WINTER– 17 EXAMINATION

Model Answer

Subject Code: 17530

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.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1-	a i)	**Comparator:-** A comparator is a precision instrument employed to compare the dimension of a given component with a working standard • It does not measure the actual dimension but indicates how much it differs from the basic dimension • **Working Principle of Mechanical comparator:-** The Mechanical Comparators utilize mechanical methods for magnifying the movement of the contact plunger brought about due to the difference between the standard and the actual dimension being checked. The usual magnifications of the mechanism ranges from 250 to 1000. • Mechanical means for magnifying the small movement of the measuring stylus, Magnification of the small stylus movement is obtained by means of levers, gear trains, rack and pinion or combination	02 marks for definition 02 marks for principle

ii)

1) Tolerance:- The difference between the maximum and minimum limits of size is called tolerance. The permissible variation in size or dimension is called *tolerance*

2) Allowance:- The difference between the maximum shaft and minimum hole is known as allowance. In clearance fit this is the minimum clearance and is positive allowance. In an interference fit, it is the maximum interference and is a negative allowance.

- It is the prescribed difference between the dimensions of two mating parts for any type of fit.
- It is the intentional difference between the lower limit of hole and higher limit of the shaft.
- Allowance may be positive or negative. The positive allowance is called clearance and negative allowance is called interference.

3) Deviation:- Deviation is the algebraic difference between the maximum or minimum size with basic size/zero line.

4) Limits: - These are maximum and minimum permissible sizes of the part.

01 for each definition

iii)

Sine bar is not used for measurement of angle greater than 45^0 :

We know that angle is measured by using sine bar is based on sine principle,

$$\sin \theta = h / L$$

Where, h = Required slip gauge combination

L = center distance of rollers.

The relationship between the angular setting accuracy ($d\theta$) and any error which may be present in the slip gauge combination (dh) or the center distance between roller (dL) can be determined by differentiating the equation $\sin \theta = h / L$

$$\text{Or } h = L \sin \theta$$

The effect of error in spacing of roller centers (dl) or error in combination of slip gauges dh on angular setting accuracy can be obtained by partial differentiation of the above equation

02 marks for explanation

02 marks for derivation

$$h = L \sin\theta$$

$$\frac{dh}{d\theta} = \sin\theta \cdot \frac{dL}{d\theta} + L\cos\theta$$

$$dh = \sin\theta \cdot dL + L\cos\theta \cdot d\theta$$

$$dh - \sin\theta\, dL = L\cos\theta \cdot d\theta$$

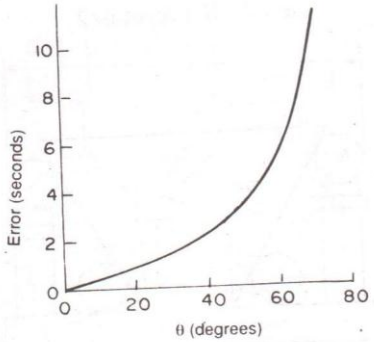
$$d\theta = \frac{dh}{L\cos\theta} - \frac{\sin\theta\, dL}{L\cos\theta}$$

$$d\theta = \frac{dh}{L\cos\theta} - \frac{dL}{L} \cdot \tan\theta$$

$$= \tan\theta\left(\frac{dh}{L\sin\theta} - \frac{dL}{L}\right)$$

But $L\sin\theta = h$

Therefore, $d\theta = \tan\theta\left(\frac{dh}{h} - \frac{dL}{L}\right)$



From above it is clear that error is the function of tan θ. Below 45^0 errors is smaller which increases rapidly above 45^0, as tan 45^0 is equal to one.

Thus in general it is preferable not to use the sin bar for measuring angles greater than 45^o if high accuracy is required

iv)

Factors affecting accuracy of measurements:-

Measuring Instrument:- The accuracy of the measurement depends upon the various static and dynamic characteristics of the 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_0c. 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.

01 for each

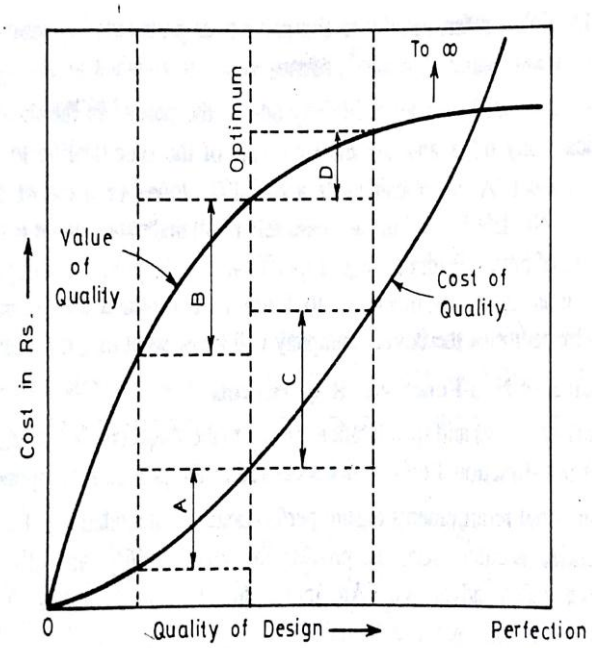
Any four

	b) i)	**Cost of quality and value of quality :** **Cost of quality:-** the cost of carrying out the company's quality functions are known as costs of quality. These includes:- 1. Market research cost of discovering the quality needs of the customer. 2. The product research and development costs of creating a product concept which will meet these quality needs. 3. The design costs of translating the product concept into information which permits planning for manufacture. 4. The cost of manufacturing planning in order to meet required quality specifications. 5. Cost of inspection and test 6. Cost of defect prevention 7. Cost of scrap, quality failures 8. Cost of quality assurance . 9. Field service and such other factors attributed to the quality improvement and maintenance. **Value of Quality:-** the value of quality can be defined as the return direct or indirect gained by the manufacturer due to mission of quality control. Value of quality is composed of : 1) Value inherent in the design 2) Value inherent in the conformance to that design. The value inherent in the design is usually called as grade. Grade is the variation in specification for the same functional use. The value of quality is to be assessed considering various factors , 1) The saving due to increased production. 2) Reduction in scrap and rework cost. 3) Increased sales of good quality product. 4) Indirect factors such as a) Reputation of the manufacturer and goodwill of the customer.	04 marks for explanation 02 marks for graph

b) Psychological stability in the enterprise due to increased sales and security of job workers.

The curve representing the cost and value of quality of design is shown in fig. 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, now B > A and therefore, improvement in quality at this level will yield more income.

However if the quality is to be improved from point 2 to 3 , then from the fig. 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.



Define TQM. Describe any 3 principal elements of TQM.

ii) **Definition :-**

It is the control of transformation process of an organisation to best satisfaction to the customer needs in most economical manner.

OR

It is the control of rating an organising culture committed to the continuous improvement through skill, team work, processes, and product quality and customer satisfaction.

1) Customer satisfaction:-

a) It is the ultimate goal in TQM, That the company should fulfill the customer expectations and make them delighted.

b) This means giving the customer more than his expectation by satisfying his requirement,

02 mark for definition,

02 marks to list the principle

03 marks for explanation (1 for each any three)

which never remain constant and keep on changing according to time, environment, fashion, standard of living etc.

2) **Continuous Improvement:-**

The organization has to cope up with the changing requirements of the customers. The various factors in improving the quality may be change in environment, development of new process, equipment, materials: innovations in a particular field, advancement in technology, change in fashion etc.

3) **Commitment of Top management:-**

For starting the TQM movement in the organization, complete change is needed in systems and structure of the organization. To 'Change', it is always resistance by works and even top level management. Because of this, it is suggested that top management should support the mission of TQM. Management should clarify concept and policies to its employees.

4) Employee Empowerment:-

a) It requires every member of the organization to accept quality as his major area of responsibility.

b) Empowering the staff assists to accomplish optimal business results through team work.

Meeting skills, positive attitude towards customer and constant enhancement of quality must be ingrained in the minds of the employees. Some of the practices, which encourage teamwork and training employee involvement include suggestion system, quality circles, self-managed teams, participative leadership etc.

2

a)

1) **CLA Value=**

$$\frac{49+27+39+24+44+26+45+27+41+25+42+28+43+26+46+29+47+28}{18}$$

02 marks

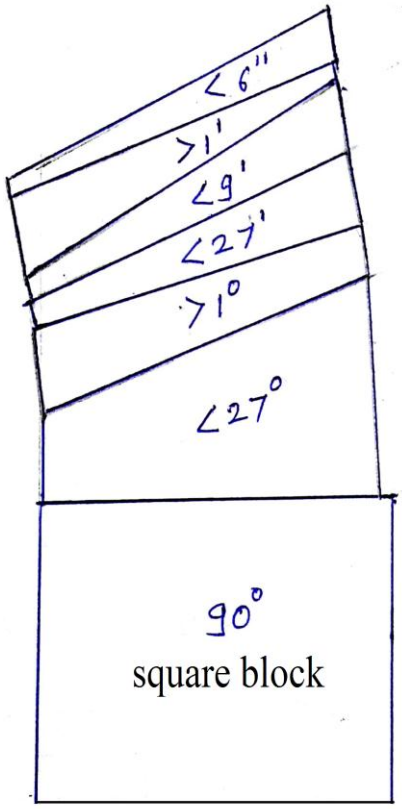
CLA Value = 35.33unit

2) **RMS Value** =

$$\sqrt{\frac{49^2+27^2+39^2+24^2+44^2+26^2+45^2+27^2+41^2+25^2+42^2+28^2+43^2+26^2+46^2+29^2+47^2+28^2}{18}}$$

02 marks

RMS Value = 36.45 unit

	b)		02 marks for list of gauges 02 marks for sketch
	c)	**1) Major diameter of External screw:-** Flat faced screw thread micrometer/bench micrometer/ Hand micrometer **2)Minor dia of Internal Screw:-** taper parallels, roller and slip gauges. Floating carriage micrometer with v- anvils , profile projector , tool makers microscope. **3) Pitch of external thread:-**screw pitch gauge, pitch measuring machine, tool mackers microscope. **4) effective dia Of External Thread:-**Tread Micrometer methods, one/two/three wire method.	01 mark each

d) **comparison between alignment test and performance test**

Sr. no	Alignment Test	Performance Test
1	Various geometrical checks are carried out, called as alignment test	Actual performance of job on machine tool is called performance test
2	These tests are carried out at static condition	These tests are carried out at working conditions
3	In this test positions of components and displacement relative to one another are checked	In this test the jobs manufactured on machine and its tolerance limits as per design are checked.
4	e.g alignment of axis of lathe spindle to saddle movement.	e.g. manufacturing of job on lathe.

01 mark each any four points

e) **Compare acceptance sampling with 100% inspection**

01 mark each (any four points)

1) The cost required for sampling inspection is quite less as compare to 100% inspection.
2) The time required for sampling inspection is less as compared to 100% inspection.
3) In sampling inspection problem of inspection fatigue which occurs in 100% inspection is eliminated.
4) Smaller inspection staff is necessary for sampling inspection as compare to 100% inspection.
5) In sampling inspection less damage to product, because only few items are subjected to handling during inspection.
6) The problem of monotony and inspector error introduced by 100% inspection is minimized.
7) Sampling inspection exerts more effective pressure on quality improvement. Since the rejection of entire lot on the basis of sampling brings much stronger pressure on quality improvement than the rejection of individual articles.
8) Sampling inspection provides less information about the product than 100% inspection.
9) Some extra planning and documentation required in sampling inspection.

	a	**characteristics of good comparator:-** 1. Robust in design and construction. 2. Linear characteristics of scale . 3. High magnification. 4. Quick response to input. 5. Minimum wear of contact point. 6. Free from oscillations. 7. Free from back lash. 8. Output must be easily readable and understandable. 9. Low in cost. 10. Less maintenance.	01 mark each (any four points)
3	b	- With the more precise demands of modern engineering products, the control of surface texture together with dimensional accuracy has become more important. - It has been observed that the surface texture greatly influences the functioning of the machined parts. - Whatever may be the manufacturing process used, it is not possible to produce perfectly smooth surface. **Reasons for controlling surface textures** It is seen that different requirements demand different surface textures. For example, 1) Heat exchanger tubes transfer heat better when their surfaces are rough rather than highly finished. 2) Brake drums and clutch plates etc. work best with some degree of surface roughness. 3) The components which are subjected to high stresses and load reversals are finished highly smooth. 4) For quieter operations the surfaces should be smooth.	04 marks for explanation

The principal reasons for controlling the surface texture are

1) To improve the service life of the components
2) To improve the fatigue resistance.
3) To reduce frictional wear.
4) To have close dimensional tolerances on the parts.
5) For good appearance.
6) To reduce corrosion by minimizing depth of irregularities.

c

Parkinson's Gear Tester :

02 marks for explanation 02 marks for fig.

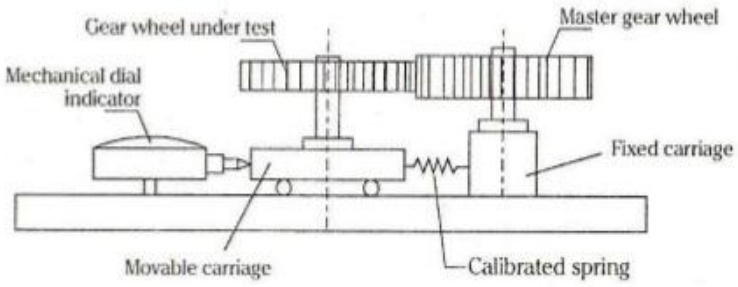
Construction: 1. One fixed spindle and other movable spindle is mounted on a flat base.

2. The movable spindle moves along with base by rolling action on the main base plate.

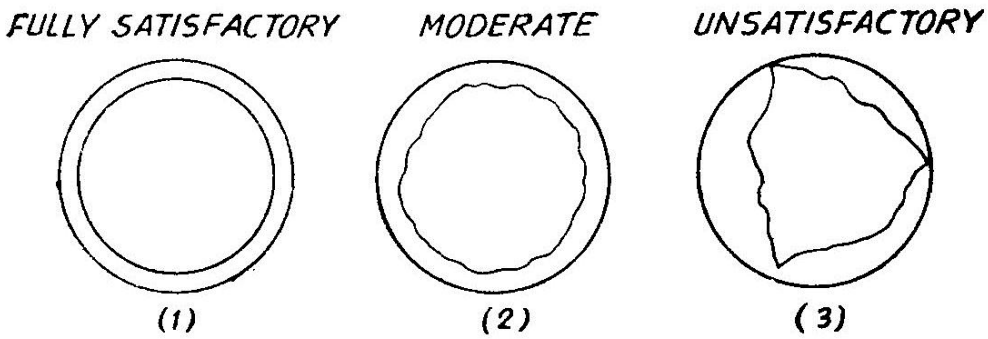
3. A Master gear is mounted on the fixed spindle and gear to be tested is mounted on movable spindle.

4. The dial gauge is set to note the errors.

Working: when master gear is rotated slowly, a gear to be tested will also get rotation movement because of their meshing. Errors in the manufactured gear cause the gear to move away from the centerline of spindle. When gear to be tested moves the floating body also moves by the same distance. Because of displacement of floating body dial gauge gives displacement. The variation in the readings can be observed and plotted in the graphical format.

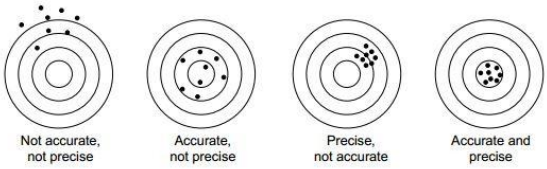


A recorder can be fitted in the form of waved circular or rectangular chart and records made of the irregularities in the gear under test . below fig shows a reproduction of a few typical charts with a reduced scale and the magnified radial errors. Gear 1 is an unsatisfactory, Gear 2 is moderate gear and Gear 3 is fully satisfactory.



d **Accuracy and Precision.**
Note:- Differentiation using appropriate figure should be given full marks

01 mark for each (any four points)

Sr. No	Accuracy	Precision
1	The closeness to the measured value with true value is called accuracy.	Repeatability of measuring process is called precision.
2	It is related to true value	It is related to average value
3	Costlier to achieve great accuracy	Easier and cheaper to achieve precision
4	Example 	

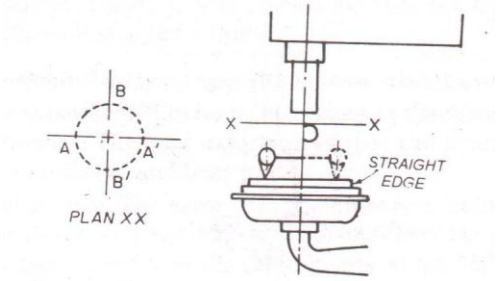
e

Sr. No.	Variable Measurement	Attribute Measurement
1.	In this measurement the record is made of an actual measured quality characteristics such as dimensions of a part in mm, hardness in Rockwell units, temperature in degree centigrade, weight in Kg etc.	In this measurement the record shows only the number of articles conforming and the number of articles falling to confirm to any specified requirements. Such as cracks in sheet by spot welds, the number of defective pieces found in a sample.
2	Precision instruments are used to measure the quality characteristics.	The conformance or non-conformance is usually inspected with the help of Limit gauges i.e GO and NO-GO gauges.
3	It gives detailed information about the product quality characteristics.	It gives information about whether the part are acceptable or not.
4	It is time consuming	It requires less time
5	Higher measurement cost.	Inspection cost is less.
6	The data obtained is called continuous data and can have any value	The data obtained is called discrete data. It has integer value.
7	To represent the collected data X bar and R chart or X bar and σ (standard deviation) charts are used	P and C charts are used
8	It may cause fatigue to the operator.	It does not cause fatigue to the operator.

01 mark for each (any four points)

4 a

i)



02 marks for explanation, 02 marks for fig.

The test is performed by placing the straight edge in positions A A' and BB' . The work table is arranged in the middle of its vertical travel. The dial guage is mounted in the tapered hole of the spindle and its feeler is made to tough the straight edge first at A and readings are taken . Then the spindle is rotated by 180^0 so that the feeler touches at point A ' and again the reading is taken. The difference of these two readings is the error in squareness of spindle axis with table. Similar reading is taken by placing the straight edge in position BB'.

Permissible errors are 0.08 / 300 mm with lower end of spindle inclined towards column only for set up AA' and 0.05 / 300 mm for set up BB'.

	ii)	**Quality of Design:-** The quality of design of a product is concerned with the tightness of the specifications for manufacturing of the product. For example, a part which has a drawing tolerance of ±0.001 mm. would be considered to have a better quality of design than another with a tolerance of ±0.01. A good quality of design must ensure consistent performance over its stipulated life span stated in terms of rated output, efficiency, overload capacity, continued or intermittent operation for specified application or service. **Quality of performance :** it is related to the performance of the product i.e how well the product performs during its prescribed life time at customers end. Quality of performance is assessed at customer end.	02 marks each
	iii)	To build dimension of 63.875 mm using a given set of 87 pieces select the following slip gauges :- 1.005 + 1.37 + 1.5 + 60.00 63.875 **Minimum number of slip gauges required are 4**	04 marks
	iv)	-The floating carriage micrometer consists of a three units a) A casting base carries a pair of centers, on which the treaded work piece is mounted. b) Another carriage mounted at exactly 90^0 to the above, which is capable to move parallel to thread axis. c) Another carriage mounted on the above, which is capable to move at 90^0 to the thread axis. - on one end of the upper carriage, there is a fixed anvil and a fiducial indicator which ensures that all the measurements are made at same pressure. **Measurement of major diameter :** -A calibrated setting cylinder having nearly same diameter as the major diameter of the thread to be measured is used as setting standard. -the setting cylinder is held between the anvils and readings are taken.	04 marks for explanation,

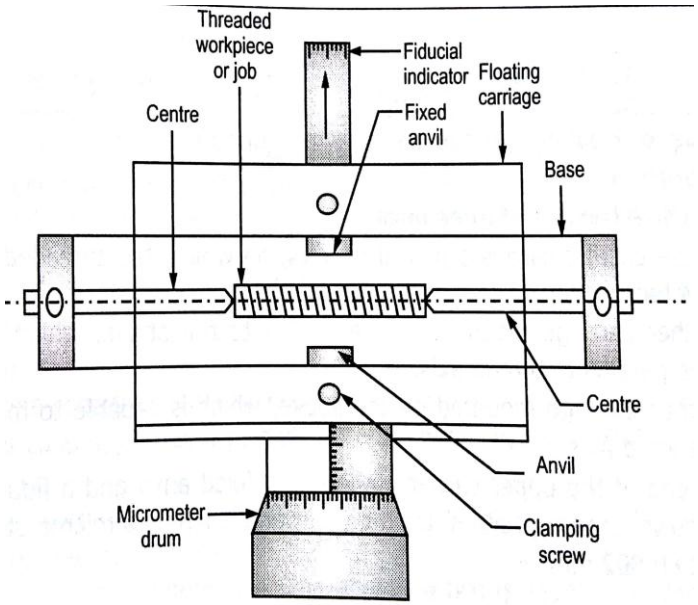
-the cylinder is then replaced by the threaded work piece and again the micrometer reading is noted.

If , D= diameter of the setting cylinder,

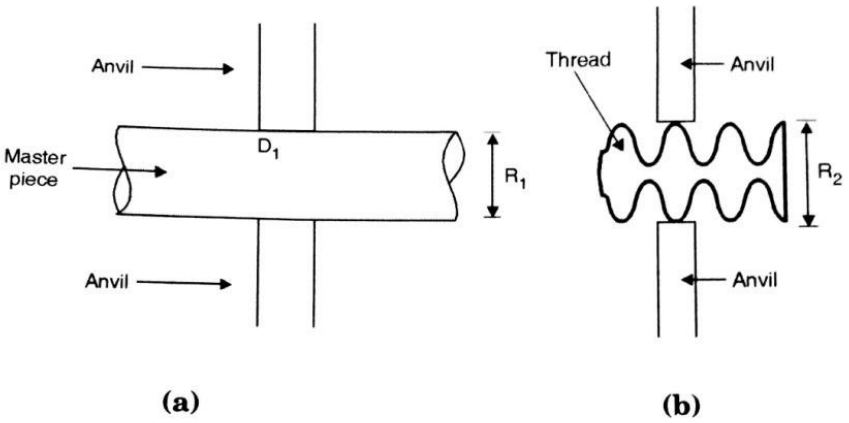
R1= reading of micrometer on setting cylinder.

R2= reading of micrometer on screw thread.

Then major diameter of screw thread, = D ± (R2-R1)



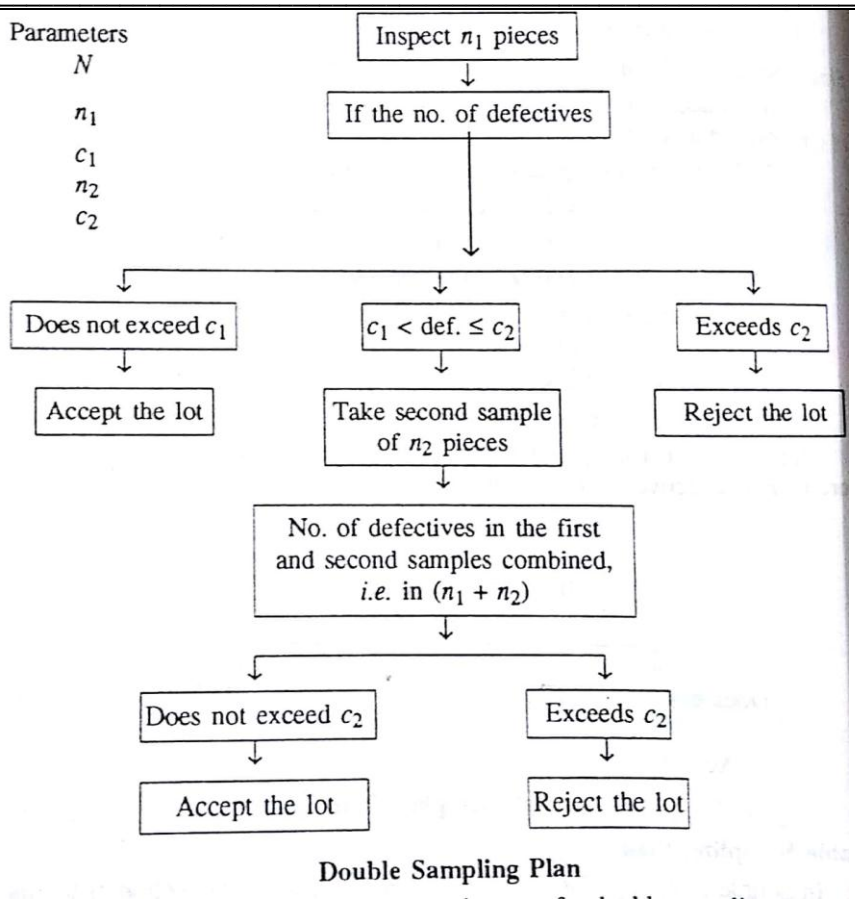
Floating carriage diameter measuring machine



(a) **(b)**

NOTE :-Sketch not essential , if drawn should be given advantage

4	b i)	**Types of sampling plans:-** 1. Single sampling plan. 2. Double sampling plan. 3. Multisampling plan. **Double sampling plan:-** In double sampling plan the decision on acceptance or rejection of the lot is based on two samples Example:- Parameters, N= lot size = 500 n1= number of pieces in the first sample. =35 C1= acceptance number for the first sample. =1 n2= number of pieces in the second sample. =50 C1= acceptance number for the second sample. =4 1. Take a first sample of 35 items from a lot of 500 and inspect. 2. Accept the lot on the basis of first sample, if it contains 0 or 1 defective. 3. Reject the lot on the basis of first sample if it contains more than 4 defectives. 4. Take a second sample of 50 items if the first sample contains 2,3 0r 4 defectives. 5. Accept the lot on the basis of first and second sample combined, if the combined sample of 85 items contains 4 or less defectives. 6. Reject the lot on the basis of combined sample if the combined sample contains more than 4 defectives.	02 marks for List, 04 marks for explanation

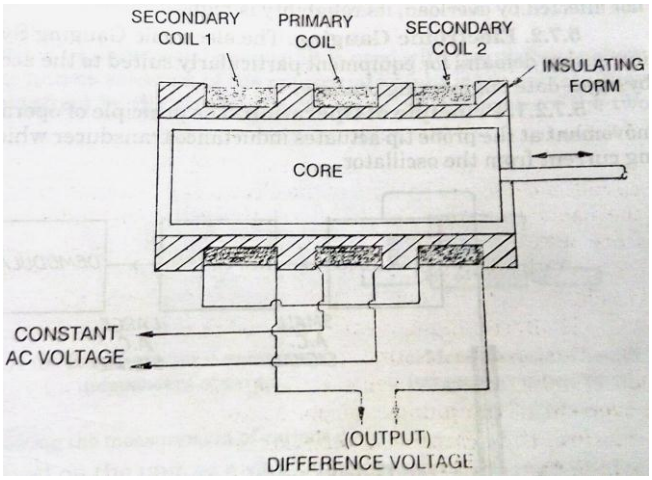


Double Sampling Plan

ii) **NOTE:- flow chart not essential , if drawn will be given full marks**

LVDT :-

LVDT is the inductive transducer used to translate linear motion into electrical signal.(displacement)



Explanation: LVDT works on mutual inductance principle. It is a transformer consisting of three symmetrically spaced coils carefully wound on an insulated bobbin. It consists of a primary coil wound on an insulated bobbin and two identical secondaries symmetrically spaced from the primary. AC carried excitation is applied to the primary and two

01 mark for definition, 02 marks for sketch, 03 marks for explanation.

secondaries are connected externally in a series opposition circuit. There is non-contacting magnetic core which moves in the center of these coils. Motion of this core varies the mutual inductance of each secondary to the primary, which determines the voltage induced from the primary to each secondary.

If the core is centered in the middle of the two secondary windings, then the voltage induced in each secondary winding will be identical and 180^0 out of phase and the net output will be zero. If the core is moved off middle position, then the mutual inductance of the primary with secondary will be greater than the other, and a differential voltage will appear across the secondaries in series which can be directly calibrated in terms of linear movement of core.

a

5

Q.5 (a)

(n) The average sample size =

$$(n) = \frac{300+350+400+400+350+375+350+320}{8}$$

$= 355.625 \approx 356$ ----- (01 mark)

$(\bar{P})$ Average fraction defective = $\frac{\text{Total defective in all samples}}{\text{Total inspected in all samples}}$

$= \frac{49}{2845} = 0.0172$ ---- (01 mark)

$$UCL_p = \bar{P} + 3*\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$$

$$= 0.0172 + 3*\sqrt{\frac{0.0172(1-0.0172)}{356}}$$

$= 0.0172 + 0.0206$

$UCL_p = 0.0378$ ------- (01 mark)

$$LCL_p = 0.0172 - 3*\sqrt{\frac{0.0172(1-0.0172)}{356}}$$

$= -0.0034$

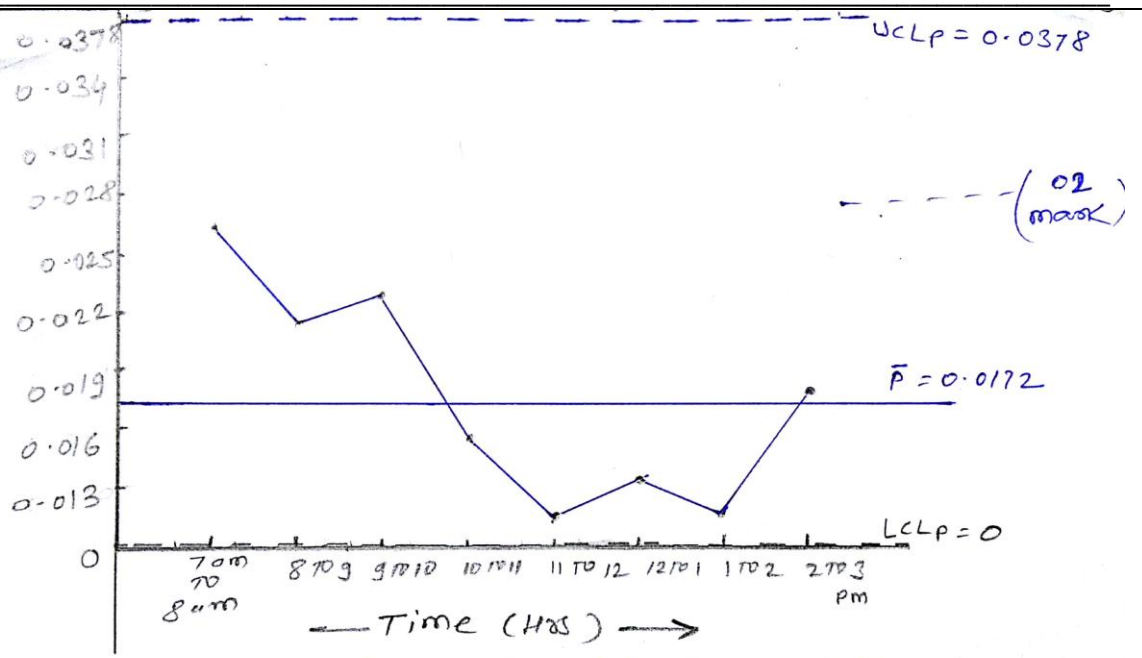
$LCL_p \approx 0$ ------- (01 mark)

Calculate fraction defectives ------- (01 mark)

1) 7 am to 8 am = $\frac{08}{300} = 0.026$
2) 8 am to 9 am = 0.020
3) 9 am to 10 am = 0.022
4) 10 am to 11 am = 0.015
5) 11 am to 12 pm = 0.011
6) 12 pm to 1 pm = 0.013
7) 1 pm to 2 pm = 0.011
8) 2 pm to 3 pm = 0.018

b

i)



(02 mark)

Conclusion :- Process is within the statistical control.
----(01 mark)

Q.5 (b)

mean $\bar{x} = \dfrac{4.11 + 4.18 + 4.19 + 4.22 + 4.25 + 4.15 + 4.16 + 4.18 + 4.18 + 4.20}{10}$

$= 4.182$ ------ (01 mark)

Mode :- 4.18 is mode ---- (01 mark)
(As 4.18 is occuring most number of times)

Median :-
Arranging data in ascending order - ---- (01 mark)

4.11, 4.15, 4.16, 4.18, 4.18, 4.18, 4.19, 4.20, 4.22, 4.25

As n is even
∴ Average of $\left(\frac{n}{2}\right)^{th}$ and $\left(\frac{n}{2}+1\right)^{th}$ term is median

∴ $\frac{n}{2} = \frac{10}{2} = 5^{th}$ term i.e 4.18 and $\left(\frac{n}{2}+1\right)^{th} = \frac{10}{2}+1 = 6^{th}$ term i.e. 4.18

∴ median $= \dfrac{4.18 + 4.18}{2} = 4.18$ ------ (01 mark)

ii)

Figure 02 marks and description 2 marks

Gear tooth thickness (chordal tooth thickness) measurement using Gear tooth vernier:-

- Gear tooth vernier calliper consists of two perpendicular vernier arms with vernier scale on each arm.

- One of the arms is used to measure the thickness of gear teeth and other for measuring depth.

- The caliper is so set that it slides on the top of tooth of gear under test and the lower ends of the calliper jaws touch the slides of the tooth at the pitch line.

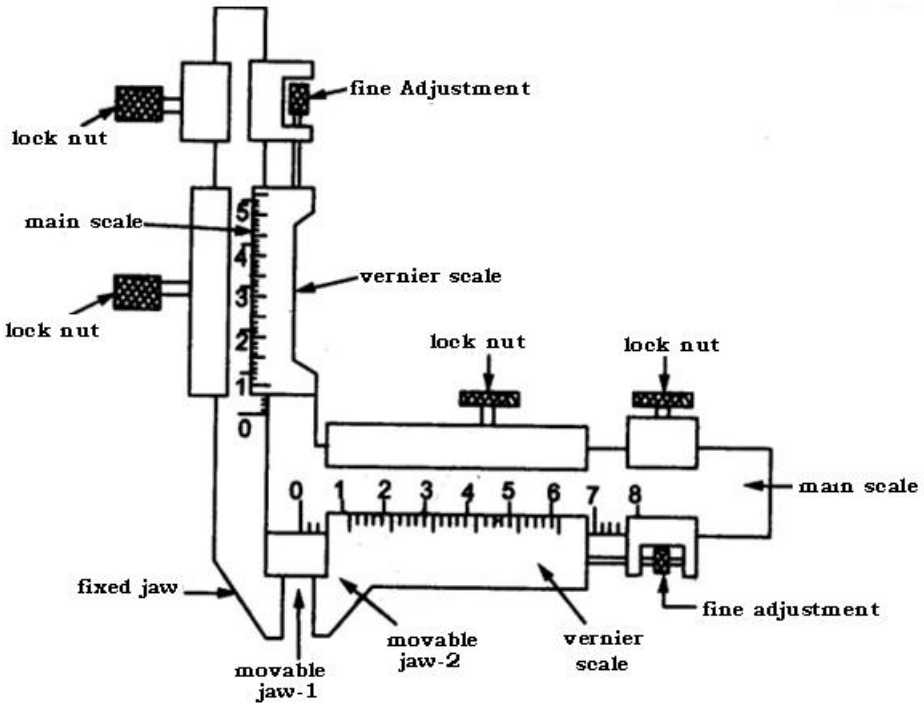
- The reading on the horizontal vernier scale gives the value of chordal thickness (W) and the reading on the vertical vernier scale gives the value of chordal addendum.

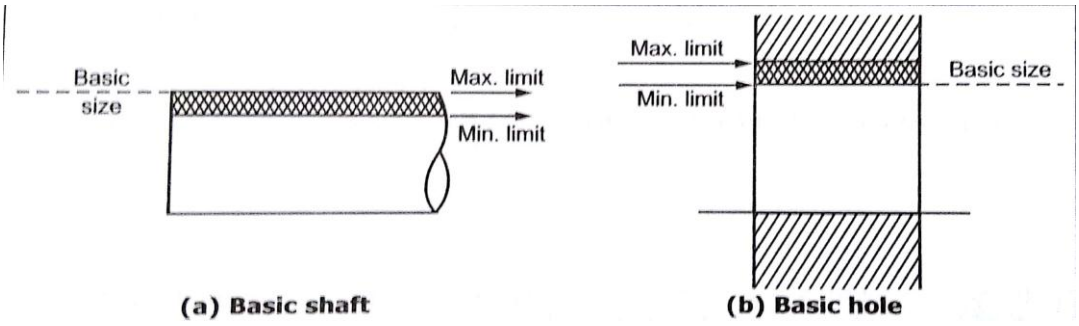
-Theoretical values of chordal tooth thickness may be calculated and compared with actual obtained values.

Chordal tooth thichness, w= N.m sin(90/N)

Addendum , h= (N.m)/2 [1+ (2/N) – cos(90/N)]

Where, N= no. of teeth, m= module



	c		
	i)	**Six sigma:-** Six sigma is defined as a disciplined, data drive approach for eliminating defects in any process of manufacturing or service industry. **Benefits of six sigma:-** 1)Customer driven 2)Continuous improvement process. 3) it helps to increase customer satisfaction. 4)improve efiiciency and effectiveness in process	01 marks for definition 03 marks for benefits (any three)
	ii)	**Basic Shaft:-** basic shaft is the shaft whose upper deviation is zero. - Thus the upper limit of the basic shaft is the same as the basic size. - It is denoted by letter "h" **Basic Hole:-** basic hole is the hole whose lower deviation is zero. - Thus the lower limit of the basic hole is the same as the basic size. - It is denoted by letter "H" 	Figure 02 marks and description 02 marks
6	a	Fig shows the construction details of the sigma comparator. The vertical beam is mounted on flat steel spring and connected to fixed members which in turn are screwed with back plate. The shank at the base of the vertical beam is arranged to take a measuring contact selected from the available range. The stop is provided to restrict movement at lower extremity of the scale. Hinged assembly carrying the forked arms. The metal ribbon attached to the forked arms passes round the spindle causing it to rotate on specially designed miniature ball bearings. The damping action to the movement is affected by a metal disc mounted on the spindle rotating in a magnetic field between a permanent magnet and a steel plate. The indicating pointer is secured to a boss on	Figure 04 marks and description 4 marks

the disc

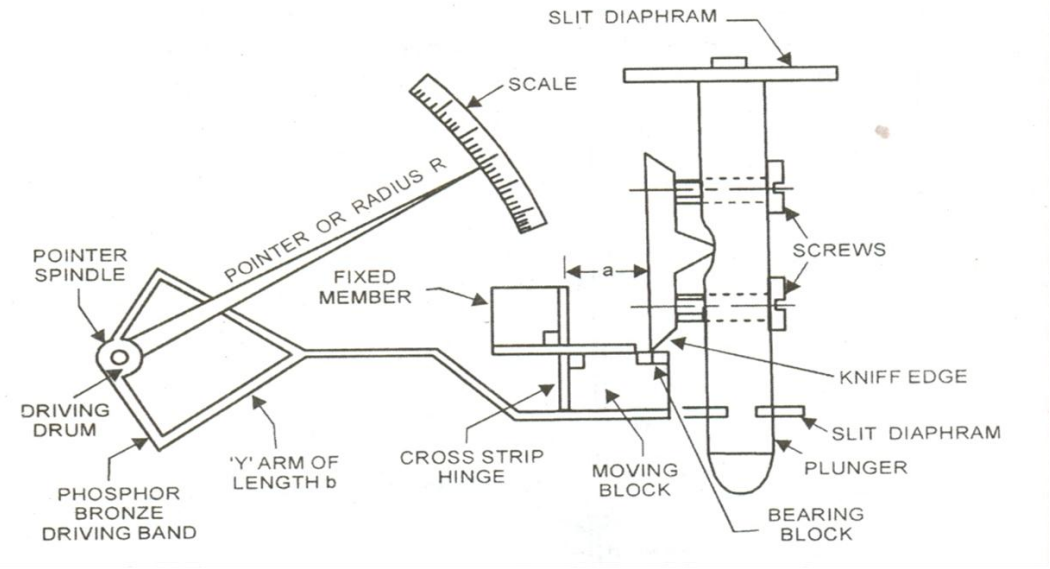
The trigger is used to protect the measuring contact. At the upper end of the measuring beam an adjustable screw is provided for final zero setting on the scale.

Total magnification of instrument is ((L/a) x (i/r)).

Where, L= effective length of the arm

a= distance of the knife edge from the pivot.

l= pointer length , r =radius of the driving drum



Sigma Comparator

b

Q 6 (b)

Sample no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
No. of defective	14	22	25	15	20	14	12	24	10	17	35	36	16	23	14	6	7	33	17	34	11	16	25	36	18
fraction defe.	0.14	.22	.25	.15	.20	.14	.12	.24	.10	.17	.35	.36	.16	.23	.14	.06	0.07	.33	.17	.34	.11	.16	.25	.36	.18

$\bar{P}$ (Average fraction defective) = $\frac{\text{Total defective in all samples}}{\text{Total inspected in all samples}}$

$= \frac{500}{25 \times 100} = 0.200$

..... 01 mark

$UCL_P = \bar{P} + 3 * \sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$

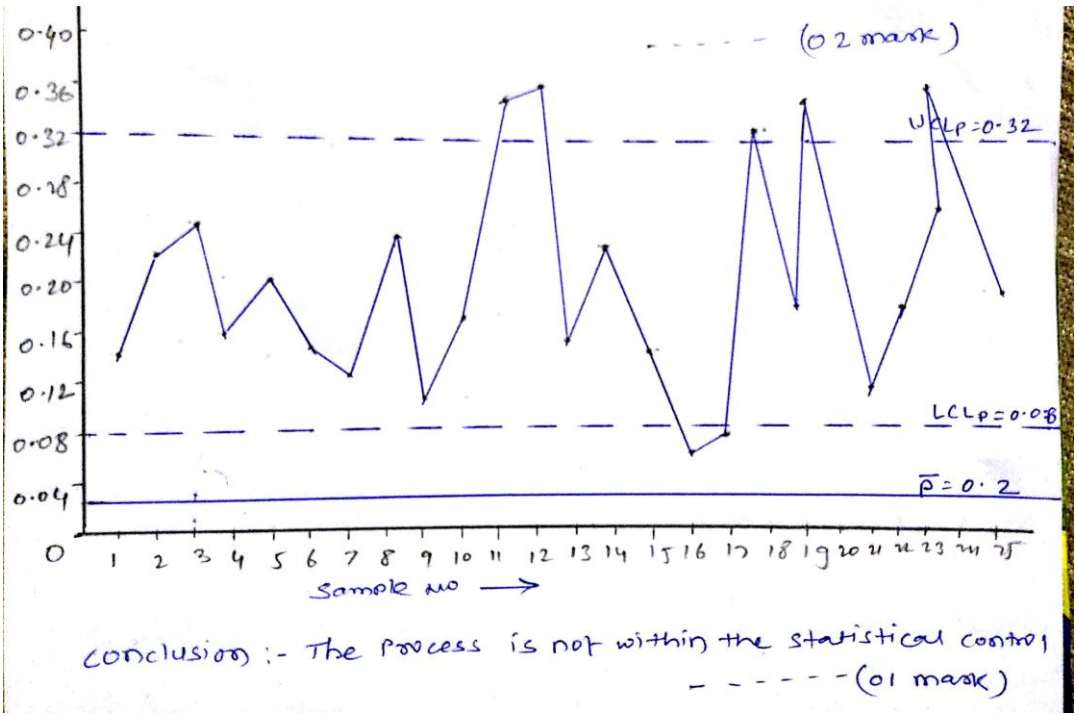
$= 0.2 + 3\sqrt{\frac{0.2(1-0.2)}{100}} = 0.2 + 0.12$

..... 01 mark

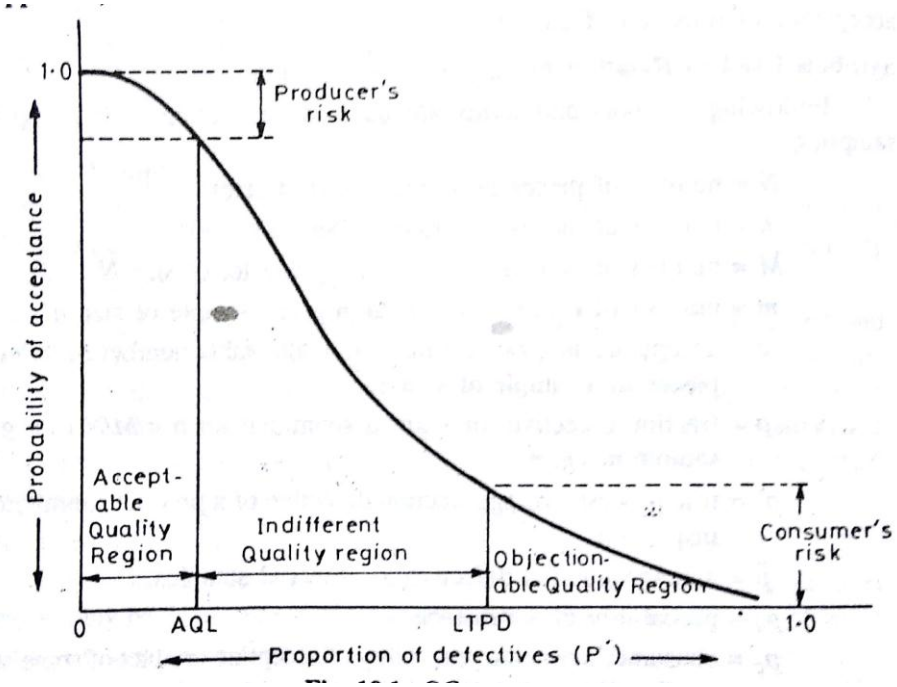
$UCL_P = 0.32$

$LCL_P = \bar{P} - 3 * \sqrt{\frac{\bar{P}(1-\bar{P})}{n}} = 0.08$ ..... 01 mark

calculate average fraction defective ---------- 02 mark



Conclusion :- The process is not within the statistical control
- - - - - (01 mark)

	c		Figure 02 marks and description
	i)	(i) Producers risk : It is the probability that a good lot will be rejected by the sampling plan. In some plans this risk is fixed at 0.05 ; in others it varies from about 0.01 to 0.10. (ii) Consumers risk : It is the probability of defective lots being accepted which otherwise would have been rejected..  	02 marks .
	ii)	The errors which can be found during the gear inspection are 1. Profile 2. Pitch 3. Cyclic 4. Gear tooth thickness 5. Backlash 6. Run out 7. Lead	01 mark each (any four

		Profile error : these errors can be traced out during inspection on optical profile projector. Many times tool marks, pits etc are observed on the profile of the gear. Pitch error : It is defined as the actual length between corresponding flanks of teeth not adjacent to each other. Tooth thickness error: It is the difference between actual tooth thickness and the required tooth thickness which is chordal tooth thickness. This can be found with gear tooth caliper. Cyclic error : it is a error occurring during each rotation of element under consideration. Backlash error : Backlash is the play between the mating tooth surfaces i.e the distance through which a gear can be rotated to bring its non working flank in contact to the teeth of the mating gear. Run out error : It is the total range of the readings of a fixed indicator with contact point applied to a surface rotated , without axial movement about a fixed axis . Run out error is related to concentricity of gear outer diameter with mounting hole. This error is find out using Parkinson gear tester.	