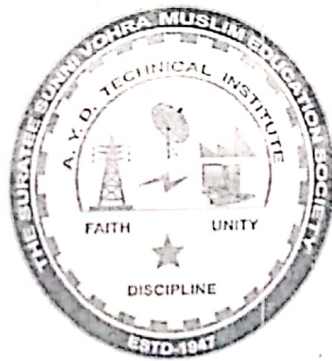


Eng

INDUSTRIAL ENGINEERING

(3351904)

A.Y. DADABHAI TECHNICAL INSTITUTE,
KOSAMBA



DEPARTMENT OF MECHANICAL ENGINEERING

A.Y. DADABHAI TECHNICAL INSTITUTE, KOSAMBA

Vision:

“To develop the Institute to impart Technical Education Globally competitive to equip students with skill and Innovative Ideas for betterment of Nation.”

Mission:

“To Nurture Qualitative, Dynamic and market driven Technical Human Resources through various branches of engineering and with value addition training programmes to cater the exact needs of nation”.

“To impart transparent and good governance along with accountability in all aspects to stock holders”.

“To enhance Industry – Institute – Alumni platform for mutual benefits”.

DEPARTMENT OF MECHANICAL ENGINEERING

Vision: -

To develop the department by imparting quality technical education to students through skill & innovative ideas to cater with the changing needs of industries & nation.

Mission: -

1. Prepare effective & responsible engineers by providing facilities & environment for quality technical education.
2. Constantly strive to improve technical & soft skills along with ethics.
3. Respond effectively to the needs of the industry and society.

TOPICS

UNIT	UNIT TITLE	PAGE NO.	
		THEORY	EXAMPLE
	IMPORTANT QUESTIONS	01 - 04	-----
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COURSE OUTCOMES: -

1. USE WORK STUDY AND METHOD STUDY METHODS TO IMPROVE PRODUCTIVITY.
2. ANALYZE WORK CONTENT AND CALCULATE STANDARD TIME IN A GIVEN SITUATION.
3. APPLY STATISTICAL QUALITY CONTROL TOOLS IN A GIVEN SITUATION.
4. SELECT MATERIAL HANDLING EQUIPMENT.
5. APPLY ERGONOMICS FOR HUMAN COMFORT AT WORK PLACE.
6. APPRECIATE THE EMERGING TRENDS IN INDUSTRIAL ENGINEERING.

QUESTIONSCHAPTER :1 INTRODUCTION TO INDUSTRIAL ENGINEERING2-marks

1. Define Industrial Engineering.
2. State the various techniques of industrial engineering. (W-17)
3. What is the role of industrial engineer in industry?(S-17)
4. Give the objective of industrial engineering.
5. Define and explain in brief productivity.(W-17)

3-marks

1. Define industrial engineering. State at least six techniques of industrial engineering. (W-18)(S-18)
2. Define productivity and explain method to improve it.(S-18) (W-18)
3. State relationship between industrial engineering & prosperity.(S-18)
4. Briefly state how productivity can be increased? (S-17)
5. Define Industrial Engineering state at least five objective of industrial engineering. (W-18)

CHAPTER :2 WORK STUDY2-marks

1. Define work study.
2. Write procedure of work study.(W-17)
3. Give the techniques of work study.
4. Define method study. Describe its procedure step by step. (W-18)
5. Name any four charts used in method study.(S-18)
6. In which chart only two activity are plotted? (W-17)
7. Sketch the sign of repeat activity and alternative processes.(W-18)
8. Draw any four standard symbol used in process chart. (S-17)
9. List four types of key information available from a process chart.(S-17)
10. Sketch the symbols used in two handed process chart with name.(W-18)
11. Draw any four symbols for therbling.(S-18),(W-18)(S-17)
12. Define performance rating. (W-17).

3-marks

1. List and draw standard symbol used in F.P.C. (S-18)
2. State the objectives of method study. (S-18)
3. Define method study describe its procedure step by step. (W-18)
4. State various recording techniques used in work study. (W-18)
5. Differentiate OPC and FPC. (W-18)
6. Describe the symbols used in FPC with examples of each. (W-18)
7. Why should we suggest proposed method after recording present method ? (S-17)
8. Explain man & machine chart with examples. (S-18)
9. Write short note on string diagram with neat sketch and state its uses. (W-18)
10. State the principle of motion economy. (S-17)
11. Define and use of man machine chart.
12. Design procedure for string diagram.

13. Explain two handed process chart.
14. Objectives of micro motion study with define.
15. Draw the therbling symbol for "grasp", "hold", "use", "assemble", "transport" & "release load" (W-17)
16. Explain SIMO chart. (S-17)
17. Advantages of film techniques in micro motion study.
18. Define work measurement and objectives of it.
19. Basic procedure of work measurement.
20. Compare cumulative and fly back timing. (W-17)
21. Define "work element" Describe briefly various types of work elements. (W-18)
22. Illustrate rules for breaking work into work elements. (W-17)
23. What do you mean by rating? (S-17)
24. Outline stepwise procedure to calculate standard time of given job. (S-17)
25. List the various allowances applied for standard time calculation with its normal range of value. (S-17)
26. Write short note on "work sampling". (S-17) (W-18)
27. Explain method of work sampling.
28. Advantages and disadvantages of work sampling.
29. What is the standard time explain its importance. (S-18)

4-marks

1. Objectives of work study.
2. Explain flow process chart.
3. Explain in brief about basic procedure of method study. (S-17)
4. Prepare man type flow process chart for polishing the specimen for metallographic study (W-17)
5. Write short note on man machine chart. (S-17)
6. Write short note on SIMO chart. (W-17) (S-18)
7. Write short note on cycle chart. (W-18)
8. Differentiate between the methods of measuring time in time study. (W-18)
9. State and briefly describe various types of allowances used in time study. (W-18)

CHAPTER :3 QUALITY ASSURANCE**2-marks**

1. Define followings.
2. Define quality control (QC) and quality assurance (QA). (S-17)
3. Define SQC. State any three SQC tools (W-18)
4. Types of frequency distribution charts. Draw any one.
5. Name the types of distribution curves and draw any one. (S-18)
6. State the types of distribution curves. (W-18)
7. Concept of probability.
8. What is reliability? (S-18)
9. Factors affecting reliability.

3-4-marks

1. Difference between Quality control and Inspection.
2. List the tools of SQC & Explain any one in brief. (S-18)
3. Draw and Explain normal distribution curve. (W-17)
4. Define the term reliability. Enlist factors affecting and improving reliability.(W-18)

5. List factor affecting reliability. (S-17)
6. Differentiate reliability and attribute charts. (W-17)

CHAPTER : 4 STATISTICAL QUALITY CONTROL

2-marks

1. Define (i) variable quality parameter (ii) Attribute Quality parameter. (S-17)
2. Objectives of control charts for variables (uses).
3. Types of interpretation of control chart and explain any two. (W-17) (S-18)
4. Producer risk. (W-17)
5. Consumer risk (S-18)
6. Indifferent quality level (IQL).

3-4-marks

1. Explain types of process variations. (W-17)
2. Explain method to draw variable quality chart.
3. List various statistical quality control (SQC) tools. (S-17)
4. Differentiate between variable and attribute quality. (W-17)
5. Write down advantages of variable quality control chart. (X-R chart).
6. Explain \bar{x} - σ chart.
7. Explain p- chart.
8. 100p chart or explain percentage defective chart.
9. np chart (number of defective chart).
10. Explain c- chart and application.
11. Explain concept of process capability (W-17).
12. Write short note on acceptable quality level.
13. Define following term used in sampling plan.
14. Advantage and disadvantage of acceptance sampling.
15. Explain single sampling plan.
16. Explain double sampling plan.
17. Difference between single sampling and double sampling plan.
18. Operating characteristic curve (o. c. curve) (W-17)
19. With the neat sketch briefly describe various parts of real operating characteristic curve. (W-18)

CHAPTER : 5 PLANT LAYOUT AND MATERIAL HANDLING

2-marks

1. Define plant layout.
2. List various types of plant layout. (S-17)
3. What is material handling?
4. Write any four name of material handling equipments. (classification) (S-17) (S-18) (W-18)

3-4-marks

1. Differentiate between product layout and process layout. (S-18) (S-18)
2. State the objectives of plant layout. (W-17)

3. Define the term plant layout. Enlist the principle and characteristics of good plant layout. (W-12)
4. Define the plant layout. State the type of plant layout. Discuss briefly any one with neat sketch advantages and limitation. (W-18)
5. State the at least two application of (i) fork lift (ii) overhead crane (iii) belt conveyor (iv) winch (W-17)

CHAPTER : 6 MODERN TREND IN INDUSTRIAL ENGINEERING

2-marks

1. List of engineering trends in industrial engineering.
2. What is means of ISO. Give family series of standards.
3. Explain in brief total quality management (TQM). (5-17) (5-18)
4. What is kaizen? (5-18)
5. Define kaizen and re engineering (W-18)

3-4-marks

1. Briefly explain role of ISO. (importance)(5-17)
2. Use of ISO standard.
3. Explain six sig-na (6σ) concept.
4. Model of sigma (6σ) (procedure).
5. Explain the important of ISO9000. (5-18)
6. Write short note on ISO9001series. (W-17)
7. Write short note on ISO9001. (W-18)
8. Explain in brief TQM (5-18)
9. Explain concept of kaizen and its applications. (W-17)
10. Write the short note on re engineering. (5-18)
11. Zero defect (ZD).
12. State the concept of JIT. (W-18)
13. State the concept of ergonomics. State its objectives and applications. (W-18)(5-17)
14. Explain anthropometry.
15. Explain in brief "normal and maximum work area". (W-17)
16. Draw neat sketch showing normal and maximum work area. (5-17)

EXAMPLES

1. CHAPTER :2 WORK STUDY:
 - i. Based on standard time calculation
2. CHAPTER :3 QUALITY ASSURANCE
 - i. Based on simple statical
 - ii. Based on standard deviation.
 - iii. Based on normal distribution curve
3. CHAPTER : 4 STATISTICAL QUALITY CONTROL
 - i. Based on sampling plan.
 - ii. Based on variable charts.
 - iii. Based on attribute charts.

CH: 1. INTRODUCTION TO INDUSTRIAL ENGINEERING

COMPETENCY :-

- Appreciate importance of Industrial Engineering, productivity and work study.
- Ways of enhance productivity
- Different techniques of Industrial Engineering.

⇒ (2-MARKS) Questions :-

1: Define Industrial Engineering.

Ans:- It is defined by American Institute as. Concerned with design, improvement and installation of integrated system of man, machine & equipment. Its aim is to increase the productivity. Productivity implies by (i) more efficient use of resources (ii) less waste per unit (iii) Higher levels of out put for fixed input. (10-17)

2 state the various techniques of industrial Engineering.

Ans:- Different techniques used in industrial Engineering to increase quality and productivity. are as under:-

- | | |
|-----------------------|--------------------------------|
| 1) Method study | (6) Material Handling |
| 2) Work measurement. | 7) Job evaluation |
| 3) motion economy. | 8) Statistical Quality Control |
| 4) Micro motion study | 9) Value analysis. |
| 5) plant layout. | |

3. What is the role of industrial Engineer in Industry ?

- Ans. (i) To make improvement in working methods and (S-T). remove unproductive activities.
- (ii) To determine standard of performance of all process and determine standard time and methods.
- (iii) To design systematic plant layout and efficient material Handling system.

- (v) To conduct the varieties of learning program and make aware about work study, method study & time study.
 (vi) To prepare job description & job specification.

4) :- Give the objectives of Industrial Engineering.

- Ans:- (i) To increase the living standard of society.
 (ii) To achieve better utilization of country's resources.
 (iii) To increase productivity of industries.
 (iv) To improve the product qualities.
 (v) To simplify the system & reduce the human efforts.
 (vi) To minimize the cost of production, & increase production capacity.

5) :- Define & explain in brief productivity, (W-17).

Ans:- Productivity may be defined as the ratio of output & input. Output means the amount produced or the number of items produced and inputs are various resources employed such as land & building, equipments & machinery, material labour etc.

It is characteristics of the production system.

$$\text{Productivity} = \frac{\text{output}}{\text{input}} = \frac{\text{Value of product or services produced}}{\text{Value of input used in producing product & services}}$$

⇒ 3-MARKS QUESTIONS :-

1. Define Industrial Engineering. state atleast six techniques of Industrial Engineering. (W-18)
 Ans:- [Answer given in Q.1 & Q.2 of 2-marks] (S-18)

2. Define productivity and explain methods to improve it. (W-18) (S-18)
 Ans:- Define productivity :- [please refer. Q.5 of 2-marks]

→ Methods to improve productivity.

- (i) Through keeping input same & to achieve more output
- (ii) Through keeping output same & to reduce the input.
- (iii) Through small increase in input & to achieve more increase in output.

→ To increase the output without increase input; each & every input must be used effectively.

→ To maintain same output by reducing input can be achieved through the reduction of input by its effective use.

→ By increase small amount of input and to achieve more output can be obtained by increasing little expense behind use of goods machines.

The improve productivity also shown as:-

- (i) long term measure
- (ii) medium term measure.
- (iii) short term measure.

3. state relationship between Industrial Engg. & prosperity. (S-18)

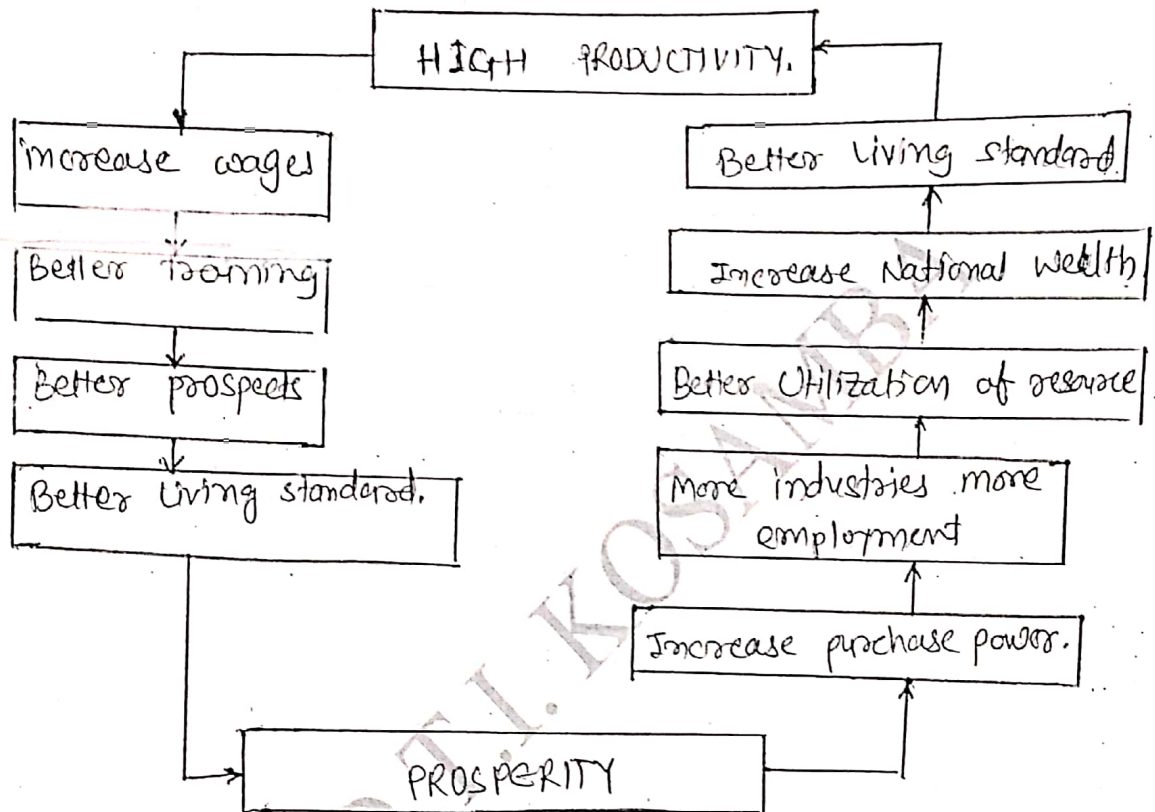
Ans:- → With the increase in productivity, industries will become more profitable and pay good wages and other firm financial benefits to their workers.

→ It will increase purchase power of workers due to that their standard of living improved.

→ Due to that increase demand of products resulting into industrial growth finally increase national income.

→ So, the increase the facilities of society will become rich & wealthy.

In this manner increase productivity result into the increase of individual & social prosperity.



Q4 Briefly state how productivity can be increased? (5-17)

Ans:- [Given Q.2 in 3-marks]

Q.5. Define Industrial Engineering. State at least five objectives of industrial engineering. (W-18).

Ans:- Define Industrial Engineering :-
[Give in Q.1 in two-marks questions page no. 1]

→ five objectives of Industrial Engineering :-

[Give in Q.4 in 2-marks questions page no. 2]

CH: 2 WORK STUDY

COMPETENCY :-

- Define workstudy, method study & work measurement.
- prepare standard charts & diagrams for method study.
- study the motion economy.
- calculate standard time and modify process for improvement.

⇒ (2-MARKS) QUESTIONS :-

1. Define workstudy.

Ans:- "Work study is the techniques of Industrial Engrg. particularly method study & work measurement. which are used in examination of human efforts in all its contexts, and systematically to the investigation of all the factors which affects the efficiency & economy of the situation, being in order to effect improve improvement."

2. Write procedure of work study. (W-17)

Ans:- It can be carried out by the following sequential steps.

1. Select :- Select work or process.
2. Record :- Record the complete information of select work.
3. Examine :- Examine the recorded details, critically.
4. Develop :- Develop best method as result of examination.
5. Measure :- measure the time consumed, of developed or improved method.
6. Define :- Define standard time for improve method.
7. Install :- Install the new, develop or improve method.
8. Maintain :- Maintain the new method by periodic checks.

3. Give the techniques of work study.

Ans:-

- | | | |
|------------------------|----------------------|--------------------------|
| 1) method study. | 5) Time study | 9) Analytical estimation |
| 2) work measurement. | 6) Plant layout | 10) P.M.T.S. |
| 3) Micro motion study. | 7) Material Handling | |
| 4) Motion economy | 8) Activity sampling | |

4. Define method study. Describe its procedure step by step. (WHE)

Ans:- Method study is the systematic recording & critical examination of existing process and proposed new process. ^{mean} developing & applying easier and more effective methods, & reducing cost.

Procedure steps :-

1. Select :- select process.
2. Record :- record all relevant facts, about process.
3. Examine :- recorded data. Examine critically.
4. Develop :- Develop most economical & efficient method.
5. Measure :- measure the time involve of develop method.
6. Define :- define accepted & develop method.
7. Install :- new method install. in std. practice.
8. Maintain :- To check regularly. as a standard practice.

5 Name any four charts used in method study. (5-18)

Ans:- The following charts used in method study.

1. outline process chart (OPC).
2. Flow process chart (FPC)
3. Two Handed process chart.
4. multiple activity chart. like man-m/c. chart.
5. SIMO chart.

→ Diagram used in method study.

1. Flow diagram.
2. string diagram.
3. Circle graph
4. Chronocycle graph.
5. Travel diagram.

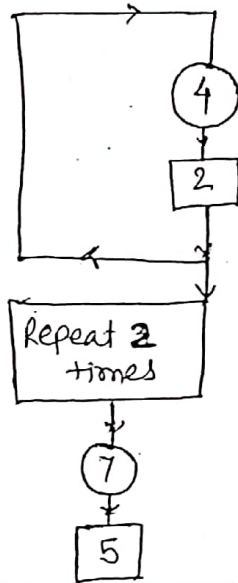
6. In which chart only two activities are plotted (W-17)

Ans:- outline process chart. (O.P.C.), having two activity plotted, like operation, (O) & Inspection (□).

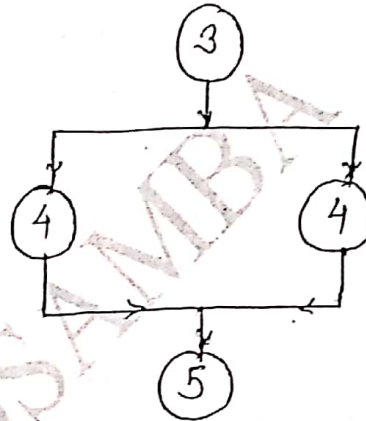
7. sketch the signs of repeat activity & Alternative processes. (W-18)

Ans:

Repeat activity.








Alternative processes



8. Draw any four standard symbols used on process charts. (S-17)

Ans:

1.  - operation.
2.  - Inspection.
3.  - Transport.
4.  - Delay.
5.  - storage

9. List four types of key information available from a process chart. (S-17)

- Ans:-
- (i) It provides better understanding and improvement of process by analysis.
 - (ii) It shows clearly relation between parts entering & final assembly.
 - (iii) It provides the no. of activities, and displays the idle activities.
 - (iv) It gives idea of production process.
 - (v) It assists the design plant layout for effectiveness.

10. Sketch the symbols used in two-handed process chart with name. (W-18)

Ans:- [Please refer q. 8 - in 2-marks.] Inspection symbol not used.

11. Draw any four symbols for handling. (S-18). (W-18) (S-17)

Handling.	symbol.	letter.	colour.
1. Search		Sh	Black.
2. Find		F	Grey.
3. Select		St	Light Grey.
4. Grasp		G	Red.
5. Position		P	Blue
6. Transport loaded		TL	Green
7. Assemble		A	Violet.
8. Use		U	Purple
9. Disassemble		DA	Light Violet.
10. Inspect		I	Brown ochre

12 Define performance rating. (W-17).

Ans:- Rating is the assessment of the worker's rate of working relative to the observer's concept of the rate corresponding to the standard pace.

Rating is that process during which the time study engineer compares the performance of the operator under observation with the observer's concept normal or standard performance.

$$\therefore \text{Performance Rating} = \frac{\text{observed performance}}{\text{normal performance}} \times 100$$

⇒ Formulas for calculating Standard Time :-

$$1. \text{ Basic time} = \text{observed time} \times \frac{\text{observed rating}}{\text{std. rating (100)}}$$

$$2. \text{ Work content} = \text{Basic time} + \text{relaxation allowance} + \text{Incident allowance}$$

$$3. \text{ Standard Time} = \text{Work content} + \text{other allowance.}$$

(3- MARKS) SUGGESTIONS.

1. List and draw standard symbols used in F.P.C. (3-18)

Ans:- [Refer. Q.8 in 2 marks.]

2. State the objectives of Method Study. (5-18).

Ans: (i) Hand & body motion in which one has to analyse particular motions, their sequence, their nature for improving task.

(ii) To analyse the work place layout, tools, equipment and change in them may losing improvement.

(iii) To analyse process. and. convert into work element.
in sequence.

(iv) product design in which one must analyse the product. from customer requirement & design requirement and modifying to satisfy customers by better service.

(v) To improve the quality. of product by incoming material, assembly & sub assembly & finish product analyses.

3. Define method study. Describe its procedure step by step. (W-18)

Ans:- [Refer. Q.4 in 2-marks]

4. State various recording techniques used in work study. (W-18)

Ans:- [Refer. Q.5 in 2-marks]

5. Differentiate OPC & FPC. (W-18)

Ans:	OPC	FPC
(i)	It is graphical presentation of the point at which material. to enter in process and sequence of all operation and inspection.	(i) It is graphical representation of all operations, inspection, transportation, delays and storage during the process. in sequences.

- (2) Generally flow of process shown by vertical line.
- (3) This chart does not show the place where work carried out & who doing.
- (4) only two basic symbols are used in this charts.
- (5) this chart does not show delay in process.
- (6) There is not required plant layout diagrams.
- (7) It draw for the process of product.

- (2) Flow of process shown. In not only vertical. lines
- (3) This charts show the place where work & who can work.
- (4) FPC charts have more than two symbols. for different activities.
- (5) This chart also the show of delay activities in process.
- (6) It has also required to analysis process by plant layout
- (7) It draw the chart for man, m/c, equipments, to flow. in production.

6. Describe the symbols used in FPC with examples of each. (11-18)

Ans - [refer. Q & S. 2-marks]

- ▽ - To issue material from the store.
- - To conduct any operation for mfg.
- - To inspect the material of process during operation as per specified dimension or quality.
- ⇒ - To transport the material to one work station to other work station.
- D - Delay indicate when flow of process is to stop at particular positions.

7. Why should we suggest proposed method after recording present method. (S-17)

Ans:- We suggest proposed method :-

- (i) To make easiest method.
- (ii) To reduce the production time.
- (iii) To reduce transportation, during the production by using plant layout, as per the process requirements.
- (iv) To increase the rate of production.
- (v) To remove the idle activities and remove in production system by using the proposed methods.
- (vi) To identify the time consuming process and change the method by propose method and increase the efficiency of worker, m/c and materials.

8. Explain Man & machine chart with examples. (S-18).

Ans:- Man machine chart is chart to illustrate the simultaneous activity of man & machine during the production process and give the details of man & m/c like working time, Idle time and total cycle time for particular job.

Also using all detail by colour code. as.

- Orange colour - combine activity.
- Green colour - Independent activity.
- Red colour - Idle activity.
- Blue colour - Walking time

for understanding of man and machine chart using a simple example. (e.g. drilling hole in job.)

M/M Time	M/M.			M/C.	Time. Min.
0.5	Lift the job in jig.	Green	Red.	Idle.	0.5.
0.2	Tight the screw & place on m/c.	change	change	Set on m/c.	0.2
0.2	move toward job on m/c.	change	change	To start m/c.	0.2
1.0	Drill hole of ϕ 6mm.	change	change	To Drill on m/c.	1.0
0.2	Tool out & stop m/c.	change	change	m/c stop.	0.2
0.2	Jig out from m/c & loose	Green	Red	Idle	0.2
0.2	Remove job from jig.	Green	Red.	Idle	0.2
0.2	clean m/c & remove chip.	change.	change	To clean m/c.	0.2
2.7 min					2.7 min.

→ Cycle time :- 2.7 min.

→ Working time :- 2.7 min.
of man.

→ Working time :- 1.8 min.
of machine

→ Idle time of man :- 0.0 min.

→ Idle time of m/c :- 0.9 min.

$$\rightarrow \% \text{ Utilization of Man} = \frac{W.T}{C.T} \times 100$$

$$= \frac{2.7}{2.7} \times 100 = \underline{100\%}$$

$$\rightarrow \% \text{ Utilization of M/c} = \frac{W.T}{C.T} \times 100.$$

$$= \frac{1.8}{2.7} \times 100 = \underline{66.67\%}$$

from this chart we say that man activity is 100% & m/c activity is 66.67%. For drilling operation 33.33% Idle.

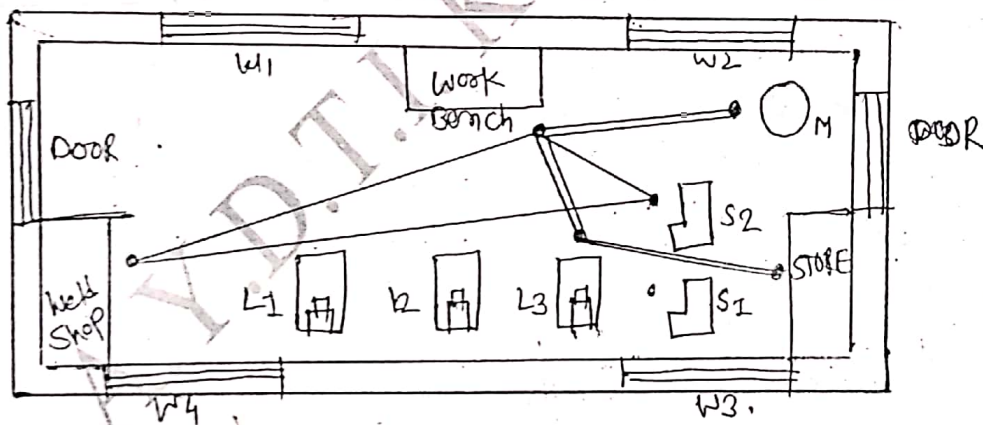
9. Write short note on string Diagram with neat sketch and state its uses. (W-18).

Ans:- There are many industrial activities in which workers are moving at 'irregular intervals' between a number of points in working area, with or without material. For. eg.

- ① Worker looking after more than one machine
- ② In restaurants where different persons are serving different tables.

Under such condition using string diagram technique for examine.

"The string diagram is a scale plan or model on which thread is used to trace and measure the path of workers, material or equipment during a specified sequence of events.



Uses :-

1. To know numbers of movements operators.
2. To useful to improve plant layout. & method of handling.
3. To know the work movement distance.
4. Give information for unnecessary & nonproductive activities.
5. More suitable & economic method found by study diagram.
6. all movements of each activities can be recorded.

10. State the principle of motion Economy. (5-17).

Ans:- The economy obtained in movement & motion of human organ at work by suitable means is called motion economy.

The principle of motion economy is the removal of the unnecessary movement and then sufficient improved in productivity results. In mass production industries a worker has repeat same movement for thousands of time at his workplace. Therefore by obtaining economy in such movement, productivity can be increased.

for achieving. economy in motion three types of studies are done as under below:-

- (i) Use of human body.
- (ii) Arrangement of work place
- (iii) Design tools & equipments.

11. Use of define and use of man-m/c chart.

Ans:- It is the multiple activity chart in which the activities of worker and machine are recorded on a common time scale to show their inter-relationship

→ Uses of man-machine chart :-

- 1) How much work is done by machine in compare to worker
- 2) How much work is done by operator in compare to m/c.
- 3) To know percentage of utilization of worker in total time.
- 4) To know percentage of utilization of m/c in total time.
- 5) To find possibility to reduce the time of idle for man and machine.
- 6) How much. more power can be employed to reduce idle time of machine.
- 7) To find out the means of reducing overall cycle time.

12. Design procedure for string diagram.

Ans: (i) To draw plant layout as per scale and to show the workstation, machines, equipments & store in it.

(ii) To stitch the layout drawing on soft board by means of pin.

(iii) To observe the movement of worker or material and trace out on the drawing of plan.

(iv) To fix the pin at every turn in a movement.

(v) To tie the thread on a pin and keep proper tension of thread so, pin cannot pull out.

(vi) and finally we check all the length of thread on the plan with using pin find out the movement of worker during the process.

(vii) For more improvement using the different colour of thread for different worker's movement on same plant layout.

13 Explain two handed process chart.

Ans:- → For recording the activities of worker's hand & his other organ and to record movement of both hands with respect to one-another on a common time scale Two Handed process chart used.

→ Therefore one hand doing some work and what is done by the other hand. is shown in chart.

→ The recording in this chart is done direct observation like flow process chart. The symbols of flow process chart used in this chart but some different meaning.

○ - operation - for gripping, holding, placing tools & parts.

⇒ - Transport - Hand movement for taking & leaving tools job & material.

D :- Delay - The situation when hand is not work.
Rest

∇ - Hold :- To hold Job, Tool & equipment in hand.
In this chart inspection is not shown because it is not done by hands.

14. Objectives of Micromotion study with Define.

Ans:- Micromotion study is set of techniques intended to divide human activity into group of movements or micromotions (therbligs) and the study of such movements helps to find for an operator one best pattern of movements that consume less time & requires less effort to accomplish the work with minimum fatigue.

→ objectives :-

1. It assists in finding the most efficient way of doing work.
2. It helps to study repetitive short cycle operations which cannot be studied by ordinary methods.
3. To train the operator regarding the motion economy.
4. It helps in collection of motion time data.
5. It assists in research projects in the field of work study.
6. It is a permanent means of keeping record of method.

15. Draw the Therblig symbol for "grasp", "Hold", "use", "Assemble", "Transport load" & "Release load". (W-17)

Ans:- Work study engineer Frank Gilbreth divided all the human movements into elements according to their purpose. These are called THERBLIG. There are 18 symbols.

[Please show & refer Q-11 in 2-marks]
for symbols.

16. Explain SIMO chart. (5-17).

Ans:- The recording techniques for Micromotion study is called SIMO chart.

- It is a graphical presentation of co-ordinate activities of an operator's body parts. The activities are described in terms of basic or fundamental motion (therbligs).
- SIMO chart is constructed to show the activities of both hands on common time scale.
- In this chart show the micromotion activities, which are very fast and short period of time.
- The movements are recorded against time measured in "winks" ($1 \text{ wink} = \frac{1}{2000} \text{ minute}$)
- The activities are very fast so, we cannot divide in different therbligs symbol. for that we use movie camera or film technique.
- Left and right hand therbligs are shown by the symbols, and color code in their respected column.

17. Advantages of film techniques in micromotion study.

Ans:- (1) Film technique provides pictorial, accurate and permanent record in sequential task.

- (2) Once the photography is done it can be studied when sufficient time available, and do not disturb production.
- (3) Film & photograph can be stored as a permanent record.
- (4) One task can be compared by many methods and useful for providing training to the operators.
- (5) Method which is extremely speedy and complex can be studied easily with the help of film technique.
- (6) Different cycles of operations can be seen number of times without disturbing the operators.
- (7) For micro examination any of the picture can be made fast, slow or stationary.

- (8) Initially costly but at long run this method is cheap.
 (9) Worker can also give their suggestions himself for improvement.

18. Define work measurement and objectives of it.

Ans:- Define :- "Work measurement is the application of techniques designed to establish the time for a qualified worker to carry out the job at defined level of performance."

→ objectives :-

1. To establish & standardise the condition for an efficient operation.
2. To standardise the standard of performance.
3. To analyse the operations with the view that the improvement is to be done on existing method.
4. To bring improvement in operating efficiency.
5. To find time required to produce a job by various methods.
6. To formulate the actual schedule of work.
7. To decide the base for incentive schemes.
8. To formulate costs & labour estimates.
9. To remove ineffective time of work method.
10. To help the management in deciding the efficiency of plant.

19 Basic procedure for work measurement.

Ans:- To carry out work measurement systematically as follows:-

- (i) select :- select the work to be time studied.
- (ii) record :- Record all relevant data relating which the work is done
- (iii) Examine :- Examine the recorded data and detailed breakdown critically to ensure that most effective method and unproductive elements are separated from the productive elements.

- (iv) measure :- To measure the time element of activities and calculate the total work cycle time.
- (v) compile :- To find standard time by adding the different allowances to the measure time which cover relaxation & personal need.
- (vi) Define :- To define precisely which time is standard for particular work.

20. compare cumulative & flyback timing. (W-17).

Ans:-

Cumulative Timing

1. Once the stop watch is started, it is not stopped before the completion of the cycle.
2. The time of work element is calculated by taking difference of its final & first readings.
3. There will not be any error in total work cycle time.
4. This timing is more accurate.
5. Skill person can measure the time of small work elements very easily.

flyback timing.

1. The stop watch is started & stopped at the beginning and end of each work element respectively.
2. As the time of each work element measured from the zero so, give reading of each work element.
2. If time of any work element is not recorded by mistake or any mistake is committed there is possibility mistake in cycle time.
4. This timing is less accurate.
5. Skilled person even face difficulty in measuring time of small work elements.

21. Define "work element" describe briefly various types of work elements. (4-18).

Ans:- Breaking the job with a view to get facilities for observing, measuring and analysing, the specific elements of work is called work element.

⇒ Types :-

- (1) Repetitive element :- The work element which is occurring in a work cycle now & again is called repetitive element. e.g. to fix Job in chuck.
- (2) Occasional element :- This element is not element of work cycle but some time appears. e.g. belt adjust sometime.
- (3) Constant element :- The work element consume same time at all time e.g. switch on, tighten nut bolts.
- (4) Variable element :- The basic time of work elements when change with the characteristics of product & equipments. e.g. the hardness of material is different when cut.
- (5) Manual element :- The work element which depends upon the speed of worker. e.g. tight nut bolt & welding job.
- (6) Machine element :- The work element which depends upon the speed of m/c. e.g. Threading on automatic lathe.
- (7) Foreign element :- The element which appeared during time study when it is not element of work cycle. e.g. chip remove to fix next job in a die.
- (8) Governing element :- The work element which consume more time in all elements is called governing element. e.g. :- Indexing & cutting teeth of gears than. M/c the gear blank.

22. Illustrate rules for breaking work into work elements, (W-17)

- Ans:-
1. Separate manual & machine elements from one another.
 2. Separate constant element from variable elements.
 3. Measure time of occasional element separately.
 4. Keep work elements small so as the time measurement becomes easy.
 5. The start & end of each elements may be such that they can be identified easily.
 6. Divide the work into elements such that the elements consuming less time can be arranged ahead of that consuming more time to create facility of measuring each elements more accurately.

23. What do you mean by rating? (S-17).

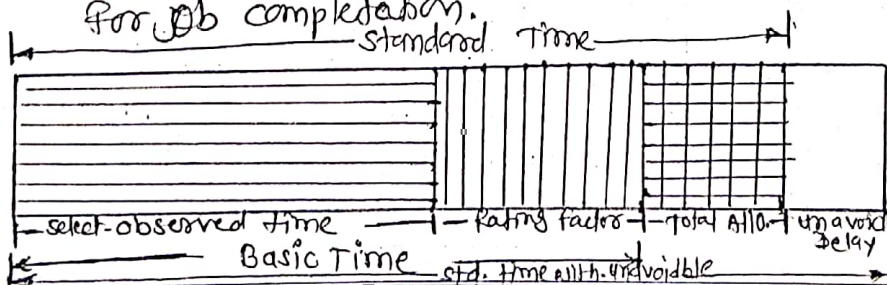
Ans:- [Refer. Q. 12. in 2nd mark]

24. Outline stepwise procedure to calculate standard time of given job. (S-17).

- Ans:-
1. Time recorded by observing the work element during time study is called observed time.
 2. The time selected from the number of observed times recorded, called selected time.
 3. Basic time:- from the selected, observed time find the basic time by observer given rating.

$$\text{So, Basic time} = \frac{\text{observed time} \times \text{observed rating}}{\text{standard rating}}$$

4. Standard time:- from basic time add some allowance for job completion.



25. List various allowances applied for standard time calculation with its normal range of value. (5-17)

Ans:- Allowance is the additional time allowed to perform the work over and above the basic time.

→ Allowance may be classified as :-

1. Relaxation allowance :- It has two major components like personal need allowance & fatigue allowance.

→ personal need for. 5% men, 7% for women.

→ fatigue allowance - 4% of basic time.

2. contingency Allowance :- This allowance may occur frequently or irregularly are provided for small unavoidable delay. like - tool breakage, tool resharpening, coolant filling, oiling. It is 5% of basic time

3. Special Allowance :-

Policy allowance, learning allowance, reject allowance. etc. Some of special allowance. learning allowance. for learn.

4. Interference allowance :-

This allowance is provided when two or more work elements occurs simultaneously.

Eg. one operator look more than one machine there occurs interference when both cycle time are differs.

5. Process allowance :- setup time, shutdown time and time of worker wasted due to defective production.

26. Write short note on "work sampling" (6-11) (10%).

Ans:- Work sampling is also called activity sampling

→ Work sampling can be defined as a method of finding the percentage occurrence of a certain activity by statistical sampling & random observations.

→ Work sampling relies upon statistical theory of sampling & probability theory.

→ Normal frequency distribution and confidence level are associated with work sampling.

→ Statistical theory of sampling period of time can construct an accurate picture of the actual situation in the system.

→ Find the no. of observation by,

$$N = \frac{4P(1-P)}{s^2 - P^2}$$

P = % occurrence of the activity being measured in fraction

S = Error in fraction.

27 Explain method of work sampling.

Ans:- (1) Decide main objectives of activity to be studied.

(2) clearly explain the objective of work sampling to all person concerned to carry out work sampling.

(3) Determine no. of observation to be taken as per given accuracy and confidence level using equation.

$$N = \text{no. of observations} = \frac{4(1-P)}{s^2 P}$$

(4) List out the activity for which observations are to be taken

(5) Decide for which activities observations will be taken by conducting preliminary study.

(6) Divide the responsibility of recording readings of work sampling.

28. Advantages & Disadvantages of Work Sampling.

Ans:- Advantages :-

- (i) The activities which are impractical or costly to measure by time study can be measure by it.
- (ii) Study of several operators or machines can be studied by a single observer.
- (iii) The worksampling consume less time compare to time study.
- (iv) without affecting the results work sampling study any time.
- (v) this study causes less fatigue to the observer as less tedious.
- (vi) Trained study observers are not required.
- (vii) work-sampling studies does not require any timing devices like stop watch.

→ Dis Advantages :-

- (i). Work Sampling can't provide detailed information
- (ii) When large no. of operators are observed or study of operators and machine is conducted only.
- (iii) In certain types of work sampling studies, the record of method used by the operator is not made.
- (iv) In this method, work rate & rating can not get.
- (v). Management & workers cannot understand statistical work involved in work sampling, as they do time study.

29. What is standard time explain its importance (5-18)

Ans:- "The time required by an average skilled operator, working at a normal pace, to perform a specified task using a prescribed method."

It includes appropriate allowances to allow the person to recover from fatigue and personal needs, an additional allowance to cover contingent elements which may occur.

$$\rightarrow \text{Std. time} = \text{basic time} + \left(\frac{\text{Total allowance base on \% of basic time}}{\% \text{ of basic time}} \right)$$

⇒ IMPORTANCE :-

1. To find out the cycle time for job complete.
2. To find out the delay in production.
3. To find out the total production during the whole day.
4. To increase the efficiency of plant by applying production rate constant.
5. To check the idle time and find the reason of it in production.
6. To assist the management to utilize the man, machine and equipment.
7. To prepare a proper schedule of production process.
8. To make cost estimation of product.
9. By this make job evaluation and wages calculation and give the incentives to the operator.
10. Finally std time can reduce the cost of production by systematic working and also achieving production rate.
11. Std time achieve the growth of industries, growth of workers and society and benefits to the country.

(4-MARKS) QUESTIONS.

1. Objectives of work study.

- Ans:-
- (1) To improve working processes & standardized procedures
 - (2) To develop better workplace layout, working condition.
 - (3) To reduce fatigue to operators & to get better product quality
 - (4) To achieve efficient planning & utilise the men, material & m/c effectively.
 - (5) To achieve effective & fast material handling.
 - (6) To increase productivity by use of industrial resource.
 - (7) To reduce unwanted movement of material & worker to reduce non productive time.
 - (8) To reduce wastage, scrap & product rejection.
 - (9) To decide training needs of staff, workers & engineers.
 - (10) To reduce cost of production & product quality maintain.
 - (11) To increase profit of the industry by increase its productivity.
 - (12) To bring industrial safety by preventing accidents through safety plant & machineries provided.

2. Explain Flow Process chart.

Ans:- When overall idea of the process has been established it is possible to go into greater details. Flow process chart is a graphical presentation of all operations, inspections, transportations, delays & storages occurring during a process which includes information considered necessary for analysis like time, quantity and distance moved. etc.

→ TYPES:-

- (1) man type:- It records what the workers do
- (2) material type:- It records what happens to the material.
- (3) equipment type:- It records how the equipment is used.

→ Information shown in F.P.C. :-

1. Types of flow process chart.
2. Information of person producing the part.
3. Information, place, time & name of operator, product process is prepared.
4. Different stages & time.
5. Distance travelled & transport activity. in it.
6. Different stages delay, inspection & storage.
7. Summary of all activities.

3. Explain in brief about basic procedure of method study. (5-17)

Ans:- [Refer Q. 4. in 2-MARKS]

4. Prepare man type flow process chart for "polishing the specimen for metallographic study (W-17)".

Ans:-

		FLOW PROCESS CHART.							
		Activity:-	Present	Proposed	Storage				
		○ - 2							
		□ - 2							
		D - 1							
		⇒ - 4							
		▽ - 2							
		meter							
St. No.	Description.	Qty.	Dist.	Time min	○	□	D	⇒	▽
1	To go at store.		5	5					
2	To issue material.			5					
3	To travel to polishing m/c.		10	10					
4	To load the job.			5					
5	To polish the job			25					
6	To inspect the finish			10					
7	To go for final insp.		15	15					
8	To hold for Insp.			20					
9	To inspect finish.			10					
10	To travel store room		5	5					
12	To store job.			5					

5. Write short note on Man-machine chart. (C.S-17).

Explain multiple activity chart giving example. (W-17)

Ans:- [Refer. Q.8 in 3-MARKS.]

6. Write short note on SIMOCHART. (W-17) (C.S-18).

Ans:- [Refer. Q-15. in 3-MARKS.]

7. Write short note on cycle chart. (W-18).

Ans:- The path of movement of worker is recorded, by attaching a small electric bulb to the part of the body which has to do movement. The photograph taken with the help of motion picture camera gives path of body member movement.

Such a record is called cycle graph. It is similar to the string diagram which also records the movement or frequency of movement of worker over the plant layout, but here used the movie camera to analyse the movement and path of the movement of worker with some scale.

There are different cycle graph, which having different providing the facility to easiness of record and accurate motion. Like a, chrono-cycle graph. there is provide blinking light. instead of continuous line. So, from this, light intensity of blinking give the speed of movement can also get and direction also, given, thus the method study can effectively & accurately done.

8. Differentiate between the methods of measuring time in time study (W-18).

Ans:- [refer the Q-19. from 3-MARKS questions]

9. State and briefly describe various types of allowances used in time study. (W-18).

Ans:- [refer the Q-24. from 3-MARKS questions]

A.Y.D.T.I. KOSAMBA

CH: 3. QUALITY ASSURANCECOMPETENCY :-

- To understand the importance of Quality.
- To prepare suitable frequency distribution chart.
- To get the idea about Quality control, and Quality assurance, reliability and statistical quality control.
- To calculate and decide the standard deviation for given data.

→ 2 MARKS. QUESTIONS :-

1. Define following :-

- (i) Quality :- "The composite product characteristics of engineering & manufacturing that determine the degree to which the product in use will meet the expectations of customers."
- (ii) Quality of design :- If design of product satisfy the requirements of customer, it is called the quality of design.
- (iii) Quality of conformance :- When one product has exactly same specification as prescribed in drawing, the product has better quality of conformance to the specifications.
- (iv) Quality of performance :- If a product gives better functional equality over long time, it is called as better quality of performance.
- (v) Quality Assurance :- It is the engineering which covered product design, production quality control and reliability is called the Quality Assurance.

(VI) Statistical Quality Control. :- To apply the techniques of statistics for the control of quality product this method to controlling of quality is called statistical quality control.

(VII) Range (R_{12n12}) :- Range is the spread of observations. Difference of max. & min. of dimensions obtained by observations is called range. 'R'.

(VIII) Mean or Average :- Mean or Average is a measure of central tendency or location, \bar{X} for (X-chart).

(IX) standard deviation (σ or σ_{12n12}) :- It is defined as the root mean square (r.m.s.) of the differences betⁿ the observed value and the mean value is denoted by ' σ '.

Q2 :- Define quality control (QC) & Quality Assurance (QA). (5-11)

Ans :- Quality Control :-

Quality control is the attempt made to obtain desired quality of product during manufacturing. Therefore quality control is important to satisfy to customer by maintaining product quality.

→ Quality Assurance :- (Refer Q.1 in 5th definition.)

Q3 :- Define SQC. State any three SQC tools. (W-18).

Ans :- SQC :- (Refer Q.1 (6) Answer)

→ state any three SQC tools :-

1. frequency distribution charts.
 - (i) Histogram
 - (ii) Bar chart
 - (iii) polygon chart.
 - (iv) Distribution curve
2. control charts for variable \bar{X} -R chart.
3. control charts for attributes :-
 - (i) P-chart
 - (ii) 100-p chart
 - (iii) np-chart
 - (iv) C-chart.

4. Acceptance Sampling.

Q.4. Types of frequency distribution charts. Draw any one.

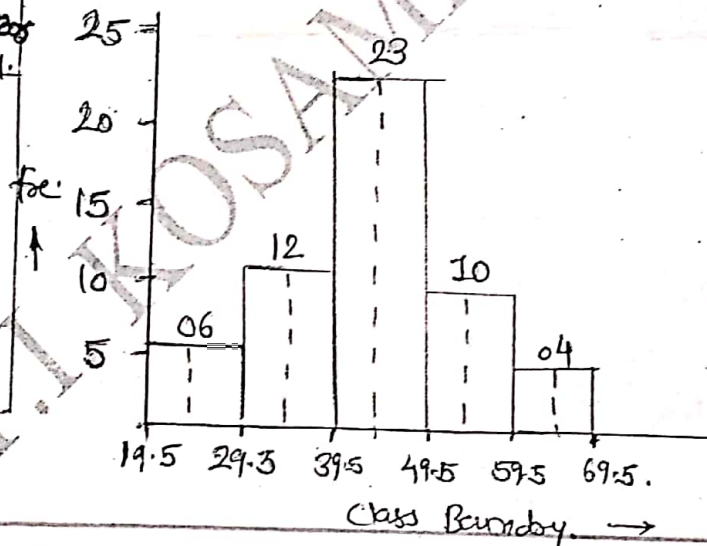
Ans: → following four charts of frequency distribution.

- (i) Frequency histogram. (ii) Frequency polygon chart
 (iii) Frequency bar chart. (iv) Frequency distribution curve.

→ Frequency Histogram :-

Histogram is way of presenting frequency distribution graphically. The height is obtained symmetrical then it indicates that the process is under control and not need to correct the process.

Class.	freq.	lower Boundary	upper Boundary.
20-29	06	19.5	29.5
30-39	12	29.5	39.5
40-49	23	39.5	49.5
50-59	10	49.5	59.5
60-69	04	59.5	69.5



Q.5. Name the types of Distribution curves and draw any one.

Ans:- There are three types of frequency distribution curves. (S-18)

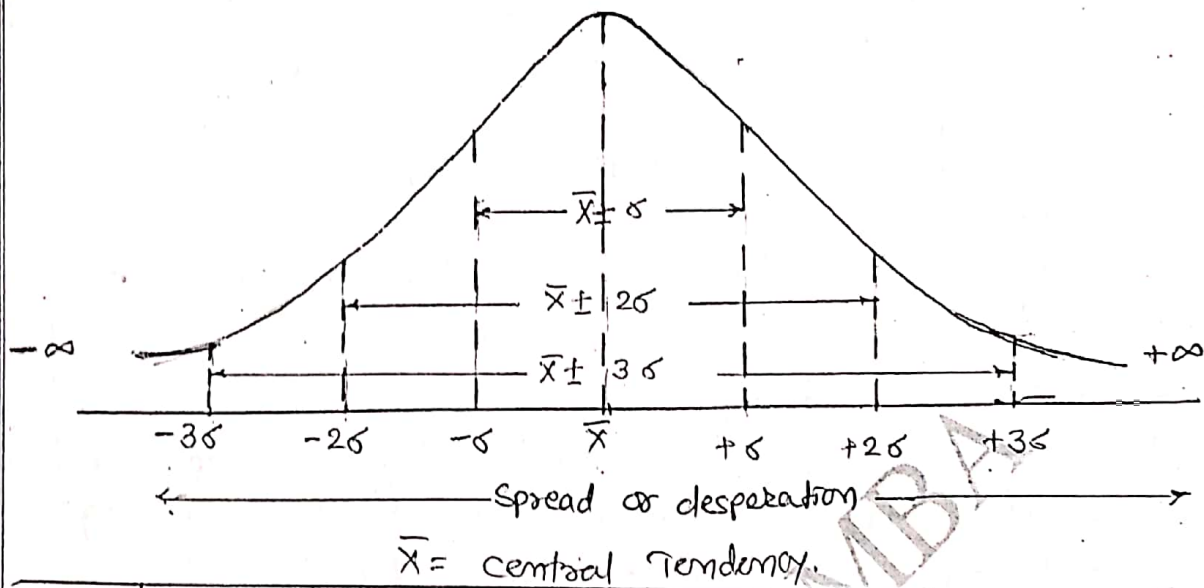
- (i) Normal distribution curve
 (ii) Binomial distribution curve
 (iii) Poisson distribution curve.

→ Normal Distribution curve :- (S-17), (W-18)

normal distribution curve shows the simplest pattern of distribution. There is generally a pattern of distribution that indicates the way in which a dimension can vary.

For measuring the areas covered under normal distribution curve the normalizing deviation is used called z-value.

$$z = \frac{X_i - \bar{x}}{\sigma} \quad \because X_i = \text{The value upto which the area is to be found}$$



Sl. No.	specification limit	percentage area under normal distribution curve.
1	$\bar{x} \pm 3\sigma$	99.73%
2	$\bar{x} \pm 2\sigma$	95.46%
3.	$\bar{x} \pm \sigma$	68.26%
4.	$\bar{x} \pm 0.6745\sigma$	50.00%
5.	$\bar{x} \pm 1.96\sigma$	95.00%

Q.6. State the types of normal distribution curves. (W-18).

Ans:- Refer Q.5. for normal distribution curve.

(i) Binomial distribution curve :-

where only two out comes are possible such as good or bad, head or tail, gain or loss, success or failure or yes or no.

Binomial distribution is used in quality control of products which can be classified as good or acceptable and bad or rejectable.

(iii) Poisson Distribution :-

It is a frequency distribution of counts of events that occur randomly during given interval of time or space. As, for example 2.5 births take place per day in a particular hospital. or 1.2 mistakes take place in a single typed sheet.

where no. of defects in particular products are calculated.

Q.7 :- Concept of probability

Ans:- Probability theory has started from the study of game of possibility. This theory applied in control charts, sampling plan and statistical techniques. The probability generally refers to totality of possible occurrence. A probability is a mathematical measure of the likelihood of an occurrence. If 'm' is the no. of times specific event occurs and 'n' is total quality likely results of the trial, the probability of occurrence of this event is m/n . 50 Green & 50 white ball in bag the pickup probability of green & white ball is $50/100$ or 0.5.

$$\therefore \text{Probability of event occurring} = \frac{A}{A+B}$$

A = event occurred.

B = event failed to occur

A+B = Total no. of event

Q.8. What is Reliability ? (5+5).

Ans:- Reliability of a product is a measure of the ability of the product to function successfully when required for a period of time in specific environment.

$$\text{Reliability } R_t = \frac{\text{no. of items working satisfactorily after time (t)}}{\text{no. of items working at the start of time (t)}}$$

Q.9: Factors affecting Reliability.

Ans- (1) product design.

(2) product technology.

(3) machinery & equipments.

(4) Environment

(5) Time period.

(6) Skill of operators

(7) Quality Control.

A.Y.D.T.I. KOSAMBA

3-4 marks. Questions.

Q.1. Difference between Quality Control & Inspection.

Ans:-	Quality Control	Inspection.
	<ol style="list-style-type: none"> 1. Inspection of product is carried out during various stages of its production, therefore inspection is a part of quality control. In quality control other activities are also involved which are other than inspection. 2. To stop the activity of producing defect product is called quality control. 3. process capacity, acceptance, sampling & control charts are used in quality control. 4. causes of defect are also found and removed it. so, defectless production can be produce. in future. 5. Responsibility shared by all the departments. 	<ol style="list-style-type: none"> 1. Inspection is a part of quality control. 2. At the various stages of production, the work of separating defective & of parts is called inspection. 3. To carry out inspection precision instruments like micrometer & vernier calipers are used. 4. Here only defective parts are separated from the ok. no other action taken. 5. Responsibility lies with the inspectors.

Q.2. List the tools of SQC & explain any one in brief (5-18) - 4 marks

Ans:- List of SQC tools - (Refer - Q.3.) &

→ frequency distribution chart for one of the tools.
(Refer - Q.4.)

Q.3. Draw & Explain normal distribution curve (W-17) (3 marks)

Ans:- (Refer - Q.5.)

Q4. Define the term reliability. Enlist factors affecting & improving reliability - (10-18) 4-marks

Ans:- Define reliability. (Refer. Q-8).

- factors affecting reliability. (Refer. Q-9)

- improving reliability by which factors as follow :-

- (i). simplification of design.
- (ii). Redundancy built into the system.
- (iii) principle of differential screening.
- (iv) principle of truncation of distribution tails.
- (v) Avoiding poor quality components.
- (vi) Principle of burn in screening.

Q5. List the factor affecting reliability (5-17) (3 marks)

Ans:- (Refer. Q-9).

Q6:- Differentiate. Reliability & Attribute charts. (Quality control) (10-17)

Ans:-

Reliability	Attribute charts. (3-marks)
<ol style="list-style-type: none"> 1. The probability of product will function satisfactorily for predecided period of time 2. Product design, quality of material production process etc. are included in reliability of product. 3. Consumer always prefer to buy reliable products and hence they go to purchase particular brand. 	<ol style="list-style-type: none"> 1. To series of effect made during production to control the quality. 2. The quality control mainly attempts to produce the product under quality. 3. The manufacturers are selling their product by producing them under quality control.

CH: 4 STATISTICAL QUALITY CONTROL

* 2-MARKS QUESTIONS

Q.1. Define (i) variable quality parameter (ii) Attribute quality parameter. (5-17).

Ans:- (i) Variable quality parameter :- It can be measured.

- Dia. of shaft, length of bolt, radius of pulley, hardness of materials, strength, density, weight & temperatures are the examples of variable quality parameter.
- To control this type of quality \bar{x} -R chart is used.
- The products are measured and based on the measurement charts are drawn
- It can be measured by measuring instruments.

(ii). Attribute quality parameter :-

- It can not be measured.
- Its quality can be said as good or bad. Surface finishing, brightness of surface, blow holes, dent, spots, colour are the examples of attribute quality parameter.
- To control this type of quality p-chart, np chart, 100p chart is used.
- It can be measured by visualization.

Q.2 Objectives of control charts for variables. (uses).

Ans:- 1). To decide whether the mfg. process is complying the specification or not.

2) To ascertain product quality.

3) To find and remove the cause of process which is not under control.

4) To decide the method for inspection.

5) To decide the product mfg is to be accepted or rejected.

6) To reduce inspection cost

7) To decide the process capability.

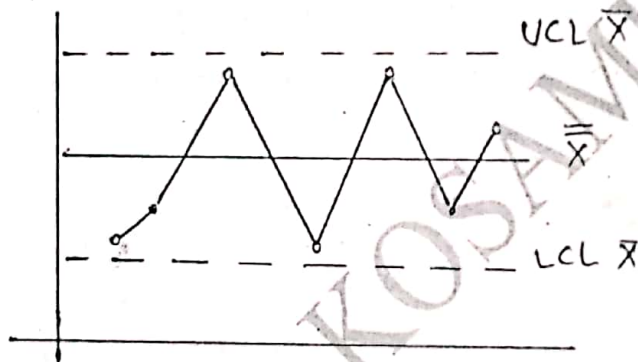
8) Which type of inspection is required decided by quality control.

Q3. TYPES of Interpretation of control chart. and Explain any two.

Ans:- TYPES :- (i) Extreme Variation. (ii) shift (iii) trend
(4) cyclic variation. (5) stratification
(6) Erratic Fluctuation.

(i). Extreme variation :- (W-17)

When the points of the graph are shifting from one control line to another. We can see some of the points also falling outside the control line.

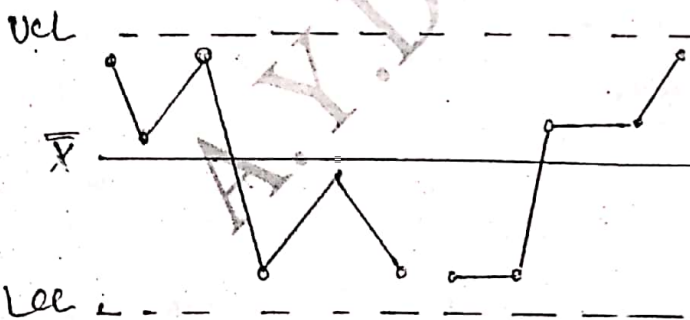


Reason

- Improper tool setting
- Just start production
- Defective material
- Work carelessly.

(ii) shift :-

In this pattern the points of the graph are shifting away from one control line and have moved towards the other.



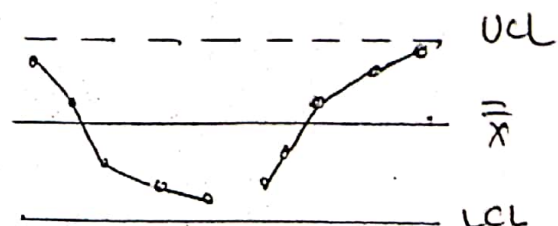
Reason :-

- Tool wear occurs.
- Worn out m/c bearing.
- Fatigue of workers.

(iii) Trend :- (S-18).

In this pattern the points are continuously moving towards upward or downward.

- causes :-
- Tool wear occurs
 - worn out bearing
 - Fatigue of workers

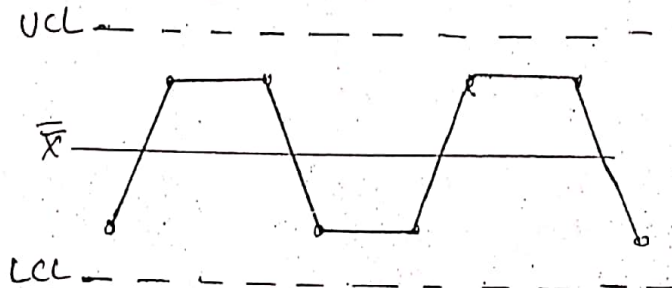


(4) Cyclic Variation :-

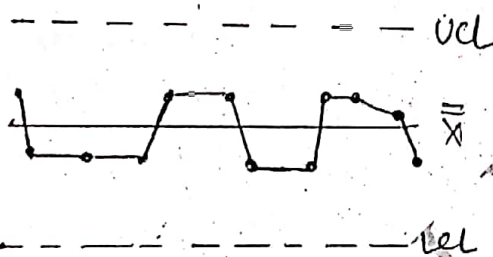
This cycle is variation is alternately moving up & down in cyclic manner.

Reason :-

- change of operator
- tool & setting loose
- defects bearing rotation.

(5) Stratification :- (S-18)

In this pattern of graph, all points looks stratified and this pattern is produce the graph nearer to centre line.

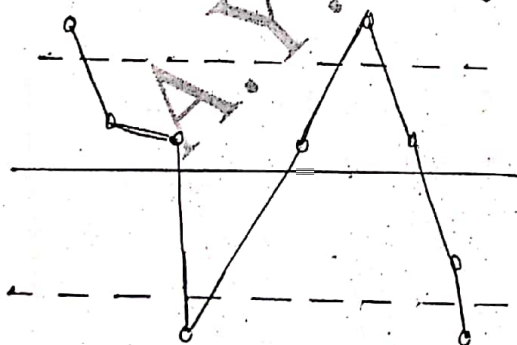


Reason :-

- Improper selection of sub group for inspection.
- Inspection can not be taken accurately upto the tolerance limit.

(6) Erratic fluctuation :- (W-17)

In this pattern the points from outside of one control limit shift abnormally to the outside the other control limit.



Reason :-

- m/c setting has been disturbed
- defect in material
- material purchase from different suppliers.

Q:4 Producer Risk :- (W-17)

Ans:- This is also called manufacturer's Risk. It is probability of rejecting a good lot which otherwise would have been accepted. When a producer submits a lot which having small percentage of defective, he feels a risk under sampling inspection of having the lot rejected on the basis of sample.

Q:5 Consumer Risk :- (S-18)

Ans:- This is also called purchaser's Risk. It is the probability of a lot being bad or even worst than the limiting quality but a good sample and thus getting accepted. It is the probability of defective batch being accepted otherwise would have been rejected.

Q:6 → Indifferent Quality level (IQL)

Ans:- when the probability of acceptance of a lot is 50%, the quality level of that lot is called IQL.

→ Lot tolerance percent defective (L.T.P.D).

It is also called limiting quality (L.Q.). LTPD is a defective level at which the lot becomes rejectable or probability of acceptance of ~~very~~ it is very less.

→ Average outgoing quality level (AOQL). :-

Between very good or very bad incoming quality the outgoing at point which the percentage of defectives in the outgoing product will reach maximum. This point is known as Average ~~and~~ outgoing quality level or limit.

3-4 marks questions :-

Q.1. Explain types of process variations.

W-17

Ans: (1) Natural variations (2) Assignable cause variations. (3 marks)

(i) Natural variations :- (Random variations)

These variations occurs in the process naturally without any specific reasons. For example, during process of turning in lathe a diameter of any shaft may be turned to 10.17 mm and another shaft may measure 10.15 mm. So, it is not possible all shaft turned to exactly 10.17 or 10.15 mm. Natural variation in the process and can be tolerated.

These variations follow the rules of S. Q. C. it is also called chance variations.

(ii) Assignable cause variations :-

These variation occurs in the process with some specific reason. For ex. a shaft is turned to 10.17 mm dia. during production. If another shaft is produced with 10.58 mm. The variation in size. due to specific reason. It may be mistake of operator or tool might not be sharpened. It should be removed.

Q.2. Explain method to draw variable quality chart.

Ans:- (1). Take random sample from production process and measure its important quality such as length, diameter it called x-variation. all such sub groups to take 4 to 5 observation. For inspection take 25 subgroup.

(2) Calculate the \bar{x} & R for all sub group. R is the difference between max. & min value of individual sub group.

(3) calculate the mean of \bar{x} & R as under

$$\bar{\bar{x}} = \frac{\sum \bar{x}}{n} ; \bar{R} = \frac{\sum R}{n}$$

(4). Calculate upper control limit.

$$UCL = \bar{\bar{x}} + 3\sigma \quad \text{OR} \quad \bar{\bar{x}} + A_2 \bar{R}$$

(5) Calculate lower control limit.

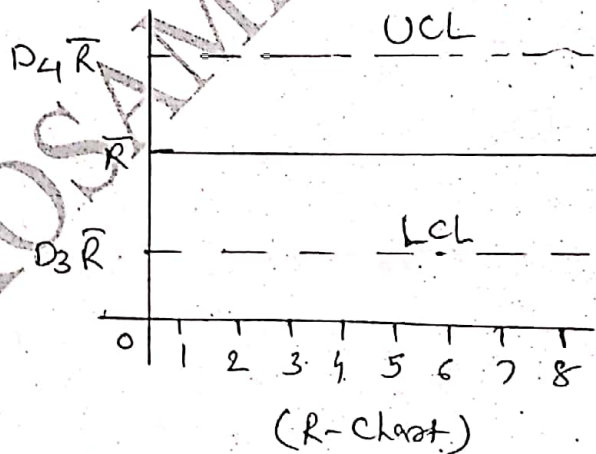
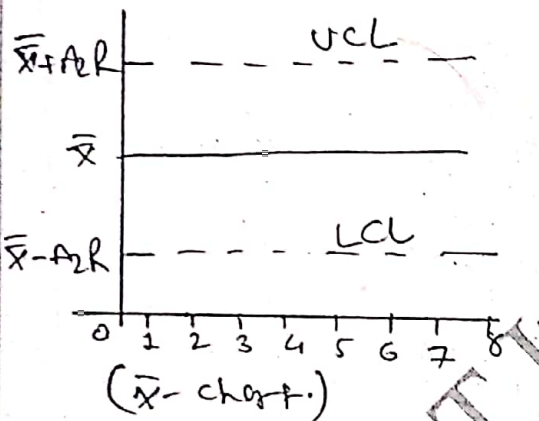
$$LCL = \bar{\bar{x}} - 3\sigma \quad \text{OR} \quad \bar{\bar{x}} - A_2 \bar{R}$$

(6) To draw control lines for R-chart.

Calculate \bar{R} of R observations then find UCL & LCL.

$$UCL = D_4 \bar{R} \quad \left(D_4 - \text{standard obtained from the table} \right)$$

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



(7) Draw the line as per mark of \bar{x} - R value which mark

(8) To find std. deviation from.

$$\sigma = \frac{\bar{R}}{d_2}$$

Q3. List various statistical quality control (SQC) tools. (5-17)

Ans:- There are various tool for SQC. (4-marks)

(i) - Variable chart :- \bar{x} -chart \bar{x} - σ chart.
R-chart

(ii) Attribute chart :- P chart, 100-P chart

NIP chart, C-chart
(iii) \bar{c} -chart. Process capability.

(iv) Acceptance sampling :- (1) single sampling (2) Double sampling

(v) operation characteristic curve (B) multiple sampling (C) sequential sampling

Q4. Differentiate between variable & Attribute quality. (10-17) (3 mark)

Ans:- (Follow. Q. 1- in 2-mark questions)

Q5. Write down advantages of variable quality control chart. (\bar{X} -R charts)

Ans:- (1) variable quality can be controlled.

(2) If any assignable cause then finding & rectified.

(3) behavior of the process can be learned.

(4) It is an effective to control quality during production.

(5) Information of change of both mean & Range can be obtain.

(6) process capability can be determined from charts.

(7) less no. of inspections are required to control quality.

Q6. Explain. \bar{X} - σ chart.

Ans:- when sample size is greater than 10 σ chart is drawn with \bar{X} -chart. In this chart, finding std. deviation (σ), and in turn std. deviation average ($\bar{\sigma}$) is calculate using formula:-

$$\bar{\sigma} = \frac{\sum \sigma}{N}$$

$\bar{\sigma}$ = Avg. std. deviation

σ = std. deviation

N = Sample no.

→ For. \bar{X} -chart :-

$$UCL_{\bar{X}} = \bar{X} + A_1 \bar{\sigma}$$

$$LCL_{\bar{X}} = \bar{X} - A_1 \bar{\sigma}$$

[∵ A_1 = constant

as per sample no. 'n']

→ for. σ -chart :-

$$UCL_{\sigma} = B_4 \bar{\sigma}$$

$$LCL_{\sigma} = B_3 \bar{\sigma}$$

[∵ B_3, B_4 = Based on

sample no. 'n']

Q7. Explain p-chart.

Ans:- Samples are taken from production and no. of faults & defects in it are counted. The size of defect is not measured. P. is defined as a ratio of number of defective units in each lot inspected to the no. of units in the lot.

$$p = \frac{\text{no. of defect product } (d)}{\text{no. of total product } (n)}$$

$$\rightarrow \text{Avg. defective fraction} = \bar{p} = \frac{\sum p}{N} \quad (N = \text{no. of sample taken})$$

$$\rightarrow \text{std. deviation } \sigma_p = \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

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

$$\rightarrow \text{Lower control limit} = LCL_p = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

Q. 8 \bar{p} chart (or) Explain percentage defective chart.

Ans:- It is called percentage defective chart. To separate the defect parts from the the sample random taken, find out the percentage defect. To calculate the Avg. percentage defect.

$$\text{chart. centre line} = 100\bar{p}$$

$$\rightarrow \text{Upper control limit} = UCL_{100p} = 100\bar{p} + 3 \cdot \sqrt{\frac{100\bar{p}(1-100\bar{p})}{n}}$$

$$\rightarrow \text{Lower control limit} = LCL_{100p} = 100\bar{p} - 3 \cdot \sqrt{\frac{100\bar{p}(1-100\bar{p})}{n}}$$

\therefore (n = sample size.)
(N = no. of samples.)

Q. 9 np chart (number of defective chart).

Ans:- In which p or percentage defective are not calculated. In this chart defects occurs in sample is controlled when sample size is constant chart drawn easily.

$$\rightarrow \text{centre line} = n\bar{p} = \frac{\sum d}{N}$$

$$\rightarrow \text{Upper control limit } UCL_{np} = n\bar{p} + 3\sqrt{np(1-n\bar{p})}$$

$$\rightarrow \text{Lower control limit } LCL_{np} = n\bar{p} - 3\sqrt{np(1-n\bar{p})}$$

Q.10 Explain c-chart and Application.

Ans:- when more than one defect is occurring in mfg. product the c-chart is drawn.

$$\rightarrow \text{Avg. defect } \bar{c} = \frac{\text{Total no. of defect}}{\text{No. of assembly inspected}}$$

$$\rightarrow UCL_c = \bar{c} + 3\sqrt{\bar{c}}$$

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

⇒ Applications:-

- (1) To control the defects occurring in motor, cars, television...
- (2) To control the defect occurring in length of wire, cloth...
- (3) To control the defect occurring in radio and TV.
- (4) To control the spot developing on painted surface.
- (5) To control defect in mica, plywood & casting.
- (6) To control defect in glass product, turbine & complex design.

Q.11 Explain concept of process capability (10-17) (4 marks)

Ans:- when all the assignable causes are removed from the process and during production only chance variations are occurring then we can say that the process is under control. The max. & min. variations occurring in such controlled process is called inherent ability.

According to statistical principles it is assumed as six times the std. deviation. Therefore process capability of any process can be calculated by formula.

$$\text{Process capability} = 6\sigma = 6 \cdot \frac{R}{d_2}$$

Process capability is the difference between the upper & lower control limits. When process is under control, then variation upto both control limits are acceptable. These variation means process capability.

Q:-12 Write short note on acceptable quality level.

Ans:- It is the highest percentage of defective in a lot which is acceptable to the purchaser. It is considered satisfactory as process average. Suppose that 3% acceptance quality level is fixed for a lot for its acceptance / rejection. It means 3% defective items of the lot is acceptable to the purchaser. It is fixed understanding between seller & purchaser. AQL is more then quality of produce is less & less no. of AQL means quality of produce is more.

Q.13 Define following terms used in sampling plan.

- Ans:-
- (1) Lot :- It is the no. of item produced for which decision of its acceptance or rejection is to be taken which denoted by 'N'.
 - (2) Sample :- no. of item or component parts drawn from the lot for purpose of inspection.
 - (3) Acceptance NO. :- It may be defined as the max. no. of defective items can be allowed in a lot for its acceptance. It denote by 'c'.
 - (4) Rejection no. :- It may be defined as the no. of defective items in a lot for its rejection. It denoted by 'r'.
 - (5) Item :- It may be defined as an object or part on which inspection is done.

Q:-14 Advantage & Disadvantage of Acceptance Sampling.

Ans:- Adv:-

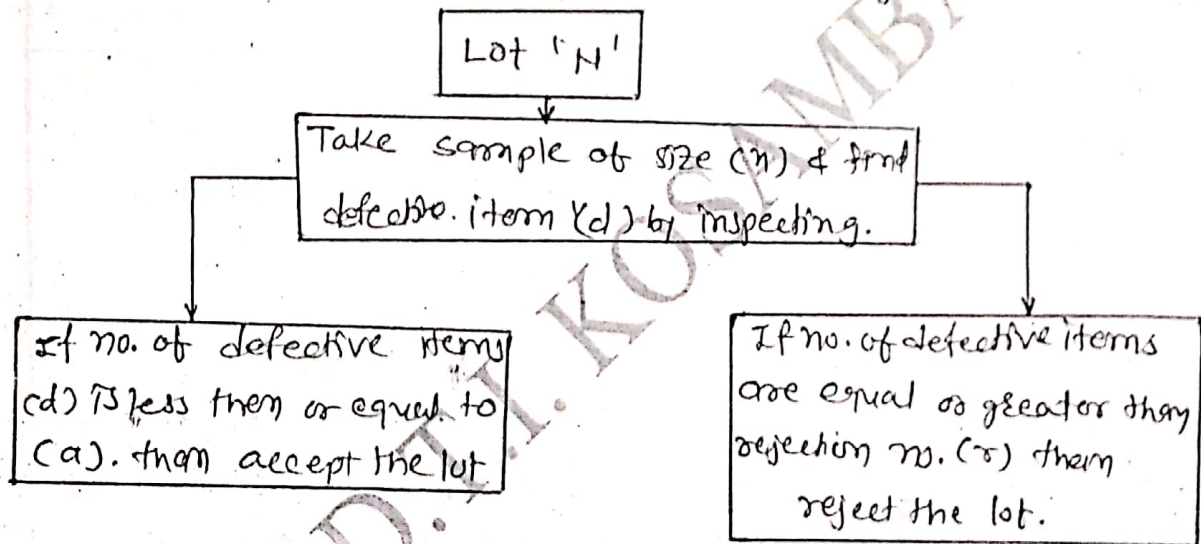
- (i) It is commonly used in those industries where there is mass production.
- (ii) It is economical and easy to understand.
- (iii) It causes less fatigue.
- (iv) The computation work involved is comparatively less.
- (v) The inspectors can be easily trained for this techniques.

→ DIV ADV :-

- (i) It does not give 100% acceptance for the confirmation of the specifications.
- (ii) Decision of acceptance or rejection is based on the sample drawn out of the lot.
- (iii) There is risk of accepting poor items & rejecting good items.

Q.15 Explain single sampling plan.

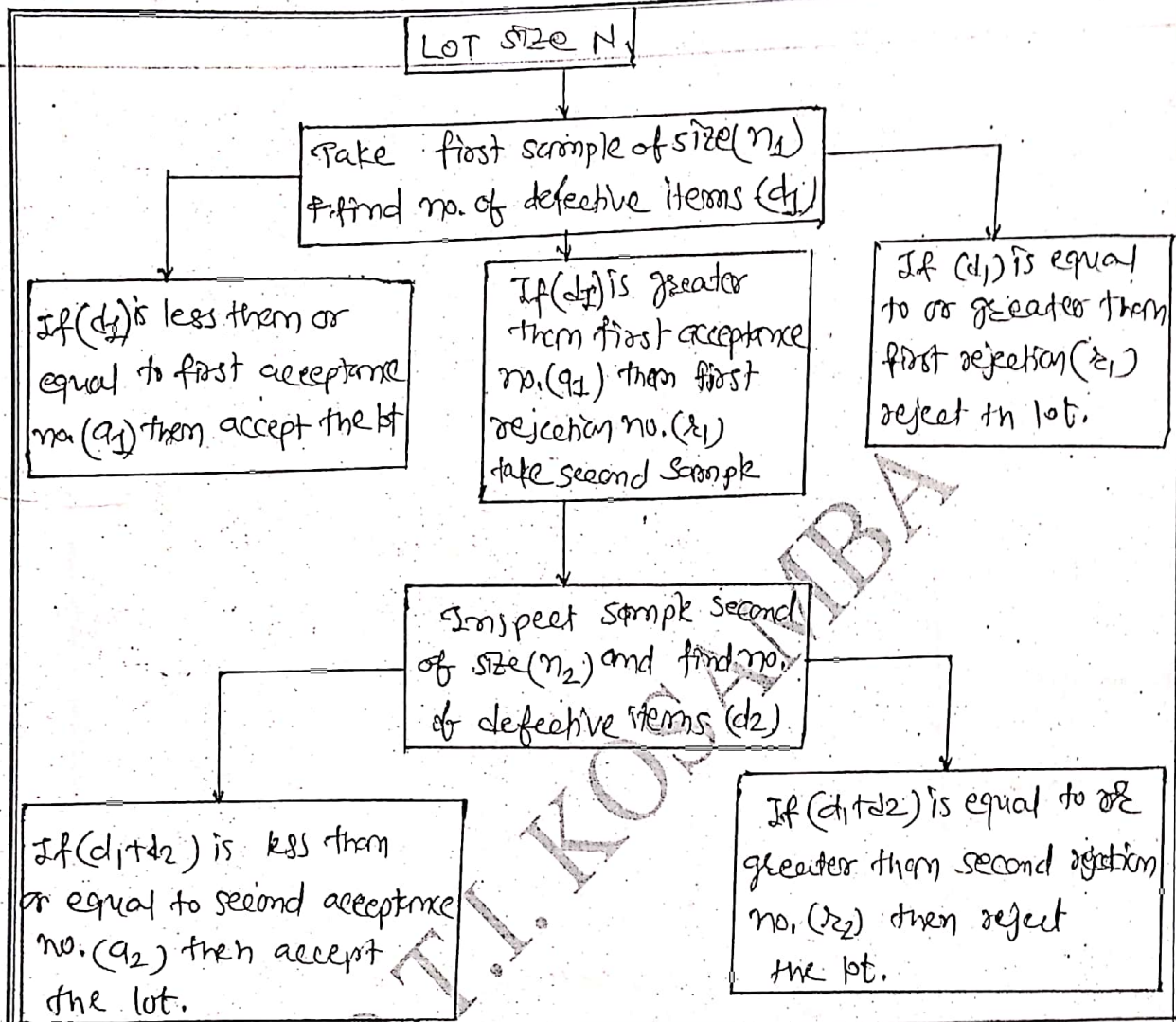
Ans:- In this plan only one sample is drawn & inspected to take decision of acceptance or rejection of the lot.



Q.16 Explain Double Sampling Plan.

Ans:- In double sampling plan decision for accepting or rejecting the lot is not taken only by inspection of one sample. When the decision is not taken by one sample, the second sample is drawn from the lot and after its inspection decision for accepting or rejecting the lot can be taken.

The process of double sampling plan is under.



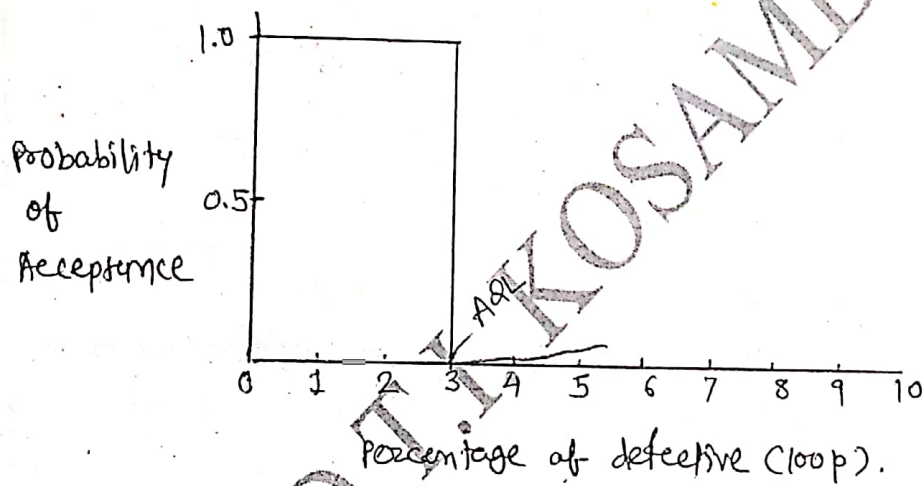
Q. 17. Difference between single sampling & Double Sampling plan.

single sampling.	Double sampling.
<p>Ans:-</p> <p>(i) As the decision for accepting or rejecting the lot is taken by inspecting only one sample</p> <p>(ii) producer does not prefer.</p> <p>(iii) more no. of sample is drawn for inspection</p> <p>(iv) This plan is less costly.</p> <p>(v) Complete information of process cannot be obtain due to the larger size of sample.</p>	<p>(i) Decision can be taken by drawing one or two samples depending upon the quality of lot</p> <p>(ii) preferable to the producer.</p> <p>(iii) Sample size is small compare to single sample plan.</p> <p>(iv) more costlier than single sample.</p> <p>(v) Due to the small size of sample complete information of process can be obtain.</p>

Q.18 :- operating characteristic curve (o.c curve)

Ans:- Sensitivity of sampling plan may be different certain sampling plan such that the decision for rejecting the lot can be obtained immediately with no. of defective items increase. The sensitivity with which such decision are obtained is called the characteristic of the sampling plan.

→ Theoretical operating characteristic curve :- (W-17)



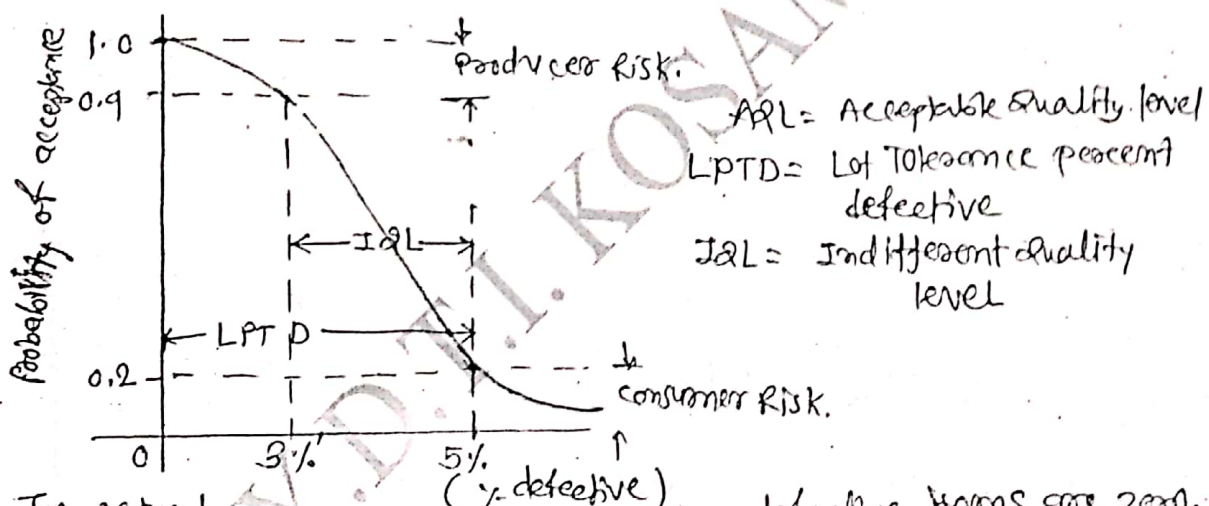
In operating characteristic curve percentage defective on x-axis and probability of acceptance on y-axis are shown. There after by increasing the percentage of defective how much probability of acceptance of lot is decreasing can be shown by drawing the curve.

suppose there are 3% defective items in a lot, then its Acceptance Quality level (AQL) will be 3%. means, 3% of defective items lot will accepted. If defective item increase beyond this, lot will become rejectable

Theoretical probability of acceptance of lot is one or 100%. The probability of acceptance must become zero immediately the defective items slightly increases the AQL.

This can be said theoretically only. At AQL = 3% the probability of acceptance is zero. This type of curve may be - on theoretical presentation,

→ Real/Practical operating characteristic curve. (at 17)



In actual characteristic curve, when defective items are zero, then the probability of acceptance of lot is one or 100%. With increase no. of defective items the probability of acceptance goes on reducing. The probability of acceptance of lot when there are 3% defective items is 0.9 or 90%. The probability of acceptance continue to reduce with the increase no. of defective items in a lot. From the curve it can be seen that 5% of defective items probability acceptance 0.2 or 20%. It means in 10 lots only 2 lots can be acceptable & lot rejected.

From the operating characteristic curve how the probability of acceptance changes with changes of defective items can be known.

Q. 19. With neat sketch briefly describe various parts of
receiving characteristic curve (W-18) (4 marks).

Ans:-
(i) Producer Risk. [Solution given in Q. 3, Q. 4,
(ii) Consumer Risk. Q. 5, Q. 6 in 2-marks questions]
(iii) L&L
(iv) R&L.
(v) LTPD.

E

A.Y.D.T.L.KOSAMBA

* CH: 5 PLANT LAYOUT & MATERIAL HANDLING *

EQUIPMENT.

2-MARKS :-

Q:1 Define plant layout :-

Ans:- The arrangement of machines, equipments, workplace and other utilities made in an industry is called plant layout.

" Plant layout is the arrangement of the machines, equipments, workplace and other facilities, established and contemplated in a way which permits the easiest flow of material at lowest cost & with minimum handling in form receipt of raw materials to despatch of the finished product "

Q:2 List various types of plant layout :- (5-17)

Ans:- There are three classical type of layouts. These days, most of plants laid out using a combination of these type. but in their pure form.

1. product layout (line type)
2. process layout (functional type).

Q:3. What is Material Handling ?

Ans:- It means to transport the material from store to production and produce material to the store and M/C parts transport to one dept. to other dept. These type of movement of material is called the Material Handling.

Q:4 Write any four name of material handling equipments (classification) (5-17)

Ans:-

* Material Handling, *

Lifting & lowering

↓ Equipment

- 1) Hand & power cranes
- 2) fixed hoist
- 3) elevators
- 4) lift
- 5) chain pulley block.

→ transportation in horizontal plane

- 1) wheel barrow
- 2) Hand cart
- 3) tractor & trailer
- 4) Tramway
- 5) skid
- 6) Con rollers

→ lifting as well horizontal transportation.

- 1) Fork lift
- 2) Crane truck
- 3) Auto truck
- 4) Gid crane
- 5) EOT crane
- 6) Gantry crane
- 7) Mono Rail.

* 3-4 mark questions *

(3 Mark)
(S-17)
(S-18)

Q.1. Differentiate between product layout & process layout.

product layout	process layout.
<ol style="list-style-type: none"> 1. layout by product correspond smooth flow of material. 2. Reduce material handling 3. less floor area is required. 4. Production planning & control easy. 5. Total production cycle time reduce 6. Same product or same sequence operation only carried out. 7. maintenance of m/c. can disturb the production process. 8. suitable for mass production of std. product. 9. Different operation are not crossed so, skill operation not required. 	<ol style="list-style-type: none"> 1. flow of material. no as smooth. 2. Expensive material handling required. 3. more floor area is required. 4. production planning & control not easy. 5. production time take more compare to product layout. 6. different products can be produced without more cost. 7. maintenance can not disturb the production process. 8. suitable for different product in less no. production. 9. Different operation are carry so, skill operator required.

Q.2 state the objectives of plant layout. (3-17) (3-mark)

Ans:- objectives:-

- (1) provide overall satisfaction and simplification.
- (2) reduce material handling.
- (3) Provide higher turn over (increase production).
- (4) Effective utilization of space.
- (5) worker convenience and job satisfaction.
- (6) labour utilisation.
- (*)

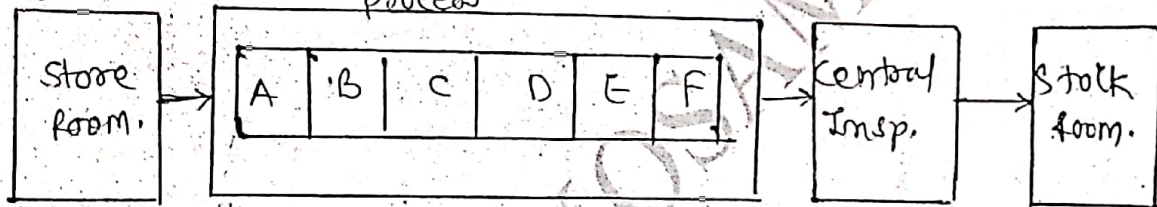
Q.3. Define the term plant layout. Enlist the principle & characteristics of good plant layout. (W-18) (4-mark)

Ans:- plant layout :- (Refer-Q-1 in 2 marks)
 Principle & characteristics :- (Refer-Q.2 in 3-marks)

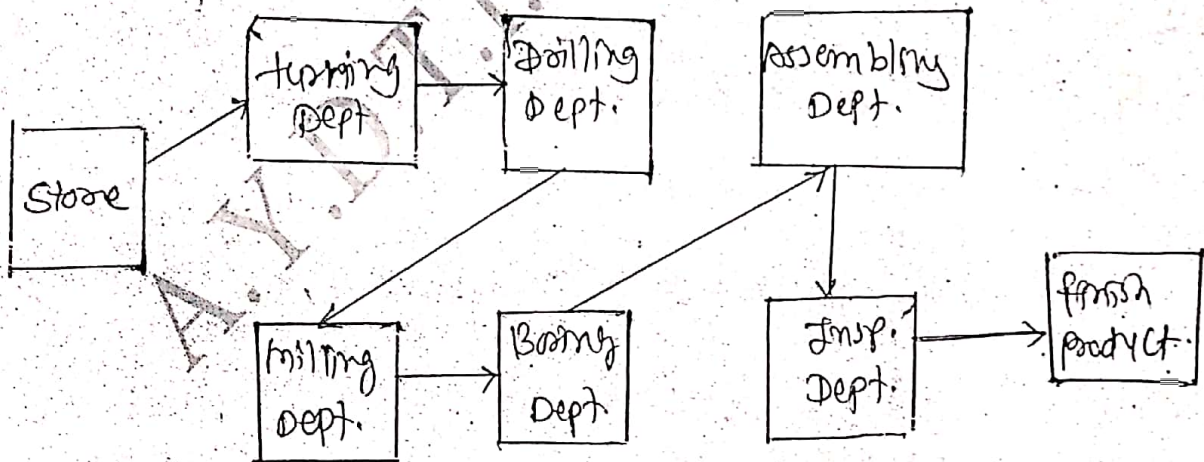
Q.4 Define the plant layout. state the type of plant layout discuss. briefly any one with neat sketch. Advantage & limitation (W-18) (4-mark)

Ans:- plant layout :- (Refer-Q-1 in 2 marks) (Pg.No. 54)
 types of plant layout :- (Q.2 in 2 marks) (Pg.No. 54)
 Adv - limitation (Q.1 in 3-marks). (Pg.No. 55)

product layout :-



process layout :-



Q.5. state the at least two application of (i) fork lift.

(ii) overhead crane (3) belt conveyor (iv) winch. (W-17) (4mark)

Ans:- use:- (i) fork lift :-

- For indoor transportation upto a short distance of 40 to 70 meter
- It can lift the material upto required height so used for stacking.

(2). overhead crane :-

- It can lift & lowering boxes with materials.
- It is used in automobile production.
- Rectangular space. overhead crane use circular space used jib crane.

(3). Belt conveyor :-

- To transport material in horizontal & inclined direction.
- Continuous flow of transportation materials.
- Fixed location provide transport.
- Pipe conveyor used piece of powdered material.

(4). Winch :-

- Lifting & lowering the equipments and stacking material as per requirement.

A.Y.D.T.I. KOSAMBA

CH: 6 MODERN TRENDS IN INDUSTRIAL ENGG.

→ 2-MARKS Questions :-

Q.1 List of emerging trends in Industrial Engg.

Ans:- 1. Various standards like ISO-9001-2008 & other 9000 series.
 2. Six sigma quality.
 3. Total Quality Control & Total Quality Management (TQC/TQM)
 4. Kaizen
 5. Re-engineering
 6. Just in time (JIT)
 7. Zero defect. (ZD).

Q.2. What is means of ISO Give family series of standards.

Ans:- ISO means International organization for standardization
 It is voluntary & non-governmental organization of
 163 members situated at Geneva Switzerland to design
 & develop international std. for industries and business.
 B.I.S. is a representative as an Indian member in ISO.

→ ISO series :-

1. ISO 9000-1987 :- It specify basic terminology & definition of quality management system in 1987.
2. ISO 9001-2000
3. ISO 9001-2008 - Revise of 2000.
4. ISO 9004.
5. ISO 14000 - for Environment Management Standard.

Q.3. Explain in brief Total Quality Management. (TQM) (S-17)

Ans:- The compilation of the management activities and (S-18) processes to obtain continuous better quality of product is called TQM.

The main objective is to satisfy the customers. To survive in the competitive market total quality is very much necessary.

→ The four basic elements of obtaining total quality are :-

- | | | |
|-----------|---------------|----------------------------|
| ① process | ③ system | } pillars of TQM
(W-18) |
| ② people | ④ Management. | |

Q.4. What is kaizen? (5-18).

Ans:- Kaizen is a Japanese technique of improving production quality of industries. In this method slow, steady but firm improvements in processes of industries and commerce are introduced & maintained. Management, supervisors, workers are simultaneously involved.

Q.5. Define kaizen & re-engineering. (10-18).

Ans:- → kaizen :- (As per above eqn. Question)

→ Re-engineering :- To create re-design having complete and basic changes in prevailing design of product for all the business activities for getting basic changes, the technique used is called re-engineering.

⇒ 3-4 marks questions :-

Q.1. Briefly explain role of ISO. (5-17) - 4 marks ^{Important} of ISO.

Ans:- (1) To develop various types of std. acceptable to all countries.

(2) To make committees in ISO which responsible to develop, publishing & revising standard.

(3) When activities of business & industries are expanding & diversifying the ISO are very useful, role in it.

(4) ISO are very useful to face international competition in the business.

(5) ISO very important because they make industries scientific as well as systematic.

(6) It is very useful to improve the quality of processes.

Q.2. Use of I.S.O standard.

Ans:- (1) ISO standards are useful as marketing tool.

(2) Name of standard on their noticeboard, letterpad, packing.

(3) For obtaining large orders from international companies.

(4) ISO standards are useful to create confidence in customers.

⑤ It standards are used for TQM. requirements.

Q.3. Explain six sigma. (6σ) concept (3 marks)

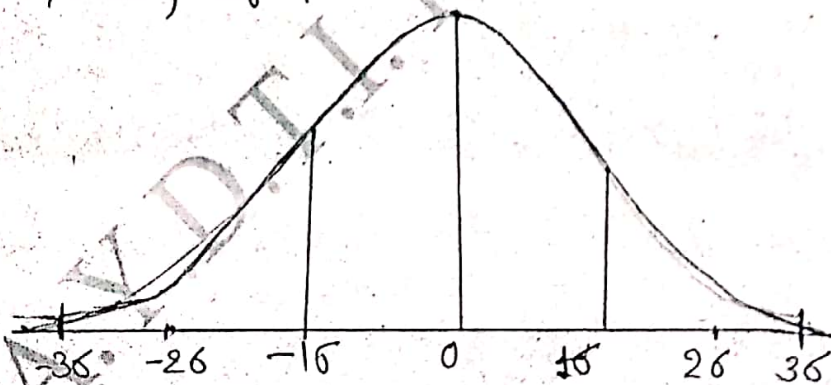
Ans! - Six sigma is a methodology present activities / processes in industries can be improved and productivity can be increased six sigma finds defects in the processes and eliminate them.

→ It uses quality management system & statistical methods to remove defect occurring in the industrial process.

→ It is follow the TQM.

→ 6σ ^{corrected} _{produced} the product 99.99% defect free

Principle :- The concept of six sigma is based on the statistical principle of normal distribution. It shows n on the both sides of mean. Area under this curve, covers all the variation & all probability. e.g. 99.99%. So, the quality of product get good this is 6σ concept.



Q4! Model of six-sigma (6σ) :- (procedure)

Ans! - (1) Define :- customer requirement clearly defined.

(2) Measure :- Measure exist data, make database.

(3) Analyse :- All factors affecting the quality & needs of customers are analyzed.

(4) Improve :- Make improvement in process based on analysis of informations and prepare std. procedure.

(5) Control :- Install new process & control it.

Q.5 Explain the importance of ISO 9000. (3-18) 3 marks

Ans:- (Q.1- in 3 marks) (Pg. no.: 59)

Q.6 Write shortnote on ISO 9001 series. (W-17) 4 marks

Ans:- International organization for standardisation one known as ISO 9000 series.

- 1) ISO-9000-1987 :- It is a standard which specify basic terminology & definitions of quality management system in 1987.
- 2) ISO 9001-2000 :- It is a quality management standard which basically specifies the requirement that any industry or business have to meet.
- 3) ISO 9001-2008 :- This standard is almost same as ISO 9001-2000 it is devised to expand some requirements of quality management system.
- 4) ISO 14000 :- Related to Environment management standards.

Q.7. Write shortnote on ISO 9001. (W-18) (4 marks).

Ans:- [Q: 2 in 2-mark & Q: 1 & Q: 2 in 3-4 marks]

Q.8 Explain in brief TQM. (3-Marks) (3-18).

Ans:- (Refer from Q-3 in 2-mark Questions)

→ need of TQM:-

- 1) To discharge responsibility of maintaining product quality
- 2) The awareness of consumers for higher quality.
- 3) To survive in national & international markets.
- 4) The increased number of production processes.
- 5) To produce complex shape products.
- 6) To make group efforts for obtaining product quality successful.

→ objective of TQM:-

- 1) To maintain quality of product.
- 2) To improve the work environment.
- 3) To implement full proof quality system to make process defectless.
- 4) To plan the incentive scheme for employee.
- 5) To include efforts of staff, suppliers, distributors.
- 6) To manufacture quality products and at the same time to reduce the cost of production.

Q.9. Explain concept of kaizen and its applications (W-17) 4 marks

Ans:- Definition of kaizen (Q.4 - in - 2 marks)

- kaizen does not make 100% improvement or radical improvement.
- kaizen considers workers as an best. capital, instead of industrial properties.
- The statistical analysis is carried for the improvement in process or production.
- The aim is not to obtain radical improvement, the cost of improvement is comparatively less.

Application :-

- 1) To reduce wastage.
- 2) stable improvement of product.
- 3) To provide delivery of product timely.
- 4) To manage record statistically.

Q.10. Write the short note on Re-engineering (S-18) (4 marks)

Ans:- To create re-design having complete and basic changes in prevailing design of product for all the business activities for getting basic changes, the technique used called re-engineering.

The production process, work of operator, management system, old belief, systems & organisation

Structures are changed by re-engineering. The main tool of the re-engineering is to effect changes with open mind. Therefore, re-engineering is called Creative activity.

⇒ Basic steps of re-engineering :-

1. To define the objectives for changes
2. To analyse the production process
3. To find out alternative & speedy process
4. To implement newly found process.
5. To speed up production work.

Q-11 :- Zero defect (ZD).

Ans:- The approach of zero defect is such that worker willingly join in quality control.

The approach of this system is to motivate the worker for gaining success of zero defect

→ Step of this system :-

- 1) worker finds the defects during production & remove the defects.
- 2) worker accept the challenge of his work.
- 3) worker inspect the product with care.
- 4) workers are getting better motivations.
 - workers tries to work without any defect. He remain active for obtaining higher standards of quality & performance.
 - The communication between the worker and supervisor will be open minded in this system.
 - worker is given responsibility of maintaining quality personally, so he immediately inform the situations beyond his control to the supervisor to take action for improvement.

- Every body can give reasons & remedies for the defects.
- To give the self inspect the quality of work. and give the responsibility for the quality.
- He is trained for care to be exercised by him in controlling the quality of product.
- Workers are motivated to work with zero defect by giving them certificate and award.

Q.12 State the concept of JIT. (10-18) (3-marks)

Ans: Just in time is abbreviated & known as JIT.

It is linked with inventory control. According to JIT, for production keeping inventory of material & components, they are purchased & when needed for production so that inventory capital investment does not required. and arrangement for storage also not required. Due to that cost of production can be reduced.

- The success of this method is based on the suppliers of material & components.
- If suppliers are prompt & reliable then & then this method can succeed

⇒ Objectives of JIT. (or) factors affecting :-

- 1) Make economical product design.
- 2) To reduce inventory cost.
- 3) To make continuous efforts of improving quality.
- 4) To reduce paper work
- 5) To easy flow of material by the simple plant layout.
- 6) To arrange the Suppliers should supply material & components when demanded.

Q.13. State the concept of Ergonomics. State its objectives and applications. (3-marks) (W-18), (S-17)

Ans:- The science of ergonomics helps to study the effects on health & safety of working environment.

- The workers interest in the job is depending on the comfortable and safe work place. Therefore, the science called ergonomics deals with the man and working environment relationship.

- Ergonomics may also be defined as the study of human ability and characteristics, which effect the design of equipment, Job & process.

- Worker get physical and mental strain while doing the work are the factors taken care of by ergonomics.

→ OBJECTIVES :-

1. To improve human well being and overall performance of mfg. system.
2. To increase the productivity, by satisfaction of worker.
3. Ergonomic tries to reduce illness, risk & injury.
4. To improve machine specification, when required for future.
5. To improve man - m/c relationship.

→ APPLICATION :-

1. To develop lighting, climate & noise level, for comfort work place.
2. To reduce the movement, by improving postures of workers.
3. To provide lever & controls for making its handling easier.
4. To achieve higher productivity.
5. To provide more human comfort & reduce fatigue to worker.
6. To achieve better design of machine.
7. To increase safety of worker & reduce accident.
8. To reduce labour turnover.

Q.14 Explain Anthropometry.

- Ans:- It is the branch of ergonomics that deals with body shape & size. It studies the measurement of physical features & functions of the human body, including linear dimensions, weight, height, volume, range of movement etc.
- Almost all the time during the day we use one or the other physical facilities like chairs, tables, desks, pen machine, car, etc.
 - Anthropometry data is useful in designing the work stations to the operator's dimensions.
 - The measurement of body members falls into two classes.
 - (i) structural dimensions (2) functional dimensions.

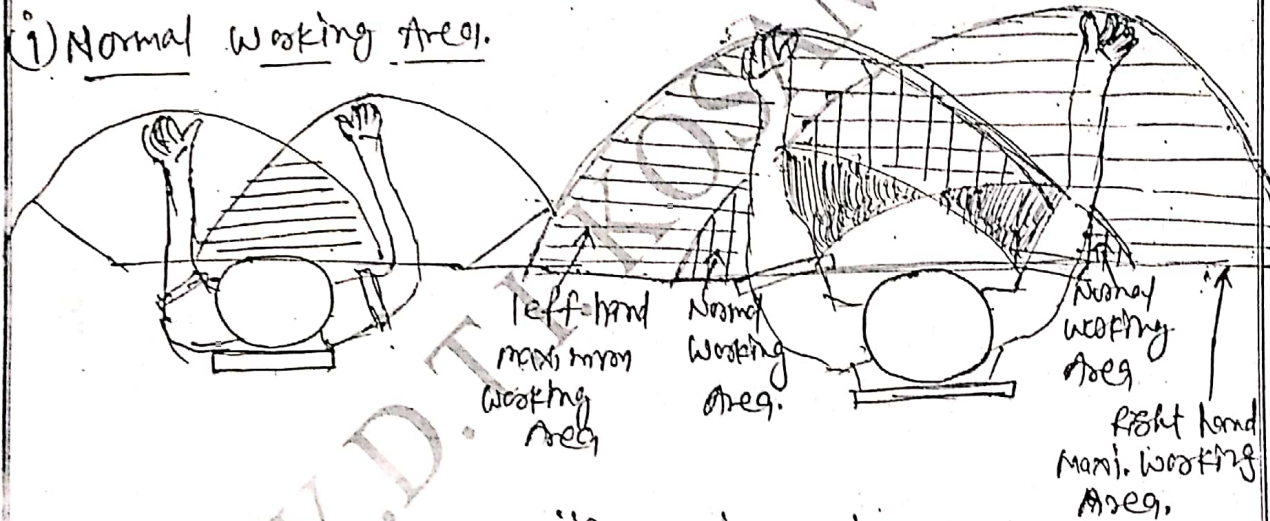
Q.15. Explain in brief "normal & maximum work area" (W-17) (4 marks)

- Ans:- When the worker has to work on components placed on work bench or machine then arrangement of components is very important.
- The movement of material & worker this design is done.
 - The area in which these movements occurs is called "working area."
 - It reduces ineffective time and make process effective.
 - Normal working area.
 - Maximum working area.
- (i) Normal working area:- In this area the movement of hand upto elbow is taken consideration. In this area operator can work easily. In which fingers, wrist & elbow of hand are working.
- One shaded portion of the normal working area is maximum facilitated area.
- (ii) Maximum working area:- In this area the movement of hands upto shoulders is considered. By rotating

full length of hands, the area in which hands are working is called maximum working area while carrying out assembly work, the equipments which are used less are arranged in this area.

→ "As per anthropometry, the area designed for working place by considering dimensions of hand upto elbow & shoulder the work can be done at less accidents, less efforts, less fatigue and within less time quality work can be done"

(i) Normal working Area.



(ii) Maxi. working Area

Q.6 Draw neat sketch showing normal & maximum work Area. (5-17) (3-mark).

Ans:- [show answer in - Q-15]

CH: 2 WORK STUDY.

Examples Based on Standard Time. #
Calculation

→ Formulas for calculating Standard Time :-

1. Basic Time :- $\text{observed time} \times \frac{\text{observed rating}}{\text{Standard Rating}} = (100)$

2. Work content :- $\text{Basic Time} + \text{Relaxation Allowance} + \text{Incidental Allowance}$

3. Standard Time :- $\text{work content} + \text{other allowance.}$

[2-3 marks]

Ex:-1 The Avg. observed element time = 12 min Avg
observed rating = 90%. Total Allowance = 10%.
Find standard time. (S-17).

Ans: (1) Find Basic Time = $\text{observed time} \times \frac{\text{observed rating}}{\text{Std. Rating.}}$

$$= 12 \times \frac{90}{100}$$

$$\text{Basic Time} = \underline{10.8 \text{ min.}}$$

(2) Work content = $\text{Basic Time} + \text{Total Allowances}$

$$= 10.8 + \left(\frac{10}{100} \times 10.8 \right).$$

$$\text{Work content} = \underline{11.88 \text{ min.}}$$

(3) Std. Time = $\text{work content} + \text{all Allowances so,}$

$$\text{Std Time} = \text{work content} + \text{other allowance}$$

$$= 11.88 + (0).$$

$$\text{Std. Time} = \underline{11.88 \text{ min.}}$$

Ex:2 observed time 20 min rating factor is 1, contingency allowances are 5%. find standard time (S-T).

Ans:- observed time = 20 min.

$$\text{rating factor} = \frac{\text{observed rating}}{\text{std. rating}} = 1.$$

$$\therefore \rightarrow \text{Basic Time} = \text{observed Time} \times \frac{\text{observed rating}}{\text{Standard rating}}$$

$$= 20 \text{ min} \times (1).$$

$$\underline{\text{Basic Time.}} = \underline{20 \text{ min.}}$$

$$\rightarrow \text{work content} = \text{Basic Time} + \text{Allowance.}$$

$$= 20 \text{ min} + \left(20 + \frac{5}{100} \right)$$

$$\underline{\text{work content}} = \underline{21 \text{ min.}}$$

$$\Rightarrow \text{Standard time} = \text{w. c} + \text{other allowance.}$$

there is no. other allowances given so,

$$\underline{\text{Standard Time}} \Rightarrow \underline{\text{work content}} = \underline{21 \text{ min.}} \text{ Ans.}$$

Ex:3 production rate needs to be 12 units an hour. The allowances assigned are 25%. If rating given is 80% for the activity find time recorded for the operator by ^{after} (W-T)

Ans:- Allowance :- 25% ; rating = 80%

$$\text{Unit Rate :- } \frac{12 \text{ hr.}}{\text{hr}} = \frac{12}{60 \text{ min}} \Rightarrow 12 \text{ nos for } 60 \text{ min.}$$

$$\rightarrow \text{std Time for 1 piece} = \frac{60 \times 1}{12} = \underline{5 \text{ min. (Std Time)}}.$$

$$\rightarrow \text{Std Time} = \text{Basic Time} + \text{Allowance.}$$

$$= \text{B.T} + \left(\text{B.T} \times \frac{25}{100} \right)$$

$$5.0 \text{ min} = \text{B.T} \left(1 + \frac{25}{100} \right)$$

$$\therefore \text{B.T.} = \frac{50}{1.25} = \underline{4 \text{ min (Basic Time)}}$$

$$\rightarrow \text{Basic Time} = \text{Observed time} + \left(\frac{\text{observed rating}}{\text{Std. rating}} \right)$$

$$4 \text{ min.} = \text{Observed time} + \left(\frac{80}{100} \right)$$

$$\therefore \text{observed time} = 4 - 0.8$$

$$\therefore \text{observed time by rating} = \underline{3.2 \text{ min.}} \text{ Ans.}$$

EX-4 The standard. per piece is 1.5 min. the output of factory is 300 per shift of 8 hours. find the productivity (8 HRS) (W-17)

$$\rightarrow \text{std. time} = 1.5 \text{ min.}$$

$$\text{shift time} = 8 \text{ HRS} \Rightarrow 8 \times 60 = 480 \text{ min.}$$

$$\text{Productivity} = \frac{480}{1.5} = 320.$$

(4-Marks)

EX-5 Calculate std time from following data for one cycle.
 loading time: 2 min, machining time: 6 min, unloading time = 1 min, inspection time: 2 min, overall rating of cycle = 95%, overall allowance = 12% of Basic time. Also find production per hour. (W-17)

$$\text{Ans!} \rightarrow \text{Observed time} = \text{loading time} + \text{Machining time} + \text{unloading time} + \text{Inspection time.}$$

$$= 2 + 6 + 1 + 2 = 11 \text{ min.}$$

$$\rightarrow \text{basic time} = \text{observed time} \times \frac{\text{observed rating}}{\text{std. rating}}$$

$$= 11 \times \frac{95}{100}$$

$$\text{basic Time} = \underline{10.45 \text{ min.}}$$

$$\rightarrow \text{Std. Time} = \text{basic time} + \text{Allowance.}$$

$$= 10.45 + \left(10.45 \times \frac{12}{100} \right)$$

$$= \underline{11.70 \text{ min.}} \text{ for one piece.}$$

$$\rightarrow \text{for one Hour} = 60 \text{ min} = 60 / 11.70 = 5.12 \approx \underline{5 \text{ piece per hr.}}$$

Ex:6 Calculate standard time from following data as per work Sampling. (1) output per shift (8HR) = 200 pieces (2) Production time (as per work sampling) = 80%. Rating, Rating 110% overall allowance = 20%. (W-17). (4 MARKS)

Ans:-

$$\rightarrow \text{Production time} = 8 \times 60 \times 0.8 = 384 \text{ min.}$$

$$\rightarrow \text{Unit time} = \frac{384}{200} = 1.92 \text{ min.}$$

$$\rightarrow \text{Basic time} = \text{observed time} \times \frac{\text{Rating}}{\text{Std Rating}}$$

$$= 1.92 \times \frac{110}{100}$$

$$\text{B.T.} = 2.112 \text{ min.}$$

$$\rightarrow \text{Standard Time} = \text{Basic Time} + \text{Allowance.}$$

$$= 2.112 + \left(2.112 \times \frac{20}{100} \right)$$

$$\text{std. Time.} = 2.534 \text{ min.}$$

CH:3. QUALITY ASSURANCE.

• Examples •

Ex:- Example based on simple statistical.

(1) Find the "median" for the following observation (W-17)
6, 13, 11, 9, 10, 5, 3, 1, 7

Ans:- Arrange the record data in ascending orders.

1, 3, 5, 6, 7, 9, 10, 11, 13

→ The middle observation shows median = 7 Ans.

(2) The observation are 4, 8, 2, 3, 4, 9, 8, 6 find mean, mode & median. (S-18).

Ans:- → Mean :- $\frac{4+8+2+3+4+9+8+6}{8} = 5.5$ Ans.

→ mode :-

observation	frequency.
2	1
3	1
<u>4</u>	<u>2</u>
6	1
<u>8</u>	<u>2</u>
9	1

Here, 4, 8 observation is more than other observation so, we find mode value is 4 & 8 Ans.

→ Median :- Rewrite the observation as ascending orders
2, 3, 4, 4, 6, 8, 8, 9

Ans:- 4, & 6 - observation is median of observation.

(3) Find the median & mode for Reading (W-18).
35, 39, 33, 36, 34, 35, 37, 36.

[follow the step as per above example no. 2]

(4) calculate mean, mode, median and spread for observations 7, 8, 4, 3, 6, 9, 4, 5 (5-17) 4-marks

Ans: (i) Mean :- $\bar{x} = \frac{\sum x}{n}$
 $= \bar{x} = \frac{7+8+4+3+6+9+4+5}{8} = \frac{46}{8} = 5.75$ Ans.

(ii) Median :- arrange observation in ascending order.

So, 3, 4, 4, 5, 6, 7, 8, 9

Median = $\frac{5+6}{2} = \frac{11}{2} = 5.5$ Ans.

(iii) Mode :- observation frequency.

3	1
<u>4</u>	<u>2</u>
5	1
6	1
7	1
8	1
9	1

Out of 8 observation, observation 4 is 2 times
 Hence Mode = 4 Ans.

(iv) Spread for observation (Range) :-

7, 8, 4, 3, 6, 9, 4, 5.

Range = Maxi value - Min value
 $= 9 - 3$
 $= 6$ Ans.

Examples:- (Based on Standard Deviation.)

Ex-1 Find the standard deviation of the following observations.

5, 8, 9, 13, 14, 3, 5, 15.

Ans:- (I) Find: $\bar{x} = \frac{\sum x}{n} = \frac{5+8+9+13+14+3+5+15}{8} = \frac{72}{8} = 9$

($\because n=8$.)

(II) Standard deviation (σ) = $\sqrt{\frac{\sum (x_i - \bar{x})^2}{n}}$

$(x_1 - \bar{x})^2 = (5-9)^2 = 16$

$(x_2 - \bar{x})^2 = (8-9)^2 = 1$

$(x_3 - \bar{x})^2 = (9-9)^2 = 0$

$(x_4 - \bar{x})^2 = (13-9)^2 = 16$

$(x_5 - \bar{x})^2 = (14-9)^2 = 25$

$(x_6 - \bar{x})^2 = (3-9)^2 = 36$

$(x_7 - \bar{x})^2 = (5-9)^2 = 16$

$(x_8 - \bar{x})^2 = (15-9)^2 = 36$

$\Rightarrow \sigma = \sqrt{\frac{(x_1 - \bar{x})^2 + \dots + (x_8 - \bar{x})^2}{n}}$

$= \sqrt{\frac{(16) + (1) + 0 + (16) + (25) + (36) + (16) + (36)}{8}}$

$\sigma = 4.27$ Ans.

Ex:2 Method of finding std. deviation (σ) when cell is given.

- find mean and std. deviation from given data. (5-18)

class	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40
frequency	5	10	14	22	13	10	5	3

Ans:

class.	(f) Frequency.	class mid point. (x)	deviation (d)	f. d.	fd^2
1-5	5	3.0	-3	-15	45
6-10	10	8.0	-2	-20	40
11-15	14	13.0	-1	-14	14
16-20	22	18.0	0	0	0
21-25	13	23.0	1	13	13
26-30	10	28.0	2	20	40
31-35	5	33.0	3	15	45
36-40	3	38.0	4	12	48
	$\Sigma f = 82$			$\Sigma fd = 11$	$\Sigma fd^2 = 245$

(i) mean $\bar{X} = (x_d \text{ or } \beta) + \frac{i \Sigma f \cdot d}{n} \rightarrow \begin{cases} x_d = 18 \Rightarrow \text{'0' indicate} \\ i = 8 - 3 \Rightarrow \text{5 class interval} \\ n = \Sigma f \Rightarrow \text{Total frequency} \end{cases}$

$$= 18 + \frac{(5)(11)}{82}$$

$$\bar{X} = 18.67 \text{ Ans.}$$

(ii). Standard deviation (σ) = $i \sqrt{\frac{\Sigma fd^2}{n} - \left(\frac{\Sigma f \cdot d}{n}\right)^2}$

$$= 5 \sqrt{\frac{245}{82} - \left(\frac{11}{82}\right)^2}$$

$$\sigma = 8.61 \text{ Ans.}$$

Also find. \bar{X} (mean) = $\frac{\Sigma f_i x_i}{n} = \frac{1531}{82} = 18.67 \text{ Ans.}$

Ex: 8 Calculate median + std. deviation for given frequency distribution. (W-18)

class	0-10	10-20	20-30	30-40	40-50
frequency	13	7	8	12	10

Ans:-

class	freq. (f)	Mid point (x)	Deviation (d)	f.d	f.d ²
0-10	13	5	-2	-26	6788.52
10-20	7	15	-1	-7	343.7
20-30	8	25	0	0	0
30-40	12	35	1	12	12
40-50	10	45	2	20	40
	$\Sigma f = 50$			$\Sigma f.d = -1$	$\Sigma f.d^2 = 111$

(i) Median = $L_m + \left[\frac{N/2 - C_{fm}}{f_m} \right] i$ → L_m = lower boundary of median class.
 → $N/2 = \frac{\Sigma f}{2} = 25$
 → $C_{fm} = 13 + 7 = 20$ from median
 → L = class interval = 10.
 → f_m = median freq. = 8

$$= 19.5 + \left[\frac{25 - 20}{8} \right] 10$$

$$\text{Median} = 25.75.$$

(ii) Std. Deviation = $(\sigma) = i \sqrt{\frac{\Sigma f.d^2}{n} - \left(\frac{\Sigma f.d}{n} \right)^2}$

i = 10 - class interval
 $n = \Sigma f = 50$

$$= 10 \sqrt{\frac{111}{50} - \left(\frac{-1}{50} \right)^2}$$

$$\sigma = 14.89 \text{ Ans.}$$

Extra ⇒ for mode :-

$$\text{Mode} = L + \left[\frac{f_2}{f_1 + f_2} \right] i$$

$$= 19.5 + \left[\frac{12}{7 + 12} \right] 10$$

$$\text{Mode} = 25.81.$$

→ f_1 = freq. of class before median.
 = 7.

→ f_2 = freq. of class after median.
 = 12

→ L = lower boundary = $20 - 0.5 = 19.5$

→ i = class interval = 10.

Ex: 4 To find the std. deviation of following observations of 500 nos. of hardness. and mean value also.

Hardness. No.	No. of pieces.
290 - 294	17
295 - 299	86
300 - 304	240
305 - 309	104
310 - 314	43
315 - 319.	10.

Ans:- [Solve example - as. per. Ex-2.] $\bar{X} = 303.0$
 $\sigma =$ } Ans

Ex: 5 Hardness of 500 products is shown in table. given below calculate the mean & std. deviation. for these product.

Hardness	frequency (f)
250 - 254	20
255 - 259	135
260 - 264	175
265 - 269	155
270 - 274.	15.

Ans: [Solve as per above prob. no. Ex. 2] $\bar{X} = 262.1$
 $\sigma = 4.6357$ } Ans.

* Examples of Normal Distribution Curve.

EX:-6 The Mean value of marks in Engg. mechanics subject of Oct-2001 is 68.5 and std. deviation is 4.25. If 200 students were appeared in that examination then how many student have scored marks between 60 to 70 percent?

Soln:- $\bar{X} = 68.5$, $\sigma = 4.25$ $X_1 = 60$ & $X_2 = 70$.

(1.) $X_1 = 60$.

$$Z = \frac{X_1 - \bar{X}}{\sigma} = \frac{60 - 68.5}{4.25} = -2.00.$$

From Standard Table for $Z = -2.00$ area under normal distribution curve $A_1 = 0.4772$.

(2) for $X_2 = 70$.

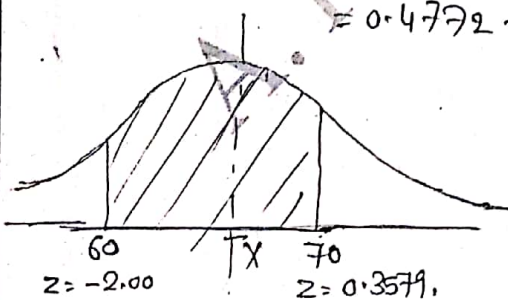
$$Z = \frac{X_2 - \bar{X}}{\sigma} = \frac{70 - 68.5}{4.25} = 0.3529.$$

From Standard Table for $Z = 0.3529$, the area under normal distribution curve is $A_2 = 0.1379$.

(3) Now A may be the area of normal curve between 60 to 70 Percentage mark

$$\therefore A = A_1 + A_2$$

$$= 0.4772 + 0.1379 = 0.6151.$$



\therefore Students have scored marks between 60 to 70 %

$$= A (\text{total no. of students appeared in the examination})$$

$$= A \times 200$$

$$= 0.6151 \times 200$$

$$= 123 \text{ students.}$$

Ex: 7 Dimensions of washers produced under mass production are normally distributed. The average & standard deviation of such 400 washers are 5.02 mm & 0.05 mm. If the washer having diameters between 4.96 mm to 5.08 are acceptable, then how many washers out of 400 washers will be acceptable. The areas from the middle of std. curve for $z = 1$, $z = 1.2$ & $z = 1.5$ are 0.3413, 0.3849 & 0.4332 respectively. [Ans: - 308 washers]

Solnⁿ :- $\bar{X} = 5.02 \text{ mm}$, $\sigma = 0.05 \text{ mm}$. Min dia. = 4.96 mm.
Total washer = 400. Max. dia. = 5.08 mm.
[Solve as per Ex-6]

Ex: 8 10,000 students were given the diploma mech. engg. Exam. in Dec-2008 by the conducted by technical examination board. The percentage Avg. was 62%. Its error and std. variation is 4. so, find.

(i) How much students get betⁿ 62% to 76%.

(ii) How much students get above the 76%.

$$\therefore z = -0.5 \text{ Area} = 0.1915$$

$$z = 3.5 \text{ Area} = 0.4995$$

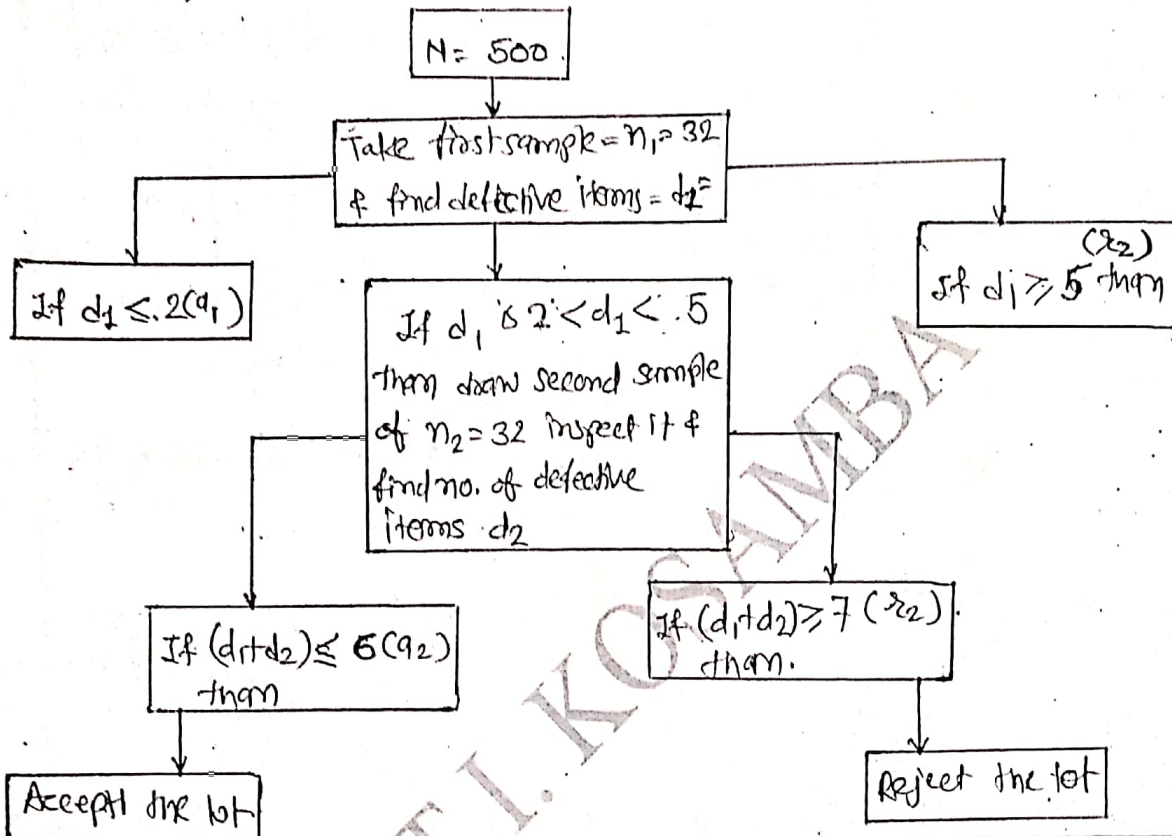
[Solve above prob. as per EX-6] Ans: (i) 6913
(ii) 3087

CH:4 STATISTICAL QUALITY CONTROL

* EXAMPLES based on sampling plan. *

(4 marks)

Ex:1 Draw sampling plan for $N=500, n_1=32, n_2=32, c_1=2, c_2=6, r_1=5, r_2=7$ (S-17)



Ex:2 Draw double sampling plan from the following data. (W-17) (3 marks)
 lot size = 2400, $n_1=80, c_1=5, r_1=9, n_2=80, c_2=12, r_2=13$.

Ans:- solve as per above question:-

Hint:- $d_1 \leq (c_1) 5$

$d_1 \geq (r_1) 9$

If $d_1 5 < d_1 < 9 \rightarrow$ second sample $\rightarrow (d_1 + d_2) \leq 12 (c_2)$ (accept lot)

$\rightarrow (d_1 + d_2) \geq 13 (r_2)$ (reject lot)

Ex:3 For a lot 3000 piston double sampling plan is to be applied as per following details prepare sampling plan. (W-18) (4 marks)

sample	sample size	acceptance no. (c)	rejection no. (r)
first	20	1	4
second	20	4	5

(follow as per above) Example.

* EXAMPLES BASED ON CHARTS * (Variables)

Ex: Inspection data of a product is as under. (7 mark)

Sample NO.	1	2	3	4	5	6	7	8
mean	62.8	61.5	62.4	61.9	62.5	63	62.7	61.3
Range	4.2	5.4	15.9	7.9	2.6	5.1	3.8	1.9

Given $A_2 = 1.02$, $d_2 = 1.69$, $D_3 = 0$, $D_4 = 2.57$ (for sample size 8 items) Draw \bar{x} -R chart & conclude.

Soln:-

$$\bar{\bar{x}} = \frac{\sum \bar{x}}{N} = \frac{62.8 + 61.5 + 62.4 + 61.9 + 62.5 + 63 + 62.7 + 61.3}{8}$$

$$\bar{\bar{x}} = 62.26$$

$$\bar{R} = \frac{\sum R}{N} = \frac{4.2 + 5.4 + 15.9 + 7.9 + 2.6 + 5.1 + 3.8 + 1.9}{8} = 5.85$$

→ Control Limit of \bar{x} -chart:-

$$\begin{aligned} \text{Upper control limit (UCL}_{\bar{x}}) &= \bar{\bar{x}} + A_2 \bar{R} \\ &= 62.26 + 1.02(5.85) \\ &= 68.22 \end{aligned}$$

$$\begin{aligned} \text{Lower control limit (LCL}_{\bar{x}}) &= \bar{\bar{x}} - A_2 \bar{R} \\ &= 62.26 - 1.02(5.85) \\ &= 56.29 \end{aligned}$$

→ Control Limit for R-chart:-

$$\begin{aligned} \text{Upper control limit (UCL}_R) &= D_4 \bar{R} \\ &= 2.57(5.85) \\ &= 15.03 \end{aligned}$$

$$\begin{aligned} \text{Lower control limit (LCL}_R) &= D_3 \bar{R} \\ &= 0(5.85) \\ &= 0 \end{aligned}$$

All data are remain between upper & lower control limit and

one data for range is out of upper and lower limit

Ex: 2 Find control limit for \bar{x} and R chart from the following data. Also find process capability. (6-17) (6 marks)
 $\Sigma \bar{x} = 357.50$, $\Sigma R = 9.90$ NO. of subgroup = 20,
 $A_2 = 0.18$, $D_3 = 0.41$, $D_4 = 1.59$ & $d_2 = 3.735$.

Soln:- $\bar{\bar{x}} = \frac{\Sigma \bar{x}}{N} = \frac{357.50}{20} = 17.87$

$\bar{R} = \frac{\Sigma R}{N} = \frac{9.90}{20} = 0.495$

→ Upper control limit for \bar{x} -chart

$UCL_{(\bar{x})} = \bar{\bar{x}} + A_2 \bar{R}$
 $= 17.87 + 0.18(0.495) = 17.96$

→ Lower limit for \bar{x} -chart

$LCL_{(\bar{x})} = \bar{\bar{x}} - A_2 \bar{R}$
 $= 17.87 - 0.18(0.495) = 17.78$

R chart :-

→ $UCL_{(R)} = D_4 \bar{R}$
 $= 1.59(0.495)$
 $= 0.787$

→ $LCL_{(R)} = D_3 \bar{R}$
 $= 0.41(0.495) = 0.203$

→ Process capability :-

$\frac{6\bar{R}}{d_2}$
 $= \frac{6(0.495)}{3.735}$
 $= 0.795$

$(\sigma) \Rightarrow 6\sigma \Rightarrow (\because \sigma = \frac{\bar{R}}{d_2})$
 \downarrow
 $6 \times (\text{Std. deviation})$

So, Process Capability = $6(\text{Std. deviation}) \Rightarrow \frac{6\bar{R}}{d_2} \Rightarrow 6\sigma$

Ex:3 Find out control chart limit for \bar{X} -bar chart, R-chart
Std. deviation & process capability. (5+8) (67 mark)

Observation	1	2	3	4	5	6	7	8
\bar{X} -bar	26.00	34.00	28.50	32.75	29.25	26.00	29.25	30.25
R	30	17	18	29	30	15	19	18

Soln: [As per Ex:2.]

$$\rightarrow \bar{\bar{X}} = \frac{\sum \bar{X}}{N} \Rightarrow N=8, UCL_{\bar{X}} = \bar{\bar{X}} + A_2 \bar{R}; LCL_{\bar{X}} = A_2 \bar{X} - A_2 \bar{R}$$

$$\rightarrow \bar{R} = \frac{\sum R}{N} \Rightarrow UCL_R = D_4 \bar{R}; LCL_R = D_3 \bar{R}$$

$$\rightarrow \sigma = \frac{\bar{R}}{d} \text{ (Std. deviation)}$$

$$\rightarrow \text{Process capability: } 6\sigma \Rightarrow \frac{6(\bar{R})}{d_2}$$

[D_4, D_3, d_2 = take as Ex:2.]

Ex:4 Calculate control limit & process capability for data.

Sample	1	2	3	4	5	6	7	8
Mean	26.00	34.00	28.5	32.75	29.25	26.00	29.25	30.00
Range	30	17	18	29	30	15	19	18

$$A_2 = 0.73, D_4 = 2.28, D_3 = 0, d_2 = 0.259.$$

Soln :- (Ex:2 follow) Pg. No. 82.

Examples on Attribute charts.

Ex: 5

After inspection of 10 samples each of 120 items (S-17)
3, 8, 4, 5, 11, 2, 6, 7, 1, 9 pieces found defective (4 marks)

solⁿ:- calculate control limits for appropriate chart.

sample	sample size (n)	defective product (d)	fraction (p = $\frac{d}{n}$) defective
1	120	3	0.025
2	120	8	0.066
3	120	4	0.033
4	120	5	0.041
5	120	11	0.091
6	120	2	0.016
7	120	6	0.05
8	120	7	0.058
9	120	1	0.008
10	120	9	0.075
	1200	56	$\bar{p} = 0.463$

$$\text{Avg. } \bar{p} = \frac{\sum p}{N} = \frac{0.463}{10} = \boxed{0.046}$$

Control limit:-

$$\begin{aligned} \rightarrow \text{UCL}_p &= \bar{p} + 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \\ &= 0.046 + 3 \sqrt{\frac{0.046(1-0.046)}{120}} \\ &= \boxed{0.1033} \end{aligned}$$

$$\begin{aligned} \rightarrow \text{LCL}_p &= \bar{p} - 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n}} \\ &= 0.046 - 3 \sqrt{\frac{0.046(1-0.046)}{120}} \\ &= \boxed{-0.0113} \rightarrow (\text{Take as a zero line.}) \end{aligned}$$

Ex: 6 Draw np chart from data given below & give conclusion

Sample No.	1	2	3	4	5	6	7	8	9	10
Batch Size	100	100	100	100	100	100	100	100	100	100
Defective	08	03	12	11	14	09	06	03	07	04

Soln:

(5-17) (17 marks)

Sample No.	Sample size	defective
1	100	8
2	100	3
3	100	12
4	100	11
5	100	14
6	100	9
7	100	6
8	100	3
9	100	7
10	100	4
	1000	77

$$\bar{np} = \frac{\sum np}{10} = \frac{77}{10} = 7.7$$

$$\bar{p} = \frac{0.77}{1000} = 0.00077$$

$$\begin{aligned} \rightarrow UCL_p &= \bar{np} + 3\sqrt{\bar{np}(1-\bar{p})} \\ &= 7.7 + 3\sqrt{7.7(1-0.00077)} \\ &= 15.88 \end{aligned}$$

$$\begin{aligned} \rightarrow LCL_p &= \bar{np} - 3\sqrt{\bar{np}(1-\bar{p})} = 7.7 - 3\sqrt{7.7(1-0.00077)} \\ &= -0.29 \text{ (taken as zero line).} \end{aligned}$$

→ no. of observations defect find under the UCL so, defecting are in control limit.

Ex-7 For the following data draw appropriate chart & make conclusion

Sample no	1	2	3	4	5	6	7	8	9	10
Sample size	100	200	200	300	150	250	100	200	200	200
defective	4	6	5	8	3	7	4	5	3	6

Soln.

S-18
(4-marks)

Sample.	Sample size (n)	defective. (d)	Fraction $P = d/n$.
1	100	4	0.04
2	200	6	0.03
3	200	5	0.025
4	300	8	0.026
5	150	3	0.02
6	250	7	0.028
7	100	4	0.04
8	200	5	0.025
9	200	3	0.015
10	200	6	0.03
	1900	51	0.274

$$\bar{p} = \frac{51}{1900} = 0.0268$$

$$\therefore \sigma_p = \sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = \sqrt{\frac{0.0268(1-0.0268)}{100}} = 0.016$$

$$UCL = \bar{p} + 3\sigma_p \\ = 0.0268 + 3(0.016) = 0.0752$$

$$LCL = \bar{p} - 3\sigma_p \\ = 0.0268 - 3(0.016) = -0.0212$$

Same follow for all sample. \bar{p} UCL, & LCL not required.