Student Copy

G. S. Mandal's
Maharashtra Institute of Technology, Aurangabad
(An Autonomous Institute)
Department of Mechanical Engineering

END SEMESTER EXAMINATION

Academic Year 2022-23 Semester-I

Class: Second Year **Date: / /2023**

Course: Metrology and Quality Control **Time: hr**

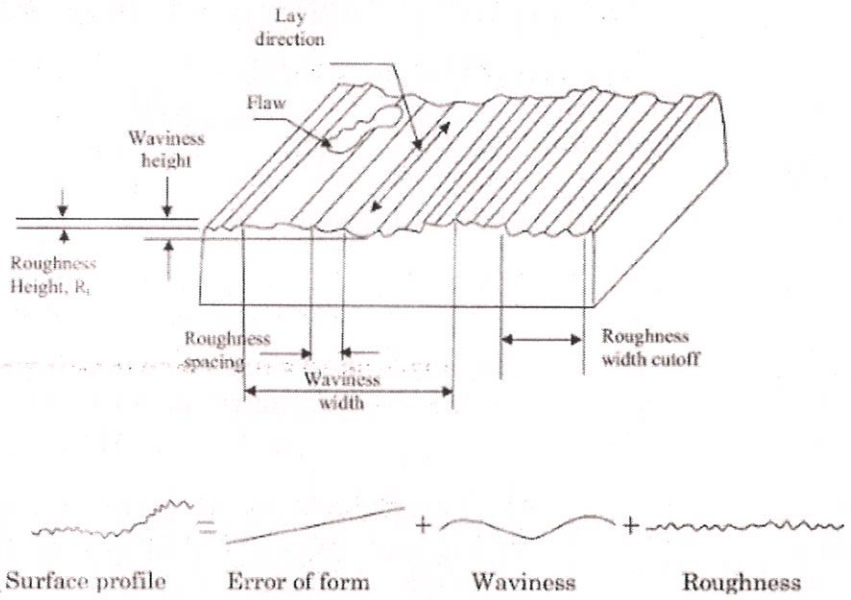
Max Marks:

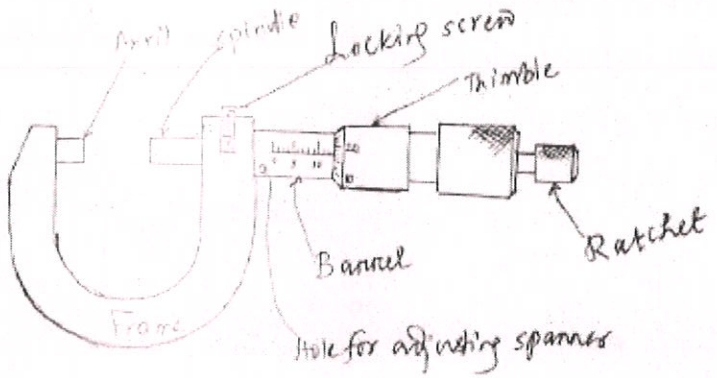
Q. 1	**Solve/Answer the following questions**	
	Answer/Solution	**Stepwise Marking Scheme**
a)	**What is accuracy and precision?** Accuracy The ability of an instrument to measure the accurate value is known as accuracy. In other words, it is the closeness of the measured value to a standard or true value. Precision is the degree to which repeated measurements under the same conditions	**1** **1**
b)	**Define process capability** Process capability is defined as a statistical measure of the inherent process variability of a given characteristic. You can use a process-capability study to assess the ability of a process to meet specifications.	**2**
c)	**What is tolerance?** Tolerance is the difference between the upper (maximum) and lower (minimum) limits.	**2**
d)	**Classify methods of measurement.** Types of measurements are: Indirect method of measurement. Direct method of measurement. Fundamental method of measurement. Substitution method of measurement. Comparison method of measurement.	**2**
e)	**Compare line standard with end standard**	**2**

Line Standard	End Standard
Distance between two engraved lines is used for measurement.	Distance between two flat parallel surfaces is used for measurement.
Scale graduations marking are not subjected to wear.	End surfaces subjected to wear.

	Quick and easy measurement.	Only one measurement at time. So, it is time consuming.	
	Limited accuracy of 0.2mm. It can't use for close tolerance measurement.	High accuracy. Dimensional tolerance as close as 0.0005mm.	
	It does not has built in datum, so alignment with measurement axis difficult.	It has built in datum, so it is easy to align with measurement axis.	
	Parallax error can be occurred in measurement.	Not subjected to parallax error.	
	Its manufacture is simple and cost low.	Complex manufacturing process required. Cost is high.	
	Example: Meter scale, Yard, etc.	Example: Slip gauges, End bars, Gap gauges etc.	

f)	**What are the benefits of acceptance sampling?** The method is applicable in those industries where there is mass production and the industries follow a set production procedure. (ii) The method is economical and easy to understand. (iii) Causes less fatigue boredom. (iv) Computation work involved is comparatively very small. (v) The people involved in inspection can be easily imparted training. (vi) Products of destructive nature during inspection can be easily inspected by sampling. (vii) Due to quick inspection process, scheduling and delivery times are improved	**2**
g)	**What are the limitations of statistical quality control?** 1. When a sample of the items drawn from the lot is not a true representative of the entire lot and does not have the same characteristics as the lot from which it is drawn. Then a good lot may be rejected and a bad one may be accepted. This is the main limitation of SQC. 2. SQC cannot be used mechanically for any production process without studying the process and without having adequate knowledge about the process. 3. SQC applied on a production process provides only the information that the process is under control or out-of-control. It cannot take	**2**

	any action for improvement.	
h)	**Discuss the term surface terminology**  	**2**
Q.2	**Explain with neat sketch working principle of micrometer** A micrometer is an instrument used for making precise linear measurements of dimensions such as diameter, thickness, and lengths of solid bodies. It is made of a C-shaped frame with a movable jaw operated by an integral screw. The fineness of the measurement depends on the lead of the screw while the accuracy of the measurement depends on the accuracy of the screw-nut combination. Parts of a Micrometer A micrometer is composed of the following parts: • Frame – It is the C-shaped body that holds the anvil and barrel in constant relation to each other. The frame is heavy and has high thermal mass. To prevent substantial heating up, it is covered by insulating plastic. • Anvil – The shiny part the spindle moves toward and the sample rests against. • Barrel – Stationary round component with a linear scale on it. • Screw – Found inside the barrel and is considered the heart of the micrometer. • Locknut – Component that one can tighten to hold the spindle stationary. • Spindle – Shiny cylindrical component that causes the thimble to move toward the anvil. • Ratchet Stop – The device on the end of the handle that limits applied pressure by slipping at a calibrated torque.	**2** **2** **2** **2**



Micrometers transform small distances into large rotations of the screw that can be read from a scale. The basic operating principle of a micrometer are as follows:

- The amount of rotation of an accurately made screw can be directly and precisely correlated to a certain amount of axial movement (and vice versa), through the constant known as the screw's lead. A screw's lead is the distance it moves forward axially with one complete turn (360°).
- With an appropriate lead and major diameter of the screw, a given amount of axial movement will be amplified in the resulting circumferential movement.

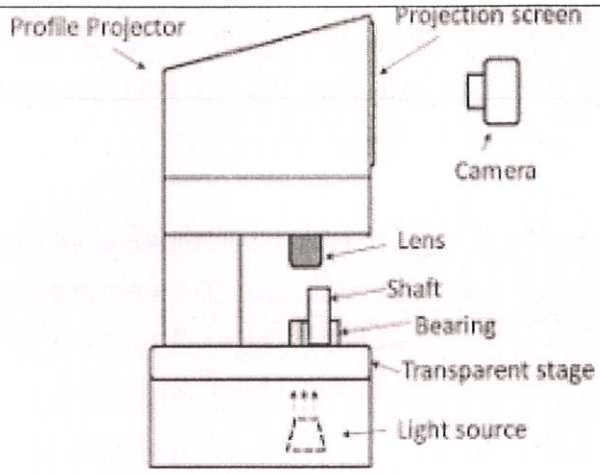
OR

Explain the working principle of profile projector.

1. Profile projectors (optical comparators) are a type of optical measuring instrument. The measurement principle is similar to that of optical microscopes.
2. The target is placed on the stage, and a light is shined on the target from underneath. This causes the target's profile, or shadow, to be projected on the screen.
3. A telocentric optical system is used to enable accurate measurements.
   Profile projectors were originally developed to inspect the outlines of targets.
4. Models equipped with measurement functions appeared later.Some large profile projectors have screen diameters that exceed 1 m
5. Profile projectors are also commonly known as an optical comparator or shadowgraph.

4

Student Copy



2

A typical profile projector illuminates from below and projects the shadow of the measuring object placed on the stage through a projection lens onto a projection screen. For this reason, it's also known as an optical comparator or shadowgraph.

2

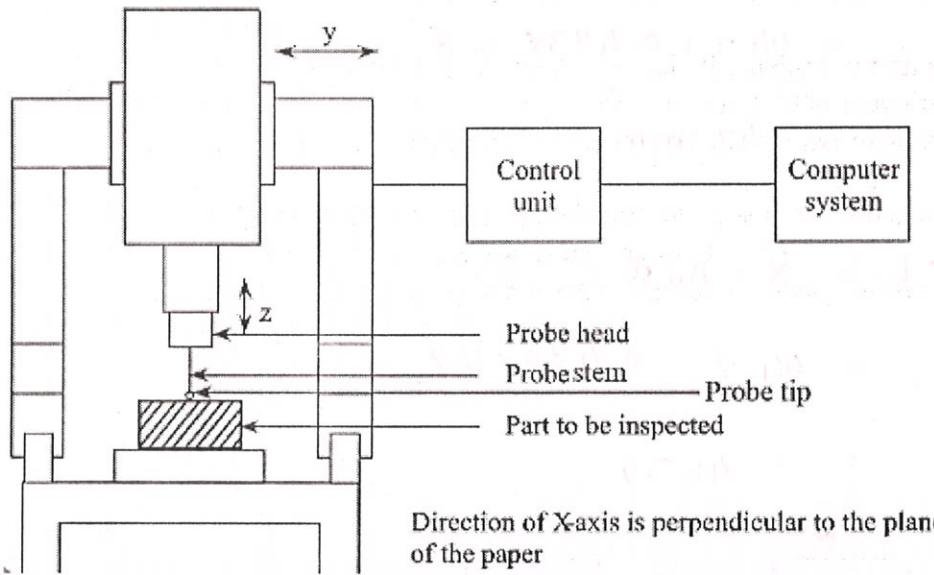
At this time, the size of the projected image is an image magnified with a correct magnification from the measuring object, and the dimension of the measuring object is measured by measuring this image.

Q.3

Apply the use of co-ordinate measuring machine for determination of dimension of a component.

2

1. CMM machine stands for Coordinate Measuring Machine. It is a tool that can measure the dimensions of a machine/tool parts using coordinate technology.
2. The dimension open to measurements include the height, width and depth in the X, Y, and Z axis. Depending on the CMM machine's sophistication, you can measure the target and record the measured data.
3. The CMM machine has the speed and accuracy to repeatably measure parts better than the traditional method.
4. It also increases productivity while reducing the tendency of having errors in the measuring process.

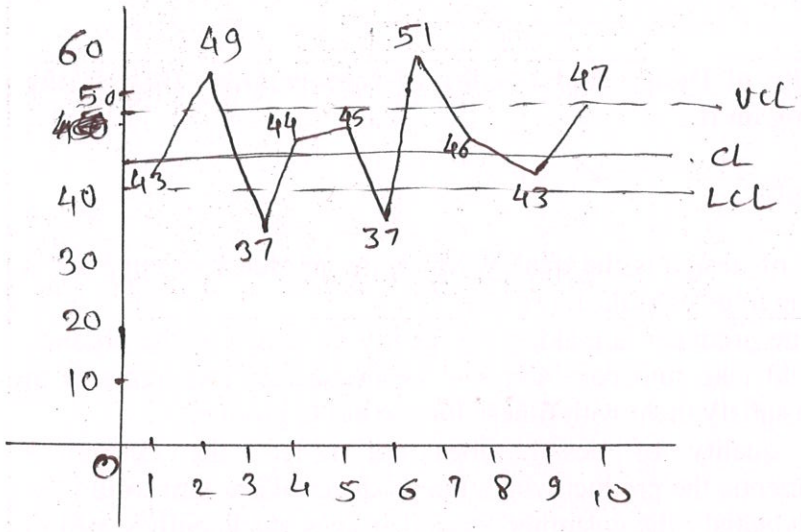


2

Student Copy

	On touching a point of the part to be measured, the probe sends an electrical signal which the computer maps out. By doing so continuously with many points on the part, you will measure the part. After the measurement, the next stage is the analysis stage, after the probe has captured the part's X, Y, and Z coordinates. The information obtained is analyzed for the construction of features. The mechanism of action is the same for CMM machines that uses the camera or laser system.	4
Q.4	Analyze the following data of measurement and comment on process capability by representing it on control chart. Given the following control chart constraint for : n = 5, $A_2 = 0.58$, $D_3 = 0$ and $D_4 = 2.115$ $\bar{\bar{X}} = \frac{\Sigma \bar{X}}{10}$ $\quad \bar{R} = \frac{\Sigma R}{10}$ $= \frac{442}{10}$ $\quad = \frac{58}{10}$ $= 44.2$ $\quad = 5.8$ $UCL = \bar{\bar{X}} + A_2 \bar{R}$ $= 44.2 + 0.483 \times 5.8$ $= 47.$ mm $LCL = \bar{\bar{X}} - A_2 \bar{R}$ $= 44.2 - 0.483 \times 5.8$ $= 41.39.$	2 4

Sample Number	1	2	3	4	5	6	7	8	9	10
$\bar{X}$	43	49	37	44	45	37	51	46	43	47
R	5	6	5	7	7	4	8	6	4	6



2

Q.5

Distinguish between producers' risk and Consumer's risk with suitable example.

1. In practice, the producer's and consumer's risks are specified in terms of the Acceptance Quality Limit (AQL) and the Limiting Quality level (LQ or LQL) respectively.
2. Once these are specified, along with their associated probabilities of rejection and acceptance respectively, a sampling plan, allowing no more than these levels of risk can be developed.
3. Producer's Risk is the probability of wrongly rejecting a compliant lot, with level of non-conformance at or below the acceptance quality limit (or proportion of non-conforming units for lots consisting of discrete items).
4. Generally the quality of an acceptable lot is expressed as the Acceptance Quality Limit. It is a point on the OC curve corresponding to some predetermined and usually low probability of rejection. This probability of rejection is called the 'producer's risk'.
5. Consumers' Risk is the probability of wrongly accepting a lot that is not of acceptable quality.
6. It is a point on the OC curve corresponding to a predetermined and usually low probability of acceptance. This probability is then called the 'consumer's risk' and the corresponding lot quality is called the Limiting Quality (LQ or LQL).
7. The Acceptance Quality Limit (AQL) (previously called Acceptable Quality Level) is the level of proportion of non-conforming items at which lots are accepted most of the time, usually taken as 95%.

4

4

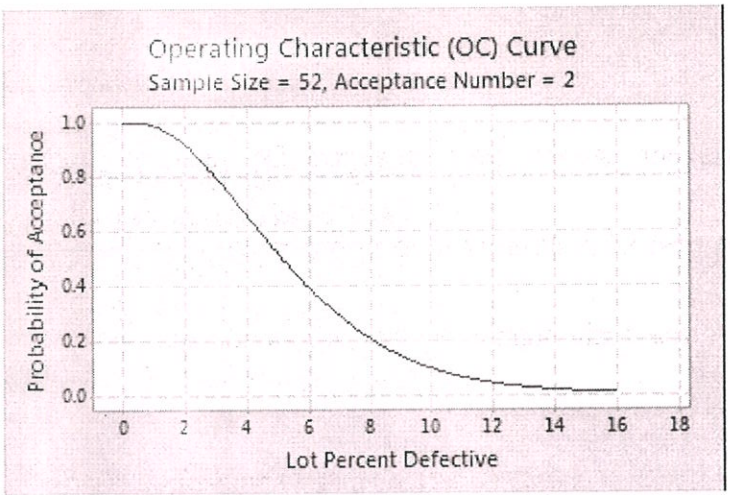
	conforming items associated with the consumer's risk, or the level of non-conforming items of lots accepted after control, in 10% of the cases.	
	OR	
	Explain Quality of Design and Quality of conformance. Discuss the factors affecting on it. Quality of design 1. Quality of design is the quality which the producer or supplier is intending to offer to the customer. 2. When the producer is making the quality of design of the product, he should take into consideration the customer's requirements in order to satisfy them with fitness for use of the product. 3. If the quality of design does not reflect the customer's requirements, the product which the producer offers him would not probably satisfy the customer, even if it does sufficiently conform to the design. 4. Quality of design is usually indicated by completeness and correctness of specifications, drawings, catalogues, etc. and is measured with fitness for use. Quality of conformance 1. Quality of conformance is the level of the quality of product actually produced and delivered through the production or service process of the organization as per the specifications or design. 2. When the quality of a product entirely conforms to the specification (design), the quality of conformance is deemed excellent. 3. Specifications are targets and tolerances determined by the designer of a product. 4. Targets are the ideal values for which production is expected to strive; tolerances are acceptable deviations from these ideal values recognizing that it is difficult to meet the exact targets all the time due to variability in material, machine, men and process. 5. For example, if an engineering component manufacturer specifies the diameter of a steel pin as 2.525 + 0.005 mm, the value 2.525 is the target value and + 0.005 is the tolerance. 6. In a similar way, in case of an Airline service, if on time arrival of a flight is specified as within 15 minutes of scheduled time, the target is scheduled time and tolerance is + 15 minutes.	4 4
Q.6	**Explain the operating characteristic curve and its importance in acceptance sampling.** 1. The operating characteristic (OC) curve depicts the discriminatory power of an acceptance sampling plan. The OC curve plots the probabilities of accepting a lot versus the fraction defective. 2. When the OC curve is plotted, the sampling risks are obvious. You should always examine the OC curve before using a sampling plan. 3. For example, you sample 52 pens from a shipment of 5000. If the actual % defective is 1.5%, you have a 0.957 probability of	4

accepting this lot based on the sample and a 0.043 probability of rejecting it.

4. If the actual % defective is 10%, you have a 0.097 probability of accepting this lot and a 0.903 probability of rejecting it.
5. Examine the OC curves, AOQ curves, and ATI curves together when evaluating sampling plans.

Use an OC curve to choose an appropriate sampling plan

1. We can compare OC curves to help choose the appropriate sampling plan.
2. In this case, the shift supervisor thinks sampling 52 pens from 5000 is too many.
3. We can develop curves for various sample sizes and acceptance numbers to illustrate the increased risk.



4

OR

In the measurement of surface roughness, heights of 20 successive peaks and valley were recorded over a length of 20 mm. Calculate CLA and RMS Value of the surface over a given data. 13,10,15,22,16,32,25,26,24,9,11,16,14,21,18. Microns.

Given, $h_1 = 13$, $h_2 = 10$, $h_3 = 15$ $h_4 = 22$ h_5 16

$h_6 = 32$ $h_7 = 25$ $h_8 = 26$ $h_9 = 24$ $h_{10} = 9$

$h_{11} = 11$ $h_{12} = 16$ $h_{13} = 14$ $h_{14} = 21$ $h_{15} = 18$

4

$$C.L.A = \frac{13+10+15+22+16+32+25+26+24+9+11+16+14+21+18}{16}$$

$$= 17 \text{ microns.}$$

Student Copy

	$RMS = \sqrt{\frac{h_1^2 + h_2^2 + \cdots - h_{16}^2}{n}}$ $= \quad 18.63$ micron.	4

Course Coordinator