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 tryto assess the understanding level of the candidate.

3) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills.

4) While assessing figures, examiner may give credit for principal components indicated in thefigure. 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.

(Note: check once again marking scheme for all questions. Insert page no. to all pages)

Q 1. A Attempt any three

a) Define metrology. State its type. **(Definition 2M + Types 2M)**

Metrology is a science of measurement. It is thus concern with the establishment, reproduction, conservation and transfer of units of measurements and there standards. The practice of metrology involves precise measurements requiring the use of apparatus and equipments to permit the degree of accuracy required to be obtained.

Types of metrology:

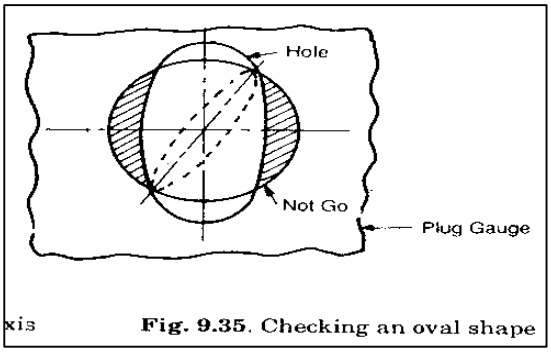
1. Legal metrology.
2. Industrial Metrology.
3. Scientific Metrology
4. Deterministic Metrology.

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

Taylor's principle of gauge design states that. **(Fig 2M + Description 2M)**

1. GO gauges should be designed to check the maximum material limit, while the NO-GO gauges should be designed to check the minimum material limit.

- The plug gauges are used to check the hole, therefore the size of the GO plug gauge should correspond to the low limit of hole, while that of NO-GO plug gauge corresponding to the high limit of hole.
- Similarly, the GO snap gauge on the other hand corresponds to the high limit of shaft, while NO-GO snap gauge corresponds to the low limit of shaft.



xis **Fig. 9.35.** Checking an oval shape

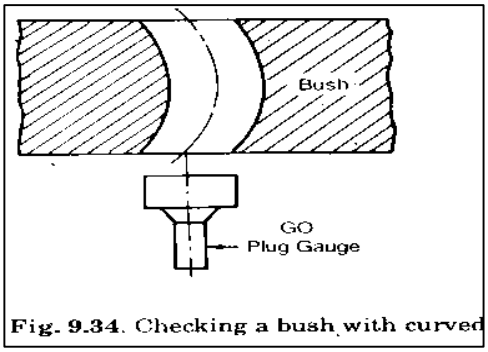


Fig. 9.34. Checking a bush with curved

2. Go gauges should check all the related dimensions (roundness, size, location etc). Simultaneously whereas NO-GO gauge should check only one element of the dimension at a time.

- Go plug gauge should have a full circular section and be full length of the hole it has to check. This ensures that any lack of straightness, or roundness of the hole will prevent the entry of full length GO plug gauge. If this condition is not fulfilled, the inspection of the part with the gauge may give wrong result.

c) Differentiate between angle gauges and slip gauges. (1 Mark each for every point)

Angle gauge	Slip gauge
1. Angle gauges enables angle to be set to the nearest 3"	1. Slip gauges are universally accepted end standard of length in industry.
2. It has triangular in cross section	2. It has rectangular in cross section
3. The angle gauges are marked with engraved V which indicates the direction of the inclined angle which affects on addition and substration of angles.	3. The direction of slip gauges is not affected in addtion and substration of dimension.
4. Angle gauges are available in 12 and 13 pieces set.	4. Slip gauges are avilable in M-45, M-87, M-112 and M-33/2.
5. Any angle can built by adding and subtraction of angle gauges in combination with square block.	5. Any linear dimesion can built by adding the combination of slip gauges.

d) What is S.Q.C? States its benefit. (Definition 1M +any three benefits3M =4M)

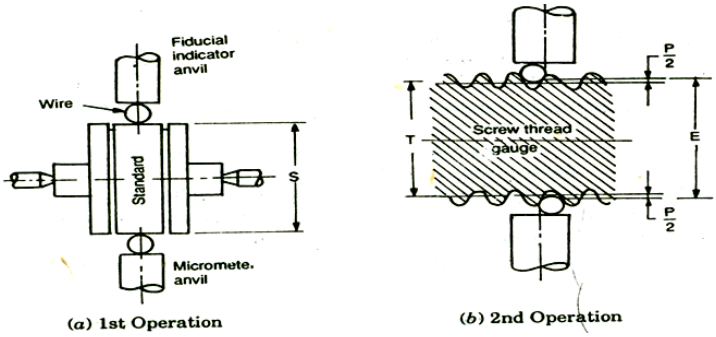
Ans: When statistical techniques are employed to control, iimprove and maintain quality or to solve the quality problems it is called Statistical Quality Control.(S.Q.C). Statistic is the collection, organisation, analysis, interpretation and presentation of data.

Benefits of Stastical Quality Control

1. The use of SQC ensures rapid and efficient inspection at minimum cost.
2. It reuduces the scrap by uncovering the causes of excessive variability in the manufactured products.
3. It uses acceptance sampling and exerts more effective pressure for quality improvement.
4. It provides ease for detection of faults.
5. It helps production process to adhere to specification.
6. Increses output and reudces the wasted machine and man hours.
7. Efficient utilization of personnel, machines and materials resulting in higher productivity.
8. Better customer relations through general improvement in product and higher share of market.
9. Elimination of bottlnecksin the process of manufacturing.

B) Attempt any one

a) Write a procedure for measuring of 'effective diameter' of screw thread by using two wire method.
(Figure 3 Marks + procedure 03 Marks)



- In two wire method wires of suitable size are placed between the standard and the micrometer anvils as shown in figure (a) and the first micrometer reading is taken. Let the micrometer reading over standard and wires $=R_1$. The standard is then replacement by the screw thread to be measured and the second micrometer reading is taken is shown in fig (b).
  Let the micrometer reading over screw thread and wires $=R_2$

The diameter of the standard = S
The diameter under the wires = T
The Effective diameter of the screw =E
Then E= T+P
$T = S- (R_1-R_2)$
P = 0.9605p-1.1657d (for Whitworth thread),
P = 0.866p- d (for Metric thread).

b) Differntiate 'line standard, end standard and wavelength standards'. Give one application of each
(3 Point each 1 Marks=3+ Application of each 01 Marks)

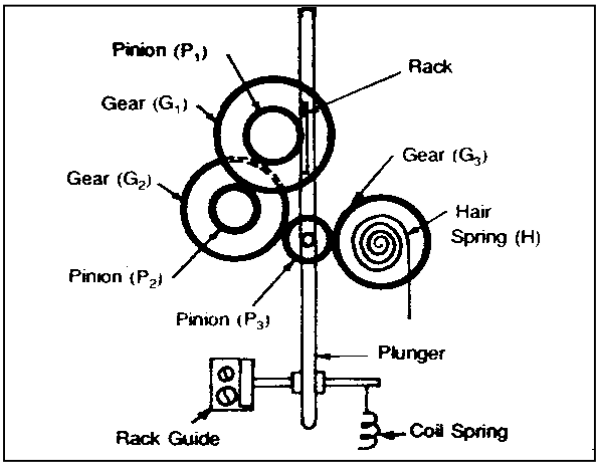
Sr. No.	Line Standard	End Standard	Wavelength Standard
1	When the length is measured as the distance between centres of two engraved lines, is called line standard	When the length is measured as the distance between two flat parallel faces, is called end standard	When the wavelengths of monocromatic light is used as natural and invariable unit of length, is called wavelength standard.
2	Line standard is not accurate and precise	End standard is accurate and precise.	Wavelenth standard is highly accurate and precise with reproducability is 3 parts in 10^{11}.
3	Wear and tear is less as compared to end standard.	More wear and tear due surfaces is in alway contact with workpiece.	It is not material standard hence no wear and tear.
4	Preservation in safe custody is required.	Preservation in safe custody is required.	Preservation in safe custody is not required.
5	Cost of standard / replica is less.	Cost of standard/ replica is high.	Cost of standard is moderate.
6	These are influence by effects of variation of enviornmental condition like temperature, pressure, humidity, and aging etc.	These are influence by effects of variation of enviornmental condition like temperature, pressure, humidity, and aging	These are **not** influence by effects of variation of enviornmental condition like temperature, pressure, humidity, and aging etc

		etc	
7	Application: Measurement of length using steel rule	Application: Measurement of length using Slip gauges	Appliction: The meter can be defined as equal to 1650763.73 wavelengths of the red orange radiation of Kripton isotope 86 gas

Q. 2 Attempt any four

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

(03 fig.+ 01 mark for labeling)



b) What is 'interchangability'? State its need and relevance in mass production industry. (2+2 Marks)

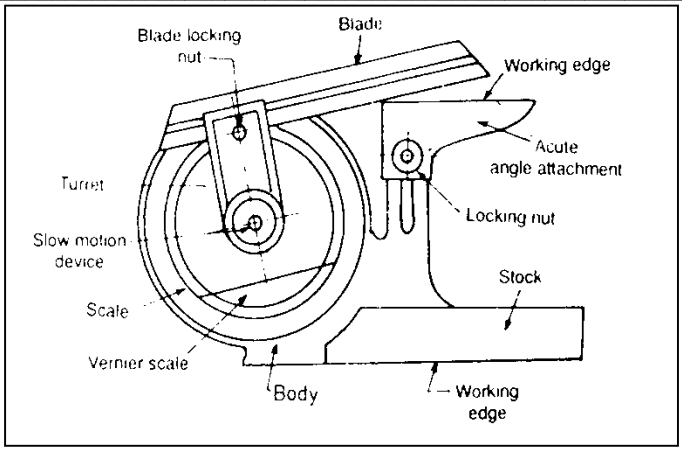
Answer: **Interchangability:** When a system of such kind is used any one component selected at random will assemble correctly with any other mating component that too, selected at random, the system is called interchangability. The manufacture of components under such conditions is called interchanble manufacture.

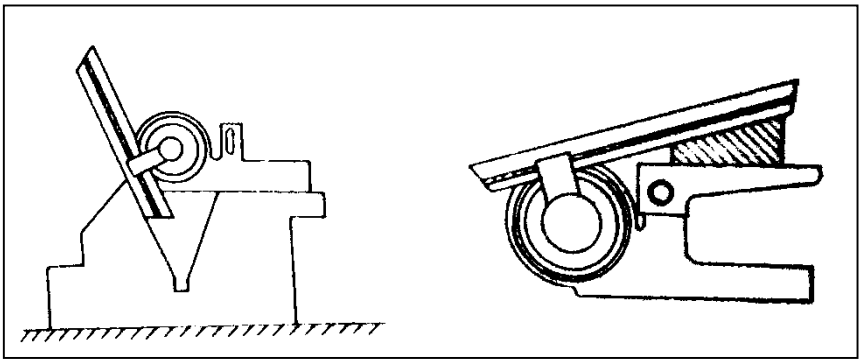
Need and relevance in mass production industry.

- It facilitates production of mating components at different places, by different operator, hence outsourcing can be possible.
- Production on an interchangable basis results in increased output with a corresponding reduction in manufacturing.
- The replacement of worn out or defective parts and repairs become very easy.
- There is a division of labour, the operator has to perform same limited operation again and again thus he becomes specialized in that particular work which helps to improve quality and reduce the time for operation.
- The products can be categorised on the basis of specific operations required which enhaces the quality and reduces the cost.

c) Draw a labled diagram of universal bevel protractor show its specific application on diagram.

(4 Marks)

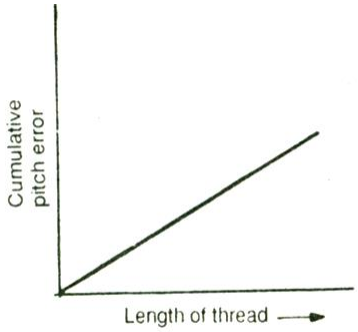




Use of bevel protector for checking of V block and measuring acute angle

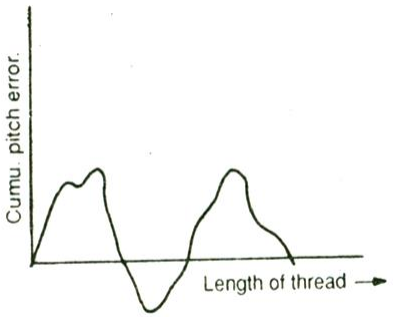
d) Name of type of pitch error. Sketch and lable each type. (Enlisting 1Mark + Sketches 1 x 3 =3)
Answer: Pitch errors

- Progressive error
- Periodic error
- Drunken error
- Erratic or irregular error



(a)

Figure a Progressive Error



(b)

Figure b Periodic error

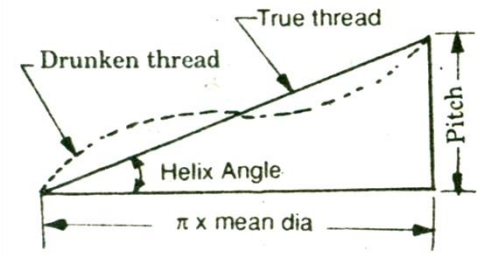


Figure c Drunken error

e) distingush between the terms 'Producers risk' and 'Consumers risk' (1x4=4 Marks)

Producers risk	Consumers risk
1. If the quality is good still from sampling plan some lots are rejected and producer has to suffer.	1. If the quality is bad still from the sampling plan some lots are accepted the consumer will suffer.
2. The producers risk is the probability of rejecting a good lot which otherwise would have been accepted.	2. Consumers risk is the probability of defective lots being accepted which otherwise would have been rejected.
3. Saying a producers risk $\alpha = 0.05$ means that in the long run about 1 lot in 20 will be rejected provided that the lots are coming from a process controlled at AQL quality level.	3. Saying that $p_{0.10} = 2.5\%$ means the consumer does not want a worse quality containing more that 2.5% defectives and he would at the most accept 10% of lots containing 2.5%
4. It is acceptable quality level	4. It is objectionable quality level

Q3. Attempt any four:

a) Define the term 'comparator'. State the characteristics of a good comparator.

(Definition 01+ any 3, 01 mark each)

Definition:

Comparator is a device which.

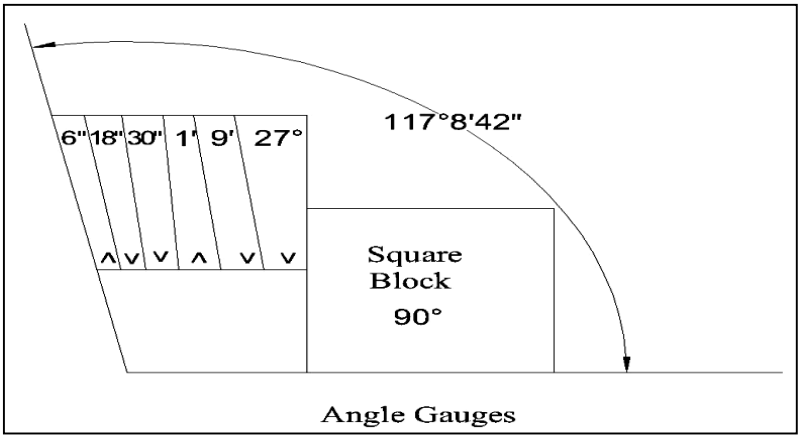
1) Pick-up small variation in dimension.
2) Magnified it.
3) Display it by using indicating device so that comparison can be made with same standard value.

Characteristics of a good comparator:-

1) It should be compact.
2) It should be easy to handle.
3) It should give quick result or quick response.
4) It should be reliable while used.
5) It's weight must be less.
6) It must be portable.
7) It must be easily available in market.
8) It should be sensitive as per requirement.
9) It should be robust in design.
10) It should have less maintenance.
11) It should be linear in scale, so that easy to read and get uniform response.
12) It should have hard point of contact with longer life.

B)117^0, 8', 42".
(02 mark calculations + 3 marks sketch)

Ans:- $117^0 = 90^0 + 27^0$
8' =9' -1'
42" = 30" + 18" - 6"



Angle Gauges

C) Differentiate between Variable Chart and Attribute Chart.

(Any 4 point, 1 mark each)

Sr. No.	Variable Chart	Attribute Chart
1	Data required is variable data.	Data required is attribute data.
2	Control of individual quality characteristics	Control of proportion of defectives or defect in sample of constant size or no of defects per unit.
3	Provide detail information on process average and variation for control of individual dimension.	They do not provide detail information for control of individual dimension.
4	They are not easily understood unless training is provided.	They are simpler as compared to X, R chart.
5	They are time consuming due to involvement of measuring, calculation & plotting.	They involve less cost & time.
6	e.g. **X bar & R**	e.g. P, n-p & c

D) State the principles of TQM (Any 4 point, 1 mark each)

Customer-focused: The customer ultimately determines the level of quality. No matter what an organization does to foster quality improvement—training employees, integrating quality into the design process, upgrading computers or software, or buying new measuring tools—the customer determines whether the efforts were worthwhile.

Total employee involvement: All employees participate in working toward common goals. Totalemployee commitment can only be obtained after fear has been driven from the workplace, when empowerment has occurred, and management has provided the proper environment. High-performance work systems integrate continuous improvement efforts with normal business operations. Self-managed work teams are one form of empowerment.

Process-centered: A fundamental part of TQM is a focus on process thinking. A process is aseries of steps that take inputs from suppliers (internal or external) and transforms them into outputs that are delivered to customers (again, either internal or external). The steps required to carry out the process are defined, and performance measures are continuously monitored in order to detect unexpected variation.

Integrated system: Although an organization may consist of many different functionalspecialties often organized into vertically structured departments, it is the horizontal processes interconnecting these functions that are the focus of TQM.

Strategic and systematic approach: A critical part of the management of quality is the strategicand systematic approach to achieving an organization's vision, mission, and goals. This process, called strategic planning or strategic management, includes the formulation of a strategic plan that integrates quality as a core component.

Continual improvement A major thrust of TQM is continual process improvement. Continualimprovement

drives an organization to be both analytical and creative in finding ways to become more competitive and more effective at meeting stakeholder expectations.

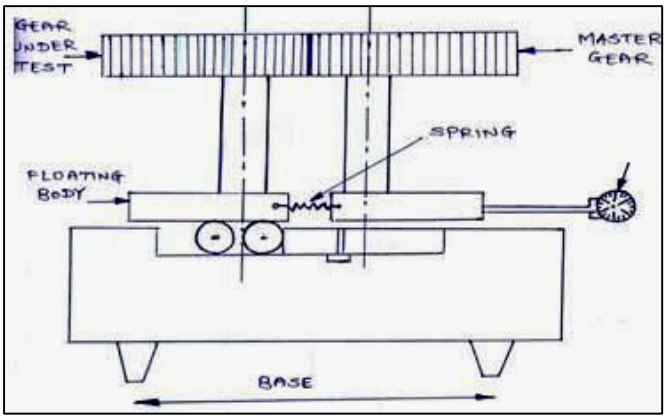
Fact-based decision making In order to know how well an organization is performing, data on performance measures are necessary. TQM requires that an organization continually collect and analyze data in order to improve decision making accuracy, achieve consensus, and allow prediction based on past history.

Communications: During times of organizational change, as well as part of day-to-dayoperation, effective communications plays a large part in maintaining morale and in motivating employees at all levels. Communications involve strategies, method, and timeliness.

E) Explain the principal of measurement of "The Parkinson Gear Tester" with neat sketch.
(Fig.02 mark +02 explanation)

Use:-

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



Principle:-

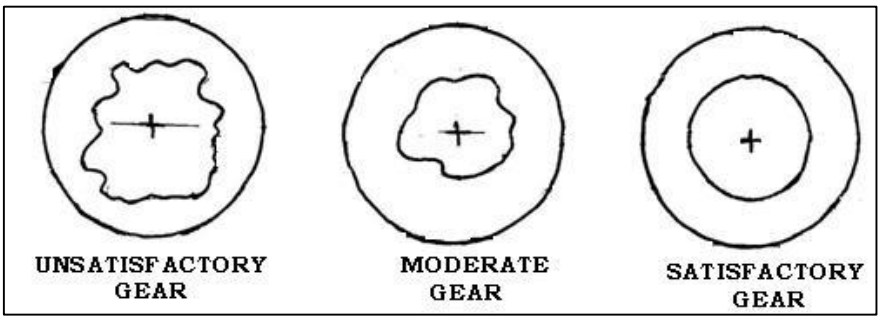
The gear to be tested is rolled in meshed with master gear and error will indicated by dial gauge.

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.

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.



Q4 A) Attempt any three.

a) Distinguish between Alignment and performance test' of a machine.

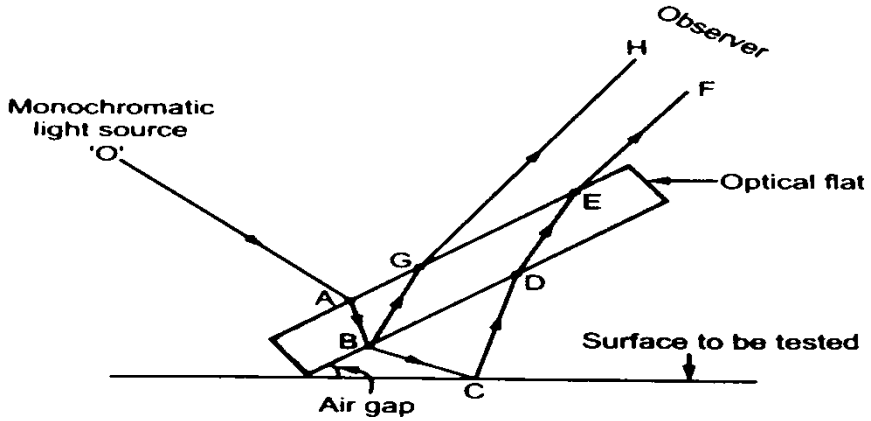
Sr. No.	Alignment Test	Performance Test
01	Alignment test are carried out for various parts of machine like its spindle, slides, holding table etc.	Performance test are carried out to access the performance of machine tool in working condition.
02	Alignment test are also called geometrical test.	Performance 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 point, 1 mark each)

b) By using optical flat and monochromatic light, state how will you determine whether given surface is concave or convex? (2 Marks for figure, 2 marks for explanation)

Following is the procedure to determine whether given surface is convex or concave

- Following fig. Shows the optical ray diagram of optical flat and the checking can be started by keeping the optical flat on the surface to be tested and monochromatic light is incident on optical flat.
- The air gap between optical flat and surface to be tested and the phase difference between reflected ray will generate the dark and bright band which gives basic idea about flatness of surface



- From diagram it is observed that ray B-C-D-E-F is longer than B-G-H by an optical distance BCD and if , **1)** BCD=n ʎ (1,2,3…..),two rays come in phase and join together as a bright band and **2) If BCD =n/ʎ9 (n=1,2,3..), then rays are out of phase, they cancel each other and gives dark band.**
- When the surface is not flat ,the band obtain will be curved and if the band curved around the line of contact the surface is convex as shown in following fig.a.
- If the bands curve in opposite direction the surface is concave as shown in fig b.

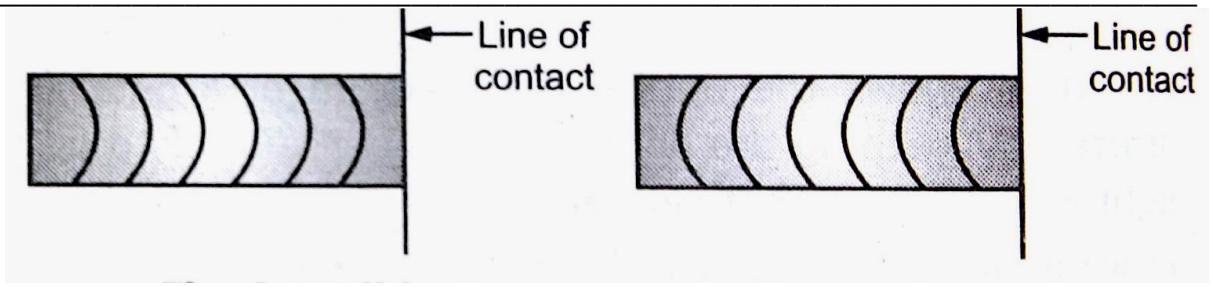


Fig.a Convex surface **Fig.b Concave surface**

c) Design a general type of plug gauge for checking a hole dimension $30^{+0.05}_{-0.03}$. Consider both wear allowance and gauge tolerance as 10%of work tolerance.

Ans:

Upper limit of hole= 30+0.05=30.05mm

Lower limit of hole=30-0.03=29.97mm

Work tolerance= Upper limit -Lower limit

= 30.05 – 29.97
=0.08 mm

Gauge maker Tolerance=10% of work tolerance

= 10/100 X 0.08
= 0.008 mm

Wear allowance = 10% of gauge tolerance
= 10/100 X 0.08
=0.0008 mm

Size of Go gauge= Lower limit + Wear allowance

= 29.97 +0.008
=29.9708mm

Size of NO-GO gauge = Upper limit

=30.05 mm

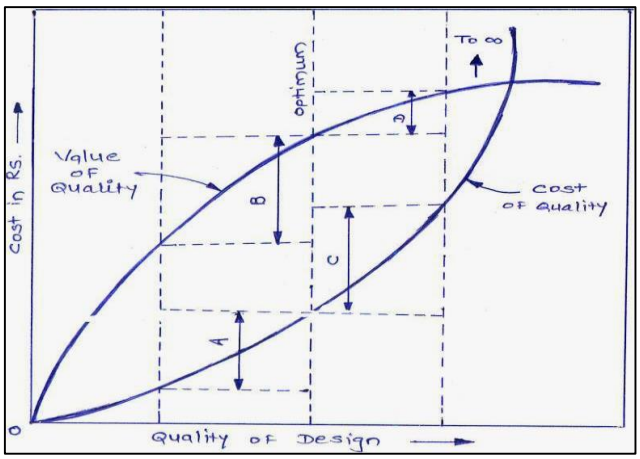
Design of plug gauge=

Limits for Go gauge= $29.9708^{+0.008}_{-0.000}$------ **02 mark**

Limits fo NO-Go gauge = $30.05^{+0.008}_{-0.000}$**-----** **02 mark**

d) Explain 'Cost of Quality' and Value of Quality 'with the help of graph.

(Graph 1 mark+ 3 mark explanation)



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

1. It is not necessary that the company should manufacture 100% quality products.
2. The study of optimum quality of design involves "Market Survey".
3. While carrying out market survey expected sale for particular quality, profit and competition in the market is to be considered.
4. The quality of design should meet the needs of the customers and at the same time its manufacturing cost should be such which will yield maximum profit.
5. The aim should be to improve quality at lower cost.
6. The curves representing the cost and value of quality of design are shown in fig.
7. If we want to improve the quality of design from point 1 to point 2 the cost of quality will increase by amount A whereas the value of quality will increase by amount B.
8. Now B >A and therefore, improvement in quality at this level will yield more income.
9. However, if the quality is to be improved from point 2 to point 3, then from the fig.
10. D < C i.e. the increase in value of quality is less than the increase in the cost of quality.

So, the quality level at point 2 is optimum quality of design. Below this optimum the profit that can be earned is not maximized and above this optimum it is uneconomical to improve the quality of design.

Q4 B. Attempt any one.

a) Compare single and double sampling plan.

(Consider any 6 point, 1 mark each)

Sr. No	Parameters	Single Sampling	Double Sampling
1	No. of sample	One sample	Two sample
2	Sample size	Large	Half of that single sampling
3	Decision for acceptance of rejection	Based on sample taken	Based on first as well as the outcome of first and second sample
4	Inspection load	High	Less
5	Variability of inspection load	Constant	Variable

6	Estimation of lot quality	Best	Intermediate
7	Amount of record keeping needed	Least	Results of first and second to be noted

b) State the characteristics and applications of Normal distribution curve.

(03 marks characteristics +03 marks applications)

Ans: Characteristics of N. D. Curve

1. N.D. curve is bell shaped and symmetrical about the mean.
2. The curve is fully defined by X-bar and σ
3. N. D. curve extends from -3σ to +3σ.
4. The limits with in curves are,

Specific limits	% of Total area
$\bar{x} \pm \sigma$	68.26%
$\bar{x} \pm 2\sigma$	95.46%
$\bar{x} \pm 3\sigma$	99.73%

Applications of N. D. Curve:

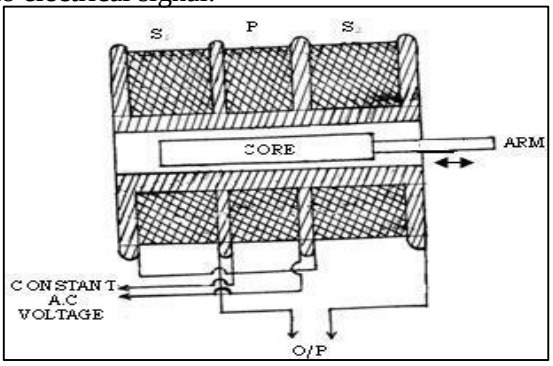
1. In process capability study it is used to find, whether the process is capable of meeting the specified tolerance or not.
2. The area under the curve between two limits represents the total % of production that will fall between these limits.
3. When selection 0f 3σ limits, we are 95.73% sure that the observations will lie within permissible limits.
4. It helps to calculate the expected proportion of observation that will be less than or equal to specified value $\bar{x}$.
5. It also help to calculate the expected proportion of observation that will be beyond the specified value of $\bar{x}$.

Q5. Attempt any two.

a) With a neat sketch explain the principle of working of LVDT. State its applications.

(02 Figure +02 Construction+02 Working+02Applications)

L.V.D.T. is work as a electrical comparator. It is most popular electro-mechanical device to convert mechanical displacement into electrical signal.



Construction:-

1. It consists of one primary and two secondary windings. The movable soft iron core is placed inside the coil, shown in figure. The core is attached to the work piece which is to be compared.
2. The secondary winding has equal number of terns and placed symmetrically on both the side of primary winding.
3. The primary winding is connected to an A.C. supply. A magnetic flux generated by this coil is cut by the soft iron core and hence the voltage is induced in the two secondary windings.
4. The total assembly is kept in stainless steel housing.

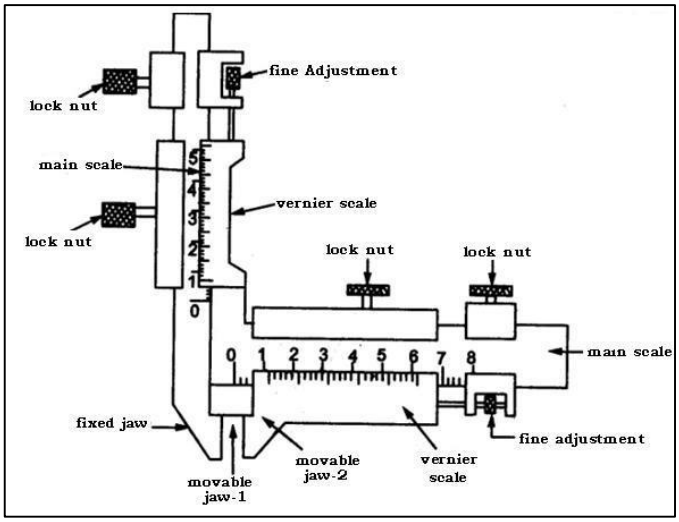
Working:-

1. As secondary windings 'S_1 '& 'S_2' are connected in series opposition as shown in figure. The net output from the transformer is the difference between secondary windings.
2. When the core is perfectly at centre equal but opposite E.M.F. is induced in secondary winding and zero output is recorded.
3. The voltage induced in secondary winding ' S_2 ' increases, if the core is shifted towards left.
4. If the core is shifted toward right then 'S_1 'increases as compare to 'S_2 '. By taking the difference between 'S_1 '& 'S_2' we can judge the position of core.

Applications:

1. Displacement measurement
2. Used to measure force, weight and pressure.
3. Used to measure tension in rod and cable.
4. Used for measurement and control of thickness of metal sheet.

b) Explain the principle of measurement of a spur gear tooth thickness using gear tooth vernier and State mathematical relations to compare chordal addendum and chordal tooth thickness.
(3marks (figure)+3 marks procedure to measurement+02mathematical relations)



Construction:-

1.It consists of one horizontal and one vertical scale for measuring width and thickness at same time.
2.It measures the thickness of tool on pitch circle. It also consists of two beams which are square with each other there are two main scale of which vernier scale sides.

3.Tooth thickness on the pitch circle is measured as the distance between the fixed jaws and movable jaw by fixing distance at adjustable jaws of vertical vernier beam.

Working principle:-

The gear tooth thickness is measured at pitch circle and it also called as pitch line thickness.

$$\frac{N.m}{2}\left[1+\frac{2}{N}-\cos\frac{90}{N}\right]$$

$$d=\frac{N+m}{2}\left[1-2m-\left(\cos\frac{90}{N}\right)\right]$$

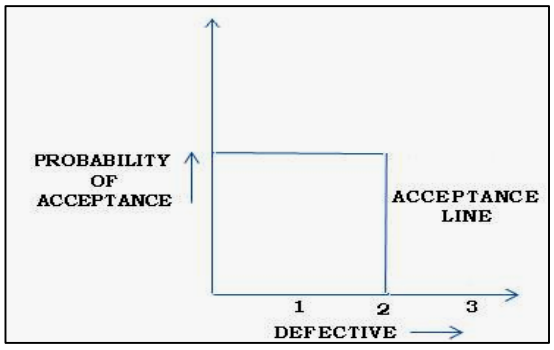
Where,
N = No. of tooth
M = module

Tooth thickness can be calibrated using gear tooth vernier by setting vertical vernier we get depth and by setting of horizontal vernier we get width of tooth.

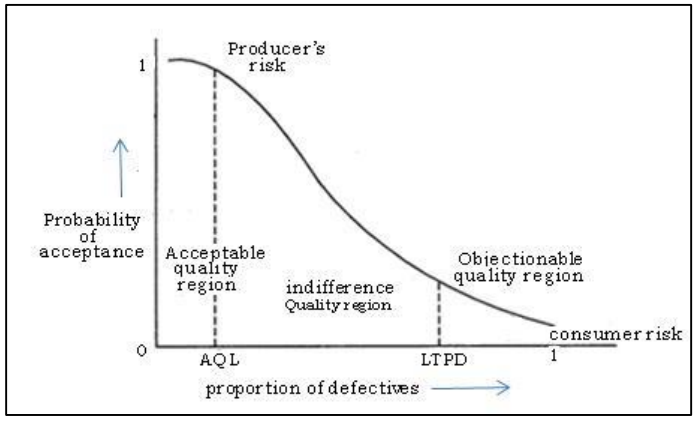
$$w=\mathrm{N.m}\sin\left(\frac{90}{N}\right)$$

c) Draw a neat labeled sketch of O.C. curve. State procedure steps of construction of O.C. curve.
(04 fig.+04 explanation)

1) Ideal OC Curve:-



2) Actual OC Curve:-



OC CURVE Procedure

1. It is graph drawn with lot fraction defective 'P' on X axis verses the probability of acceptance on Y axis, as shown in figure.
2. The OC curve defines the actual characteristics of a given acceptance sampling plan.
3. An OC curve shows, for every possible fraction defectives 'P' on a given lot will be accepted by the acceptance sampling plan that the OC curve represents.
4. An OC curve provides the means of evaluating the operation of an acceptance sampling plan.
5. This risk in a particular sampling plan can be determined by considering the results of samples dwran from a large number of lots of various quality levels using the mathematical theory of probability.
6. Every sampling plan has its own consumer and producer's risks as indicated by its OC curve.

Q6.Attempt any two:

a) i) Distinguish between 'Primary Texture'& 'Secondary Texture'.

Primary Texture:- (2 Marks)

It is the roughness of surface. It also called micro-geometrical error. It is irregularity of small wavelength. These irregularities of third order and fourth order i.e. of feed marks of cutting tool and rupture of material due to separation of chips.

These irregularities are caused due to direct action of cutting element on material. The evaluation of surface finish is based on height of character of irregularities.

Secondary Texture:- (2 Marks)

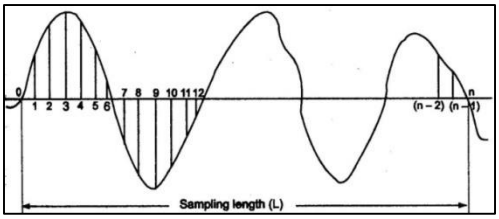
It is also the roughness of surfaces. It is irregularities of larger wavelength. It is also called as macro-geometrical error.

This irregularity of first and second order .i.e. of due to lack of straightness of guide ways of tool, weight of material itself and due to vibration and chatter marks.

ii) Define CLA and RMS values as applied to surface roughness measurement.

CLA Value (Centre Line Average Method) :- (2 Marks)

The average height from a mean line of all co-ordinates of the surface regardless of it's sign.



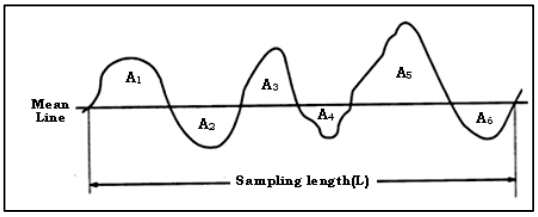
Mathematically,

$$\text{CLA Value} = \frac{A_1 + A_2 + A_3 + A_4 + \ldots\ldots\ldots + A_n}{L}$$

$$\text{CLA Value} = \frac{\Sigma A}{L}$$

RMS Value (Root Mean Square):- (2 Marks)

It is a square root of arithmetic mean of values of square of co-ordinates of the surface from mean.



Mathematically,

$$\text{RMS Value} = \sqrt{\frac{Y_1^2 + Y_2^2 + Y_3^2 + ...Y_n^2}{N}}$$

N = no of co-ordinates.

b) i) State the meaning of Quality of design and Quality of conformance.

Quality of design (2 Marks)

Quality of design of product is concern with tightness of specification for manufacturing of that product.

e.g. A part which has drawing tolerance has 0.01mm is consider having better quality of design over the tolerance has 0.1 mm.

Quality of conformance (2 Marks)

Quality of conformance means how well manufacture the product confirms (matches) to the quality of design.

Requirement of good 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.

ii) State the importance of 'Quality Audit'. (Any four point, 1 Mark for each)

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.

c)

Sr.No.	Lot size	Defectives	Fraction Defectives	% defectives
1	**728**	**48**	**0.0659**	**6.59**
2	**724**	**83**	**0.1146**	**11.46**
3	**720**	**80**	**0.1111**	**11.11**
4	**730**	**58**	**0.0794**	**7.94**
5	**724**	**60**	**0.0828**	**8.28**

01 mark for table

$$\overline{P} = \frac{\sum d}{\sum n} = \frac{329}{3626} = 0.0907 = 9.07\%$$ ---------- (01 Mark)

$$n = \frac{3626}{5} = 725.2$$ ---------- (01 Mark)

$$UCL = \overline{P} + 3\times\sqrt{\frac{\overline{P}(1-\overline{P})}{n}}$$

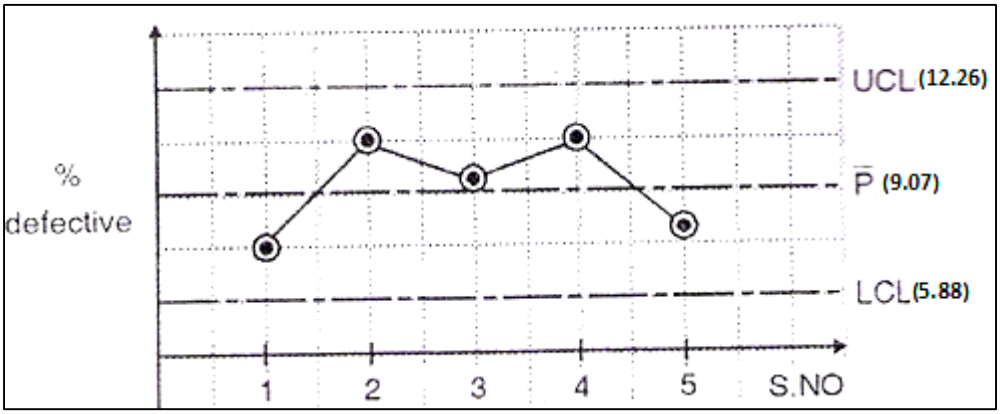
$$= 0.0907 + 3\times\sqrt{\frac{0.0907(1-0.0907)}{725.2}} = 0.1226$$

$$UCL = 12.26\% \text{ ---------- (01Mark)}$$

$$LCL = \overline{P} - 3\times\sqrt{\frac{\overline{P}(1-\overline{P})}{n}}$$

$$= 0.0907 - 3\times\sqrt{\frac{0.0907(1-0.0907)}{725.2}} = 0.058$$

$$LCL = = 5.88\% \text{ ---------- (01 Mark)}$$



(Graph 02 mark)

Conclusion: (01 mark)

As all points are within control limits, hence given Process is in Control.