WINTER– 16 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	Metrology: Metrology is the science of measurement. Metrology is primarily concerned with the establishment, reproduction, conservation and transfer of units of measurement and their standards. Necessity Of metrology: 1. Metrology can be used for selection of proper measuring instrument in industries. 2. Metrology can be used for deciding the proper measuring standards. 3. Metrology can be used for minimizing cost of inspection. 4. Metrology can be used for determining process capabilities. 5. Metrology can be used for deciding or finding out tolerances. 6. Metrology can be used for maintaining accuracy and precision at the time of inspection.	02+02

b

Difference between hole basis system and shaft basis system :

01 for each

Hole basis system	Shaft basis system
1.hole size is kept constant and shaft size is Varied for obtaining different fits.	1.shaft size is kept constant and hole size is Varied for obtaining different fits.
2. Hole whose lower deviation is zero (H hole) is used.	2. Shaft whose upper deviation is zero (h hole) is used.
3. Preferred in mass production.	3. Not Preferred in mass production.
4. Initial cost is less as fewer drills and reamers are required.	4. Initial cost is more as many drills and reamers are required.
5. Space required is less.	5. Space required is more.

c

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

02 + 02 for equation

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

$$h = L \sin\theta$$

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

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

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

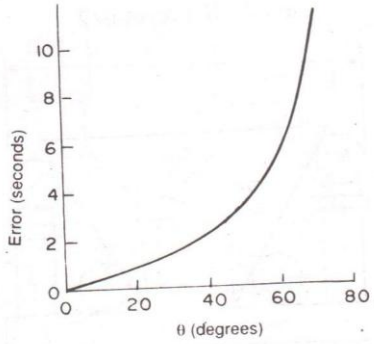
$$d\theta = \frac{dh}{L\cos\theta} - \frac{\sin\theta\, dL}{L\cos\theta}$$

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

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

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

d

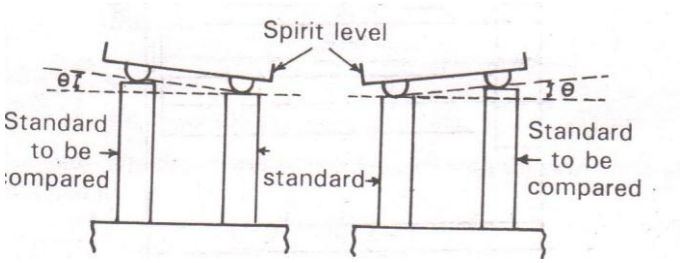
Process Capability: The process capability can be defined as the minimum tolerance to which the machine can possibly be expected to work and produce no defectives under the specified conditions. 02+02

Or

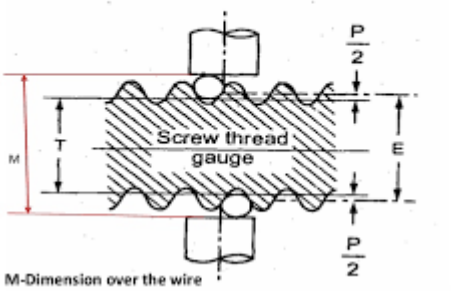
Process Capability: The process capability can be defined as the minimum spread of a specific measurement variation which will include 99.73 % of the measurements of given process. The process capability =6σ.

The process capability is achieved as follows:
1. Selecting a part to be produced that is representative of the type of operation performed by the machine.

2. Inspecting each part (total of at least 100) as it is produced and noting its characteristics with a measuring instrument.

		3. Tabulating the readings of measurement. 4. Calculate average $\overline{x}$ and range R for each sample. 5. Calculate the grand average $\bar{\bar{X}}$, which measure centering of process. 6. Calculate control limits and plot $\overline{x}$ and R chart, & Calculate process capability 6σ.	
1b	a	(Brooks level comparator is having highest magnification, but explanation of similar types of compartator which is also having highest magnification may be considered) Comparator which is having highest magnification – Brooks level comparator : This comparator is having highest magnification. It is used in standard room for calibration purpose. The instrument can detect differences in length as small as 0.00002 mm.  Advantages : 1. It provides an excellent means from comparing end gauges. 2. The instrument is commercially available in size to accommodate gauges upto 01 m in length. Disadvantages: 1. Comparator is slow 2. It needs a room temperature to be maintained at 20^0 c	02 +02+02
	b	Procedure for measuring effective diameter of screw thread using two wire method.	03+03

Two wire method:



1. First the micrometer reading is noted on a standard cylinder (gauge) . Let the reading as R1.
2. Then taking the micrometer reading with wires over the standard cylinder (gauge). Let the reading as R2.
3. Then putting the work piece whose effective diameter is to be found.
4. Micrometer reading is taken by placing two wires over the work piece. Let reading over the wire as M.
5. Then the effective diameter is calculated as ,
6. E = T + P where E = Effective Diameter.

T = Dimension under the wires = S – (R1 – R2) or T = M- 2d

P = Wire constant.

S = standard cylinder (gauge) diameter.

d = Wire Diameter.

2 a Various Sources of errors in Measurement: — 01 for each

1. Defect in measuring Instrument.

2. Adjustment of an Instrument.

3. Imperfection in instrument design.

4. Method of location of instrument.

5. Environmental Effects.

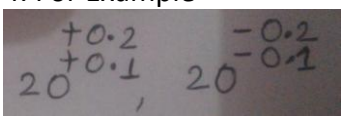
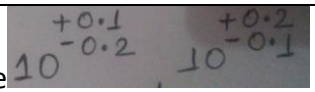
6 Error because of properties of object.

1. Error due to surface finish of object.
2. Error due to change in size of object.
3. Observation error.

4. Error caused by measuring forces of instrument.

b

01 for each

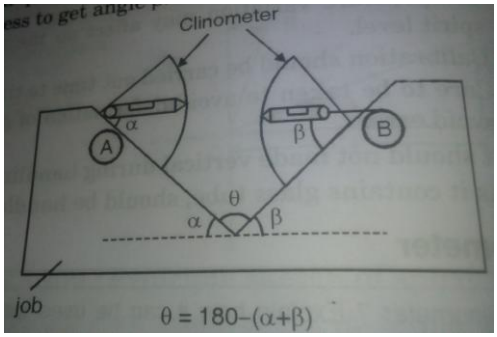
Unilateral Tolerance System	Bilateral Tolerance System
1. Both limit of variation are on same side of zero line.	1. Both limit of variation are on different side of zero line.
2. Both limits are having same sign i.e. +ve or –ve.	2. Both limits are having different sign i.e. +ve and –ve.
3. Where mating parts must be interchangeable unilateral tolerances are preferred.	3.Not preferred for interchangeable parts.
4. For Example 	4. For Example 

C

02+02

Clinometer: A Clinometer is angle measuring device. Clinometer is a special case of application of spirit level, used for determining the included angle of two adjacent faces of work piece.

Use of Clinometer: Determining the included angle of two adjacent faces of work piece.



1. First the clinometer is placed on surface A and rotary arm is adjusted to horizontal position as shown in fig. Measure the angle α.

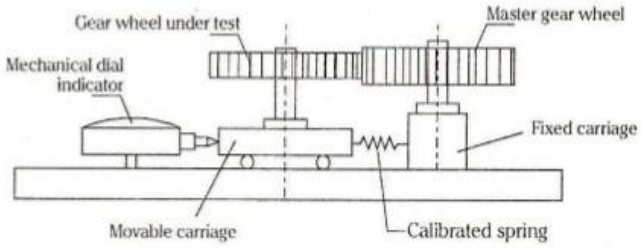
2. Place the Clinometer on surface B, adjusts the rotary arm to horizontal position.

Measure the angle β.

s3. Then the included angle is measured as below,

$$\Theta = 180 - (\alpha + \beta).$$

d Parkinson's Gear Tester : 02+02



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.

e 100 % Inspection is not preferred in the industry for mass production due to following reasons. 04

1. Cost required for inspection is more as compared to sampling inspection.

2. Time required for inspection is more.

3. Operator suffers from inspection fatigue.

4. More staff is required for inspection.

5. Due to more handling chances of damage increases.

6. 100 % inspection not possible where destructive testing is required.

3 a

Characteristics of line standards — 02+02

1. Accurate engraving on the scale can be done, but it is difficult to take full advantage of this accuracy
2. It is easier to use a scale over a wide range
3. The scale marking are not subjected to wear although significant wear on leading end leads to under sizing.
4. There is no built in datum in scale which would allow easy scale alignment with the axis of measurement. This again leads to under sizing

Characteristics of end standards

1. Highly accurate and well suited to close tolerance measurement
2. Time consuming in use
3. Dimensional tolerance as small as 0.0005 mm can be obtained
4. Subjected to wear on their measuring faces

b

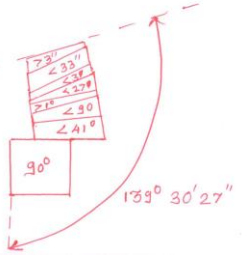
Development of angle : $139^0\ 30'27''$ — 04

1) As 139° is greater than 90°, first use 90° (square Block)
$139^\circ - 90^\circ = 49^\circ$

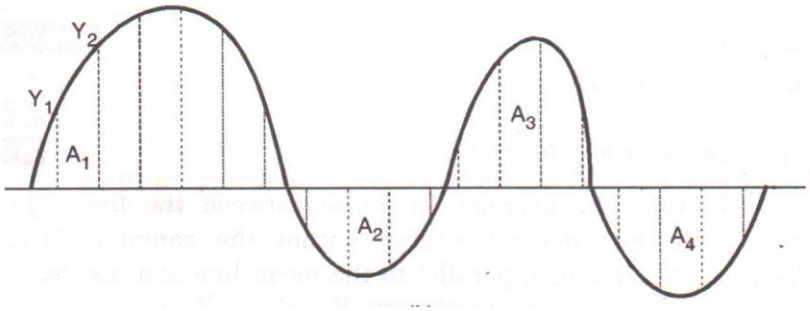
2) $49^\circ = 41^\circ + 9^\circ - 1^\circ$

3) $30' = 27' + 3'$

4) $27'' = 30'' - 3''$



	c	Statistical Quality control : It is the collection, analysis and interpretation of inspection data to solve the problems related to quality control. It is always desired to use SQC methods in mass production. Benefits of SQC : 1. Better quality level 2. Uniformity of quality 3. Avoid wastage of material 4. Proper use of equipment 5. Reduction in scrap and rework	02+02
	d	Types of errors in threads : there are at least five important errors in threads 1. major , 2. minor , and 3. effective diameter, 4. pitch and 5. angle of thread form. Errors on the major diameter will cause interference with the mating thread . errors on the effective will cause either interference between the flank or general slackness and possible weakening of assembly . the effects of errors in pitch and angle of either thread of mating pair are not so apparent although it will be obvious that pitch errors are likely to cause the progressive tightening and interference on assembly. Pitch and angle errors have a special significance and can be precisely related to effective diameter.	02+02
	e	I) CLA : Centre line average (CLA) is the value of height of the undulation of the surface . This practice is adapted for obtaining the numerical evaluation of the surface texture is to use a parameter base on the cross sectional profile of the surface under examination.	01 for each

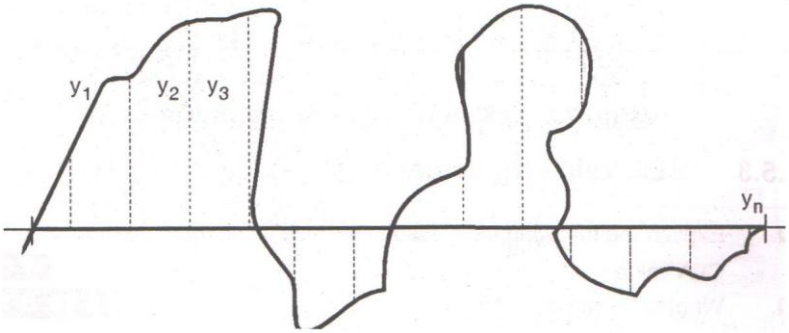


Ii) Ra: Arithmetic mean deviation from the mean line of profile is the average value of the ordinates from the mean line Ra (Roughness average)

$$R_a = \frac{1}{n}\int_0^n |y| \cdot dx = \frac{\sum A}{L}$$

ii) RMS value : It is defined as the square root of the arithmetic means of values of the squares of ordinates of surface from mean line.

$$\text{RMS value} = \sqrt{\frac{y_1^2 + y_2^2 + y_3^2 + \ldots}{n}}$$



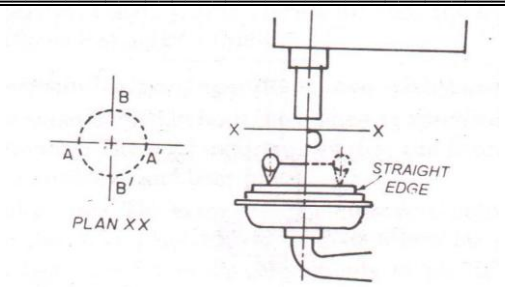
iv) Rz : the average difference between the five highest peaks and five deepest valleys within the sampling length measured form a line , parallel to the mean line and not crossing the profile are taken which are defined as ,

$$R_Z = \frac{1}{5}\left[(R_1 + R_2 + R_3 + R_4 + R_5) - (R_6 + R_7 + R_8 + R_9 + R_{10})\right]$$

02+02

4A a

Squareness testing of drilling machine spindle .



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'.

02=02

b

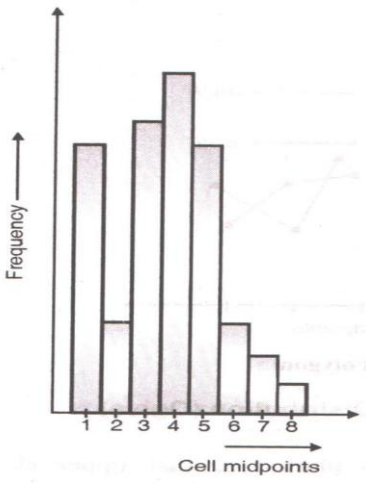
SQC tools :

1. frequency histogram
2. bar chart
3. frequency polygon / rectilinear chart
4. cumulative frequency distribution (Ogive curve)

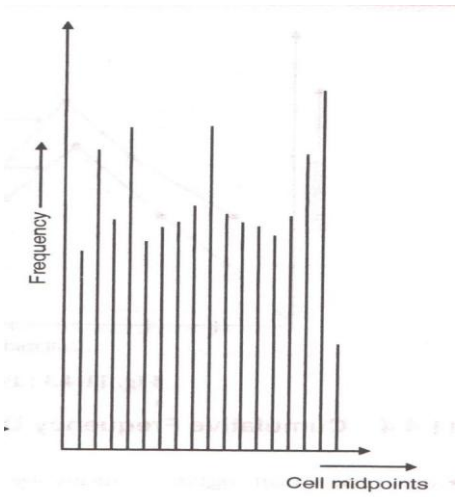
Explain any one of the following :

a) Frequency

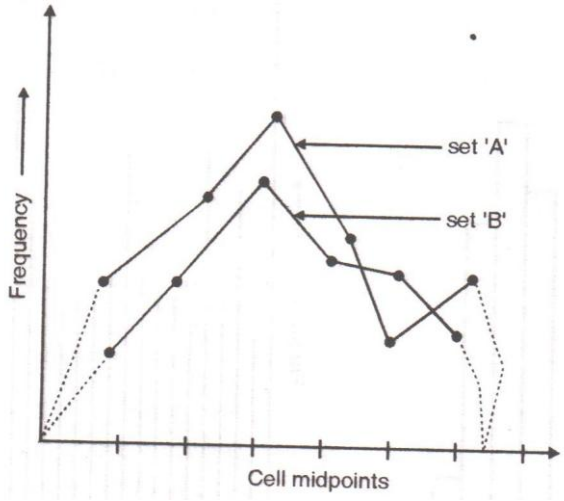
On X axis class intervals and on Y axis frequency is to be plotted. Height of column represents class frequency. Most simple in construction and interpretation.



ii) Bar chart :- is a graphical representation of frequency distribution in which the bars are centred at midpoint of cells. Height of bar represents the frequency of particular cell.



iii) Frequency Polygon :- It is series of straight line joining the points which are plotted at cell midpoints with a height properties to cell frequency.



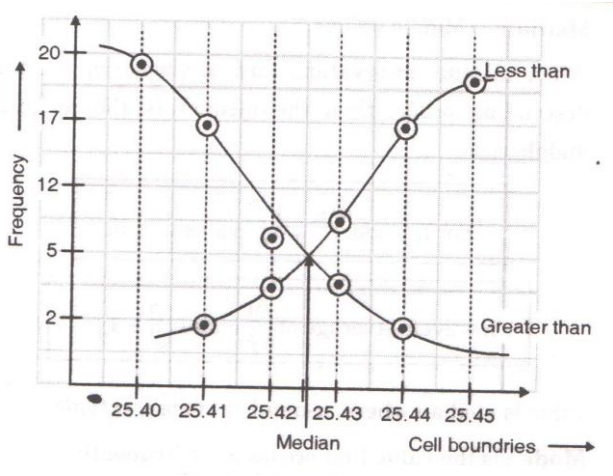
iv) Ogive Curve:- Less than ogive curve:- Plotted against upper class boundary and not against class mid point.

Greter than ogive :- Plotted against lower class boundary.

e.g.

Sr. No	Boundaries	Frequincy	Greater than	Less than
01	25.40 - 25.41	3	20	3
02	25.41 – 25.42	5	17	8

03	25.42 – 25.43	7	12	15
04	25.43 -25.44	3	5	18
05	25.44 – 25.45	2	2	20



Meaning of $25H_8s_6$:

A hole is designated by capital letter while shaft by small letter. Basic size is 25 mm. Basic hole is designated H. For the basic hole fundamental deviation (lower deviation) is zero i.e. for $25H_8$ – 25 mm hole with tolerance grade IT_8 .

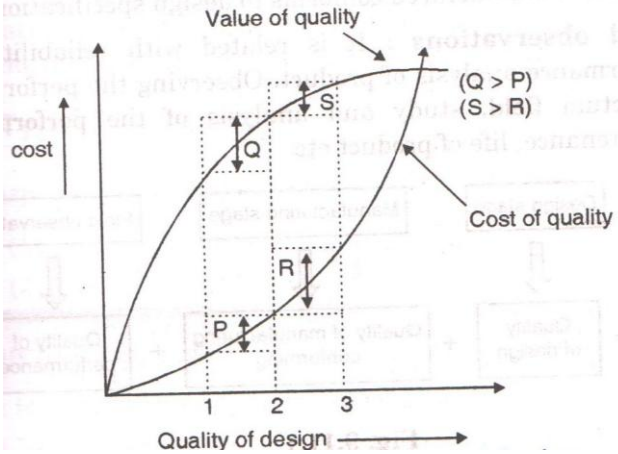
The basic shaft whose upper deviation is zero is designated by small letter i.e. S_6 – means 25 mm shaft with tolerance grade IT_6 . s is used for interference type of shaft with hole $\mathbf{H_8}$

04

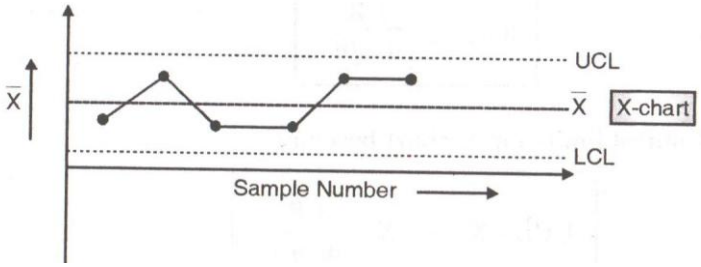
C

Cost of quality and value of quality :

The balance between the cost of quality and value of quality gives optimum quality of design. From companies point of view profit is more important. It is not necessary that the company should manufacture 100% quality product the study of optimum quality design involves market survey. While carrying out market survey, expected sale for particular quality, profit and competition in the market is to be considered. The quality of design should meet the need of the customer and at the same time its manufacturing cost should be such which will yield maximum profit.

	d		02+02
4B	a	Advantages of ISO 9000 : 1. ISO 9000 series of standards useful to meet the requirements of an internationally uniform quality system 2. It would enhance foreign exchange. So it is important for the Indian industry to adopt it 3. It enables the company to built customer' s confidence 4. It reduces the need of assessment by multiple buyers 5. Motivates the employees and develops pride in them for achieving excellence Limitations : 1. Formulation and document of the system is complicated and time consuming 2. Assessment and registration are also expensive 3. Unless carefully interpreted and planed the system can become bourdon some. 4. It need to change attitude and accept new working practices may strain the management	03+03
	b	Control Chart:- is a method which specifies the state of statistical control, it is device for attaining statistical control and device to judge whether statistical control have been attained or not. Classification of Control Charts:- $\ddot{X}$-R Chart and $\ddot{X}$ -6 chart for measurable quality characteristics, variables	06

P- char and C- chart for Defectives and defects (attribute data)



Calculation procedure:

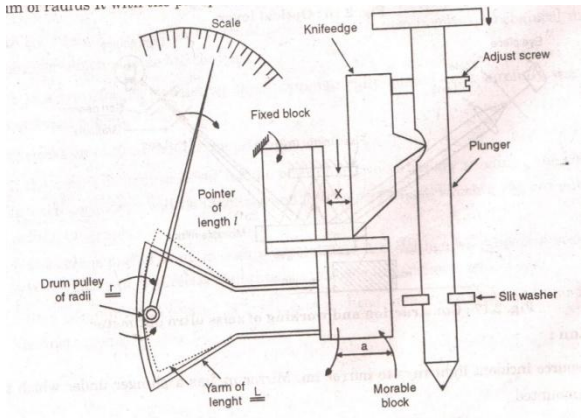
1. Calculate the average X and range R for each subgroup
2. Calculate the grand average X and average range R
3. Calculate 3 sigma limits on control chart
4. Calculate the control limit for R chart

5 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 the disc

Figure 04 marks and description 04 marks

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.



b

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

List of errors 01 mark , Detail description of error 01 mark each

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.

Picth 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 calliper.

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.

c

This is the problem related to U chart.

Step I calculate the number of defects per unit in each lot (U)

U = c/n = no. Of defects in the lot / no.of units in the lot

Sample calculation for day 1

U= 4/20 = 0.20

Step II Calculate U bar

U bar = Total defects in all lots / Total units in all lots

02 marks for each stepand 02 for graph

U bar = 18/ 136 = 0.132

Step III Calculate UCL , LCL for each lot

UCL : U bar + 3(sq. Root U bar/ n)

LCL : U bar - 3(sq. Root U bar/ n)

Sample calculation for day 1

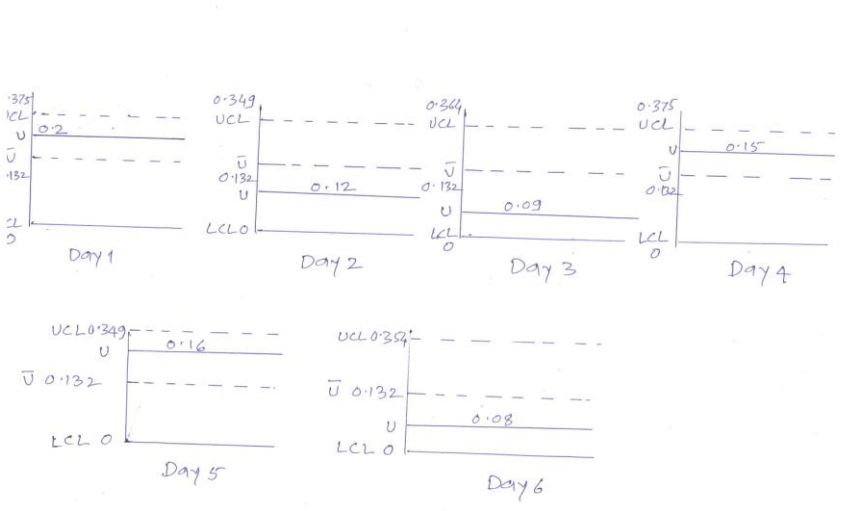
UCL 0.132 + 3 ($\sqrt{0.132/20}$) = 0.375

LCL : 0.132 – 3 ($\sqrt{0132/20}$) = -0.11≈0

(if LCL is negative then assume it to 0)

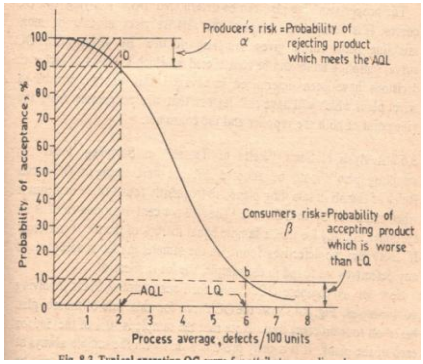
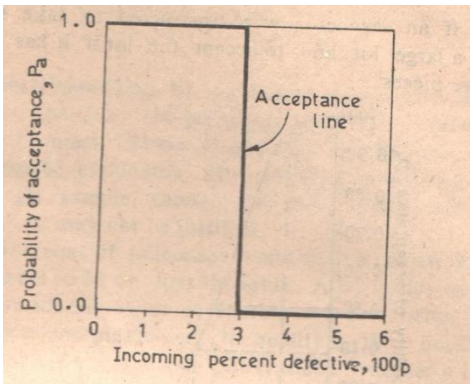
Day	1	2	3	4	5	6
No. Of PCB checked (n)	20	25	22	20	25	24
Defects found (c)	4	3	2	3	4	2
U	0.2	0.12	0.09	0.15	0.16	0.08
UCL	0.375	0.349	0.364	0.375	0.349	0.354
LCL	0	0	0	0	0	0

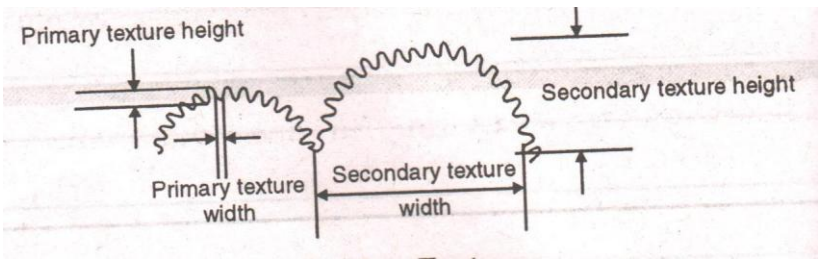
For each day the control chart can be drawn separately



From the above table it is evident that for each day value of the U is properly in between UCL and LCL, hence the process is under control.

If the problem is solved by another method it may be considered

6	a	An Operation Characteristic curve commonly called OC curve provides the means of evaluating the operation of an acceptance sampling plan. It depicts the varying conditions of incoming materials and illustrates the risk inherent in a sampling plan at each quality level of the incoming material. Thus every sampling plan has an OC curve. An OC curve shows , for every possible fraction defective 'p' in a given lot submitted for inspection , the probability 'pa' that such a lot will be accepted by the acceptance sampling plan that the OC curve represents. It is the graph drawn with lot fraction defective on X axis against probability of acceptance on Y axis. (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 that a bad lot will be accepted by the sampling plan.  Actual OC curve  Ideal OC curve	Explanation of OC curve – 02 marks ; Figure Ideal OC curve – 02 marks ; figure Actual OC curve – 02 marks ; Producers risk – 01 mark ; Consumers risk – 01 mark
	b	Quality of conformance ; It is concerned with how well the manufactured product confirms to the quality of design, means confirms to the specifications adopted for design of the product.	Quality of

		During designing , it is necessary to obtain high level of quality of conformity. 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. Quality of performance depends on quality of design , manufacturing, sales , services Factors affecting quality of product 1. Quality of incoming materials 2. Machines, tools , instruments 3. Men 4. Quality systems are not adopted 5. Poor design 6. Mistakes in manufacturing 7. Excess material handling 8. After sales services 9. Non adherence to specifications 10. Rework	conformance -03 marks ; Quality of performance – 03 marks ; factors – 02 marks
c		Student may have many other factors which affect quality of the product. (i) Primary texture : Irregularities of small wavelength are called primary texture. These are generally caused due to cutting tools, friction, wear etc., it is also termed as roughness. (ii) Secondary texture : Irregularities of considerable wavelength are called secondary texture, also called as waviness. These are generally caused due to misalignments, non linear feed motions, generally due to problems in machine tools (iii) sampling length : It is length of the profile necessary for evaluation surface roughness. Sampling length is related to the manufacturing process adopted, desired surface roughness value and the measuring instrument available. (iv) Lay : Lay is the direction of predominant surface pattern, decided by the manufacturing process adopted or lay is decided depending on manufacturing process adopted.  	02 marks for each of the above terms.
