



**Important Instructions to examiners:**

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

**Q1. Attempt any three.**

**a) Define metrology and state its four objectives.**

**Definition:**

“It is a science of measurement which deals with the measuring instruments, measuring technique and measuring standards”

**. objectives**

1. To ensure that the product is as per quality standard.
2. To enhance total customer satisfaction.
3. To reduce rework and rejections.
4. To increase profitability of organization.
5. It helps in manufacture of interchangeable parts.
6. Overcome the short coming in the production process.

**(Any 4) 1/2 mark each**

**b) What is the meaning of 35H8f8 with respect to fit and basis system.**

35 H<sub>8</sub> means an H-hole of basic size 35mm having tolerance grade IT8.

**1 mark**

35 f<sub>8</sub> means an f-shaft of basic size 35 mm having tolerance grade IT8.

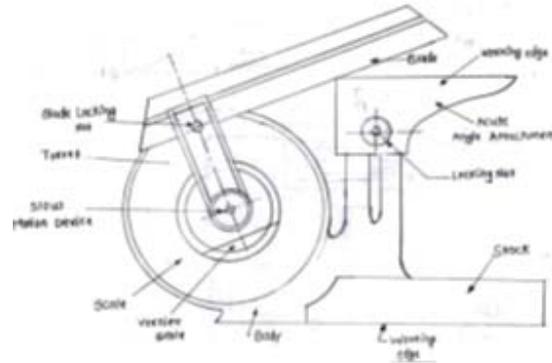
**1 mark**

35 H<sub>8</sub> f<sub>8</sub> is fit indicated by its basic size 35mm followed by symbols representing the limits of hole and shaft, the hole being stated first.

The type of fit is clearance fit.

**2 mark**

**c) Draw a labeled diagram of universal bevel protractor. State its uses.**



**Labeled sketch 3 marks**

Uses:

1. Angle measurement in degree, minutes and seconds. **1 mark**
2. To set the given angle.
3. To measure known or unknown angle

**d) Define Median, mode, range and Standard deviation.**

**1) Median:-**

When all observation are arrange in ascending and descending order the median is magnitude of middle case.

a) For odd number median =  $\frac{N+1}{2}$

b) For even number median =  $\frac{N}{2}$

**2) Mode:-**It is value that occurs most frequently is known as mode.

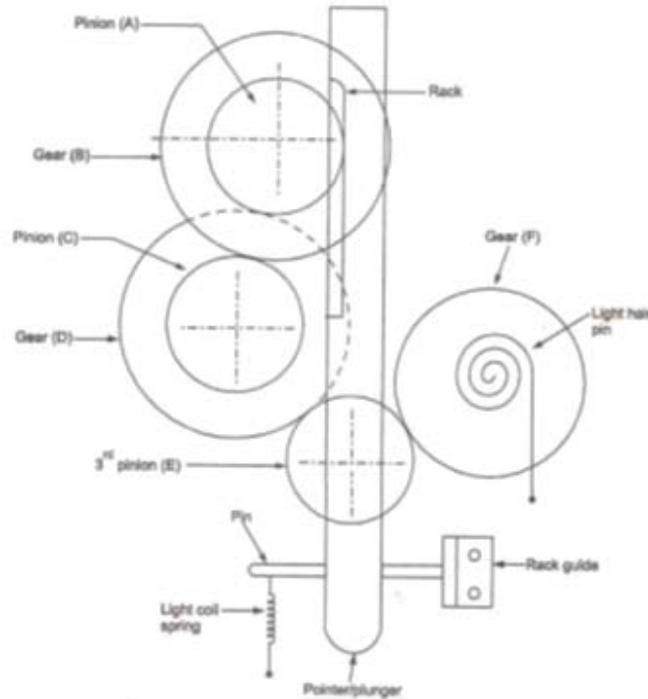
**3)Range:-** It is difference between largest observed value and smallest observed value

Range =largest value – smallest value

**4) Standard deviation:-** It is the root mean square of the difference between the observations and mean.

**B) Attempt Any One:**

**a) Draw a labeled diagram showing the working mechanism of Dial indicator.**



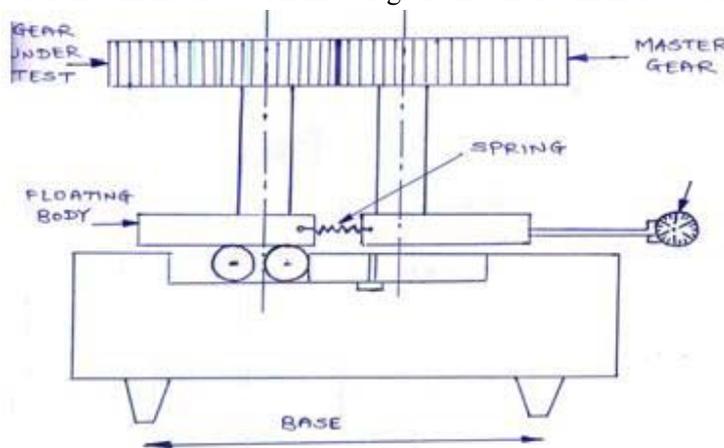
b) Describe with neat sketch the working “The Parkinson Gear Tester”

**Use:-**

By using this instrument instead of measuring individual error composite error are checked.

**Principle:-**

The gear to be tested is rolled in meshed with master gear and error will indicated by dial gauge.



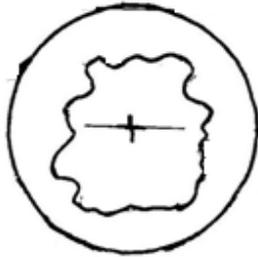
2 marks

**Construction:-**

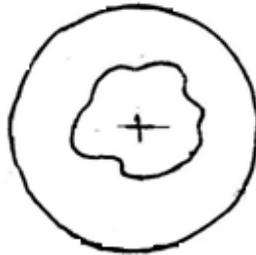
- 1) The fixed spindle and other movable spindle is mounted on flat plate.
- 2) The movable spindle moves with the base by rolling axle on main base plate.
- 3) The master gear is mounted on fixed spindle where the gear to be tested is to mounted on movable spindle.
- 4) The dial gauge is to set to note the error which shown in fig. **2 marks**

**Working:-**

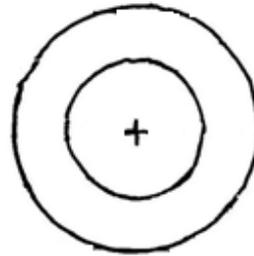
- 1) Master gear rotated slowly a gear to be tested will also get rotation because of meshing.
- 2) The error in the manufacturing gear (tested gear) caused to gear to moved away center line of spindle.
- 3) When gear is moves, the floating body is also moves by same displacement.
- 4) The vibrations in the reading can be observed and plotted in graphical format.



UNSATISFACTORY  
GEAR



MODERATE  
GEAR



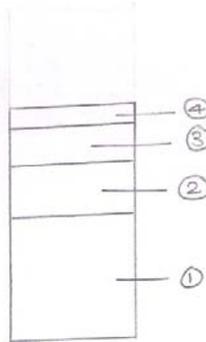
SATISFACTORY  
GEAR

2 marks proper explanation.

Q2. Attempt any four.

a)

$$\begin{array}{r}
 73.975 \\
 - 1.005 \quad \text{--- (4)} \\
 \hline
 73.970 \\
 - 1.47 \quad \text{--- (3)} \\
 \hline
 72.50 \\
 - 2.5 \quad \text{--- (2)} \\
 \hline
 70.00 \\
 - 70.00 \quad \text{--- (1)} \\
 \hline
 00.00
 \end{array}$$



2 marks calculation + 2 marks fig.

b) State the Taylor's principle of gauge Design.

Ans:-

Statement:-

Go gauge should check maximum material condition and no go gauge should check minimum material condition.

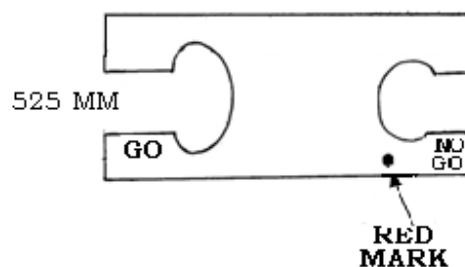
It also state that, go gauge should check all the possible elements of dimensions at a time, while no go should check only one dimension at a time. **2 marks**

Example:- 1 mark for each example.

1) If some one want to check large quantity of shafts having size mm, then the sizes corresponds to go and no go ends are as follows:-

**Go** - 25.1 mm = max material condition.

**No go** – 24.9 mm = min material condition.

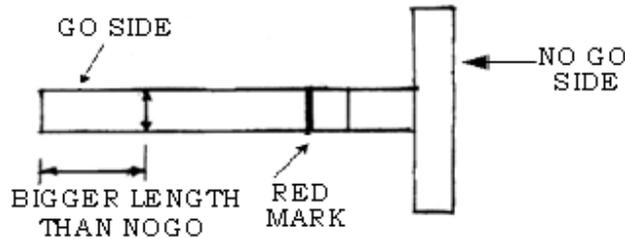




2) If some one want to check a hole having size mm in mass production then as per Taylor's principle the sizes corresponds to go and no go ends are as follows.

**Go** – 24.9mm = max material condition.

**No go** – 25.1mm = min. material condition.



c) Differentiate between Angle Gauges and Slip Gauge.

Ans:-

Sr. No.	Angle Gauge	Slip Gauge
01	Angle gauges are used for angle measurement.	Slip gauges are used for linear measurement.
02	They having marks having positive or negative.	Slip gauges do not have marks.
03	They can be added or subtracted.	They can added but do not subtracted from each other.
04	It is available in degree, minute and second.	It is available in mm and inches.
05	It is set of 13 gauges.	It is set of M-45, M-86 and M-105 etc.

1 mark each for any 4

d) Explain with neat sketch working principle of floating carriage dial micrometer.

Floating carriage micrometer is also called screw thread measuring machine or bench micrometer.

Principle of floating carriage: it works on Principle of Nut & Bolt /Screw threads. As drum of micrometer rotates by one revolution, it will move forward by one pitch of interval thread.

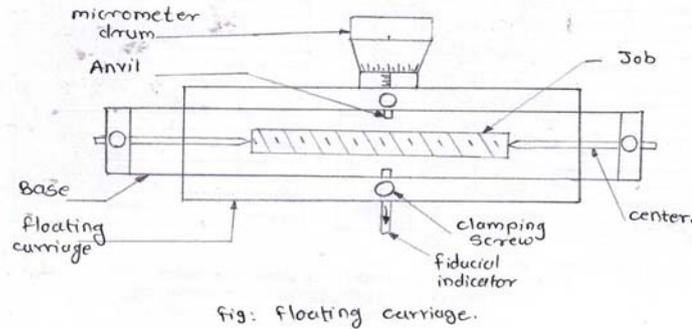
The movement will be measured using number of division on drum and main scale i.e. Micrometer principle.

Floating carriage consist of

- 1) Two centers held on pillars of base
- 2) These centers are used for holding the job.
- 3) Lower slide is kept on the base, and the top slide is placed over the lower slide
- 4) Top slide has two pillars.

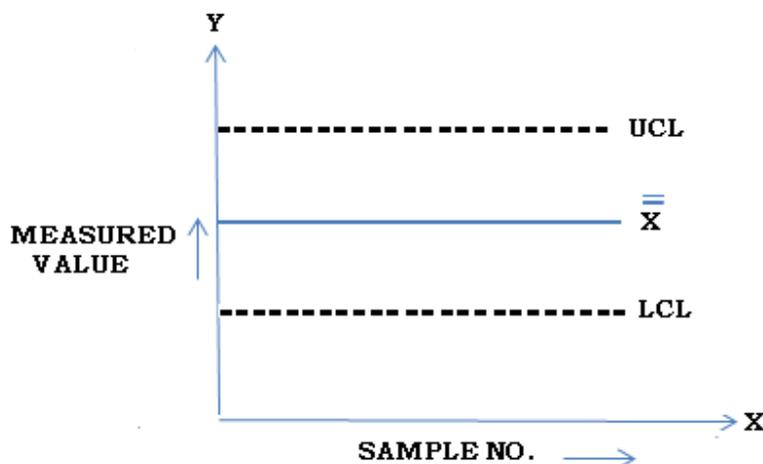


- 5) One pillar consists of micrometer drum having least count of 0.0002 mm.  
6) The other pillar consists of a fiducial indicator which senses the pressure applied on the anvil end.



. 2 marks for figure, 2 marks for explanation]

e) Write the various steps in Constructing  $\bar{X}$  and R chart Consider Suitable Example.



- 1) on X axis sample nos and on Y axis measured values
- 2) Calculate  $\bar{X}$  (average of average value) & draw horizontal thick line of that value.
- 3) Calculate the values of UVL & LCL & draw by following formulae's.

$$UCL = \bar{X} + 3\delta$$

$$LCL = \bar{X} - 3\delta$$

**OR**

$$UCL = \bar{X} + 3\delta$$

$$LCL = \bar{X} - 3\delta$$

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

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



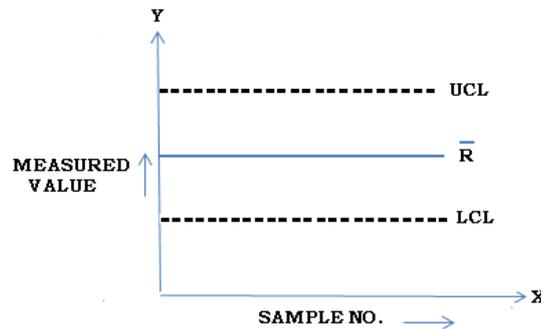
$$\bar{\bar{X}} = \frac{\sum \bar{X}}{N}$$

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

The values of  $\delta$ ,  $A_2$ ,  $\bar{X}$  &  $R$  are given in problem.

$N$  = number of sample

**‘R’ Chart. (Range chart).**



- 1) Calculate  $\bar{R}$

$$\bar{R} = \frac{R_1 + R_2 + R_3 + R_4 + \dots + R_n}{N}$$

- 2) Draw thick horizontal line as per the value of  $\bar{R}$ .  
3) Calculate UCL & LCL by following formulise.

$$UCL = D_4 \bar{R}$$

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

Where,  $D_3$  &  $D_4$  are constant which are given in that particular sample size.

- 4) If value of ‘sigma’ ( $\delta$ ) is given in UCL & LCL can be calculated by,

$$UCL = D_2 \delta$$

$$LCL = D_1 \delta$$

**2 marks x-chart +2 mark for R-chart.**



Q 3 a)

**Line Standard**

- 01 When length is express as distance between two parallel line is called line standard.
- 02 Measurement is quick and easy.
- 03 It is not used for præcised measurement.
- 04 It is subjected to parallax error.
- 05 It is not subjected to wear and tear.
- 06 It is cheaper.
- 07 It is simple in construction.
- 08 No skilled worker is required for measurement.
- 09 It is not so accurate.

Ex. Scale, meter tape, yard.

**2 marks for any 4 points**

Ex : Tape, Scale

**End standard 2 marks for any 4 points**

- 01 When length is expressed as distance between two parallel faces is called as end standard.
- 02 It is subjected to wear and tear.
- 03 It is costlier.
- 04 It is complicated in construction.
- 05 It is not subjected to parallax error.
- 06 It is used for præcised measurement
- 07 It is very accurate.
- 08 It is very accurate.
- 09 Measurement is time consuming.

Micro meter, Vernier, slip gauges

( Ex Slip Gauges)

b)

90<sup>0</sup> squre block



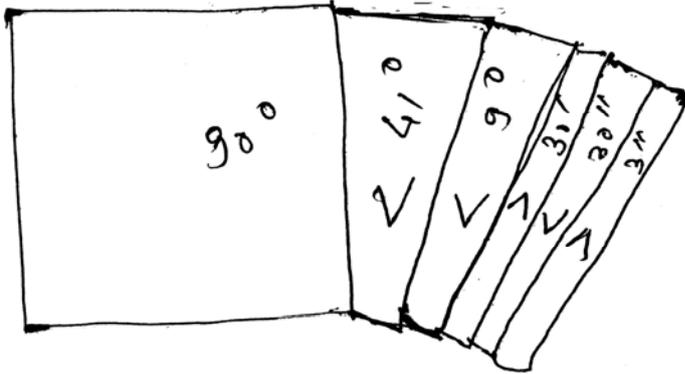
$$139-90 = 49^{\circ}30'27''$$

$$41^{\circ}9'$$

$$-30'$$

$$+30''-3''$$

Min 05 gauges are required



2 mark calculation+ 2 marks fig.

c) Differentiate between Variable Chart and Attribute Chart.

Sr. No.	Variable Chart	Attribute Chart
01	e.g. $\bar{X}$ & R	e.g. P, n-p & c
02	Data required is variable data.	Data required is attribute data.
03	Control of individual quality characteristics	Control of proportion of defectives or defect in sample of constant size or no of defects per unit.
04	Provide detail information on process average and variation for control of individual dimension.	They do not provide detail information for control of individual dimension.
05	They are not easily understood unless training is provided.	They are simpler as compared to X, R chart so can be easily understood.
06	They are time consuming due to involvement of measuring, calculation & plotting.	They involve less cost & time.

Any 4 points 1 mark each

d) types of error in thread

1. Drunken thread.
2. Progressive pitch error.



3. Periodic pitch error.
4. Irregular error. **1 mark each**

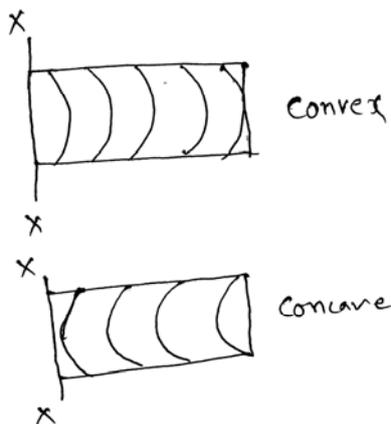
**e) State the meaning of,**

1. **Sampling length:** it is the length of profile necessary for evaluation of surface roughness.
2. **Lay:** - It is the direction of the predominant surface pattern ordinarily determined by the method of production used.
3. **Waviness:** It results from the factors such as machine or work deflections, vibrations, chatter, heat treatment. It is the component of surface roughness upon which roughness is superimposed.
5. **Roughness:** It is caused due to the irregularities in the surface roughness which results from the inherent action of the production process. It is due to feed marks and the irregularities with in them.

**1 mark for each**

**Q4. Attempt any three.**

a. if the fringe pattern observed is curved towards line of contact X-X then it is convex surface and if it is away from line of contact it is concave surface. As shown in sketch



**b) What is S.Q.C.? State the benefits of S.Q.C.**

**Ans:-** “SQC is the collection analysis and interpretation of data to solve a particular Problem”. **1 marks**

**benefits of SQC (Statistical Quality Control)**

- 1) Increase the efficiency and cost reduction.
- 2) More effective pressure.
- 3) Improvement in inspection standard.
- 4) Reduction of scrap.
- 5) Reduction in customer complaints
- 6) Improve productivity.
- 7) Reduces wastage of men & machine hours. ( **1/2 mark any six**)

**c) Write difference between Hole Basis and Shaft Basis System.**

**Ans:-**



Sr. No.	Hole Basis System	Shaft Basis System
01	Lower deviation of hole is zero.	Upper deviation of shaft is zero.
02	Limits of hole is kept constant and those on shaft are varied to obtained desired type of fit.	Limit on shaft is kept constant and those on hole are varied to obtain desired type of fit.
03	It is preferred for mass production.	It is not suitable for mass production.
04	It is easy to manufacturing.	It is difficult to manufacturing.
05	It required less amount of capital and storage needed produced shaft of different sizes.	It needs large amount of capital and space for tool storage.

**1 mark for each point**

**d) What is quality of conformance? List the factors controlling quality of conformance**

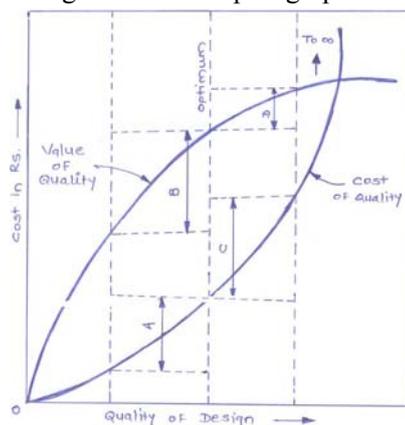
**Ans:-** Quality of conformance means how well manufactured product confirm (matches) to the quality of design. **2 marks**

**factors controlling quality of conformance**

- 1) Raw material, machines, tools, measuring instrument should be of adequate (good) quality.
- 2) Proper process should be selected.
- 3) Operator should be well trained and experienced.
- 4) Proper care should be taken during the material handling. **2 marks**

**Q4 B) Attempt any one.**

**a) Explain the meaning of optimum quality of design with the help of graph.**



The balance between the cost of quality and value of quality gives optimum quality of design.

2. It is not necessary that the company should manufacture 100% quality products.

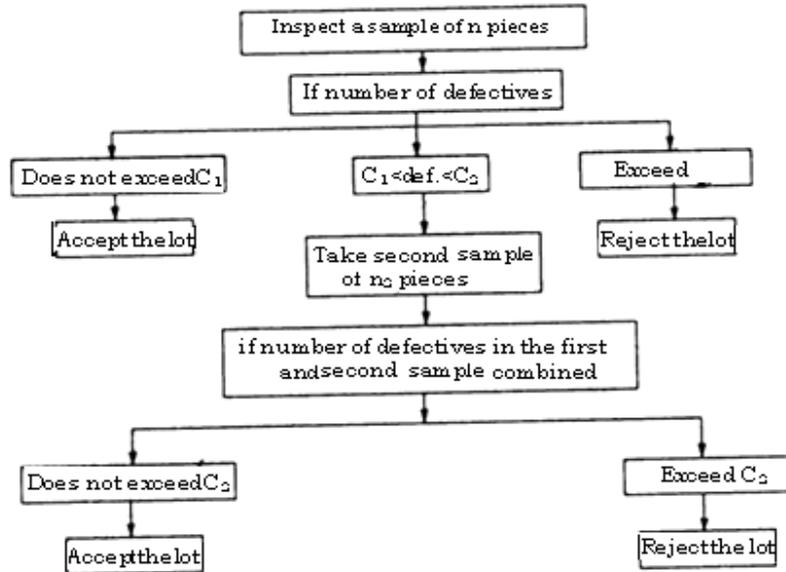
3. The study of optimum quality of design involves “Market Survey”.



4. While carrying out market survey expected sale for particular quality, profit and competition in the market is to be considered. **3 marks explanation+ 3 marks graph**

b) Enlist different sampling plan and explain double sampling plan

1. single sampling plan
2. double sampling plan
3. multi sampling plan **2 marks**



**2 marks**

$N_1$  = number of piece in first sample

$C_1$  = acceptance number for first sample

$N_2$  = number of pieces in second sample

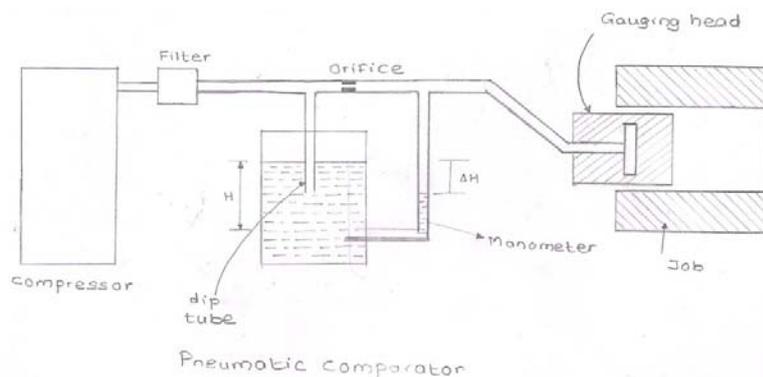
$N_1 + n_2$  = number of pieces in two samples combined.

$C_2$  = Acceptance number for two samples combined. **Meaning 2 marks**

**Q5. Attempt any two.**

a) Explain with neat sketch construction and working of pneumatic comparator.

Ans:-



**4 marks**

Principle:-



A pneumatic comparator or air gauge utilize a pneumatic circuit to measure linear dimensions of component.

Construction:-

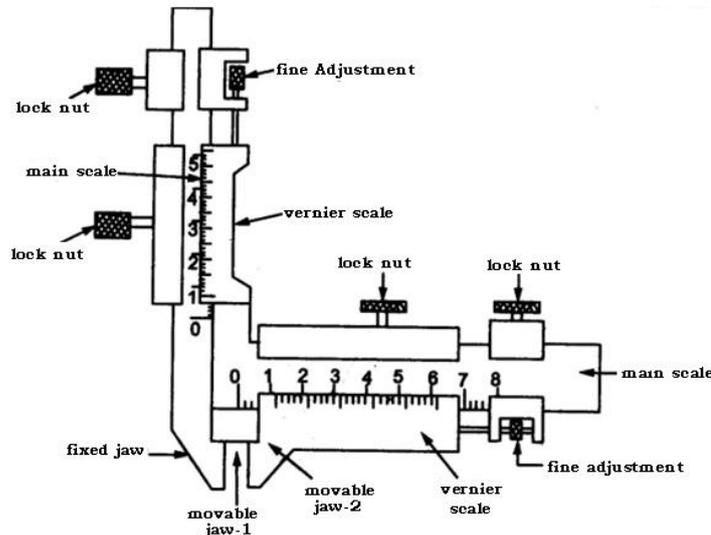
- 1) It consist of FRL (filter regulation and lubrication unit)
- 2) A vehicle tank is filled with water a dip tube immersed into the tank up to depth corresponding to the back air pressure it required a calibrated manipulated tube is connected between water tank and control orifice as shown in figure. **2 marks**

Working:-

- 1) A compressed air from it source is given to the input through FRL unit. Its pressure is then reduced and maintained at constant value by dip tube into water chamber.
- 2) Air will bubble out from the bottom of dip tube and air moving through a control valve will be at a constant pressure.
- 3) The air at constant pressure then passes through a control orifice and escaped through the measuring jet.
- 4) When there is no restriction to the escape of air this level of water in manometer tube will consider with that in the tank.
- 5) Due to this back pressure will be created in pneumatic circuit and level of water in monometer fall down. **2 marks**

**Note: any one sketch of pneumatic comparator only**

**b) Draw the neat sketch of gear tooth vernier caliper and write the procedure for measuring chordal tooth thickness.**



1. Tooth thickness and depth is calculated using for setting vertical limb of gear tooth vernier.
2. Tooth thickness (c or w) is measured by setting depth (h or d) on vertical limb of vernier, as the distance between the fixed jaws and movable jaw by fixing distance at adjustable jaws of vertical vernier beam.

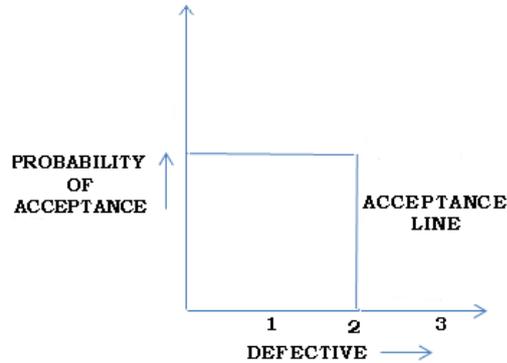
**3marks (figure)+3 marks procedure to measure chordal tooth thickness)**

**c)What is an O.C. curve? Draw ideal and actual O.C.curve and explain**

- i)Producer risk
- ii)Consumer risk.

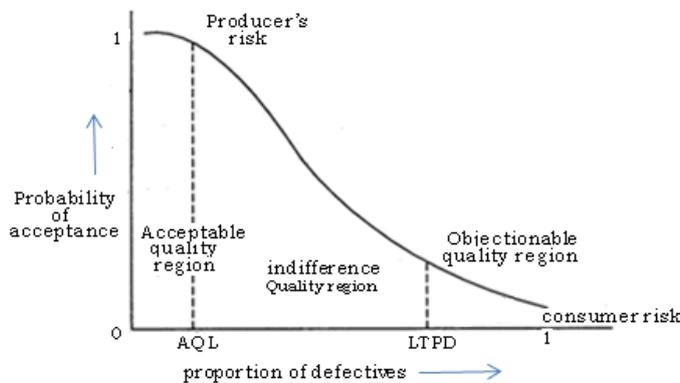


1) Ideal OC Curve:-



1 mark

2) Actual OC Curve:-



OC curve is a graph of fraction defective against probability of acceptance. It compares there performance over range of possible quality levels of all products. It provides means of revolting the sampling plan. It also provides the risk inherent in a sampling plan. At each level of product quality.

3 marks

1) **Producer's Risk:-**

Producer risk is that probability for a given sampling plan, that a lot will not be accepted. The quality of which has designated numerical value representing a level which, it is general design to accept. **2 marks**

It is generally expressed in %.

2) **Consumer's Risk:-**

Consumer risk is that probability for a given sampling plan that a lot will be which has designated numerical value of more defectives.

2 marks

**Q6 Attempt any two.**

a)



$$\bar{C} = \frac{\sum C}{N} \dots 1 \text{ MARK}$$
$$= \frac{185}{25}$$

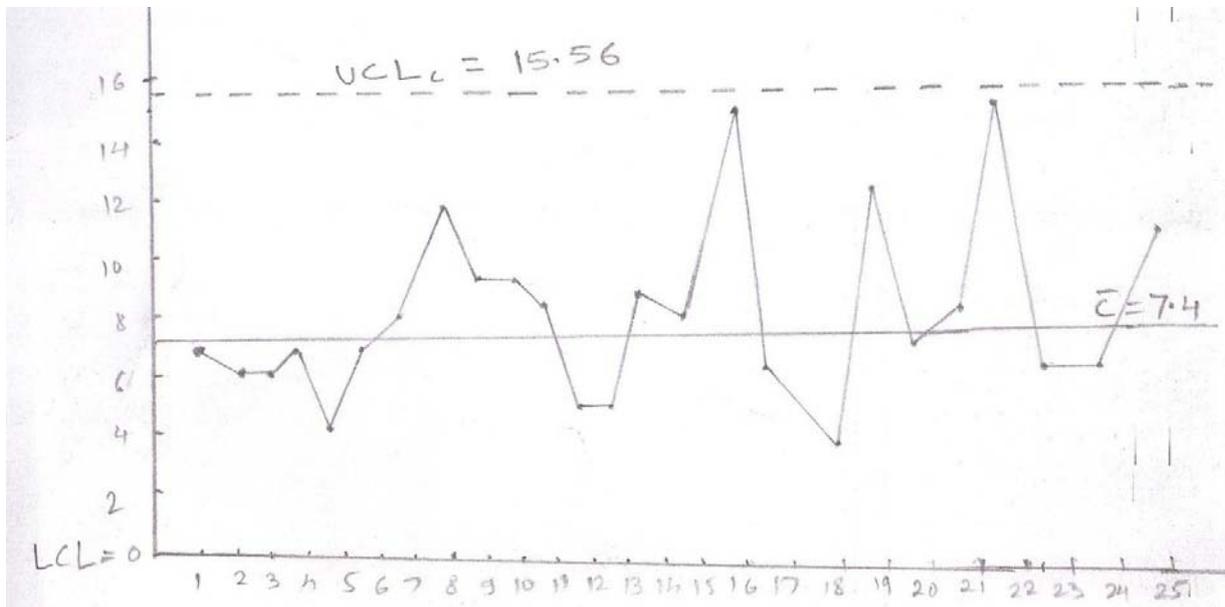
$$\boxed{\bar{C} = 7.4} \dots 1 \text{ MARK}$$

$$UCL_c = \bar{C} + 3\sqrt{\bar{C}} \dots 1 \text{ MARK}$$
$$= 7.4 + 3\sqrt{7.4}$$

$$UCL_c = 15.56 \dots 1 \text{ MARK}$$

$$LCL_c = \bar{C} - 3\sqrt{\bar{C}}$$
$$= 7.4 - 3\sqrt{7.4}$$
$$= -0.76$$

$$LCL_c \approx 0 \dots 1 \text{ MARK}$$



**Graph 2 marks**

Process is in control. **1 mark.**

**b) Quality Audit:** A Systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives. **2 mark**

**Steps of Quality Audit**

- 1) To check whether the system is working properly.
- 2) To know are there non conformities in the system.

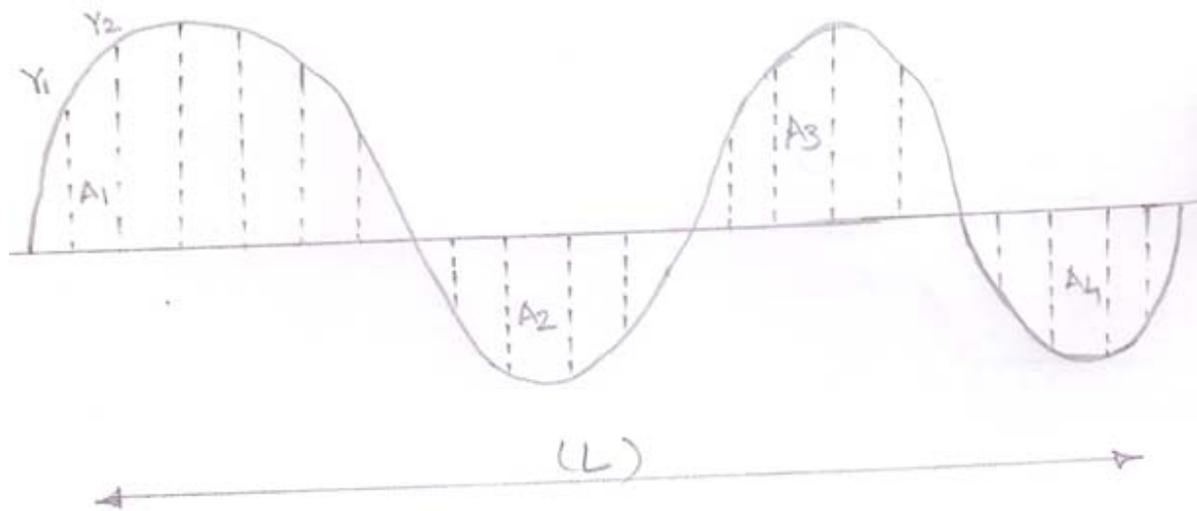


- 3) To know whether identified problems have been corrected.
- 4) To make focus on potential problems.
- 5) Checking the performance and understanding the shop personal.
- 6) Quality audit are performed to find whether end product satisfy the desired Quality specification.
- 7) Quality audit are important for proper functioning of all equipment and Machinery.
- 8) Collecting the customer complaints regarding quality and steps taken to Correct them. **1 mark for each point**

**c.i. Define CLA and RMS values as applied to surface roughness measurement.**

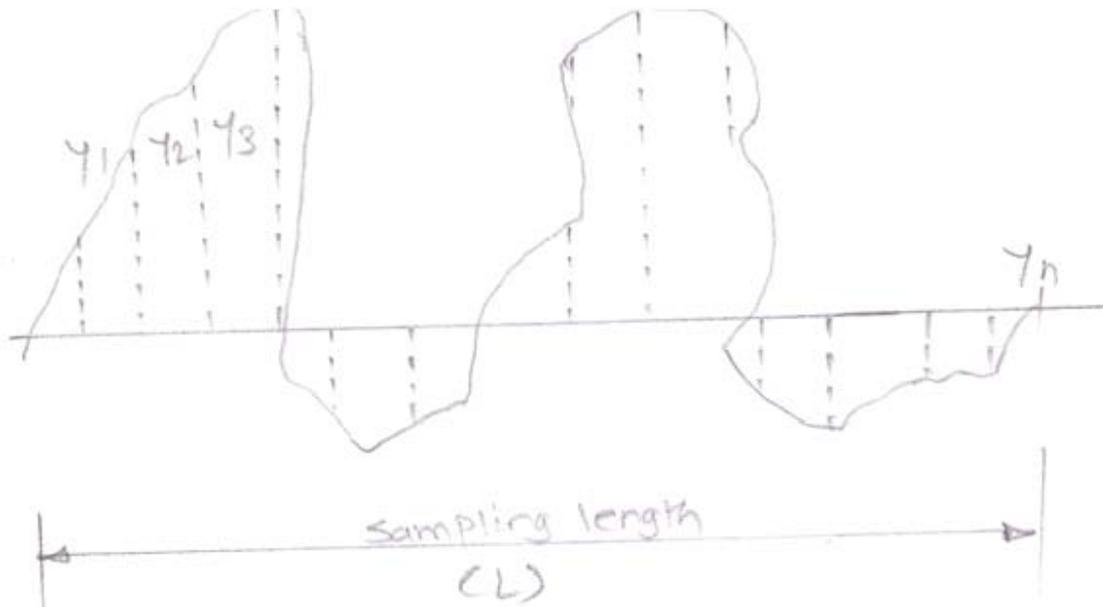
**CLA Value:**

Arithmetic mean deviation from the mean line of profile is the average value of the ordinates from the mean line is called CLA value. **1 mark**



**1 mark fig.**

**RMS Value:**the square root of the arithmetic means of values of the squares of ordinates of the surfaces, from mean line. **1 mark**



1 mark fig.

c)ii. Differentiate between Alignment Test and Performance Test.

Sr. No.	Alignment Test	Performance Test
01	Alignment test are carried out for various parts of machine like its spindle, slides, holding table etc.	Performance test are carried out to access the performance of machine tool in working condition.
02	Alignment test are also called geometrical test.	Performance test is also called as practical test.
03	These tests are carried out loaded and unloaded condition.	These tests are carried out in working condition.
04	It is done to check the grade of manufacturing of machine tool.	These tests are carried out to check the accuracy of finished product.
05	It consists of checking the relationship between various machine elements when the machine tool idle and unloaded.	It is carried out to know whether machine tool is capable of producing the part within the specified element or not.

Any 4 points 1 mark each.