WINTER– 18 EXAMINATION

Subject Name: MQC **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	**Define Metrology and state its four objectives** Metrology: can be defined as the Science of Measurement. Objectives of metrology: 1) To ensure that the product is as per quality standard. 2) To enhance total customer satisfaction. 3) To reduce rework and rejections. 4) To increase profitability of organization. 5) It helps in manufacture of interchangeable parts. 6) Overcome the short coming in the production process. 7) To achieve standardization.	**Definition 02** **Objective ½ each any 4 points**
	ii	**Differentiate between comparator and a measuring instrument.**	**1 mark each for any 4 points**

Sr. No.	Instrument	Comparator
01	It is not give any magnification.	It gives magnification.
02	Skilled operators are required.	Semi-skilled operators are required.
03	Observational error is occur.	Parallax error is occur.
04	Maintenance is less.	Maintenance is more.

05	Remote controlling is not possible.	It may be operate by remote.
06	Uniform response is not obtained.	Uniform response is obtained.
07	Used for checking and measurement.	Used for comparsion.
08	Less sensitive.	More sensitive.
09	Ex. Vernier calliper	Sigma comparator is ex.

iii **Taylors Principle of Gauge design:-**

02 marks for principle

It states that

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

02 marks for example

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 corresponds 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.

2) GO gauges should check all the related dimensions (roundness, size, location ect). Simultaneously whereas NO-GO gauge should check only one element of the dimension at a time. For example the bush to be inspected has a curved axis and a short GO plug gauge is used to check it. The short plug gauge will pass through all the curves of the bent bushing. This will lead to wrong result that the workpiece (hole) is within the prescribed limits. Actually such a bushing with curved hole will not mate properly with its mating parts and thus defective. A go plug gauge with adequate length will not pass through a curved bushing and the error will be detected. A long plug gauge will thus check the cylindrical surface not in one direction but in a number of sections simultaneously.

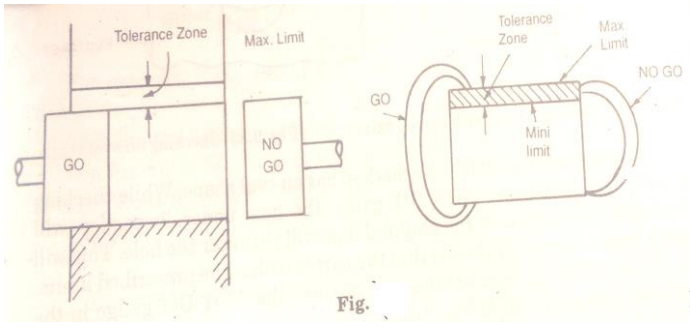


Fig.

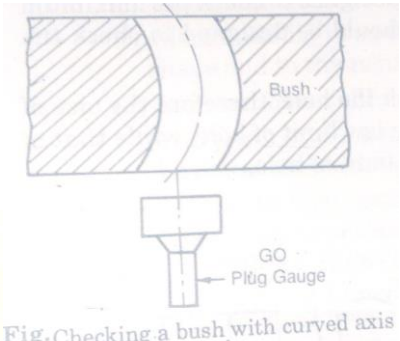


Fig. Checking a bush with curved axis

Note:- figure not essential if drawn will be given advantage

iv **Define mean, Mode, Median and Standard Deviation.** — **01 mark each**

Mean: - Mean is some of the values in a distribution divided by number of values.

Mode: - The mode of a set of numbers is that value which occurs with the greatest frequency.

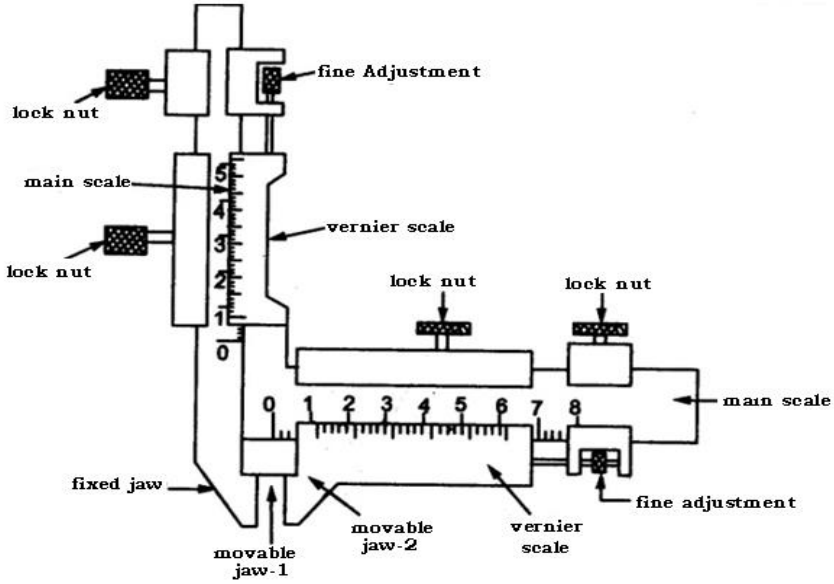
Median: - Is the magnitude of the middle case in the value that has half the observations above it and half below it.

Standard deviation:-It is a measure of the dispersion or it is the root mean square deviation of the observed values about their mean. It is denoted by σ.

b i **Differentiate between line standard, end standard and wavelength standard (any Six points).** — **01 mark each**

Any six points

Sr. No.	Line Standard	End Standard	Wave length standard
01	When length is express as distance between two parallel line is called line standard.	When length is expressed as distance between two parallel faces is called as end standard.	When the length is expressed in terms of Krypton 86 wavelength is called as wavelength standard.
02	Measurement is quick and easy.	Measurement is time consuming.	Measurement is time consuming.
03	It is not used for précised measurement.	It is used for précised measurement.	It is used in laboratories.
04	It is subjected to parallax error.	It is not subjected to parallax error.	It is not subjected to parallax error.
05	It is not subjected to wear and tear.	It is subjected to wear and tear.	It is not subjected to wear and tear.
06	It is cheaper.	It is costlier.	It is costlier.
07	It is simple in construction.	It is complicated in construction.	It is complicated in construction.
08	No skilled worker is required for measurement.	No skilled worker is required for measurement.	Skilled worker is required for measurement.
09	It is not so accurate.	It is very accurate.	It is highly accurate.
10	Ex. Scale, meter tape, yard.	Micro meter, Vernier, slip gauges	Krypton 86, Mercury 198, Cadium 114.

	ii	**Classify Control charts and writ procedure for any one chart.** **Control charts can be classified as** 1) Variable data charts($\bar{X}$,R chart) 2) Attribute data chart (p,c Chart) The generalized procedure for any one of the above charts is as below. 1. Calculate average, range for ($\bar{X}$, R chart). Fraction defectives for p chart. 2. Calculate upper Control limit and Lower control limits for each type of charts using mathematical expressions. 3. Plot the appropriate control chart. 4. Conclude whether the process is under control or not. (Any one chart described on the above steps carries full marks)	**02 marks for classification,** **04 marks for procedure**
2	a	**Draw labeled diagram of Gear Tooth Vernier caliper.**  	**02 marks for sketch,** **02 marks for labelling.**
	b	**Why sine bar can't be used above 45^0 angle.** 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	**03 marks for description,**

be determined by differentiating the equation $\sin \theta = h / l$ 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.

$$h = L \sin \theta$$

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

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

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

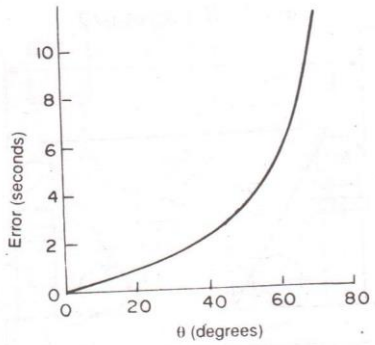
$$d\theta = \frac{dh}{L \cos \theta} - \frac{\sin \theta \, dL}{L \cos \theta}$$

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

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

But $L \sin \theta = h$

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

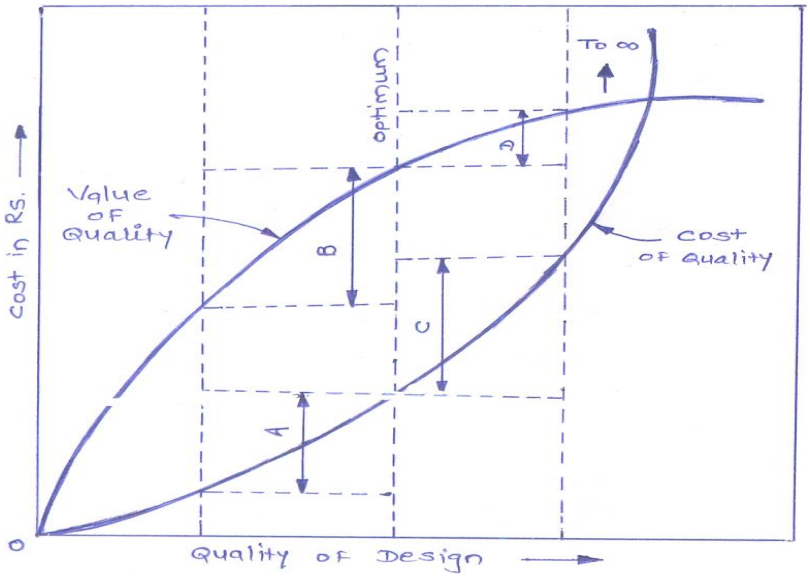


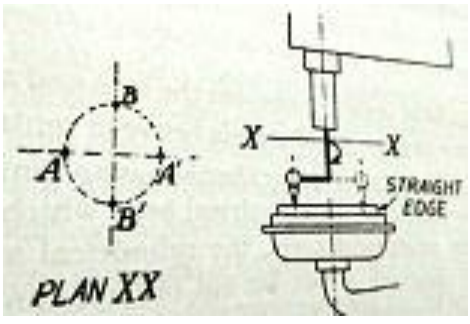
01 mark for sketch.

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.

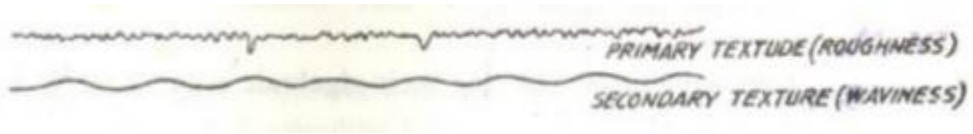
Thus in general it is preferable not to use the sin bar for measuring angles greater than

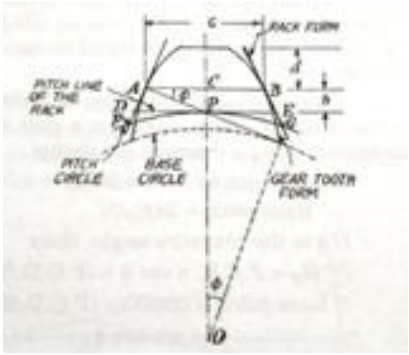
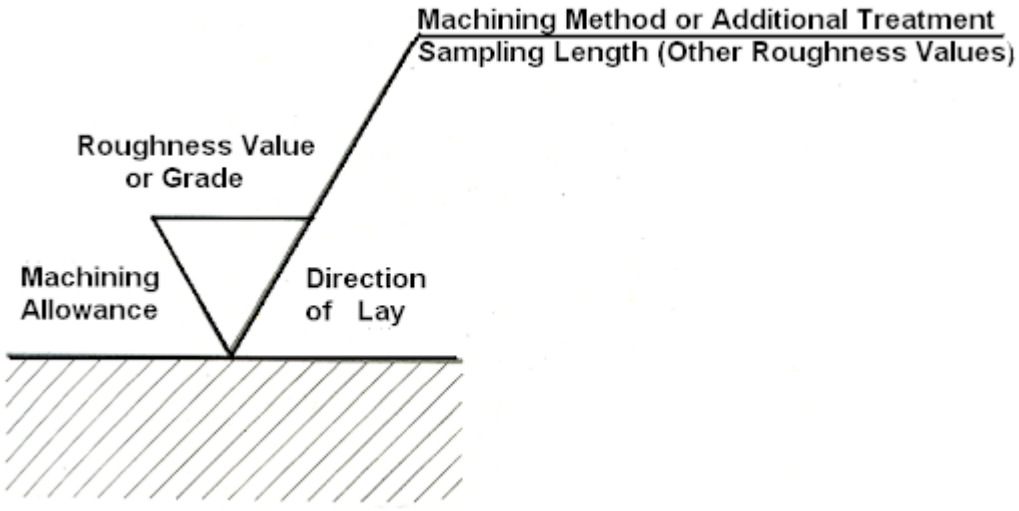
45 ^{o} if high accuracy is required

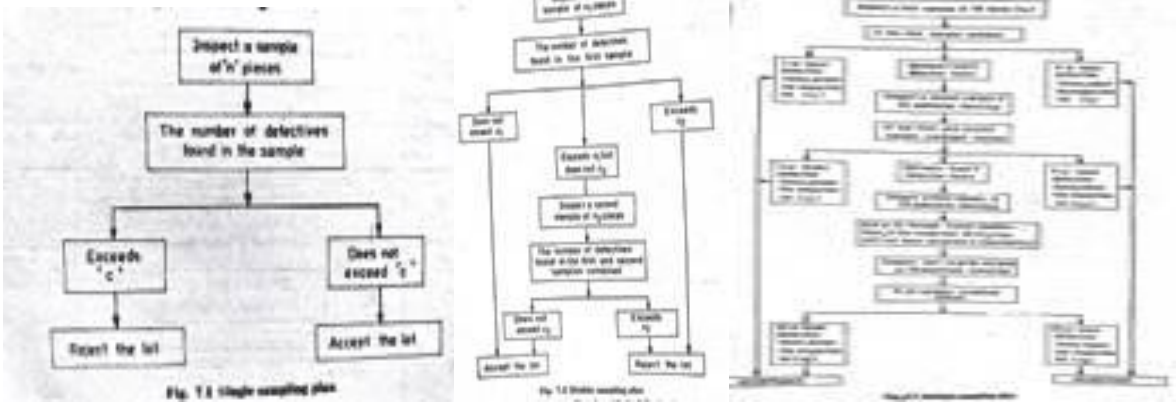
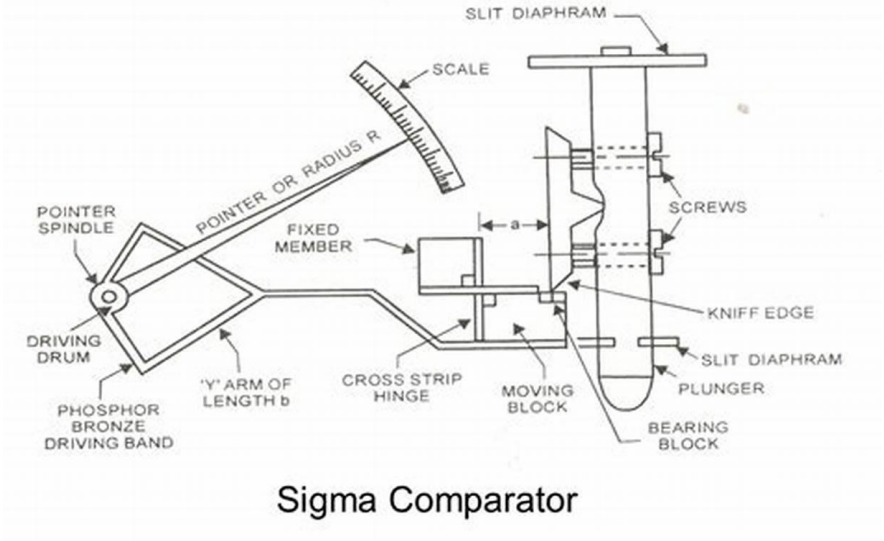
	c	**Cost of Quality and Value of Quality.**  1. The balance between the cost of quality and value of quality gives optimum quality of design. 2. It is not necessary that the company should manufacture 100% quality products. 3. The study of optimum quality of design involves "Market Survey". 4. While carrying out market survey expected sale for particular quality, profit and competition in the market is to be considered. 5. 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. 6. The aim should be to improve quality at lower cost. 7. The curves representing the cost and value of quality of design are shown in fig. 8. 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. 9. Now B >A and therefore, improvement in quality at this level will yield more income. 10. However, if the quality is to be improved from point 2 to point 3, then from the fig. 11. 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.	**02 marks for figure** **02 marks for explanation**

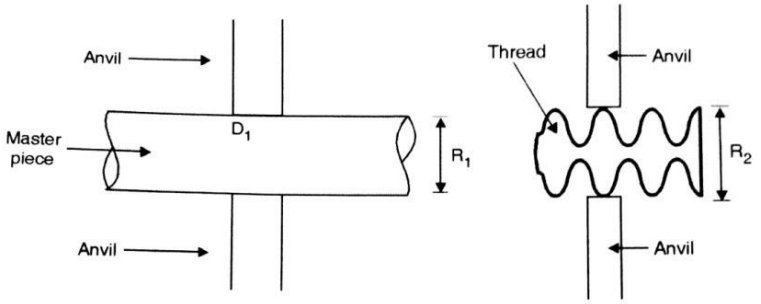
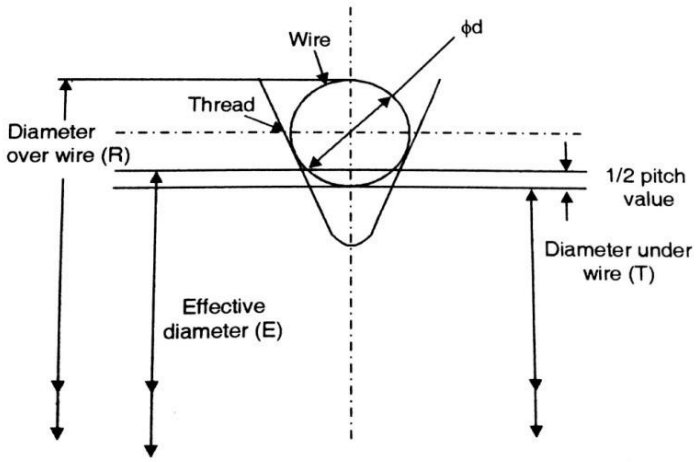
	d	**State the methodology of Six sigma improvement and explain any one of them.** Methodology of six sigma; - The fundamental objective of six sigma methodology is focus on process variation, process improvement, variation control. Six sigma is scientific approach for eliminating defects. In general there are two six sigma methodologies 1. For existing products / processes DMAIC (Define , Measure, Analysis, Improve, Control) 2. For development of new products / processes DMADV (Define , Measure, Analysis, Design, Verify) DMAIC : • It refers to strategy of finding solutions and eliminating root cause. • Design and management are two sectors which can be focused DMADV: • This methodology can be used when a product or process is not in existence, but is needs to be developed. • Design and verify are two important steps in this methodology	**01 mark for methodology** **03marks for explanation**
	e	**Enlist any four factors affecting accuracy of instrument.** 1. Handling of instruments. 2. Errors in instrument. 3. Wear of different components of instrument. 4. Operating and environmental conditions**.** **5. Calibration of instrument** **6. Proper method of using an instrument**	**01 mark each** **any four points**
3	a	For this test a straight edge is placed in position AA' and BB' as shown in fig. The dial indicator is mounted on spindle such that its tip will touch to straight edge. Now the spindle is slowly rotated through 180^0 and the dial indicator reading is noted at different positions. The difference of two readings gives the error in squareness of spindle axis with table.  	**02 marks for figure** **02 marks for explanation**

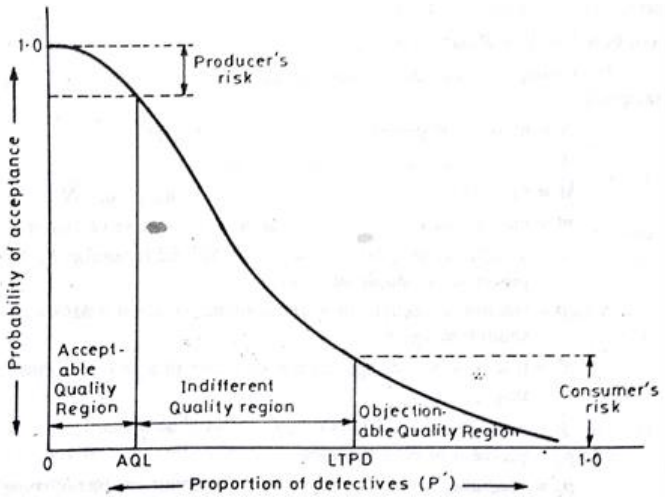
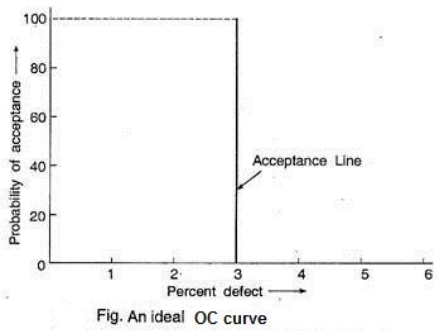
	b	Angle to be developed $121^0 36' 27''$ 121^0 ($90 + 27^0 + 3^0 + 1^0$) = 4 $121 - 90 = 31^0$ $31^0 = 27^0 + 3^0 + 1^0$ $36' = 27' + 9'$ ($27' + 9'$) = 2 $27'' = 30'' - 3''$ ($30'' - 3''$) = 2 	**Calculation - 02** **Sketch -02**
	c	35H6f8 i) 35 – Diameter of shaft and hole i.e basic size ii) H – Type of hole iii) 6 – IT 6 grade of tolerance for hole (10i) iv) f – Type of shaft v) 8 – IT8 grade of tolerance for shaft. (25i) vi) 35H6f8 indicate hole basis system, clearance fit	**04 marks**
	d	**Errors in gears** 1) Runout 2) Radial runout 3) Axial runout 4) Periodic error 5) Cyclic Error 6) Tooth thickness error 7) Pitch error 8) Profile error 9) Backlash 1) Runout:- it is the total range of reading of a fixed indicator with the contact point applied to a surface rotated, without axial movement , about a fixed axis. 2) Radial runout :- it is the runout measured along a perpendicular to the axis of rotation. 3) Axial runout:- it is the runout measured parallel to the axis of rotation, at a specified	**01 mark for list,** **03 marks for explanation (any one)**

		distance from the axis. 4) Periodic error:- An error occurring at regular intervals not necessarily corresponding to one revolution of the component. 5) Cyclic Error:- It is the error occurring during each revolution of the element under consideration. 6) Tooth thickness error:- it is the value obtained by subtracting the design tooth thickness from the actual tooth thickness measured along the surface of the reference cylinder. 7) Pitch error:- pitch error is a source of gear noise and the character of noise will depend upon how pitch errors are produced and how they are distributed. i) Adjacent pitch error ii) Cumulative pitch error 8) Profile error:- it is the maximum distance of any point on the tooth profile form and normal to the design profile when the two coincide at the reference circle. 9) Backlash :- It is the play between the mating tooth surfaces i.e the distance through which a gear can be rotated to bring its nonworking flank in contact to teeth of mating gear	
	e	**Primary Texture**:- The surface irregularities of small wavelength are called primary texture or roughness. It is caused by direction of cutting tool, friction, wear, corrosion, tool feed rate **Secondary Texture**:- The surface irregularities of considerable wavelength of periodic character are called secondary texture or waviness. It is caused due to disturbance in set up, misalignment of centers, lack of straightness in guide ways, nonlinear feed motion  	**02 marks for figure** **02 marks for explanation**
4	a i	**Constant chord method** Constant chord of a gear is measured where the tooth flanks touch the flanks of the basic rack. The teeth of the racks are straight and inclined to their center lines at the pressure angle. The tooth thickness of the rack along this line is equal to the arc tooth thickness of the gear round its pitch circle. The constant chord is defined as the chord joining those points, on opposite faces of the tooth, which make the contact with mating teeth when	**01 mark for sketch** **03 marks for**

		the center line of the tooth lies on the line of the gear center. The value of AB and its depth from the tip, where it occurs can be calculated mathematically and then verified by an instrument Pd = arc PF =1/4 * π * m C = constant chord =2AC = (π/2mcos^{2}ϕ)  	**explanation**
	ii	**Labeled diagram of surface finish on drawing**  	**02 marks for sketch** **02 marks for labeling**
	iii	**Importance of quality audit** • It helps to verify whether systems are implemented and working correctly or not. • Identify the quality problems. • Identify non conformities. • Analysis of problems. • Corrective and preventive actions • Customers requirements are fulfilled or not • Quality audit is not an fault finding process, but it is a tool for continuous improvement	**01 mark for each point (any four points)**

	iv	**Types of sampling plan** Commonly used types of sampling plans are; 1. Single sampling plan 2. Double sampling plan 3. Multiple sampling plan  (Sampling plan can be in the form of explanation or flow chart)	**01 mark for types** **03 marks for explanation (any one)** **With flow chart**
	b i	 Sigma Comparator **Advantages of Sigma comparator** 1. large indicator scale with pointer 2. Higher magnification 3. Robust design. 4. Good for shop floor use 5.Least count up to 0.25 micron is available	**03 marks for figure** **03 marks for advantages (any three)**

	ii	1) Effective diameter can be measured by using floating carriage instrument which is more accurate. 2) For measurement of effective diameter two wire methods are used. 3) Two wire methods consist of use of two identical based size of wires. 4) Fig. shows the 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. 5) fig. shows geometrical sketch with one thread and one wire. 6) Various terms are defined as Diameter over wire= R which is measured as shown in fig. Diameter under wire = T Pitch value = P (it is difference between effective diameter and diameter under wire) 7) From fig 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 8) For reducing various types of errors master piece can be used at the time of measurement.  (a) (b) **Fig.**  (c) **Fig. Two wire method**	**Explanation-03** **Fig.-03**

5	a	  Fig. An ideal OC curve i) Producer's risk: It is the probability to rejecting a good lot which otherwise would have been accepted. ii) Consumer's risk: It is the probability of defective lots being accepted which otherwise would have been rejected. iii) Acceptable quality Level (AQL):- AQL can be defined as the maximum per cent defectives that for the purpose of sampling inspection can be considered satisfactory as a process average.it represents the maximum proportion of defectives which the consumer finds definitely acceptable. As an AQL is an acceptable quality level, iv) Rejectable quality level (RQL):- it is also called as lot tolerance percent defective (LTPD). It represents the proportion of defectives which the consumer finds definitely unacceptable. v) Average outgoing quality (AOQ) :- it represents the average percent defective in the outgoing products after inspection, including all accepted and all rejected lots which have been 100 % inspected and defectives replaced by non-defectives.	**04 marks for figure (02 marks for each type of curve), 04 marks for definitions (01 mark each any four)**

b

Q.5

(b)

Sample No.	Defective found out of 50 (P)	fraction Defective
1	4	0.08
2	5	0.1
3	0	0
4	3	0.06
5	2	0.04
6	5	0.1
7	1	0.02
8	6	0.12

—— (1 mark)

Total fraction Defective : 0.52

Average fraction defective $= \bar{P} = \frac{\Sigma P}{\Sigma n}$

$= \frac{26}{8 \times 50} = 0.065$ (OR) $\frac{0.52}{8}$

$\bar{P} = 0.065$

—— (1 mark)

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

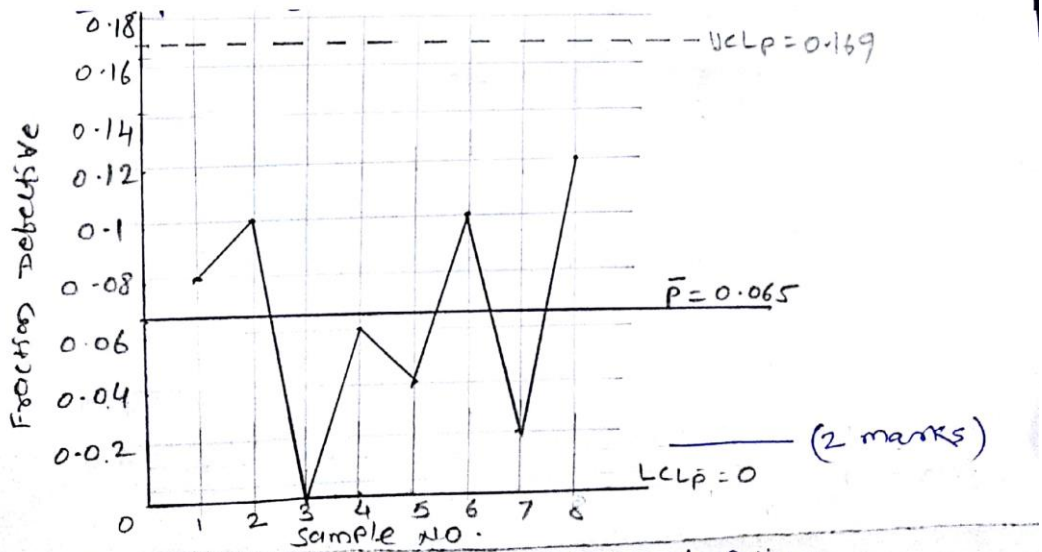
$= 0.065 + 3 * \sqrt{0.065(1-0.065)/50}$

$UCL_P = 0.169$ —— (1 mark)

$LCL_P = \bar{P} - 3 * \sqrt{\bar{P}(1-\bar{P})/n}$

$= -0.0395$

$LCL_P = 0$ —— (1 mark)

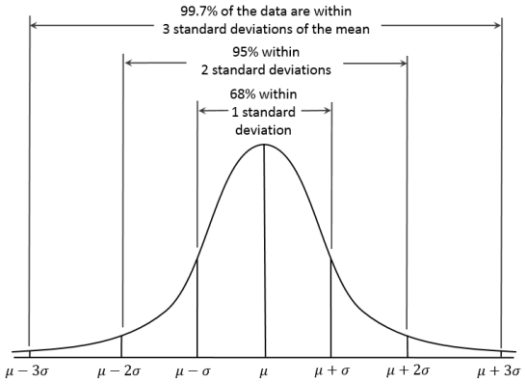


—— (2 marks)

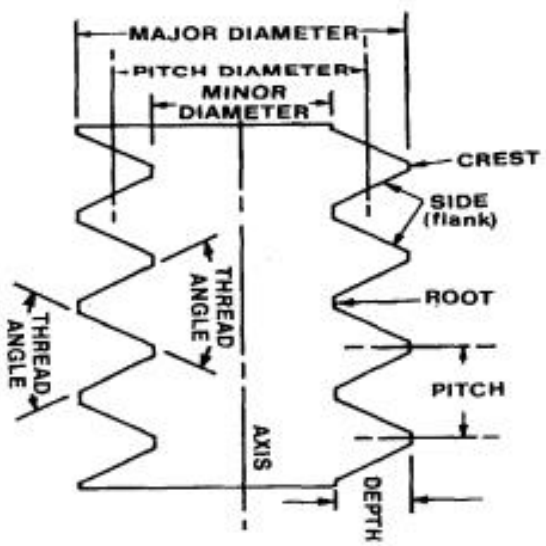
Conclusion :- The process is within statistical control —— (1 mark)

$= 0.0013 + 0.0152$

	c	**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 build customer confidence that it is capable of delivering the products or services of desired quality. 4. It reduces the need of assessment by multiple buyers. 5. Motivates the employees and develops pride in them for achieving excellence. 6. Adaptation of ISO 9000 results in improvement in efficiency, and reduction in inspection, scrap and rework. 7. It helps the company to provide a framework for continuous improvement in quality. **Limitations of ISO 9000:-** 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 needs to change attitude and accept new working practices may strain the management.	**04 marks for advantages (any four)** **04 marks for limitations (any four)**
6	a i)	**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. Or 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. In other words The process capability =6σ'. As 6σ' is taken as a measure of the spread of the process, which is also called natural tolerance. Process capability study is carried out to measure the ability of the process to meet the specified tolerances. By this study, it becomes possible to know the percentage of the products which will be produced within ±3σ limits on either side of the mean. When the process is functioning under the chance cause system the distribution of the individual products coming from it will tend to be normal, and if we set the tolerance at ±3σ for the distribution, 99.7% of the products will fall within these tolerance limits	**04 marks for explanation**



ii) **Screw Thread Profile:-**



02 marks for sketch

02 marks for labeling

b **i) Straightness:-** a line is said to be straight over a given length, if the variation of the distance of its points from two planes perpendicular to each other and parallel to the generation distance of the line remains within the specified tolerance limits.

02 marks for each term

ii) Wringing of slip gauges:- wringing is the process of adhering measuring faces of a gauge block , by sliding or pressing the gauge against the measuring faces of the another gauge blocks without the use of any extraneous means.

OR

Wringing is the phenomenon of adhesion of two flat and smooth surfaces when they are brought into close contact with each other. The force of adhesion is such that the stack of a set of blocks will almost serve as a single block.

iii) Pitch of screw thread:- the distance measured parallel to the axis from a point on a thread to the corresponding point on the adjacent thread is called pitch of thread.

iv) Tolerance:- the permissible variation in size or dimension is called tolerance.

c

Given Data

$\Sigma\bar{x} = 3596.2$, $\Sigma R = 196$, $N = 20$, $n = 5$

$A_2 = 0.577$ $D_3 = 0$, $D_4 = 2.11$

$\bar{\bar{x}} = \frac{\Sigma\bar{x}}{N} = \frac{3596.2}{20} = 179.81$ ——— (1 mark)

$\bar{R} = \frac{\Sigma R}{N} = \frac{196}{20} = 9.8$ ——— (1 mark)

$UCL_{\bar{x}} = \bar{\bar{x}} + A_2\bar{R}$ ——— (1 mark)

$= 179.81 + (0.577 * 9.8)$

$= 185.4646$ ——— (1 mark)

$LCL_{\bar{x}} = \bar{\bar{x}} - A_2\bar{R}$ ——— (1 mark)

$= 179.81 - (0.577 * 9.8)$

$= 174.1554$ ——— (1 mark)

$UCL_R = D_4\bar{R}$

$= 2.11 * 9.8$

$= 20.68$ ——— (1 mark)

$LCL_R = D_3\bar{R}$

$= 0 * 9.8$

$= 0$ ——— (1 mark)