Q.1(a) Attempt any THREE of the following: **[12]**

Q.1(a)(i) Define line standard and end standard. Give one application of each. **[4]**

(A) Line standard is the standard in which distance is measured between two parallel lines.
Application : Steel rule, measuring tape
When the distance is measured between two parallel surfaces it is called as end standard
Application : Slip gauges, End bars

Q.1(a)(ii) State the Taylor's principle of gauge design. **[4]**

(A) Taylor's principle of gauge design states that.

(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 NOGO snap gauge corresponds to the low limit of shaft.

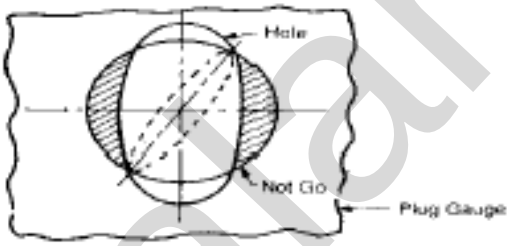


Fig. : Checking an a oval shape

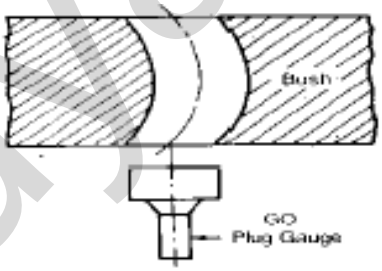


Fig. : Checking a bush with curved

(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.

Q.1(a)(iii) Differentiate between 'angle gauges' and 'slip gauges'. (four points) **[4]**

(A)

	Angle gauges	**Slip gauges**
(i)	Angle gauges enables angle to be set to the nearest 3".	Slip gauges are universally accepted end standard of length in industry.

(ii)	It has triangular in cross section.	It has rectangular in cross section.
(iii)	The angle gauges are marked with engraved V which indicates the direction of the inclined angle which affects on addition and substration of angles.	The direction of slip gauges is not affected in addtion and substration of dimension.
(iv)	Angle gauges are available in 12 and 13 pieces set.	Slip gauges are avilable in M-45, M-87, M-112 and M-33/2.
(v)	Any angle can built by adding and subtraction of angle gauges in combination with square block.	Any linear dimesion can built by adding the combination of slip gauges.

Q.1(a)(iv) If length of sine bar is 100 mm, find the length of slip gauges required to build an angle of 14° by using M45 slip gauge set. **[4]**

(A) **Given data :** Length of sine bar (I) = 100 mm Angle (θ) = 14°

Height of slop required (h) = ?

Sin θ = h/I

Sin 14 = h/100

h = 24.192 mm

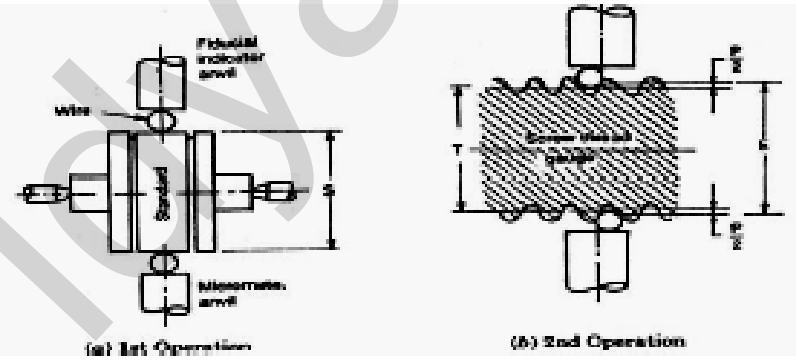
For 24.192mm, slips are as follows using M45 set

Slips	Remaining size	slop s
1.002	23.19	01
1.09	22.1	01
1.1	21	01
1	20	01
20	0	01

Q.1(b)Attempt any ONE of the following: **[6]**

Q.1(b)(i) Write a procedure for measuring of 'Effective diameter' of screw thread, by using 'two-wire method'. **[6]**

(A)



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 =R1. 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- (R1-R2)

P = 0.9605p-1.1657d (for Whitworth thread), P = 0.866p- d (for Metric thread).

Q.1(b)(ii) Differentiate 'line standard', 'end standard' and 'wavelength standard'. (Give one application of each of them). [6]

(A)

	Comparative Point	Line standard	End standard	Wavelength Standard
(1)	Accuracy	Less accurate (± 0.1 mm)	Moderate accuracy (± 0.001 mm)	Highest
(2)	Time required for measurement	Less	More	Most
(3)	Method of measurement	Easy	Little difficult	Very difficult to arrange set up of measurement
(4)	Cost of inspection	Less	More	Highest
(5)	Errors	Parallax error	Environmental error, stylus pressure errors	No errors except human error
(6)	Care	Engraved scale Markings should be protected	Ends should be protected by offering optimum stylus pressure	They are not subjected to changes in ambient conditions. So less care required.
(7)	Example	Steel rule	Micrometer	Monochromatic source of light.

Q.2 Attempt any FOUR the following : [16]

Q.2(a) State the advantages and limitations of mechanical comparator. [4]

(A) Advantages of mechanical comparators

(i) Cheaper in cost.
(ii) No need of external power source.
(iii) Generally linear scales are adopted
(iv) Robust and compact designs.
(v) Easy to sue and understand.

Limitations of mechanical comparators

(i) Due to moving parts more wear and tear.
(ii) Sensitive to shocks and vibrations.
(iii) Parallax errors are possible.
(iv) Range of applications is limited.

Q.2(b) What is 'Interchangeability'? State its need and relevance in mass production industries. [4]

(A) 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.

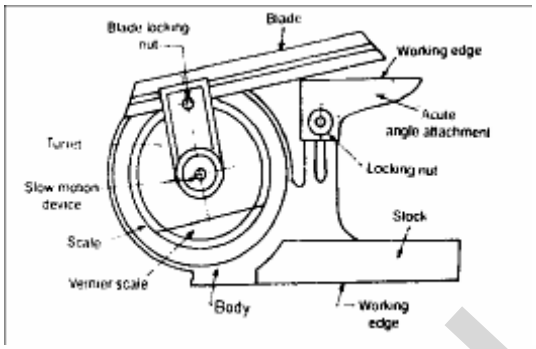
Need and relevance in mass production industry.

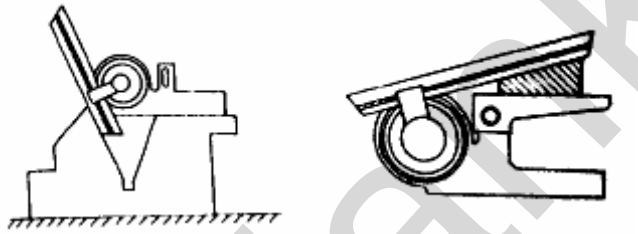
- It facilitates production of mating components at different places, by different operator, hence outsourcing can be possible.
- Production on an interchangable basis results in increased output with a corresponding reduction in manufacturing.
- The replacement of worn out or defective parts and repairs 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.

Q.2(c) Draw a labelled diagram of a universal bevel-protractor show its specific application on diagram. **[4]**

(A)



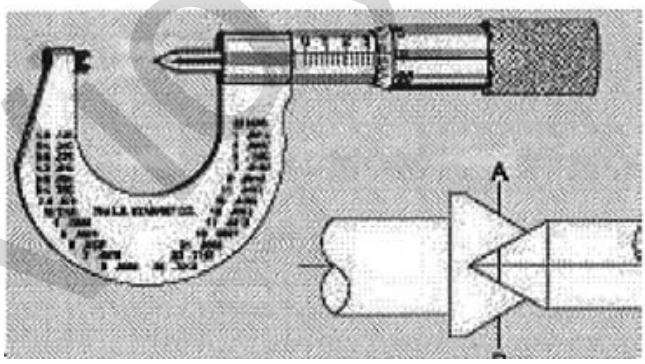


Use of bevel protector for checking of V block and measuring acute angle

Q.2(d) Draw a neat labelled sketch of screw thread micrometer. State its principle of working. **[4]**

(A) Screw thread micrometer is similar to the simple outside micrometer. The difference is instead of flat anvils, thread profile anvils are used in screw thread micro meter. The anvils are removable. Anvils are selected depending on type and pitch of thread.

Screw thread micrometer is used to measure root diameter and major diameter of threads. The method of finding total reading is same as that of the simple micrometer



Q.2(e) Explain the terms Calibration and Traceability. **[4]**

(A) **Calibration :** The instruments, gauges to be used for measurement should be of known accuracy in order that the result obtained are meaningful. In order to identify the errors and rectification of errors the instruments are compared with masters or standards. This act of comparison is known as calibration.

Traceability : Traceability is the property of the results of a measurement, not of an instrument or calibration report or laboratory. Traceability means the result of measurement can be related to a reference through series of calibration reports.

Q.3 Attempt any FOUR of the following : [16]

Q.3(a) Define the term 'comparator'. State the characteristics of a good comparator. [4]

(A) Definition:

Comparator is a device which.

(i) Pick-up small variation in dimension.

(ii) Magnified it.

(iii) Display it by using indicting device so that comparison can be made with same standard value.

Characteristics of a good comparator :

(i) It should be compact.

(ii) It should be easy to handle.

(iii) It should give quick result or quick response.

(iv) It should be reliable while used.

(v) It's weight must be less.

(vi) It must be protable.

(vii) It must be easily available in market.

(viii) It should be sensitive as per requirement.

(ix) It should be robust in design.

(x) It should have less maintenance.

(xi) It should be linear in scale, so that easy to read and get uniform response.

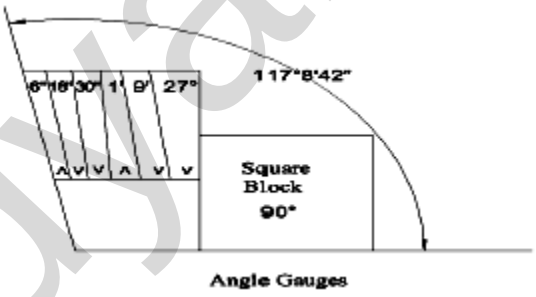
(xii) It should have hard point of contact with longer life.

Q.3(b) An angle of 117° 8′ 42″ is to be set and measured with the help of standard angle gauges and square block. Select the minimum number of pieces and sketch the arrangement. [4]

(A) 117° = 90° + 27°

8′ = 9′ -1′

42″ = 30″ + 18″

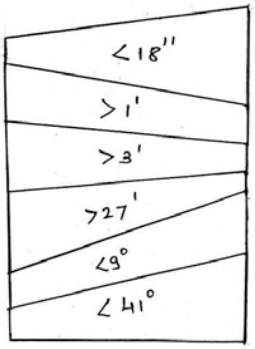


Q.3(c) An angle of 49° 29′ 18″ is to be developed by using standard angle gauge set of 13 pieces. Calculate the gauges required and sketch the arrangement. [4]

(A) Given angle of 49° 29′ 18″ can be build using following set of angle gauges

41° + 9° – 27' – 3' – 1' + 18"

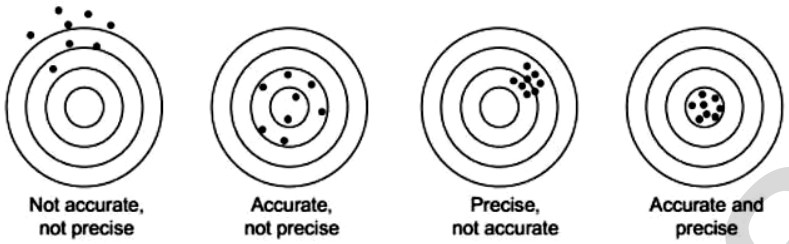
– Minimum number of angle gauges = 06



Q.3(d) Distinguish between accuracy and precision with suitable sketch. [4]

(A)

	Accuracy	Precision
(i)	The closeness to the measured value with true value is called accuracy.	Repeatability of measuring process is called precision.
(ii)	Costlier to achieve great accuracy	Easier and cheaper to achieve precision
(iii)	It is related to true value.	It is related to average value.
(iv)	Example	Example



Q.3(e) Define any four factors affecting accuracy of measurements. [4]

(A) Factors affecting accuracy of measurements

Measuring Instrument : The accuracy of the measurement depends upon the various static and dynamic characteristics of measuring instruments. (like range, readability, sensitivity, repeatability etc.)

Environmental Conditions : Factors like temperature, pressure and humidity greatly affects on the accuracy of the measurement.
As per the international practices temperature in the test laboratories should be maintained at 20°C
It is recommended to maintain positive air pressure (10-20 N/m^2)

Calibration of instruments : It is important that any measuring system should be calibrated periodically to get meaningful results.

Handling of instruments : Measuring instruments must be handled carefully to avoid the errors in measurement and also to save the life of instrument.

Proper method of using an instrument.

Q.4(a) Attempt any THREE of the following: [12]

Q.4(a)(i) Distinguish between 'Alignment test' and 'Performance test' of a machine tool. [4]

(A)

	Alignment test	Performance test
(i)	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.
(ii)	Alignment test are also called geometrical test.	Performance test is also called as practical test.
(iii)	These tests are carried out loaded and unloaded condition.	These tests are carried out in working condition.
(iv)	It is done to check the grade of manufacturing of machine tool.	These tests are carried out to check the accuracy of finished product.
(v)	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.

Q.4(a)(ii) Define the terms Rq, CLA, RMS and R_Z values with respect to surface finish. [4]

(A) **Rq (Geometric average roughness) :** Rq is the geometric average height of roughness component irregularities from the mean line, measured within the sampling length.

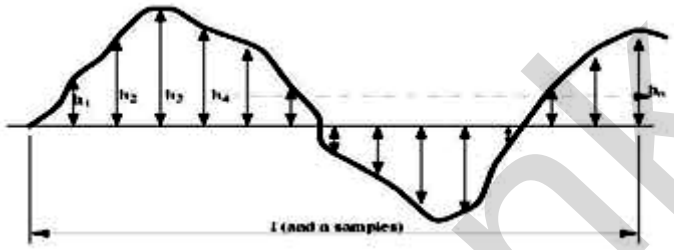
CLA : It is defined as the average height from a mean line of all ordinates of the surface regardless of the sign.

$$\textbf{CLA} = Ra = \frac{\sum h}{n} = \frac{h_1 + h_2 + ... + h_n}{n}$$

RMS : It is defined as the square root of the mean of the squares of the ordinates of the surface measured from the mean line.

$$\textbf{RMS} : \sqrt{\frac{h1^2 + h2^2 + h3^2 + ... + hn^2}{n}}$$

selected length L is divided into n equal parts h1, h2, h3, h4, ..., h_n are the heights of selected points 1,2,3,4….n.



Rz : in this the average difference between the five highest peaks and five deepest valleys within the sampling length, measured from a centre line.

Rz = 1/5 [(R1 + R2 + R3 + R4 + R5) − (R6 + R7 + R8 + R9 + R10)]

Q.4(a)(iii) Design a general type plug gauge for checking a hole dimension $30^{+0.05}_{-0.03}$. [4]
Consider both wear allowance and gauge tolerance as 10% of work tolerance.

(A) 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
= 0.08mm
Gauge maker Tolerance = 10% of work tolerance
= 10/100 × 0.09
= 0.008 mm
Size of NO-GO gauge = Upper limit
= 30.05mm

Design of plug gauge =
Limits for Go gauge = $29.9708^{0.008}_{0.000}$

Limits for No-Go gauge = $30.05^{+0.008}_{-0.000}$

Q.4(a)(iv) What is the meaning of $35H_8f_8$? State meaning of each term. [4]

(A) 35 H_8 means an H-hole of basic size 35mm having tolerance grade IT8.

35 f_8 means an f-shaft of basic size 35 mm having tolerance grade IT8.

35 H_8 f_8 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.

Q.4(b) Attempt any ONE of the following: **[6]**

Q.4(b)(i) Compare single and double sampling plans. **[6]**

(A)

	Parameters	Single Sampling	Double Sampling
(i)	Number of sample	One sample	Two sample
(ii)	Sample size	Large	Half of that Single sampling
(iii)	Decision for acceptance or rejection	Based on sample taken	Based on first as well as the outcome of first and second sample
(iv)	Inspection load	High	Less
(v)	Variability of inspection load	Constant	Variable
(vi)	Estimation of lot quality	Best	Intermediate
(vii)	Amount of record keeping needed	Least	Results of first and second to be noted

Q.4(b)(ii) Define TQM. Describe any 3 principal elements of TQM. **[6]**

(A) TQM :

Definition : TQM is the business process and philosophy founded on customer satisfaction and ends with the customer.

TQM refers to the involvement of staff in an organization together which includes suppliers, distributors, and even customers in bringing about quality satisfaction.

Elements of TQM

(i) Customer satisfaction : It is the ultimate goal in TQM and thus forms the focal element in TQM. TQM aims at satisfying customer's requirements which never remain constant but keep on changing in times, environment, circumstances, needs, fashion, standard of living etc.

(ii) Do it right first : TQM adopts the policy of ZERO defects. There is no scope for rework and rejections. The right first time or zero defect is the result of an emphasis on prevention and use of SPC (statistical process control).

(iii) Continuous Improvement : the organization has to scope up with the changing requirement of customers. The TQM strives for ever better quality, cost reduction to face competition and for the survival of the organization.

(iv) Employee Involvement : all the persons working in the organization including managers and workers should be involved in TQM operation. A positive attitude towards customer and constant enhancement of quality must be ingrained in the minds of the employees.

(v) Empowering the staff

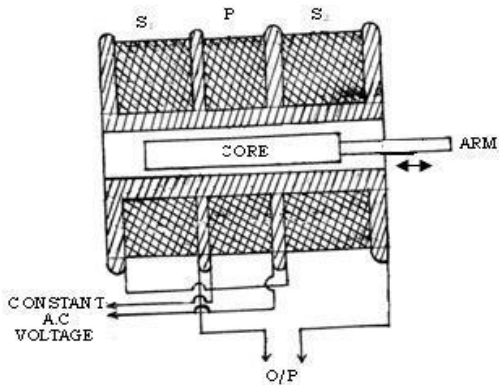
(vi) Benchmarking

(vii) Feedback mechanism

Q.5 Attempt any TWO of the following: **[16]**

Q.5(a) With a neat sketch explain the principle of working of LVDT. State its applications. **[8]**

(A) LVDT is work as a electrical comparator. It is most popular electro-mechanical device to convert mechanical displacement into electrical signal.



Construction:

(i) 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.

(ii) The secondary winding has equal number of terns and placed symmetrically on both the side of primary winding.

(iii) 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.

(iv) The total assembly is kept in stainless steel housing.

Working:

(i) 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.

(ii) When the core is perfectly at centre equal but opposite E.M.F. is induced in secondary winding and zero output is recorded.

(iii) The voltage induced in secondary winding ' S_2 ' increases, if the core is shifted towards left.

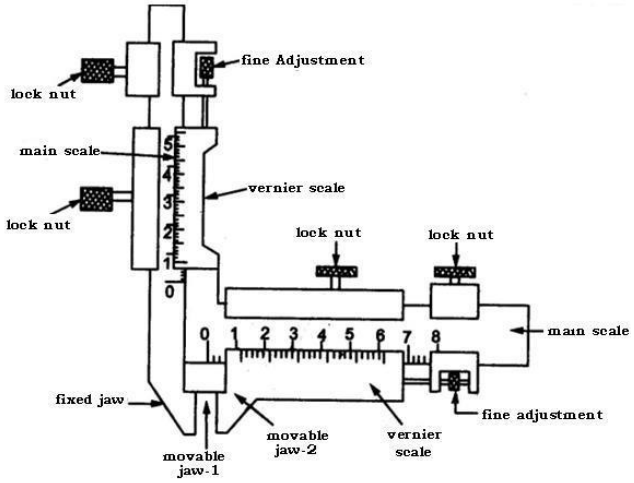
(iv) If the core is shifted toward right then '$S1$ 'increases as compare to 'S_2 '. By taking the difference between 'S_1 '& 'S_2' we can judge the position of core.

Applications:

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

Q.5(b)Explain the principle of measurement of a spur gear tooth thickness using gear tooth vernier. State mathematical relations to compute chordal addendum and chordal tooth thickness. **[8]**

(A)



Construction:

(i) It consists of one horizontal and one vertical scale for measuring width and thickness at same time.

(ii) 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.

(iii) 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,

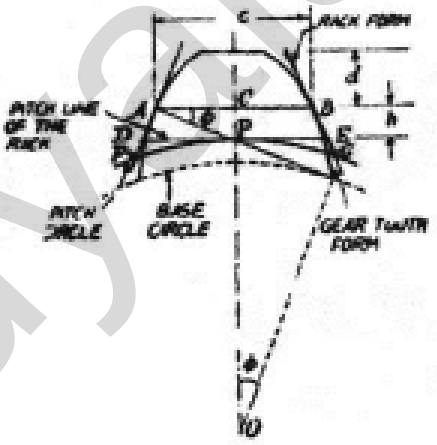
N = No. of tooth

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.

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

Q.5(c) With a neat sketch, explain measurement of tooth thickness by constant chord method. [8] (A)



Constant chord of a gear is measured were the tooth finals touch the flank of the basic rack. The teeth of the rack are straight and inclined to their centre lines at the pressure angle as shown in figure.

The gear tooth and rack space are in contact in the symmetrical position at the point of contact of the flanks. The chord is constant at this position irrespective of the gear of the system in mesh with the rack. This is the property utilized in the constant chord method of the gear measurement.

The measurement of tooth thickness at constant chord simplified the problem for all number of teeth. Line AB is known as constant chord. The value of C and its depth from the tip d where it occurs can be calculated mathematically and then verified by an instrument.

$\therefore \quad d = m\left(1 - \frac{\pi}{4}\cos\theta\sin\theta\right)$

$C = AB$ = constant chord

$C = AB - \pi/z\ m.\cos^2\theta$

Q.6 Attempt any TWO of the following: [16]

Q.6(a) Explain in brief two wire method for thread measurement. [8]

(A) (i) Effective diameter can be measured by using floating carriage instrument which is more accurate.

(ii) For measurement of effective diameter two wire methods are used.

(iii) Two wire methods consist of use of two identical based size of wires.

(iv) Figures shows that measurement of (thread and wire) dimension. The wires of are to be inserted in such a way that

(a) They should be inserted in the same thread and

(b) The flank surfaces are tangent to the wire.

The dimension of thread wire is indicated by R.

(v) Figure shows geometrical sketch with one thread and one wire.

(vi) Various terms are defined as

Diameter over wire = R which is measured as shown in figure.

Diameter under wire = T

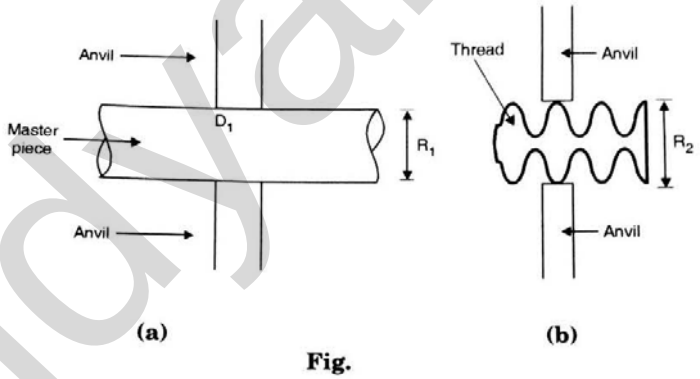
Pitch value = P (it is difference between effective diameter and diameter under wire)

(vii) From figure it is clear that effective diameter E is addition of diameter under wire and pitch value.

$E = T + P$

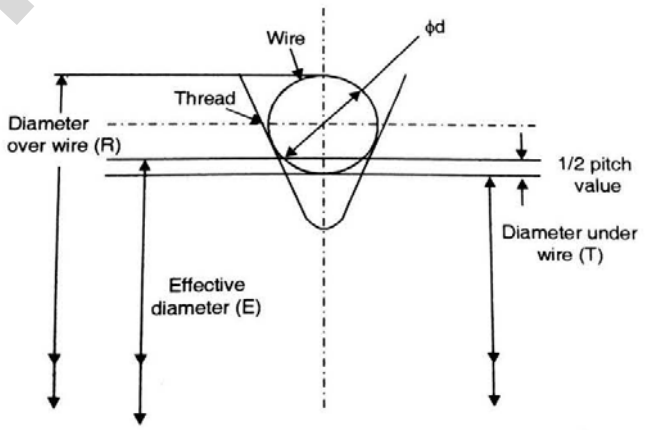
$E = (R - 2d) + P$ where $T = R - 2d$, E = effective diameter, R = diameter over wire, d = wire diameter, P = pitch value

(viii) For reducing various types of errors master piece can be used at the time of measurement.



(a) (b)

Fig.



(c)

Fig. Two wire method

Q.6(b) Following are the inspection results of magnets for 10 observations. Draw appropriate control chart and write your conclusion. [8]

Given : A_2 = 0.58, d_3 = 0, d_4 = 2.11

Day	1	2	3	4	5	6	7	8	9	10
No. of defective magnets	58	83	70	80	72	58	64	78	80	84
Magnets inspected	721	728	720	730	720	700	710	700	710	740

(A)

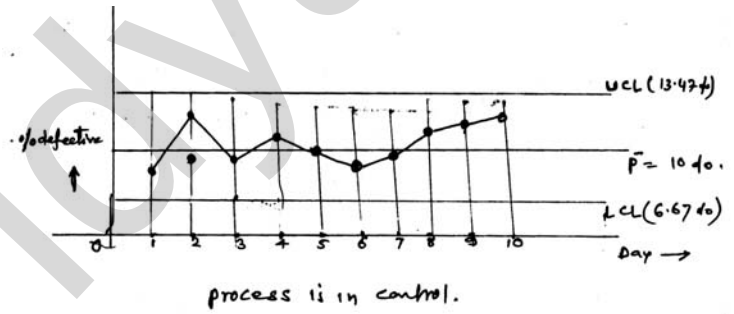
Day	No. of defective magnets	Magnets inspected	% defectives
1	58	721	8.04
2	83	728	11.4
3	70	720	9.7
4	80	730	10.9
5	72	720	10
6	58	700	8.2
7	64	710	9.01
8	78	700	11.14
9	80	710	11.26
		Σn = 7179	Σd = 727

$$\bar{P} = \frac{\Sigma d}{\Sigma n} = \frac{727}{7179} = 0.101 = 10\%, \qquad n = \frac{\Sigma n}{n} = \frac{7179}{10} = 717.9$$

$$\text{VCL P} = \bar{P} + 3\frac{\sqrt{\bar{P}(1-\bar{P})}}{n} = 0.101 + 3\sqrt{\frac{0.101(1-0.101)}{717.9}}$$

$$= 0.134 = 13.47\%$$

$$\text{LCL P} = \bar{P} - 3\sqrt{\frac{P(1-P)}{n}} = 0.0673 = 6.73\%$$



process is in control.

Q.6(c) Following are the inspection results of magnets for five observations. Draw appropriate control chart and conclude. [8]

Week No.	1	2	3	4	5
No. of magnets inspected	728	724	720	730	724
Defectives found	48	83	80	58	60

(A)

	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

$$\bar{P} = \frac{\Sigma d}{\Sigma n} = \frac{329}{3626} = 0.0907 = 9.07\%$$

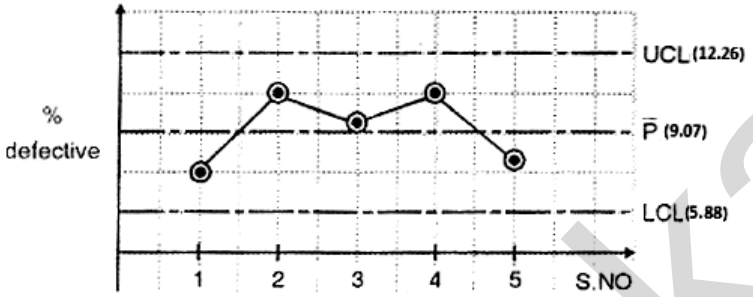
$$n = \frac{3626}{5} = 725.2$$

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

UCL = 12.26%

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

LCL = 5.88%



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