goods can be stacked are above the other to store more items in the same room.

*) principle of safety, security & satisfaction :-

→ Working places should be safe, well ventilated & free from dust, noise, fumes, odours & other hazardous cond'ns.

*) Principle of mgm flexibility :-

→ The good layout is one that can be altered without much cost & time. The machinery is arranged in such a way that the changes of the production process can be achieved at the least cost.

*) Process Layout :- (Functional Layout)

→ The layout is recomended for batch production. All machines performing similar type of operation are grouped at one location in the process layout.

→ for ex :- All lathes, milling m/c, shaping m/c, grinding m/c kept at one place.

Adv :- Better utilization of equipments.

→ Wide flexibility exists during alotment of work to equipment & workers.

→ Better product quality because to attained one time of m/c

→ Varieties of Jobs coming as different Job orders make the work more challenging & intresting.

Disadv :- For same amount of production more space is required.

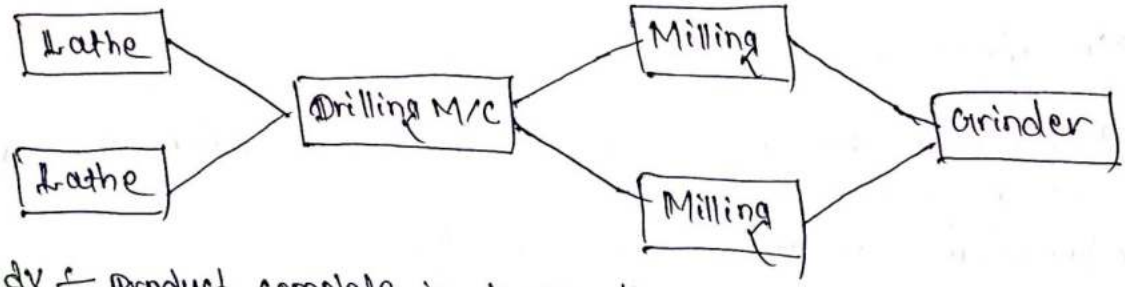
→ More materials in process remain in queue for further operation

→ Work in process inventory is large.

→ Production planing & control is difficult.

Product Layout :-

→ The Various operations on raw material are performed in a sequence & the machines are arranged in the sequence in which the raw material will be operated upon.



Adv :- Product complete in lesser time.

→ Smooth & contineous work flow.

→ Simplified Production, planning & control.

→ Automatic material handling, less movements, so cost is reduced.

Dis adv :- Lack of flexibility.

→ One inspector has to attained a number of m/c in a production line.

→ More m/c to be purchased & kept which require high capital investment.

Combination Layout :-

→ This is called the mixed type of layout usually a process layout is combined with the product layout.

→ For ex :- refrigerator manufacturing uses a combination layout.
Manufacturing various components → process layout

for assembling of components → product layout.

CH 02 operations & research :-

→ Introduction :-

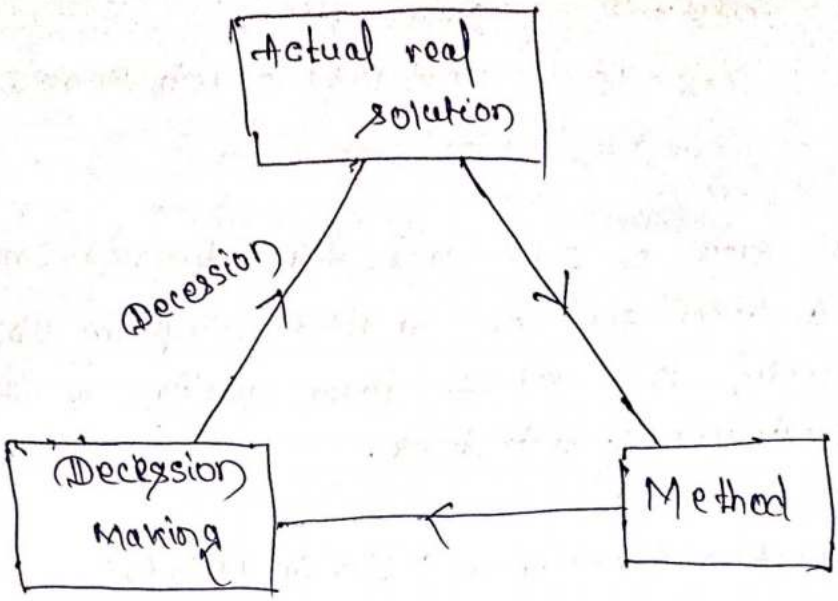
→ Operation research signifies research on operations. It is the organised application of modern science, mathmatics & computer technics, to Govt, business & industrial problems arising in the dirc to complex & the management of the large system of men, materials, money & machines.

→ Methoddogy :-

1→ Understand the actual real situation, capture the same & define the problem.
2→ Formulate in mathmatical model.
3→ Develop a mathmatical solution.
4→ Implement the ~~dicision~~ decision to the real situation,
5→ Verify the results,

Methods of operation research :-

1→ Linear programming
- → Graphical linear programming.
- → Transportation method.
- → Simplex method.



*) Linear programming :-

*) Linear programming is a powerful mathmatical technique for finding the best use of limited resources of a concern. It may be defind as a technique which alocates scarce available resources under cond"s of certainity in a optimum manner to achieve the company objectives which may be max" overall profit or minimum overall cost.

Linear programming problem :-

→ A linear form is meant a mathmatical expression of the type $a_1x_1 + a_2x_2 + \ldots\ldots + a_nx_n$, where $a_1, a_2 \ldots\ldots a_n$ are the constants & $x_1, x_2 \ldots\ldots x_n$ are the variables. The form programming refers to the process of determining a particular plan of action.

Linear programming deals with the optimisation (maximize or minimize) of a func of variables known as objective func, subjected to a set of linear equations or inequalities known as constraints or restrictions.

for eg :- Max $z = 8x + 3y$. (objective function)

$x+y = 12$ } Linear eq^n
$x-y = 10$ } constraints or restrictions.

General form of linear programming problem $\frac{0}{0}$

→ The general from of LPP calls for optimising (maximize or minimize) a linear func of variables called the objective function subjected to a set of linear equations & inequalities called the constraints & restrictions.

→ General form $\frac{0}{0}$

* objective function (max or min) $Z = c_1x_1 + c_2x_2 + \cdots + c_nx_n$

→ subjected to the constaints $= a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n$ $(\leq \text{or} \geq)\ b_1$

$a_{12}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n\ (\leq \text{or} \geq)\ b_2$

$\vdots$

$a_{m1}x_1 + a_{m2}x_2 + \cdots + a_{mn}x_n\ (\leq \text{or} \geq)\ b_n$

& $x_1, x_2 \cdots x_n \geq 0$.

→ A firm manufactures two type of products A & B sales them at a profit of rupees 2 on time A & rupees 3 on thime B. Each product is processed in 2 machines G & H. Type A requir 1 min. processing time on 'G' & 2 mins on each. Type B requires 1 min processing time on m/c G & 1 min on M/c 'H'. The M/C 'G' is available for not more than 8 hours & 40 Minits while M/C H is available for 10 hours. During any working day. Formulate the problem as LPP.

suppose :-

x_1 no of products A are Manufacturing.

x_2 no of products B are manufacturing.

Machines	Types of products in (minutes)		
	product A (x_1 unit)	product B (x_2 unit)	Available time in (min)
G	1	2	400 m
H	2	1	600 m
profit	Rs 2.	Rs 3	

Max $Z = 2x_1 + 3x_2$ (objective fun^n)

linear eq^n = $x_1 + x_2 \leq 400$ m
$2x_1 + x_2 \leq 600$
} constraints

Problem :- A furniture Manufacturer Makes two products chairs & tables. Each chair contributes a profit of Rs. 20 & each table of Rs. 40. chairs & tables, from raw materials to finished products are processed in 3 sections S_1 & S_2 & S_3 in section S_1 each chair requires one hour & each table requires 4 hours of processing time. In sec^t S_2 Each chair requires 3 hours & each table one hours & in sec^t S_3 the times are 1 hour & 1 hour for chair & table respectively. The Manufacturer wants to optimize his profits if sec^t S_1, S_2 & S_3 can be avail for not more than 24, 21, 8 hours respectively.

suppose :-

Here x_1 No of chairs are manufactured.

x_2 No of tables are manufactured.

Process	Types products in mints.		
	Product of chairs x_1	Product of tables x_2	Available time in min.
S_1	1	4	1440 min
S_2	3	1	1260 min
S_3	1	1	480 min
Profit	Rs 20	Rs 40	

Max^{m} $Z = 20x_1 + 40x_2$ (objective fun^{c})

linear eq^{n} $= x_1 + 4x_2 \leq 1440$

$3x_1 + x_2 \leq 1260$

$x_1 + x_2 \leq 480$

} linear eq^{n} or constraints.

$x_1 \geq 0$, $x_2 \geq 0$ Non negative constraints.

→ A firm can produce 3 type of clothes says A, B & C. three kinds of wool are required for it says red, green & blue wool. one unit lenght of type A cloth needs two yards of red wool & 3 yards of blue wool. One unit lenght of type B cloth needs 3 yards of red wool, 2 yards of green wool & 2 yards of blue wool. One unit length of type C cloth needs 5 yards of green & 4 yards of blue wool. The profit from sale of 1 unit length of

Type A is Rs. 10, type B is Rs. 8 & type C is Rs 5. Determine how the firm should use the available material so as to maximize the profit. formulat this as LPP.
(N - the company has a stock of only 8 yards of red wool, 10 yeard of green wool, & 15 - blue.

	Types of products.			
	red (x_1)	green (x_2)	blue (x_3)	Available yeared
A	2	0	3	8
B	3	2	2	
C	0	5	1	
Profit	Rs. 10	Rs. 8	Rs. 5	

Suppose x_1 units of A cloths are manufactured.

x_2 units of B Cloths are manufactured.

x_3 units of C Cloths are manufactured.

required of tool.	Types of products			
	A (x_1)	B (x_2)	C (x_3)	Available yeard.
red	2	3	0	8
green	0	2	5	10
blue	3	2	1	15
profit	Rs. 10	Rs. 8	Rs. 5.	

$Max^m Z = 10x_1 + 8x_2 + 5x_3$ (objective fun^n).

suppose $2x_1 + 3x_2 \leq 8$

$2x_2 + 5x_3 \leq 10$

$3x_1 + 2x_2 + 4x_3 \leq 15.$

} linear eq?

$x_1 \geq 0$, $x_2 \geq 0$, $x_3 \geq 0$ Non negative constraints.

→ A farm manufactures two types of products A & B sales them at a profit of Rs-2 on the type A on ~~cost~~ Rs 3 on type B. Each product is process on two m/c's x & h. Type A requir 1 minute of processing time on x & 2 minute on h. Type B requires 1 min on x & 1 min on h. The M/C x is available for not more than 6 hours & 40 minutes while M/C 'h' is available for 10 hours during any working day. Formulate the problem as LPP in graphical method.

M/C's	Product's		
	type A	type B	time required in (min)
x	1	1	400 min
h	2	1	600 min
profit	Rs-2	Rs-3	

$$\text{Max } z = 2x_1 + 3x_2 \quad \text{(objective fun}^{n}\text{)}$$

suppose $x_1 + x_2 \leq 400$

$2x_1 + x_2 \leq 600$

In constraints C_1 : $x_1 + x_2 = 400$

Let $x_1 = 0$: $0 + x_2 = 400 \Rightarrow x_2 = 400$

Let $x_2 = 0$ $x_1 = 400$

x_1	x_2
0	400
400	0

In constrain C_2 : $2x_1 + x_2 = 600$

Let $x_1 = 0$; $2 \times 0 + x_2 = 600$

$\Rightarrow x_2 = 600$

Let $x_2 = 0$; $2x_1 + x_2 = 600$

$\Rightarrow 2x_1 = 600$

$\Rightarrow x_1 = 600/2 = 300$

x_1	x_2
0	600
300	0

Max $Z = 2x_1 + 3x_2$

Point O = (0,0) = 0

A = (300, 0) = 600

B = (200, 200) = 1000

C = (0, 400) = 1200

Max Z = 1200

the max^m objective fun^c is 1200 at point C

In constrain

$x_1 + x_2 = 400$

$2x_1 + x_2 = 600$

(−) (−) (−)

$-x_1 = -200$

put the value in eq^n (1)

$200 + x_2 = 400$

$\Rightarrow x_2 = 400 - 200$

$= 200$

PROJECT Evaluation & completion by CPM & PERT :-

Project Management :- A project consist of interrelated activities which are to be executed in a certain order before the entire test is completed.

→ The activities are interconnected in a logical sequence which is known as precedence relationship.

→ Project is represented in the form of a network for the purpose of analytical treatment to get solutions for scheduling & controlling its activities.

Techniques :- There are two techniques are involved for managing & completing & evaluating the project.

(1) CPM :- (Critical Path Method)
(2) PERT (Project Evaluation & Review technique).

Phases of project Management :-

→ Planning :- Preventing Dividing the project into distintict activities.
→ Estimating time requirement for each activity.
→ Establising residence relationships among the activities.
→ construction of the arrow / network diagram.
→ scheduling :- Determines the start & end time of each & every activity.
→ Controlling :- Uses the arrow diagram or network diagram & time chart for continuous monitoring & progress reporting.

CRITICAL PATH METHOD & (CPM)

→ Critical path of a project network is the longest path in that network.

This can be identified by simply listing out all the possible paths from the start node of the project to the end node & then selecting the path with the max^m sum of activity times on that path.

Two phase & Determines earlist start time [ES] of all the nodes, this is called forward pass.

→ Determines the latest completion [LC] of various nodes this is called backward Pass.

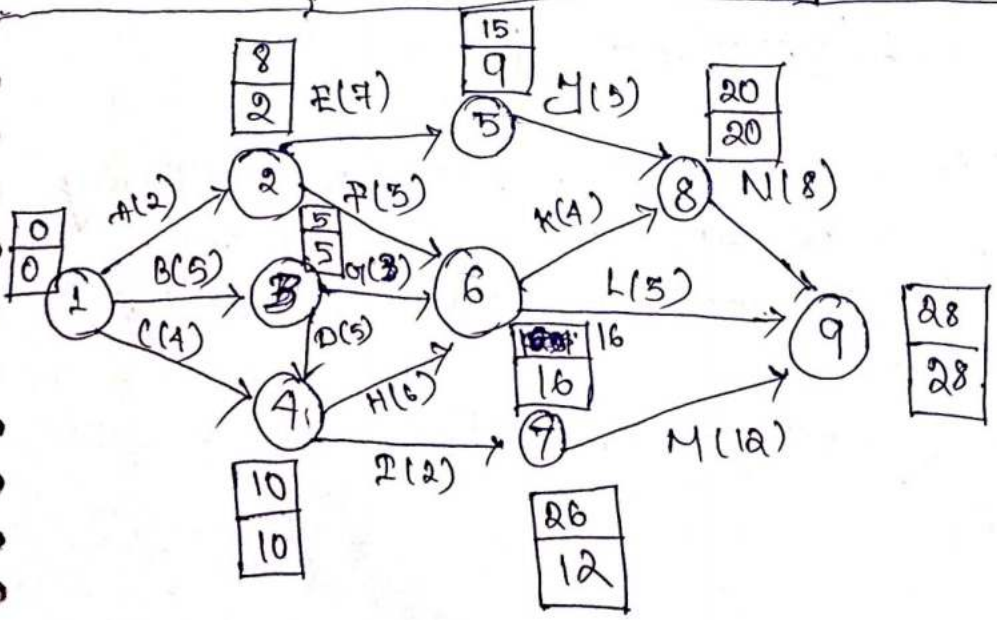
For ex:- The following data given in a table represents the completion of project given ideas about activity, immidiate predecessor & durations.

Q) (a) construct the CPM network

(b) Determine the critical path & project completion time

(c) compute total floats & free floats for non critical activities.

Activity	Immediate predecessor	Duration Month
A	—	2
B	—	5
C	—	4
D	B	5
E	A	7
F	A	3
G	B	3
H	C, D	6
I	C, D	2
J	E	5
K	F, G, H	4
L	F, G, H	3
M	I	12
N	J, K	8



cond' for finding the critical path :-

(1) earliest start time of

$ES_i = LC_i$

$ES_j = LC_j$

$ES_j - ES_i = LC_j - LC_i = D_{ij}$

∴ Critical path = 1-3-4-6-8-9

B-D-H-K-N

Project completion time

$= 5+5+6+4+8$

$= 28$ months.

Total Floats :-

It is the amount of time that the completion time of an activity can be delayed without affecting the project completion time.

$TF_{ij} = LC_j - ES_i - D_{ij}$

Free Floats :- It is the amount of time that the affecting completion time can be delayed without affecting the earliest start time of immidiate successive activities in the network.

$FF_{ij} = ES_j - ES_i - D_{ij}$

Activity	Duration	Total Float	Free float
A	2	6	0
B	5	0	0
C	4	6	6
D	5	0	0
E	7	6	0
F	3	11	11
G	3	8	8
H	6	0	0
I	2	14	0
J	5	6	6
K	4	0	0
L	3	9	9
M	12	2	4
N	18	0	0

Q1)

activity	Immidiate Producer	Duration	Total Float	Free float
A	—	6		
B	—	5		
C	—	4		
D	A	2		
E	B	2		
F	C	5		
G	C	2		
H	EF	4		
I	D	5		
J	HG	2		

PERT (Project Evaluation Research technique)

* Previously we have already discussed about the cpm network. In Critical path method all the activities are time deterministic in nature.

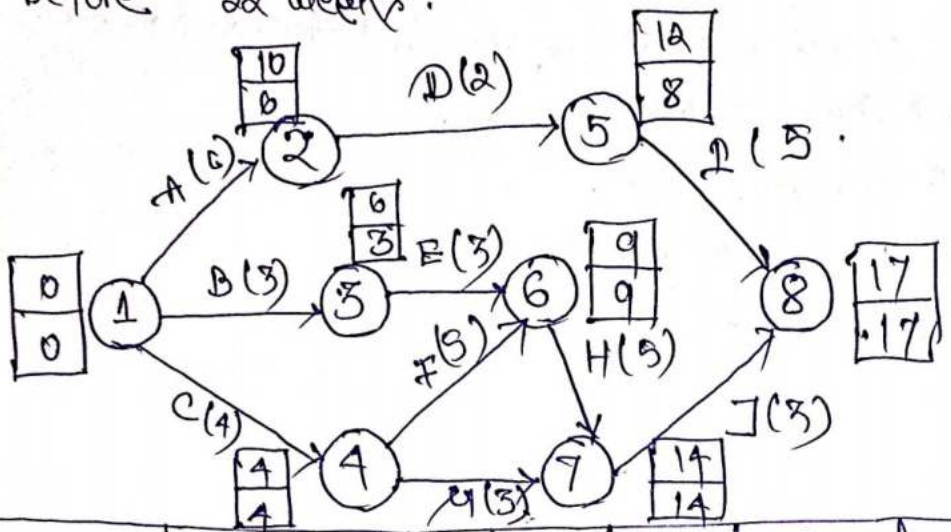
→ But in case of project evaluation & research technique (PERT) each activities will have 3 time estimates

① Optimistic time.
② Most likely time
③ pessimistic time.

→ for example :-

Activity	Immidiate predecessor	Duration		
		optimistic time	Most likely time	pessimistic time
A	—	5	6	7
B	—	1	3	5
C	—	1	4	7
D	A	1	2	3
E	B	1	2	9
I	C	1	5	9
G	C	2	2	8
H	F, I	4	4	10
I	D	2	5	8
J	H, G	2	2	8

① construct the project network.
② find the expected duration & various of each activity.
③ find the critical path & expected project completion time.
④ What is the probability of complete in the project on or before 22 weeks.



Activity	Immidiat producer	O	M	P	expected mean duration	Variance.
A	—	5	6	7	6	0.11
B	—	1	3	5	3	0.44
C	—	1	4	7	4	2
D	A	1	2	3	2	0.11
E	B	1	2	9	3	2.77
F	C	1	5	9	5	1.77
G	C	2	2	8	3	1
H	E, F	4	4	10	5	1
I	D	2	5	8	5	1
J	H, G	2	2	8	3	1

(iv) Project completion time

1 - 4 - 6 - 7 - 8

C - f - H - J

4 + 5 + 5 + 3 = 17 week.

(v) $P(x \leq 22) = P\left[\frac{x-\mu}{\sigma} \leq \frac{22-\mu}{\sigma}\right]$

	μ	σ^2
C -	4	1
f -	5	1.77
H -	5	1
J -	3	1
	17	4.77

$\sigma^2 = 4.77$

$\sigma = \sqrt{4.77} = 2.18$.

$P\left[\frac{x-\mu}{\sigma} \leq \frac{22-\mu}{\sigma}\right]$

$\frac{22-17}{2.18} = 2.29$

At 2.29 = 0.9867

= 98.67 % Ans

PERT (project evaluation & Rivew technique)

→ It is probabilistic in nature

→ The activity duration is on certain & the expected time is calculated from to, tm, tp.

→ It is an event oriented technique.

→ The pert uses the terms like network diagram & event

→ The pert differenciate bet^n critical & noncritical activity.

→ The dummy activity is required for sequencing of the project

→ The pert finds the application in project & resources where the man, material & the money is required.

→ The pert is suitable in research & development of defence project.

CPM (critical path method)

→ It is time determinastic in nature.

→ This is a well known activity with certain duration & expected time is the actually time taken by the project & it is a single time estimate.

→ It is an activity oriented technique.

→ It uses the the terms like area diagram & nodes.

→ It uses only the critical activities.

→ The dummy activity is not necessary for representing project & the arrowe diagram is necessary.

→ CPM is used in project where the minimum cost is required & the better utilization of resources is done.

→ The cpm is suitable in industrial setting plant maintanance & civil construction project.

INVENTORY Control — CH # 03

The word inventory means "stock". & control means "Management"

Inventory → Stock.

Control → Management → proper use of any item → Effectiveness & Efficiency.

→ In simple words Inventory management / control means, it is the control over the stock by the manager, so that there is proper uses of material is possible with least wastage.

Inventory Control :-

(I) It may be defind as the scientific method of finding out howe much stock should be maintained in order to meet the production demands & be able to provide right type of material at right time in the right quantities & competitive prices.

(II) The objectives are

(a) To minimize investment in inventory.

(b) To maximize the service levels to the firms customers.

classification of Inventories :-

(1) Raw inventories (raw materials)

(2) Work in progress inventories.

(3) Finished inventories.

(4) Indirect inventories.

(1) Raw Inventories :- Raw materials & semifinished products supplied by another form which are raw items for present Industry.

→ Raw materials are those untabricated materials which haven't undergone any operation since they are received

from the suppliers, for ex:- pipes, channels, angles, Round bars.

(3) Work in progress inventories :-

→ Semi finished products at various storages of manufacturing cycle.

→ The items or materials in partially completed condition of manufacturing.

(3) Finished Inventories :-

→ They are finished goods lying in stock rooms & wating dispatch

(4) Indirect inventories :-

→ The inventories refer to those items which don't form the part or the final product but consumed in the production process.

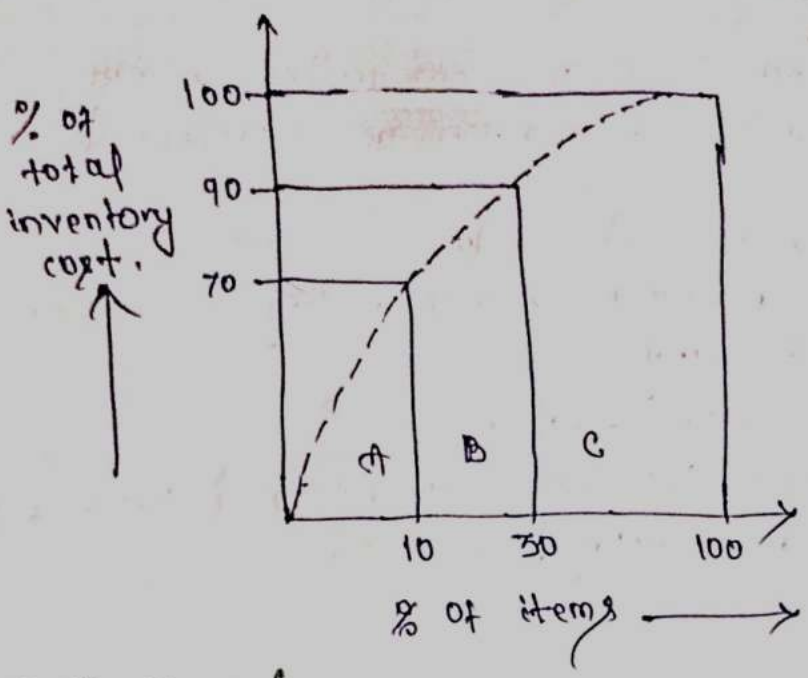
→ for example :- M/C spares, oil, grease, spare parts, lubricants.

Objectives of Inventory :-

- purchasing Materials at economical price at proper time & in sufficient quantity as not to run stock.
- providing a suitable & secure storage location.
- To maintain timely record of inventories of all the items.
- A definite inventory identification system.
- Adequate & responsible store room staff.
- Suitable requisition procedure.
- To provide a reserve stock.

ABC Analysis :-

→ ABC analysis helps differentiating the item from one another & tells how much valued the item is & controlling it to what extent is in the interest of an organization.



(1) A - Items :-

→ A items are high valued but are limited or few in number. They need careful & close inventory control & proper handling & storage facilities should be provided.

→ A items generally 70-80 % of the total inventory cost & 10% of the total items.

(2) B - Items :-

→ B items are medium valued & their number lies in between A & C items. They need moderate control. They are purchased on the basis of past requirments.

→ B-items are generally 20-15 % of total inventory items.

(3) C - Items :-

→ C - items are low valued, but maximum numbered items. These items don't need any control. These are least important items, like clip, all pins, washers rubber bands. No record keeping is done.

→ C-items generally 10-5 % of the total inventory cost & constitute 75 % of the totall items.

*Functions of Inventory :-

→ Separate different operations from one another & make them independent, so that each operation can be performed economically.

→ Maintain smooth & efficient production flow.

→ Purchase in desired quantities & thus nullify the effects of changes in prices or supply.

→ Keep a process continually operating.

→ Creat motivational effect. A person may be tempted to purchase more if inventories are displayed in bulk.

X

PLANT MAINTENANCE

Plant :- A plant is a place, where men, materials, money, equipment, machinary etc are brought together for manufacturing products.

Maintenance :-

Maintenance of facilities & equipment in good working cond^n is essential to achieve specified level of quality & reliability & efficient working. It helps in maintaining & increasing the operational efficiency & of plant facilities & contributes to revenue by reducing operating of production.

Objectives of Plant maintenance :-

→ To achieve minimum break down & to keep the plant good working condition at the lowest possible cost.
→ To keep M/C in such a cond^n that permit to use without any interrupter.
→ To increase functional reliability of production facilities.
→ To maximize the useful life of the equipment.
→ To minimize the frequency of interruption to production by reducing breakdown.
→ To enhance the safety of man power.

Imp of Maintenance :-

→ Equipment breakdown leads to an inevitable loss of production.
→ An improperly maintained or neglected plant will sooner or later require expensive & frequent repairs, because with the passage of time all machines or other facilities, building, etc wear out & need to be maintained to func properly.
→ plant maintenance plays a prominent in production management

because plant breakdown creates problem such as –

- ✓ loss of production time.
- ✓ spoilt materials.
- ✓ failure to recover overheads (because loss in production hours).
- ✓ Need of over time.
- ✓ Need for sub contracting work.
- ✓ Temporary work shortage – workers require alteration work.

Duties, Functions & Responsibilities of Plant Maintenance Department.

(a) Inspection :-

→ Inspection is concern with the routine schedule checks of the plant facilities to examine their cond^{n} & to check for needed repairs.
→ Inspection ensures the safe & efficient operation of equipment & machinery.
→ Frequency of inspection depends upon the intensity of the use of the equipment.
→ Items removed during maintenance & overhaul operation are inspected to determine flexibility of repairs.
→ Maintenance items received from vendors are inspected for their fitness.

(b) Engineering :-

→ It involves alterations & improvements in existing equipments & building to minimize breakdown.
→ Maintenance department also undertakes engineering & supervision of constructional projects that will eventually become part of the plant.

→ Engineering consulting services to production supervision are also the responsibilities of maintenance department.

(c) Maintenance :- Maintenance of existing plant equipment.

→ Maintenance of existing plant buildings & other services facilities such as yards, central stress, roadways.
→ Minor installation of equipments, buildings & replacements.
→ Prevent breakdown by well-conceived plants of inspection, lubrication, adjustments, repair & overhaul.

(d) Repair :-

→ Maintenance department carries corrective repairs to avoid unsatisfactory cond^{n}s found during preventive maintenance inspection.
→ Such a repair work is of an emergency nature & is necessary to correct breakdowns.

(e) Overhaul :-

→ It is a planned, shedule reconditioning of plant facilities such as machinary etc.
→ It involves replacement, reconditioning, reassembly etc.

(f) construction :-

→ In some organization, maintenance department is provide with equipment & personnel & it takes up construction Job also.
→ It handles construction of wood, brith & steel structures, electrical installation etc.

(g) Salvage :-

→ It may also handle disposition of scrap or surplus materials.
→ This involves segregation & disposition of production scrap.

(h) Clerical Jobs :-

→ Maintenance department keeps records of cost, of time progress on jobs, electrical installations, water, steam, air & oil lines, transport facilities.

(i) Generation & distribution of power.

(j) Providing plant protection.

(k) Establishing & maintaining a suitable store of maintenance materials.

(l) House keeping.

(m) Pollution & noise control.

* Types of Maintenance :-

→ It can be classified into 4 types

1. Corrective or breakdown maintenance.
2. Scheduled maintenance.
3. Preventive maintenance.
4. Predective maintenance.

(1) Corrective or breakdown Maintenance :-

→ corrective or breakdown maintenance implies that repairs are made after the equipment is out of order & it can't perform its normal func any longer.
for ex :- Electric motor will not start, a belt is broken.

→ under such conditions, production department calls on the maintenance department to rectify the defect. The maintenance department checks into the difficulty & makes the necessary repairs.

→ After removing the fault, maintenance engineers don't attend the equipment again until another failure or break down occurs.

→ Breakdown maintenance is economical for those equipment whose down time & repair costs are less.

→ Breakdown type maintenance involves little adminstrative works, few records & comparative small staff.

Causes of equipment breakdown :-

→ Lack of lubrication.
→ Neglected cooling system.
→ Failure to replace worn out parts
→ External factors (too higher or too voltage).

Disadv of breakdown maintenance :-

→ Breakdown occurs at inopportunity times, which lead to poor, hurried maintenance & excessive delays in production.
→ Reduction of output.
→ Move spoilt material.
→ Increased chances of accidents & less safety to both workers & machines.
→ Direct loss of profit.
→ Breakdown maintenance can't be employeed to cranes, lifts, hoists & pressure vessel.

(2) Scheduled Maintenance :-

→ Scheduled maintenance is a stich-in-time procedure aimed at availing breakdowns.
→ scheduled maintenare do inspection, lubrication, repair & overhaul of certain equipments are done in predetermined scheduled.

→ Schedule maintenance practice is generally followed for overhauling of Machines, cleaning of water & other tanks, white washing of building etc.

(5) Preventive Maintenance %

→ A system of scheduling, planned or preventive maintenance tries to minimize the problems of breakdown maintenance.
→ It is a stich-in-time procedure.
→ It locates weak spots in all equipments, proceeds them regular inspection & minor repairs reducing the danger of unanticipated breakdown.
→ preventive maintenance involves,
→ periodic inspection of equipment & machinary to prevent production breakdown an harmful depreciation.
→ Upkeep of plant equipment to correct fault.

Objective of PM %

→ To minimize the possibility of unanticipated production interruption & major breakdown by locating the fault.
→ To make plant equipment & machinary ready to use.
→ To maintain the optimum productive efficiency.
→ To maintain the operational accuracy.
→ To achieve max^m production & minimum repair cost.
→ To ensure safety of life & limbs of the workers.

Advantages :-

→ Reduce breakdown & down time.
→ Lesser odd-time repairs.
→ Greater safety for workers.
→ Low maintenance & repair cost.
→ To achieve Max^m production & minimum repair cost.
→ Better production quality.

(4) Predictive Maintenance :-

→ It is a newer maintenance technique.
→ It uses human senses etc other sensitive instruments such as audio gauge, vibration analyser, amplitude meters, pressure, temp & resistance strain gauges to predit troubles before the equipment fails.
→ Unusual sound coming out of a rotating equipment predict an trouble, an electric cable excessively hot at one points predicts an trouble.
→ In predictive maintenance, equipment cond'ns are measured periodically or on a continuous basis enables maintenance men to take timely action such as equipment adjustments, repair & overhaul.

CH-06 : CONTEMPORARY quality Management

CONCEPT :-

→ Concept of total Quality Management :- (TQM)

Total → Made up of the whole.

Quality → Level of excellence of a product of degree of excellence of a product or service providers.

Management → It is the time manner of controlling or in other words we can also say that it is the act, art or manner of controlling handling & directing.

* Total Quality management (TQM) is the art of managing the whole to achieve excellence.

Defination :- TQM is a set of systematic activities carried out by the entire organisation to effectively & efficiently achieve company's objectives so as to provide products & services with level of quality that satisfies customers at the appropriate time & price.

Key Element of TQM :-

1 → Top Management commitment & support.
2 → Customer involvement & focus.
3 → Employee involvement & focus.
4 → Leadership & strategic planning.
5 → Contineous improvement.
6 → Company wide quality culture.
7 → Customer statisfiction & delight.

Steps in implementing TQM :-

It is also known as PDCA analysis

P → Plan
D → DO
C → Check
A → ACT

PLAN :- Define & analysis a problem & identify the root cause.

DO :- Devise a solution, developed detailed action, plan & implement it systematically.

CHECK :- Conform out comes against plan identify deviations & issues.

ACT :- Standardize solution Review & define next issues.

Adv of TQM :-

→ Sharpens competitive edge of the enterprise.
→ Excellent customer satisfaction.
→ Improvement in organisational performance.
→ Good public image of the enterprise.
→ Helps in checking non productive activities & waste.
→ Better personal relation.

Dis adv of TQM :-

→ production distruption.
→ Employee resistance.
→ Quality is expensive.
→ Discourages creativity.

Six Sigma (6σ)

→ The basic means of six sigma is zero defect.

Sigma (σ) is coming from the Greek letters & basically called as standard deviation.

* Motorala is the first company who developed six sigma (6σ) in 1986 (Bill smith)

Def^n → It system of statistical tool & techniques focused on eleminating defects & reducing process variability.

Six sigma relates to the connection bet^n number of defects per million opperteunities & the number of standard deviation found within a process specification.

ISO (International standard organization)

→ International organization standardigation is founded on 23rd February 1947.

Main objective → To achieve, maintain & contineously improve product quality & also improve the quality of operation.

ISO-9000 → It is a series of standard related to the quality management.

** In 1979 → BSI (British standard institute) → submit a format proposal for ISO.

** In 1987 At ISO-9000 was published in UK & canada.

→ It is a management methodology adopted by company to deliver the product & service that meet the customer expection.

→ The implement of ISO 9000 standard doesn't mean the higher level quality but it forces a company to assure its customer that the product are manufactured A/C to the standard.

Why a company want ISO 9000 Registration :-

→ for Customer satisfaction.
→ Improve organization management & product service quality.
→ Entering into the global market.
→ Exporting internationally.

ISO - 14000 :- It is a family of standards related to environmental management. It provides standard in 3 major area.

① Management system :- systems development, an integration of environment responsibility into the business planning.
② Operation system :- It is about the consumption of natural resources & energy.
③ Environmental system :- It is about measuring a managing emission & other wastages.

*) The ISO-14000 standards was published in 1922.
*) ISO-14000 deal with, How the company manage the environmental inside the facility & immediate outside the facility.

*) **7S** :- 7-S Means → Strategy
→ Structure
→ System
→ Skill
→ Staff.
→ Style.
→ Share values.

→ The 7S is a tool for understanding the internal situation of an organisation there are 3 hard elements & 4-soft elements.

→ Hard elements :- Once this elements will be established then we can't change it further.

→ Soft elements :- Can be changed day to day time.

→ This frame work is based on the principle that the 7 elements are all important & the firm to performing well these 7-elements need to be alligned & mutually supporting.

→ If is change is proposed for ex:- a new strategy or a change of leadership the frame work can be used as a diagnostic tool (such as to fig out where the problem will lie) or as a way of implementing proposed change (such as to focus the change effort around one specific element). For the change to work, all 7 elements will have to be alligned for support it.

→ The key of this 7s model is that all the the seven areas are interconnected & a change in one area requires change in the rest of a firm for it to func effectively.

When to use :-

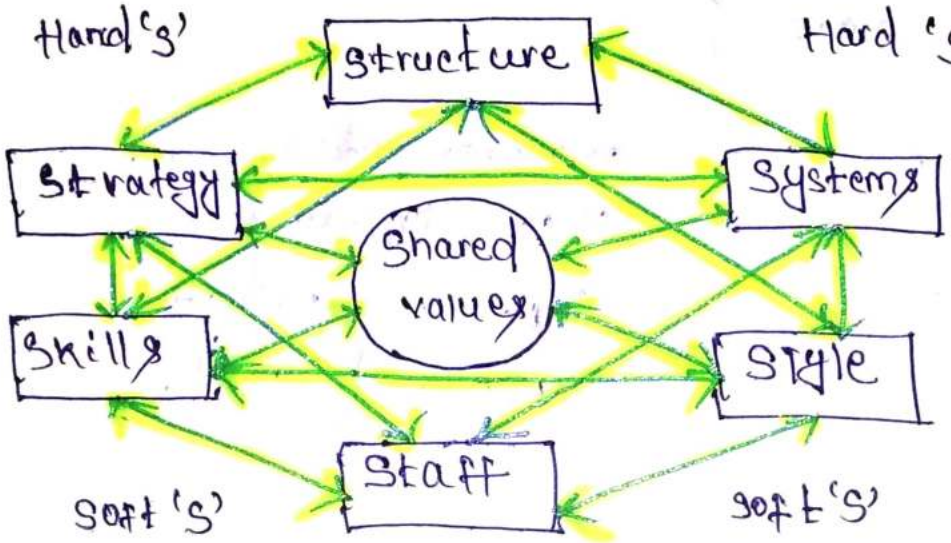
The 7S model can be applied to many situations & is a valuable tool when organisational design is at quetion. The most common uses are :-

1) To facilitate organisational change.
2) To help implement new startegy.
3) To improve the overall performance of a firm.
4) To facilitate the merger of organisation.

7-S MODEL :-

strategy structure & system are hard elements that are much easier to identify.

→ on the other hand, soft areas, although harder to manage, are the foundation of the organisation & are most likely to creat the sustained competative advantage.



* LEAN Manufacturing :-

→ Lean means thin. It doesn't mean that thin manufacturing but in basic it is that working muscles without fat.

→ Hence here fat is means of non value adding activities & muscles means value adding activities.

Defination :-

→ Lean manufacturing is a systematic approach in which identifying & eliminating the waste or non value added activities & maximize the value added activities, means maximising the profit.

→ It is the type of manufacturing in which products are manufactured by using less material, less money, less manpower, less space & in less time.

Objective :- Waste reduction, reduction of cost & increasing the profit & customer satisfaction.

8-Types of Waste :-

1) Transportation
2) Inventory
3) motion
4) Waiting
5) Overproduction
6) Over processing
7) Defect → Reject
8) unutilized skill.

Inspection & quality control

CH-05

Introduction :-

→ It is defind as the act of chequing a product or component in an organisation.

→ It means that the chequing the aspectbility of the manufacturing product.

→ Inspection measures the quality of a product in a specific standards.

→ The quality of the product is specified by its strength, hardness, shape & size, chemical composition & precision with surface finish.

→ The objective of inspection is as follows :-

(a) It separates the defective components from the nondeffective one & ensures the quality of the product.

(b) It also locates the defect in a raw material & the process.

(c) It also detects the sources of weakness & troubles in the finished product & cheques the work of a designer.

(d) Inspection build the reputation of an organisation by reducting the number of complaines from the customer.

TYPES of Inspection :-

1. floor inspection
2. fixed inspection
3. key point inspection
4. final inspection.

Floor inspection :- The inspection focus on the shop floor of the organisation.

→ It consist of m/c to m/c chequeup along with the simplex of the various m/c operatory.

→ It helps catching the errors befor the final product is reading.
→ It is more effective & desireable because the work is not to be transpotted to another inspection place.

Fixed Inspection :-
→ In this inspection the defects are discovered after the Job is complete.
→ The work piece or Job is brought for inspection.
→ This type of inspection in used when the equipment & tools can't be brought on the sub floor.
→ It is a type of centraliage inspection.
→ The workers & the inspectors don't come in contact with each other

Key point inspection :- Every product has a key point in the process of manufacturing.
→ A key pt is a stage at which the product requires an expensive operation.
→ The inspection at this stage avoid unnecessary expenditures on the poor products.
→ The poor quality product is finally rejected in this type of inspection

Final inspection :- The final inspection of the product includes the appearance & performance of the product.
→ Many inspection test method are available for final inspection like tensile test, impact test etc.
→ It is also a centralised inspection & makes use of special equipments & tools.

Factors affecting the inspection :-

- → Quality of the product
- → Dimension
- → Shape & Size
- → strength
- → Hardness
- → Volume & Density.

Planning of inspection :-

- → Single sampling plan
- → Double " "
- → Multi. " "
- → sequential " " (or) (item by item analysis).

Single sampling plan :-

→ In this plan a lot of samples is accepted or rejected on the basis of a simple drawn from the lot.

→ In this method a single sample is drawn from no of components

→ the size of the sample & find the no of defective table.

→ the sample & find the no of defective components.

→ If the defective pieces exceed the acceptance no the got of the sample is rejected & if the defective pieces are less in no then the sample is accepted.

→ In the case of rejected sample, inspect each & every piece of the sample & replace the defective parts from the tools & correct it.

→ The characteristics of sampling plan :-

① It is easy to design, explain & administer.

② The partical type of sampling plan is selected from the lots

(3) It reduces a lower cost of training & supervising the employees, transporting & of samples.

(4) It is a very & more economical.

(5) It involves a bigger sample size.

(6) It involves the record keeping in pass no.

(7) It provides the maximum information connecting to the quality of each sample.

(Double sampling plan) :-

→ It is used when it is not possible to decides the fate of the single sample from the first sample lots.

→ If second sample is drawn out of the same lot & the decision is take for that sample (accept / reject).

→ The result is taken on a basis of defect of 1st & 2nd sample.

→ The characteristics of the double samples are :-

(1) It involves less inspection than that of single sampling plan.

(2) It is more expensive than single sampling plan.

(3) It is easier to sale to the customer because the psychologically idea of giving a 2nd chance for accepting of the product or samples.

(4) The permits a small size of the sample.

(5) It involves more over heads for acceptance of the product.

(6) It also involves more round keeping than single sampling plan.

Multiple sampling plan :-

→ A multiple sampling plan accepts or rejects a lot of samples on the basis of several samples taken at a time.

characterstics :-

* It involves a smaller first smaller sample than single & double sampling plant.
* It is comparatively difficult to design & explain to the administer.
* It includes a high over head cost than other sampling plans.
* It involves more record keeping.
* It also involves a lower degree of inspection & protection due to small size of sample is taken.
* It also involve automatic sampling of the products & improves the efficiency of the administater.

Sequential sampling plan :-

→ It is also called as item by item analysis of the sample.
→ It is a plan in which the sample size is increased by one piece at a time till the sample becomes large.
→ It Contains Sufficient no of defective parts to decides if it is accepted or rejected.
→ It is easy to design any more expensive.
→ It also involves more steps to take a decision.
→ Since the Samples Size is increasing at a time the sample results are analysid.
→ The analysis of the result of the sample is fast than other sampling plans.
→ The cost of the sample is less.
→ The over head cost is maximum.
→ The multiple sampling plan is based on this type of sampling plant.

Control charts : Def' :-

*) It is a graphical presentation of collected information in day to day life.

* It is based on statistical sampling theory in which a sample size is drawn at random from a lot.

* All the process in this chart is semi-automatic or automatic with respect to the dimension of the product

* A control chart detects the variation in the processing of the different samples within a limit.

* It also Judge the quality of the items or samples.

* It is dynamic in nature & it is kept current & upto datate.

* It can be revised & plotted time distantly on the basis of variation of the sample.

* It is based & the theory of probability.

Purpose & adv of control charts :-

→ A control charts indicates if the process is in control or out of control.

→ It determines the process variability & detects unusual variation)

→ It also ensures the quality of the products.

→ The rejected sample can be minimised & rectify by this process of by using the control chart.

→ It provides the information about the selection process of sample & setting the tolerance limit.

→ The control charts build up the reputation of the organisation by customer satisfaction.

Appl? :- It uses for final assemby of the products called as attribute chart.

→ It is also used for manufacturing of component (Shaft, spindle pins, holes & slots) coming under variable chart.

SAMPLE QUESTION

Sub: Industrial Engg.

Date:

2-mark Question / 5-mark question :-

(1) What do you mean by Plant lay out?
(2) Write down the principles of plant lay out?
(3) Difference process lay out and product lay out?
(4) Write down the objectives of Industrial engineering.
(5) What is optimization and write its ~~test~~ technique.
(6) Discuss about linear programming and its application?
(7) Write down the definition of projects?
(8) Difference Activities and Event?
(9) What do you mean by predecessor and successor activities?
(10) What is dummy activity?
(11) What is critical and Non-critical activities?
(12) What do you mean by PERT?
(13) What is the concept behind 'CPM'?
(14) What are the objectives of 'CPM'?
(15) What are the factors affecting plant location?

Signature.....

Date:

(16) Write down the need for plant lay out?
(17) Write down the objectives of plant lay out?
(18) What do you mean by inventory?
(19) What is inventory and describe types of Inventories?
(20) What are the objectives of inventory control?
(21) Discus about economic order quantity in details?
(25) Explain ABC analysis?
(26) Describe objective of Plant maintenance?
(27) Write down the advantages of preventive maintenance?
(28) Write down the concept of Total quality management?
(29) Explain about ISO-9000/14000 and its objectives?
(~~30~~)
(30) What do you mean by six sigma?
(31) What is lean manufacturing?
(32) Define Inspection and quality control?
(33) Write briefly about 7-S model.
(34) Describe types of Inspection and planning of Inspection?

Signature

Date:

10-marks Question:

(1) Explain the concept of ISO-9000 & 14000 and its evolution?

(2) Explain the concept of statistical quality control?

(3) What do you mean by plant maintenance? Explain the type of maintenance in details.

(4) Describe the duties, functions and responsibilities of plant maintence dept.?

(5) Explain and derive economic order quantity for basic model?

(6) Difference CPM & PERT.

(7) Explain distinct features of CPM & PERT?

(8) Write the definition of plant lay out and explain its type / classification?

(9) Write down the objectives and principle of plant layout?

(10) Write down the factors governing plant location?

(11) Write down the short notes on

(a) 7-S

(b) Six sigma.

(c) JIT

Signature.....