



MODEL ANSWER

SUMMER– 17 EXAMINATION

Subject Code:

17530

Subject Title:

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	Needs of the inspection:- 1) To ensure that the part, material or a component confirms to the established standard. 2) To meet the interchangeability of manufacturer. 3) To maintain the customer relation by ensuring that no faulty product reaches the customer. 4) Provide the means of finding out shortcomings in manufacture. 5) It helps to purchase good quality of raw material, tools, equipment which governs the quality of the finished product. 6) It helps to coordinate the functions of quality control, production, purchasing and other other departments of the organization. 7) To take decision on the defective parts.	01 mark each, any 4 points



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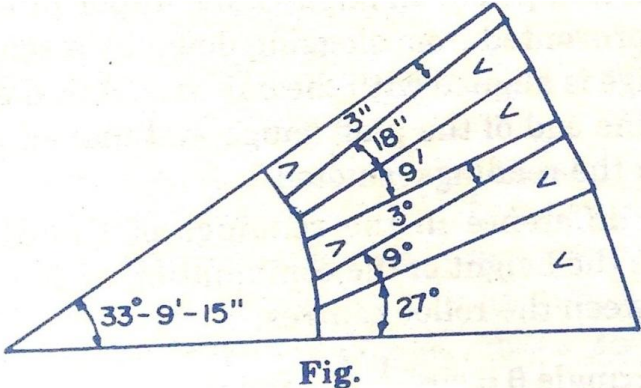
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Q. No.	Sub Q. N.	Answer	Marking Scheme
	b	<p>Advantages of Wavelength standard over material standard</p> <p>1) It is not a material standard and hence it is not influenced by effects of variation of environmental conditions like temperature, pressure and humidity.</p> <p>2) It need not be preserved or stored under security and thus there is no fear of being destroyed as in case of meter and yard.</p> <p>3) It is not subjected to destruction by wear and tear.</p> <p>4) This standard is easily available to all standardizing laboratories and industries.</p> <p>5) There is no problem of transferring standard to other standards meter and yard.</p> <p>6) It gives a unit of length which can be produced consistently at all the times in all the circumstances.</p> <p>7) It can be used for making comparative measurements of very high accuracy.</p>	<p>01 mark each, any 4 Advantages</p>
	c	<p>13 pieces standard set of angle gauges contains following angle gauges</p> <p>Degree:- 1° , 3° , 9° , 27° , 41°</p> <p>Min:- $1'$, $3'$, $9'$, $27'$</p> <p>Second:- $3''$, $6''$, $18''$, $30''$</p> <p>Minimum number of angle gauges required to obtain the angle</p> <p>$33^{\circ} - 9' - 15''$ are as follows:-</p> <p>$27^{\circ} + 9^{\circ} - 3^{\circ} + 9' + 18'' - 3''$</p>	<p>02 Marks</p>

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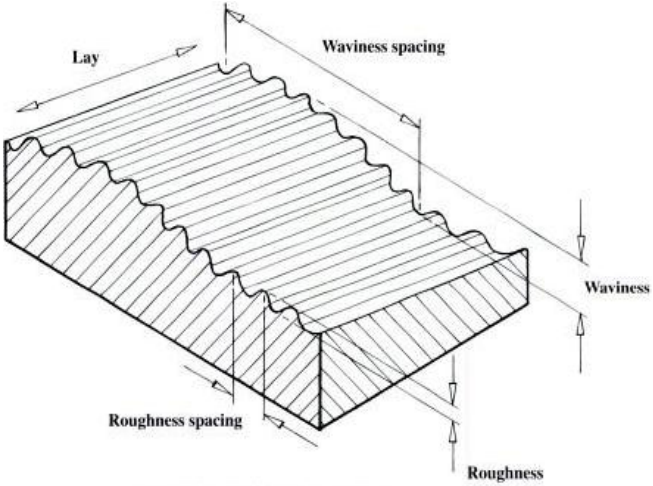
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Q. No.	Sub Q. N.	Answer	Marking Scheme
		<p>The arrangement of the angle gauges is as shown in fig.</p>  <p style="text-align: center;">Fig.</p> <p>d</p> <p>1) Runout:- it is the total range of reading of a fixed indicator with the contact point applied to a surface rotated, without axial movement , about a fixed axis.</p> <p>2) Radial runout :- it is the runout measured along a perpendicular to the axis of rotation.</p> <p>3) Axial runout:- it is the runout measured parallel to the axis of rotation, at a specified distance from the axis.</p> <p>4) Periodic error:- An error occurring at regular intervals not necessarily corresponding to one revolution of the component.</p> <p>5) Cyclic Error:- It is the error occurring during each revolution of the element under consideration.</p> <p>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.</p> <p>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.</p> <p style="padding-left: 40px;">i) Adjacent pitch error ii) Cumulative pitch error</p> <p>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.</p>	<p style="text-align: right;">02 Marks</p> <p style="text-align: right;">01 mark each any 4 type</p>

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Q. No.	Sub Q. N.	Answer	Marking Scheme
	e	<p>Primary Texture:- the surface irregularities of small wavelength are called primary texture or roughness.</p> <p>Secondary Texture:- The surface irregularities of considerable wavelength of periodic character are called secondary texture or waviness.</p> <p>Sampling Length:- it is the length of the profile necessary for the evaluation of the irregularities to be taken into account. It is also known as cut off length.</p> <p>RMS value in surface finish:- R.M.S. value is defined as the square root of the arithmetic mean of the values of the squares of the ordinates of the surface measured from a mean line.</p> $RM \sqrt{\frac{h_1^2 + h_2^2 + h_3^2 + \dots + h_n^2}{n}}$ 	<p>01 mark each</p> <p>Note:- figure not required , if drawn give advantage</p>



Q. No.	Sub Q. N.	Answer	Marking Scheme
	f	Objectives of quality control:- <ol style="list-style-type: none">1. To improve the company's income2. To reduce the production cost through reduction in losses due to defects, rework, scrap , customer return etc.3. To achieve interchangeability in large scale production.4. To produce optimum quality at minimum price.5. To ensure customer satisfaction through quality level.6. To make the inspection prompt to ensure production of non-defective products7. To improve quality and productivity by process control experimentation and customer feedback.8. Developing quality consciousness in the organization.	01/2 mark each any 8 objectives
	g	Procedure for p chart:- <ol style="list-style-type: none">1. Record the data for each subgroup of number of articles inspected and number of defectives.2. Compute P (fraction defective) for each subgroup, $p = \frac{\text{Number of defective in subgroup}}{\text{number of articles inspected in subgroup}}$3. Compute \bar{p} (Average fraction defectives), $\bar{p} = \frac{\text{Total no. of defectives}}{\text{Total quantity inspected}}$	04



		4. Compute control limits, $UCL_p = \bar{p} + 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$	
1	g	$LCL_p = \bar{p} - 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$ 5. Plot each point on the graph.	
2	a	<p>Legal metrology is concerned with the units of measurement, methods of measurement and the measuring instruments, in relation to the statutory technical and legal requirements.</p> <p>The legal metrology is directed by a national organization which is also called National Service of Legal Metrology.</p> <p>It includes a number of international organizations whose ultimate object is to maintain uniformity of measurement throughout the world.</p> <p>The functions of legal metrology:-</p> <ol style="list-style-type: none">1) To ensure conservation of national standards.2) To guarantee their accuracy by comparison with international standard.3) To carry out scientific and technical work in all fields of metrology and methods of measurements.4) To regulate, advise, supervise and control the manufacture and repair of measuring instruments.5) To inspect the use of these instruments and the measurement operations when covered under public guarantee.6) To detect fraud of measurements.7) To organize training in legal metrology.	<p>02 marks for Explanation,</p> <p>02 marks for functions any two mark each</p>



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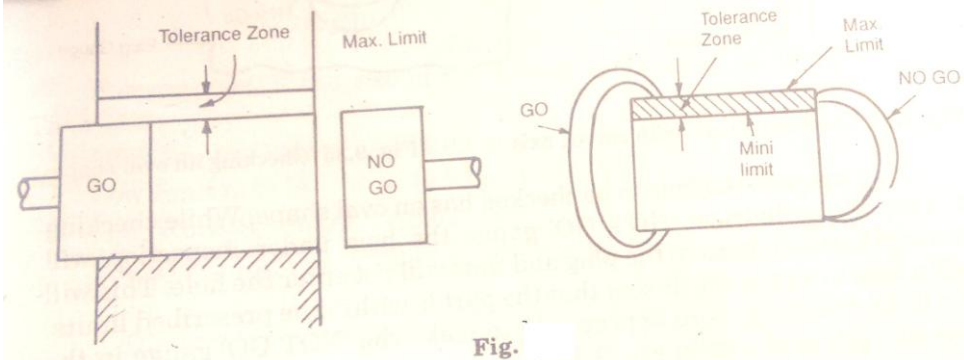
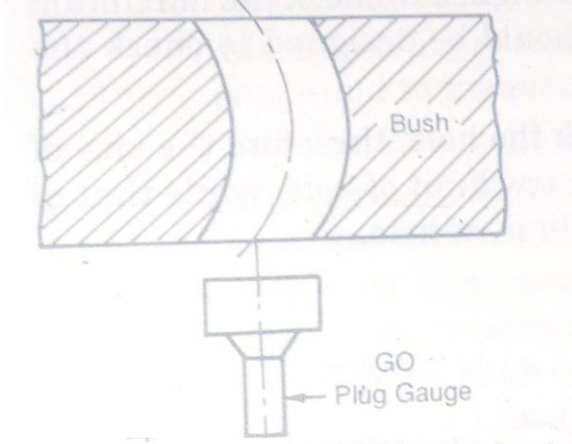
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Q. No.	Sub Q. N.	Answer	Marking Scheme
	b	<p>8) To take the part in the work of other national organizations interested in metrology.</p> <p>Need of comparators:- in mass production identical components , parts are produced on a very large scale. To achieve interchangeability these parts should be produced to a close dimensional tolerances. As a result, inspection is often more concerned with the dimensional variation from the standard or basic dimension of the part. To this extent inspection becomes a process of comparing manufactured part to the master part imagined by the designer.</p> <p>Uses of Comparators:-</p> <ol style="list-style-type: none">1) Comparators are used as laboratory standards.2) Used as working gauges to prevent work spoilage and to maintain required tolerance at all important stages of manufacture.3) Used as final inspection gauges.4) Used as a receiving inspection gauges for checking parts received from outside sources.5) For checking newly purchase gauges.	<p>02 mark for need,</p> <p>02 marks for uses any four ½ mark each</p>
	c	<p>Taylor's Principle of Gauge design:-</p> <p>It states that</p> <ol style="list-style-type: none">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. <p>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.</p> <ol style="list-style-type: none">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.	<p>01 mark for each statement,</p>

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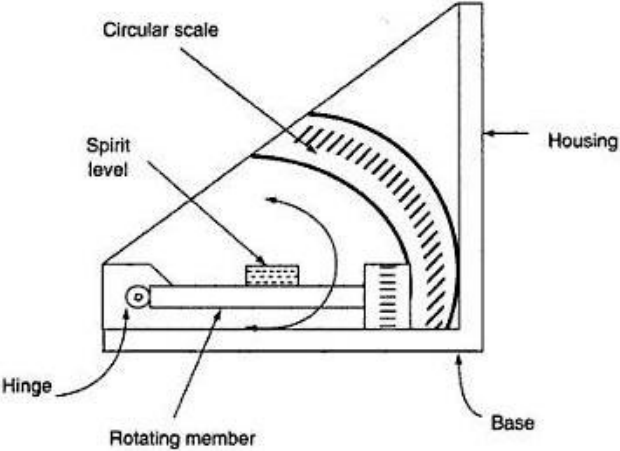
Q. No.	Sub Q. N.	Answer	Marking Scheme
		<p>For example the bush to be inspected has a curved axis and a short GO plug gauge is used to check it. The short plug gauge will pass through all the curves of the bent bushing. This will lead to wrong result that the workpiece (hole) is within the prescribed 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.</p>  <p style="text-align: center;">Fig.</p>  <p style="text-align: center;">Fig.-Checking a bush with curved axis</p>	<p>02 marks for Explanation</p> <p>Note:- figure not required , if drawn give advantage</p>



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Q. No.	Sub Q. N.	Answer	Marking Scheme
	d	<p>Clinometer : it consists of a spirit level mounted on a rotary member carried in a housing, one face of the housing forms the base of the instrument. There is a circular scale on the housing. The angle of inclination of the rotary member relative to the base can be measured by a circular scale. The scale may cover the whole circle or only part of it. Clinometer is generally used to determine the angle included between two adjacent faces of a work piece. The base of the instrument is placed on one of the surfaces and rotary member is adjusted till zero reading of the bubble is obtained. The angle of rotation is then noted on the circular scale against an index. The instrument is then placed on the other surface and the reading is taken in the similar manner.</p>  <p>The diagram illustrates the internal components of a clinometer. It shows a rectangular housing with a circular scale on its top surface. A spirit level is mounted on a rotating member that can pivot around a hinge at the front. The base of the housing is the surface on which the instrument is placed. Labels include: Circular scale, Spirit level, Hinge, Rotating member, Housing, and Base.</p>	<p>02 marks for Explanation,</p> <p>02 marks for sketch</p>
	e	<p>Two wire method:-</p> <p>In this method the effective diameter of screw thread is measured by placing two wires or rod of identical diameters between the flanks of the thread as shown in fig. and measuring the distance over the outside of these wires.</p> <ul style="list-style-type: none">- in two wire method wires of suitable size are placed between the standard and the micrometer anvils and first micrometer reading is taken.- Let the micrometer reading over standard and wires=R_1.-the standard is then replaced by the screw thread to be measured and the micrometer reading is taken.- Let the micrometer reading over screw thread and wires = R_2.	<p>04 marks for correct answer</p>

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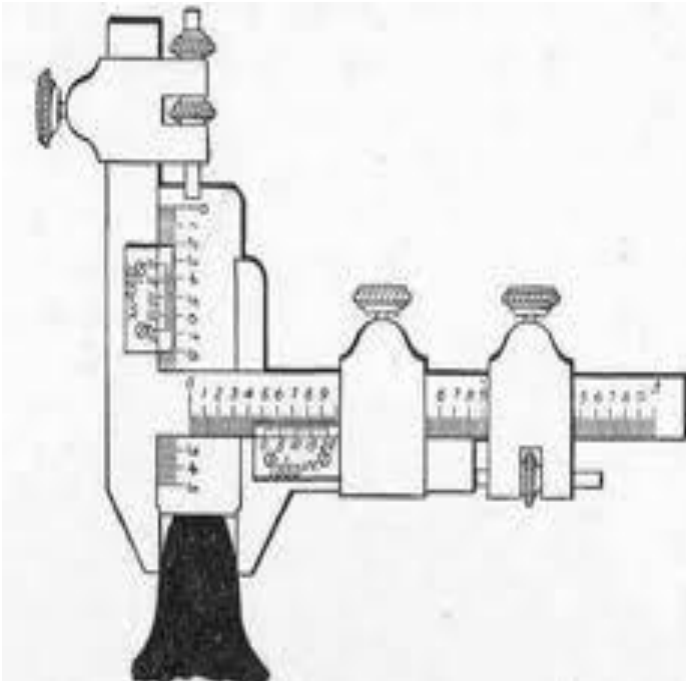
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Q. No.	Sub Q. N.	Answer	Marking Scheme
		<p>The diameter of the standard = S</p> <p>The diameter under the wires = T</p> <p>The effective diameter of the screw = E</p> <p>Thus $E = T + P$</p> <p>Where, $T = S - (R_1 - R_2)$</p> <p>And P is a constant calculated for different threads, it depends upon the diameter of wire and pitch of the thread.</p> <div style="text-align: center;"> <p style="text-align: center;">(a) 1st Operation (b) 2nd Operation</p> <p style="text-align: center;">Fig.</p> </div>	<p>Note:- figure not required , if drawn give advantage</p>



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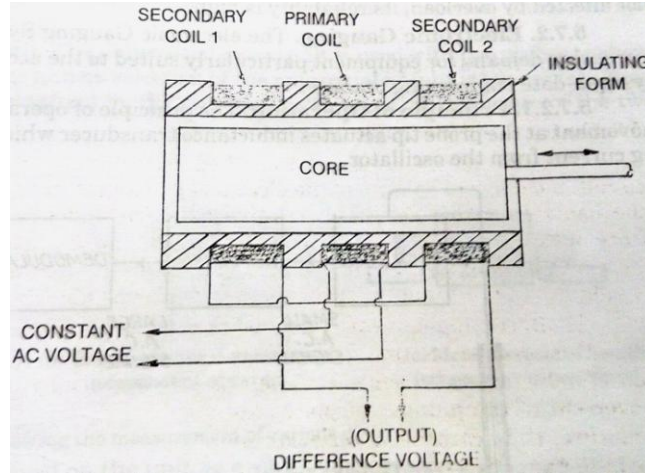
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Q. No.	Sub Q. N.	Answer	Marking Scheme
	f	<p>Gear tooth thickness (chordal tooth thickness) measurement using Gear tooth vernier:-</p> <ul style="list-style-type: none">- Gear tooth vernier calliper consists of two perpendicular vernier arms with vernier 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. 	<p>02 marks for Explanation,</p> <p>02 marks for sketch</p>

3

a

LVDT Electrical comparator



02 marks for explanation and 02 for sketch

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 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° 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.



3 b Design Of GO and NO-GO Gauge:

04

$$\begin{aligned} \text{Hole size} &= 30 \begin{matrix} +0.05 \\ -0.03 \end{matrix} \text{ mm} \\ \text{Maximum size of Hole} &= 30.05 \text{ mm} \\ \text{Minimum size of Hole} &= 29.97 \text{ mm} \\ \therefore \text{Total work Tolerance} &= 30.05 - 29.97 \\ &= 0.08 \text{ mm} \end{aligned}$$

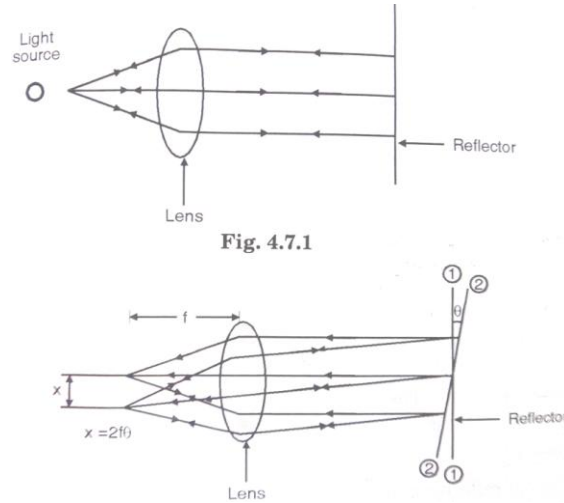
For GO & NO-GO Gauge design
Taking wear allowance and gauge allowance
as 10% of work allowance

$$\begin{aligned} \therefore \text{Gauge allowance} &= 10\% \text{ of } 0.08 \\ &= 0.008 \text{ mm} \\ \therefore \text{wear allowance} &= 10\% \text{ of } 0.08 \\ &= 0.008 \text{ mm} \end{aligned}$$

sizes of Gauges :-

$$\begin{aligned} \text{Go gauge} &= 29.97 \begin{matrix} + (0.008 + 0.008) \\ + 0.008 \end{matrix} \\ &= 29.97 \begin{matrix} + 0.016 \\ + 0.008 \end{matrix} \\ \text{NO GO gauge} &= 30.05 \begin{matrix} + 0.008 \\ + 0.000 \end{matrix} \\ &= 30.05 \begin{matrix} + 0.008 \\ + 0.000 \end{matrix} \end{aligned}$$

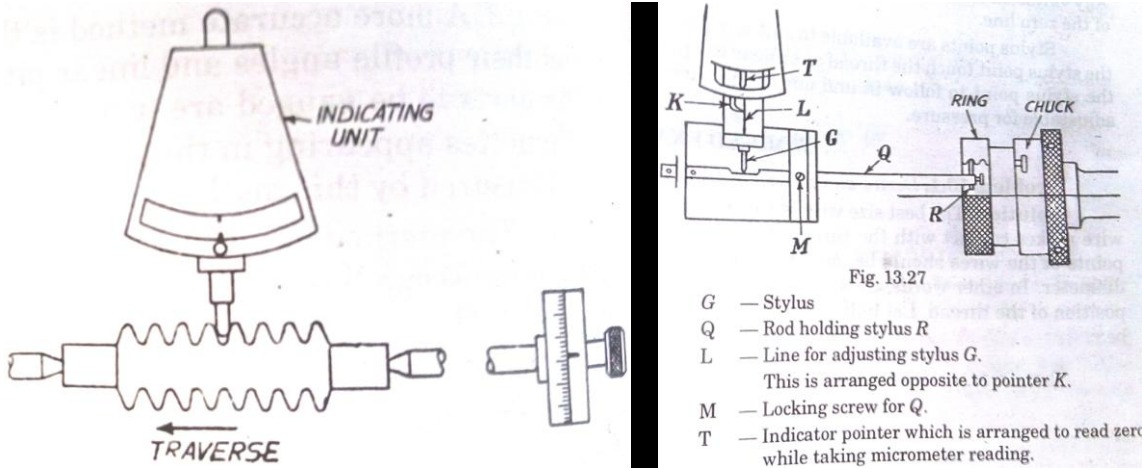
3 c Working Principle of Angle Dekkor :



02 marks for explanation and 02 for sketch

Explanation: O is a point source of light placed at the principal focus of a collimating lens. The rays of the light from O incident on the lens will now travel as a parallel beam of light. If this beam now strikes a plane reflector which is normal to the optical axis, it will be reflected back along its own path and focused at the same point O . If the plane reflector be now tilted through a small angle θ , then parallel beam will be deflected through twice this angle, and will be brought to focus at O' in the same plane at a distance X from O . Obviously, $X = 2\theta \cdot f$, where f is the focal length of the lens.

3 d



2 marks for explanation and 02 for sketch

Measurement of Pitch For External Thread Measurement of Pitch For External Thread

Explanation:

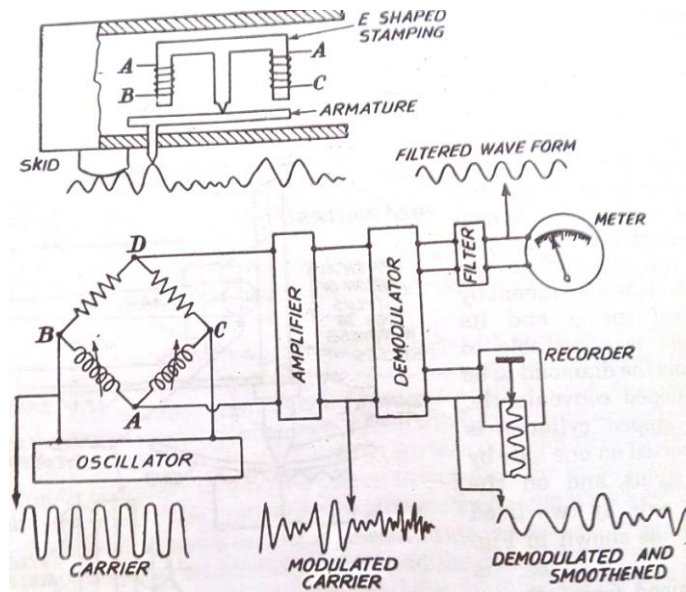
Measurement of Pitch For External Thread: - Pitch of external thread is measured by using Pitter screw measuring machine. The screw under measurement is held stationary between centers on the machine. The indicating unit, carrying the stylus is carried on a slide which is mounted on balls. The slide is actuated by means of micrometer by which readings are taken. The stylus, falls in and out due to leaf spring and pointer shows zero, when stylus is at central position of thread. The slide is moved with micrometer and readings are taken each time the indicator shows zero.

3

e

Measurement of Pitch For External Thread:- Pitch of internal thread is measured by using Pitter screw measuring machine by using an adaptor. This adaptor carries a bar which can be inserted into the ring, the stylus being fitted to the bar end engaging with the thread in usual manner. The screw under measurement is held stationary between centers on the machine. The indicating unit, carrying the stylus is carried on a slide which is mounted on balls. The slide is actuated by means of micrometer by which readings are taken. The stylus, falls in and out due to leaf spring and pointer shows zero, when stylus is at central position of thread. The slide is moved with micrometer and readings are taken each time the indicator shows zero.

Taylor- Hobson Talysurf :



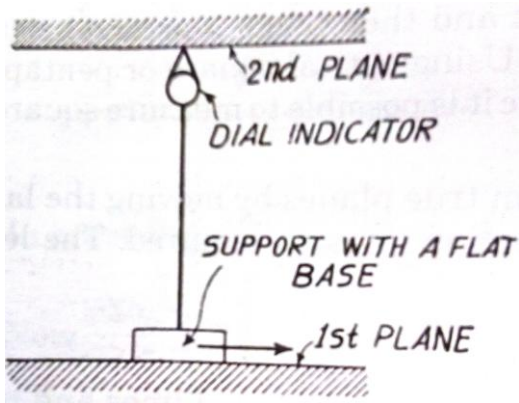
Explanation: The Taylor- Hobson Talysurf is an electronic instrument working on carrier modulating principle. The measuring head of this instrument consists of a diamond stylus and skid or shoe which is drawn across the surface by means of a motorized driving unit. In this case the arm carrying the stylus forms an armature which pivots about the center piece of E- shaped stamping. On two legs of (outer pole pieces) the E – shaped stamping there are coils carrying an AC current. These two coils with other two resistances form an oscillator. As the armature is pivoted about the central leg, any movement of the stylus causes the air gap to vary and thus the amplitude of the original AC current flowing in the coil is modulated. The output of the bridge thus consists of modulation only. This is further demodulated so that the current now is directly proportional to the vertical displacement of the stylus only.

The demodulated output is caused to operate a pen recorder to produce a permanent record and a meter to give a numerical value directly.

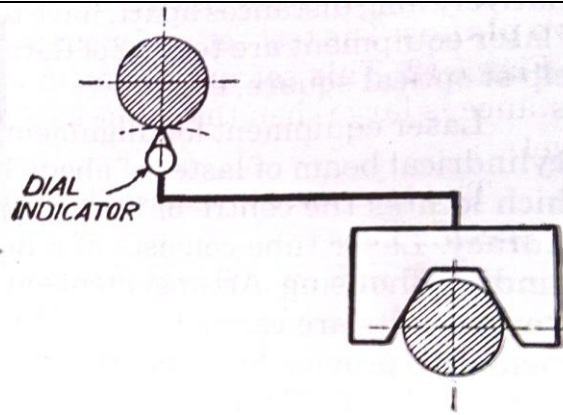
02 marks for explanation and 02 for sketch

3

f



Parallelism between two plane



Parallelism between two axes

02 marks for explanation and 02 for sketch

Parallelism between two planes: - The test for parallelism of two planes is carried out in two directions (generally perpendicular to each other). The dial indicator, which is held on a support with a flat base, is moved in one plane over a given length, and the feeler is made to rest against the second plane; and the deviation is noted down.

Parallelism between two axes: - In this test, the dial indicator is held on a support with a base of suitable shape, so that it slides along a cylinder representing one of the two axes; and the dial indicator is adjusted so that its feeler slides along the cylinder representing the second axis. The maximum deviation between the axes at any point may be determined by gently rocking the dial indicator in a direction perpendicular to the axes. In the same way the parallelism may be tested in the perpendicular plane.

01 for each

4

a

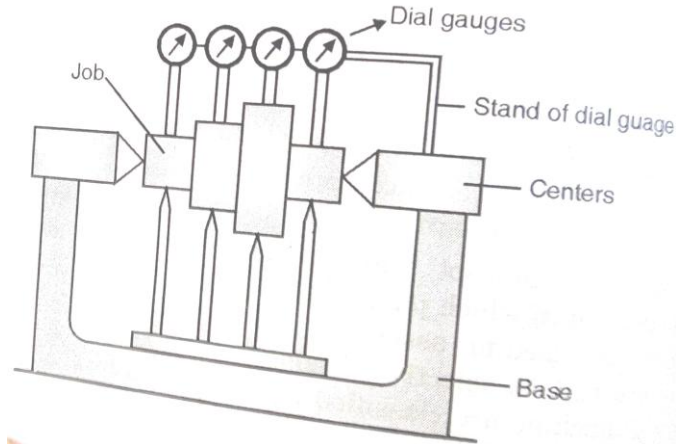
Characteristics of End Standard :

1. End standards are having accuracy up to 0.001 mm.
2. Measurement by End standard is time consuming.
3. Environmental errors can occur in end standard.
4. Manufacturing of end standards is complex.
5. End standards are used for calibration purpose.

4

b

Multi Gauging Machine :



02 marks for explanation and 02 for sketch

Explanation: Multi Gauging machines are useful for measurement of number of dimensions at a time. Part to be checked are compared with setting standards and the deviation is recorded.

First the setting standard is held between two centers than the dial indicators are adjusted to the zero position for different dimensions. Than setting standard is removed and the component to be tested is fixed between centers and the readings of dial indicators are recorded.

Advantages of Multi Gauging Machine :

1. Number of dimensions can be measured at a time.
2. Time for inspection is very less.
3. Cost of inspection is less.

Pitch Errors in Screw Thread: Following are the Pitch errors in screw thread

4

c

1. Progressive pitch error
2. Periodic pitch error
3. Irregular error

01

1. Progressive pitch error:- As the length of thread increases ,the cumulative pitch error increases this is called as progressive pitch error. This error occurs when the tool work velocity ratio is incorrect.
2. Periodic pitch error:-Error is getting repeated itself at a regular intervals along the thread is known as periodic pitch error. In this case, successive portions of the thread are either longer mean. This type of error occurs when the tool work

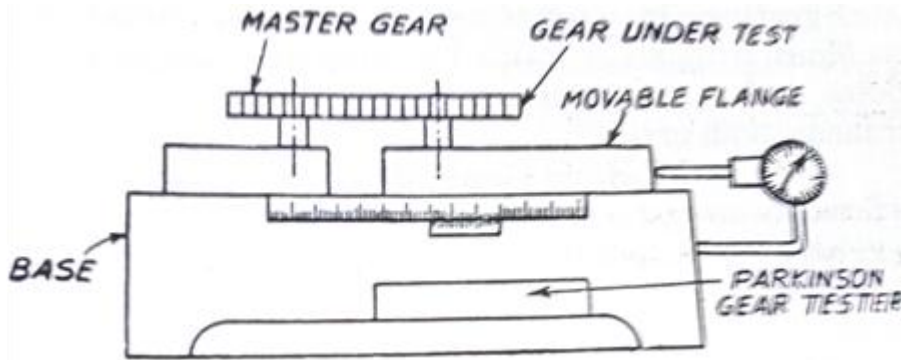
03

velocity ratio is not constant.

- Irregular error:- These type of errors are not having specific causes and correspondingly no specified characteristics also. These errors include erratic pitch error.

d

Parkinson Gear Tester:



Explanation:- The principle of this device is to mount a standard gear on a fixed vertical spindle and the gear to be tested on another similar spindle mounted on a sliding carriage, maintaining the gears in mesh by spring pressure. Movements of the sliding carriage as the gears are rotated are indicated by a dial indicator, and these variations are a measure of any irregularities in the gear under test.

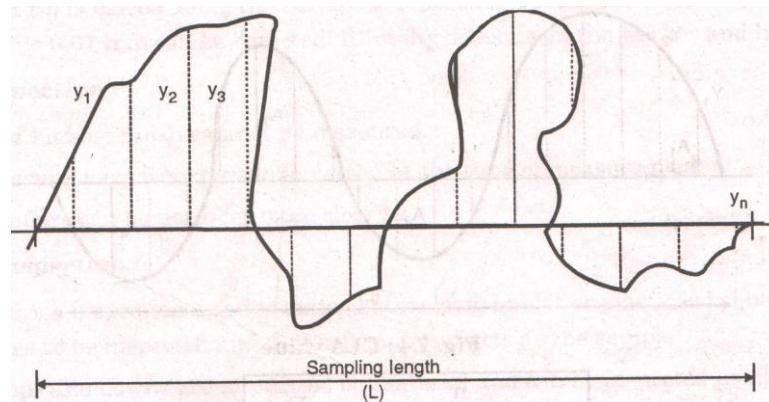
When standard gear is rotated slowly, a gear to be tested will also get rotation movement because of their meshing. Errors in the gear cause the gear to move away from the centerline of spindle. When gear to be tested moves, the floating body, also move, by the same distance. Because of displacement of floating body, dial gauge gives reading.

The variations in the readings can be observed and plotted in the graphical format.

e

Methods of Evaluation of surface roughness:

- Root mean square value method (RMS Value)

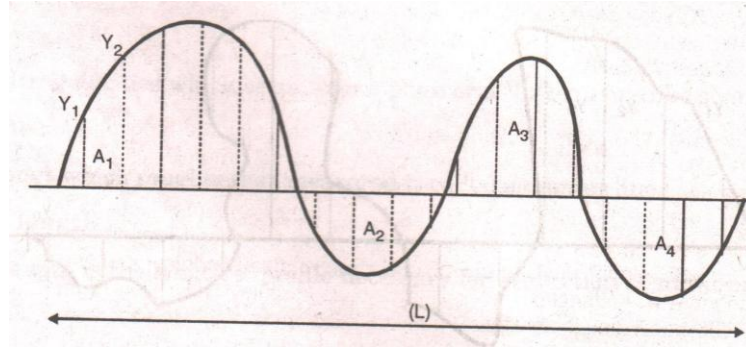


02 marks for explanation and 02 for sketch

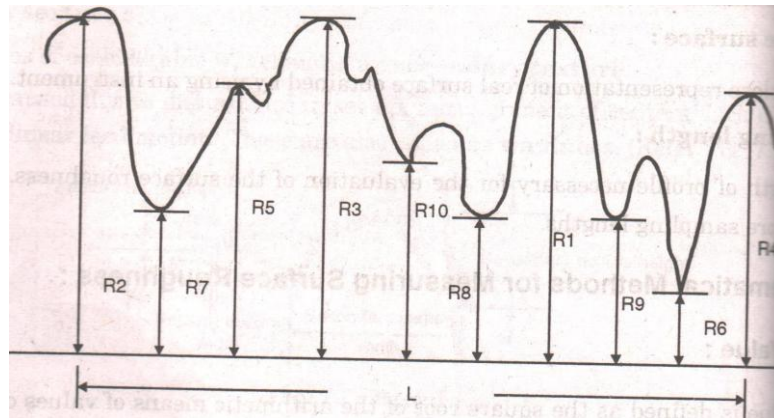
01

03

2. Centre line average method (CLA Value)



3. Ten point average method (Rz Value)



Explanation of any one method with diagram and formula

Types of Quality Audit:

F

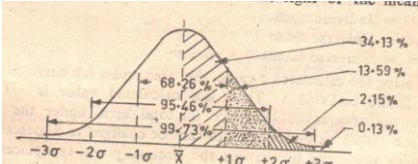
1. Internal Audit: - when an organization conducts an audit on its own quality system using its own staff / external consultants, the audit is known as internal quality audit. Important points are: auditing staff must be trained for conducting this exercise and should not bias against the functional department being audited.
2. An External Audit: - The External quality audit is performed by the purchasing organization upon the supplier organization. The idea here is to have an assessment of the supplier's processes in order to have confidence that the

04



5	a	<p>supplier would be able to supply goods or services of an agreed quality level on a sustained basis. Important point is these audits can be performed by the trained personnel of the purchasing organization or an outside agency hired by them.</p> <p>3. An Extrinsic Audit: - This audit is performed by the certification bodies (ISO registered bodies) on the applicant organization seeking such certification. If these, auditors, after conducting the quality audit on the organization with respect to a standard, find the organization to be worthy enough, the certification is granted to the organization. Third party audits normally results in the disruption of day-to-day activities of the organization being audited during the duration of the audit. Apart from the registered certification bodies, the third part audit may also be conducted by some government departments dealing with environment and pollution, health and safety, atomic energy etc.</p> <p>Essential characteristics of good comparator are</p> <ol style="list-style-type: none">1. Easy to operate2. Output must be easily readable and understandable.3. Easy availability.4. Low in cost.5. Robust in design.6. Useable by unskilled labour.7. Quick response to input.8. Less maintenance.	½ mark each
	b	<p>Factors controlling quality of design are;</p> <ol style="list-style-type: none">1. Design does not reflect the customer's requirements,2. The product which the producer offers would not probably satisfy the customer, even if it does sufficiently conform to the design.3. Quality of design is usually indicated by completeness and correctness of specifications.4. Drawings, catalogues, etc.	any 04 factors 01 mark each
	c	<p>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</p> <ol style="list-style-type: none">1. For existing products / processes DMAIC (Define , Measure, Analysis, Improve, Control)	2 marks each methodology



d	<p>2. For development of new products / processes DMADV (Define , Measure, Analysis, Design, Verify)</p> <p>Various types of sampling methods are;</p> <ol style="list-style-type: none">1. Single sampling2. Double sampling3. Multiple sampling <p>Description of any one of the above sampling method. (student may explain using flow process chart)</p>	01 mark
e	<p>Various factors responsible for the variation due to assignable causes are;</p> <ol style="list-style-type: none">1. Tool wear2. Poor quality of raw material.3. Faulty jigs and fixtures.4. Untrained operator.5. Metrology errors.6. Machine problems such as loose moving parts.7. Incorrect machining parameters.8. Careless attitude of operators.	½ mark each
F	<p>Process capability :- It may be defined as the minimum spread of a specific measurement variation which will include 99.73% of the measurement from the given process.</p> <p>There is always specification requirement for any quality characteristic and the process is expected to produce parts within the specified limits. Process capability can be considered as 3σ on either \bar{X}</p> <p>C_p and C_{pk} are process capability indices, the values of which indicates centering of process measurements</p>	02 marks
	 <p>A normal distribution curve is shown with the mean \bar{X} at the center. The standard deviation intervals are marked as $-3\sigma, -2\sigma, -\sigma, \bar{X}, +\sigma, +2\sigma, +3\sigma$. The corresponding percentages are: 34.13% between \bar{X} and $\pm\sigma$; 13.59% between $\pm\sigma$ and $\pm2\sigma$; 2.15% between $\pm2\sigma$ and $\pm3\sigma$; 0.13% outside $\pm3\sigma$. Cumulative percentages are also shown: 68.26% within $\pm\sigma$, 95.45% within $\pm2\sigma$, and 99.73% within $\pm3\sigma$.</p>	01 mark



6

a

Step I Calculate average \bar{X} and range R for each day

Day	1	2	3	4	5	6	7	8
\bar{X}	23.76	23.77	23.77	23.77	23.77	23.75	23.77	23.76
R	0.07	0.11	0.06	0.08	0.04	0.05	0.06	0.06

01 mark for each step

Step II Calculate $\bar{\bar{X}}$ and \bar{R}

$$\bar{\bar{X}} = 23.76, \quad \bar{R} = 0.06$$

Step III Calculate statistical control limits for \bar{X} chart

$$UCL \bar{\bar{X}} + A_2 \bar{R} = 23.76 \quad LCL \bar{\bar{X}} - A_2 \bar{R} = 23.73$$

Step IV Calculate statistical control limits for R chart

$$UCL D_4 \bar{R} = 0.12 \quad LCL D_3 \bar{R} = 0$$

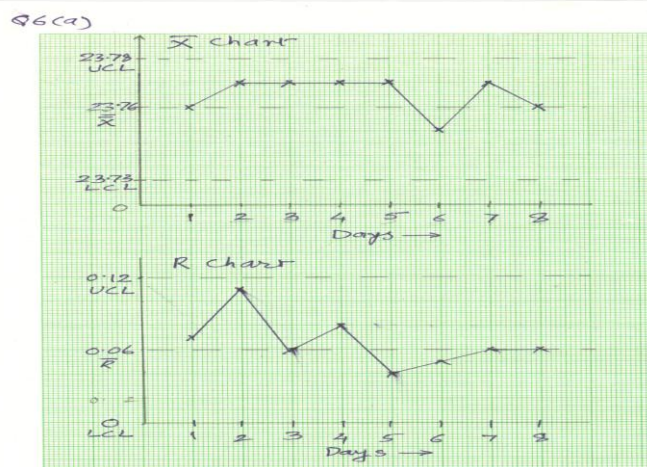
Step V Plot \bar{X} chart

Step VI Plot R chart

Step VII Calculate $\sigma = \bar{R} / d_2 = 0.023$

Step VIII Calculate $X_{\max} 23.75 + 0.1 = 23.85, X_{\min} 23.75 - 0.1 = 23.65$

$$\bar{\bar{X}} + 3\sigma = 23.829, \quad \bar{\bar{X}} - 3\sigma = 23.691$$



Process meets specifications

b

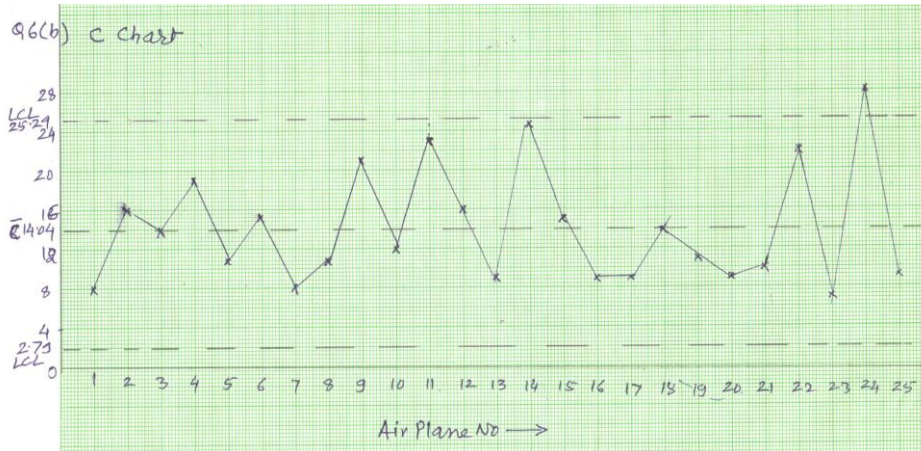
Step I Calculate \bar{C} = Sum of total defects / quantity inspected

$$\bar{C} = 351/25 = 14.04$$

Step II Calculate statistical control limits for C chart

$$UCL \bar{C} + 3(\sqrt{\bar{C}}) = 25.29 \quad LCL \bar{C} - 3(\sqrt{\bar{C}}) = 2.79$$

Step III Plot C chart



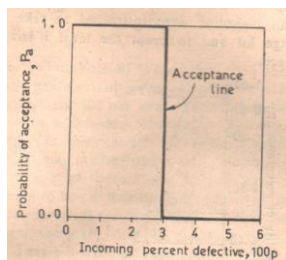
Step IV Comments on C chart

c

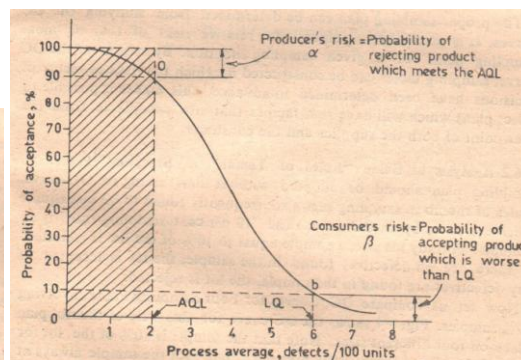
An Operation Characteristic curve commonly called OC curve provides the means of evaluating the operation of an acceptance sampling plan. It depicts the varying conditions of incoming materials and illustrates the risk inherent in a sampling plan at each quality level of the incoming material. Thus every 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



Ideal OC curve



Actual OC curve

01 mark

02 marks

03 marks

02 marks

04 marks description

02 mark for each curve

