SUMMER 18– EXAMINATION

Model Answer Subject Code: 17530

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q. No.	Sub Q. N.	Answer	Marking Scheme
1	**a)** i)	**Scientific metrology** - is concerned with the establishment of units of measurement, the development of new measurement methods, the realization of measurement standards, and the transfer of traceability from these standards to users in a society. **Industrial metrology** -is concerned with the application of measurement to manufacturing and other processes and their use in society, ensuring the suitability of measurement instruments, their calibration and quality control. **Legal Metrology**- is part of metrology which relates with units of measurements, methods of measurements and instruments to the statutory, technical and legal needs. Examples:- (Any Two) 1. Measurement of health. 2. Measurements for human safety. 3. Industrial measurements, accuracy, Interchangeability. 4. Measurement of net quantity.	03 Marks for definitions (one mark each) 01 for applications
	ii)	**Taylors Principle of Gauge design:-** 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.	

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 etc.). 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 work piece (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.

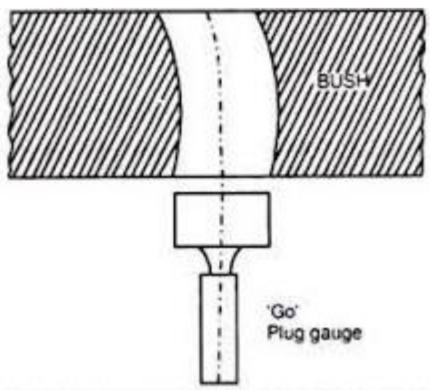


Fig. Checking a Bush with a Curved Axis.

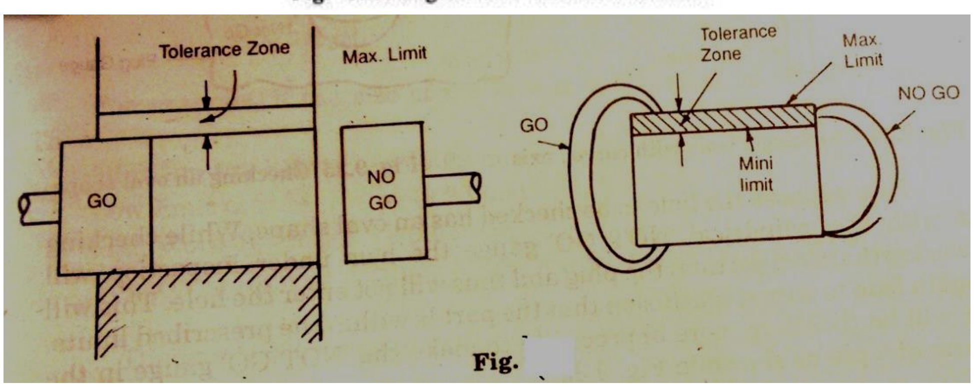


Fig.

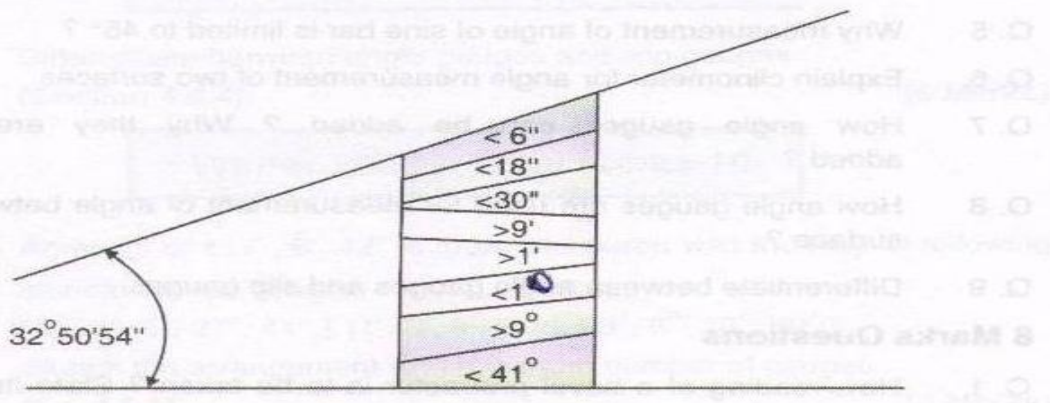
2 marks for explanation, 2 marks for sketch

iii

$$32^\circ = 41^\circ - 9^\circ$$

$$50' = 1^\circ - 9' - 1' \quad [\therefore \text{Greater than } 40]$$

$$54'' = 30'' + 18'' + 6''$$



2 marks for combination of minimum number of gauges,

2 marks for sketch

iv

Sr. No.	Variable Control Charts	Attribute Control charts
01	Variable data is considered such as dimension, hardness, temp etc.	Attribute data is considered such as casting having defects, cracks in sheets etc.
02	Data can be used to plot X and R chart	Data can be used to plot p and C chart.
03	This method gives exact dimension.	This method simply notes presence or absence.
04	Eg. Length of rod is 24 mm.	Eg. Number of defects in casting.

1 mark each, any four points

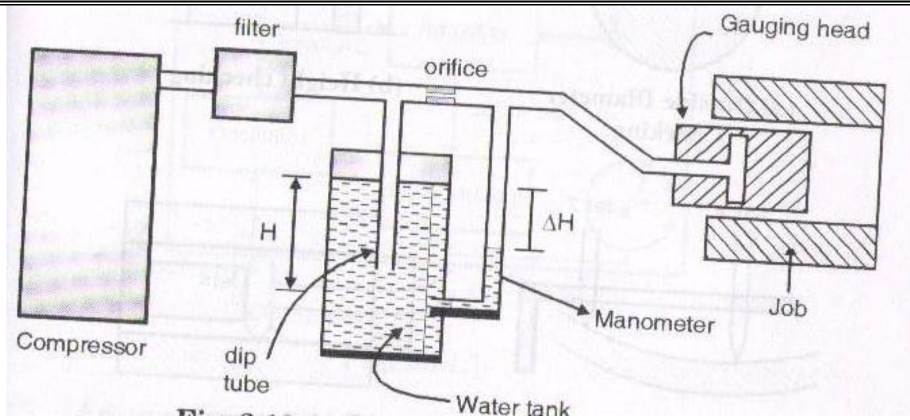
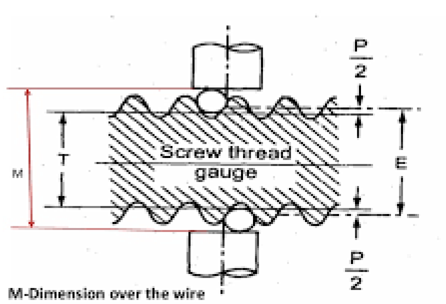
b)

i)

Pneumatic Comparator is widely used for measuring the roundness and taperness of cylinder bore.

Pneumatic comparator Working:- Water is filled in a tank and dip tube is inserted up to level H. High pressure and excess air may bubble out in water tank , then air flows through control orifice to gauging head. Due to restriction to gauging head back pressure is exerted on the air and is shown by manometer. Accuracy up to 1цm can be measured by using this instrument.

2 mark to state name comparator, 2 marks for sketch, 2 marks for explanation

			
	ii)	**Procedure for measuring effective diameter of screw thread using 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. **Two wire method:** 	4 marks for explanation, 2 marks for sketch

2	a)	**Need of Inspection in Industry:-** In order to determine the fitness of anything made, man has always used inspection. But industrial inspection is of recent origin and has scientific approach behind it. It came into being because of mass production which involved interchangeability of parts. In old craft, same craftsman used to be producer as well as assembler. Separate inspections were not required. If any component part did not fit properly at the time of assembly, the craftsman would make the necessary adjustments in either of the mating parts so that each assembly functioned properly. Actually speaking, no two parts will be alike/and there was practically no reason why they should be. Now new production techniques have been developed and parts are being manufactured in large scale due to low-cost methods of mass production. So hand-fit methods cannot serve the purpose any more. When large number of components of same part is being produced, then any part would be required to fit properly into any other mating component part. This required specialization of men and machines for the performance of certain operations. It has, therefore, been considered necessary to divorce the worker from all round crafts work and to supplant hand-fit methods with interchangeable manufacture.	4 marks for correct explanation.
	b)	**1. Selective Assembly**:- Selective assembly is a cost-effective approach for reducing the overall variation and thus improving the quality of an assembled product. In this process, components of a mating pair are measured and grouped into several classes (bins) as they are manufactured. The final product is assembled by selecting the components of each pair from appropriate bins to meet the required specifications as closely as possible. This approach is often less costly than tolerance design using tighter specifications on individual components. It leads to high-quality assembly using relatively inexpensive components. Example :- Automobile assembly system Or any relevant example. **2. Interchengability: -** An interchangeable part is one which can be substituted for similar part manufactured to the same drawing. In earlier times production used to be confined to small number of units and the same operator could adjust the mating components to obtain desired fit. With time the concept of manufacturing techniques kept on changing and today the same operator is no more responsible for manufacture and assembly too. With economic oriented approach, mass production techniques were inevitable, that led to breaking up of a complete process into several smaller activities and this led to specialization. As a result various mating components will come from several shops, even a small component would undergo production on several machines. Under such conditions it becomes absolutely essential to have strict control over the dimensions of portions which have to match with other parts. Any one component selected at random should assemble correctly with any other mating component, that too selected at random. When a system of this kind is ensured it is known as interchangeable system. Interchangeability ensures increased output with reduced production cost. Example:- Nut Bolts, or any relevant example	1 and ½ mark for each explanation , ½ mark for each example any one .
	c	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, $\sin \theta = h / l$	2 marks for explanation,

Where, h = Required slip gauge combination

l = center distance of rollers.

The relationship between the angular setting accuracy (dθ) 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 θ = h / l . or h = l sin θ
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.

2 marks for derivation. Graph not essential if drawn give advantage.

$$h = L \sin\theta$$

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

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

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

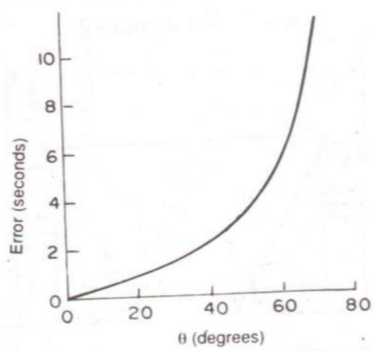
$$d\theta = \frac{dh}{L\cos\theta} - \frac{\sin\theta\, dL}{L\cos\theta}$$

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

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

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

1. It consists of one horizontal and one vertical scale for measuring width and thickness at same time.
2. It measures the thickness of tool on pitch circle. It also consists of two beams which are square with each other there are two main scale of which vernier scale

2 marks for explanation, 2 marks for sketch

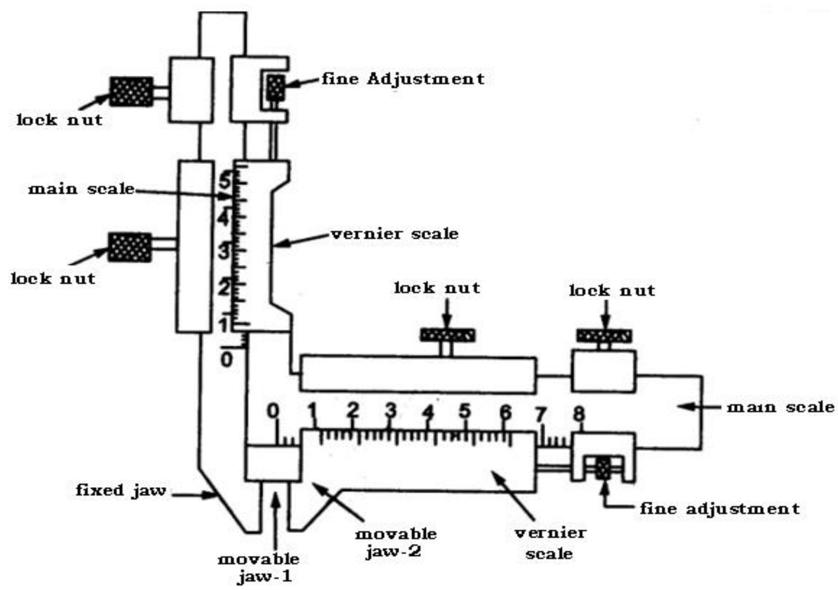
sides.

3. Tooth thickness on the pitch circle is measured as the distance between the fixed jaws and movable jaw by fixing distance at adjustable jaws of vertical vernier beam.
4. Tooth thickness can be calibrated using gear tooth vernier by setting vertical vernier we get depth and by setting of horizontal vernier we get width of tooth.

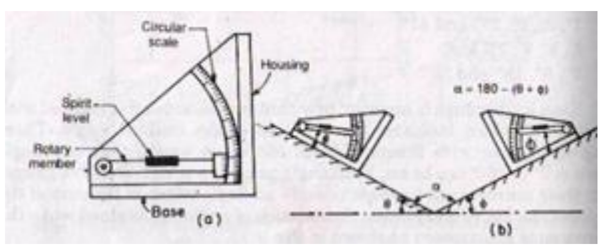
Chordial Depth:- $d = \frac{Nm}{2}\left[1 + \frac{2}{N} - \cos\left(\frac{90}{N}\right)\right]$

where, N – Number of teeth
m – module

Chordial Thickness:- $W = N \cdot m \sin\left(\frac{90}{N}\right)$



	e	**Compare acceptance sampling with 100% inspection** 1) The cost required for sampling inspection is quite less as compare to 100% inspection. 2) The time required for sampling inspection is less as compared to 100% inspection. 3) In sampling inspection problem of inspection fatigue which occurs in 100% inspection is eliminated. 4) Smaller inspection staff is necessary for sampling inspection as compare to 100% inspection. 5) In sampling inspection less damage to product, because only few items are subjected to handling during inspection. 6) The problem of monotony and inspector error introduced by 100% inspection is	1 mark to each point, any four points

		minimized. 7) Sampling inspection exerts more effective pressure on quality improvement. Since the rejection of entire lot on the basis of sampling brings much stronger pressure on quality improvement than the rejection of individual articles. 8) Sampling inspection provides less information about the product than 100% inspection. 9) Some extra planning and documentation required in sampling inspection.	
3	**a**	Wringing;- defined as the property of measuring surfaces of a gauge block of adhering, by sliding or pressing the gauge against the measuring faces of other gauge block or the reference face of datum surfaces, without the use of any extraneous means. Conditions of wringing:- 1. Faces of blocks must be clean. 2. Block must exhibit a standard of flatness and smoothness. 3. Apply light pressure in oscillation movement. 4. During wringing if the process observe feeling of roughness stop the process and clean the blocks.	2 marks for definition, 2 marks for conditions
	b	Instrument used to measure the adjacent angle:- Vernier Clinometer  It consists of a spirit level mounted on a rotary member carried in housing. One face of the housing forms the base of the instrument. There is circular scale on the housing. The angle of inclination of the rotary member relative to the base can be measured by circular scale. The scale may cover the whole circle or only a part of it. Instrument is used to determine the angle included between the two adjacent faces of the work piece.	2 marks to suggest the instrument, 2 marks for principle, sketch not required if drawn give advantage
	c	Process Capability study – importance in solving quality problems;- process capability is nothing but the six sigma and 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 it become possible to know the percentage of the products which will be produced within six sigma limit on either side of the mean X. without process capability tolerance can't be achieved.	4 marks for explanation

d

Sr. no.	Features	External thread	Internal thread
01	Minor Diameter	Vee-pieces on Floating carriage machine	Taper parallels OR rollers
02	Effective Diameter	Micrometer method OR one, two, three wire method	Thread Comparator
03	Pitch	Zeiss pitch OR lead measuring instrument	Standard pitch machines using adapter
04.	Thread Angle	Optical projection	Profile thread plugs

1 mark each

e

Various techniques of qualitative analysis for surface finish:- Practically three roughness measures have shown themselves to be particularly useful.

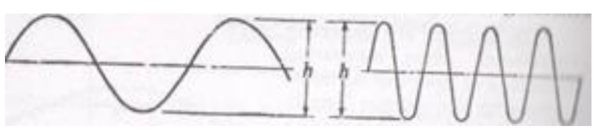
1. Maximum peak to valley Height of Roughness

2. Root mean Square value (R.M.S.)

3. Centerline average method (C.L.A.)

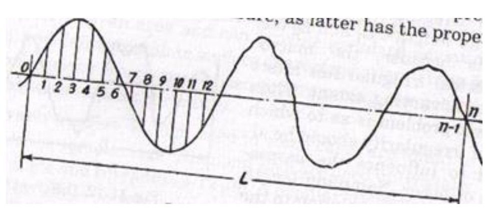
Explanation of any Two

1. Maximum peak to valley Height of Roughness:- This is the most commonly used method. In this method two cases arrases , if peak to valley height is same and frequencies of irregularities are different. In second case surface is more rough in comparison to first one. This is a simple method of analysis and it is used where it is desired to control the cost of finishing for checking the rough finishing.



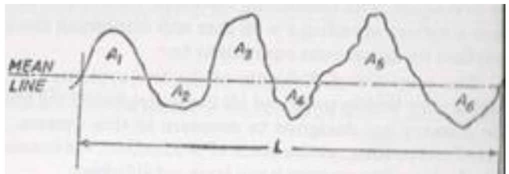
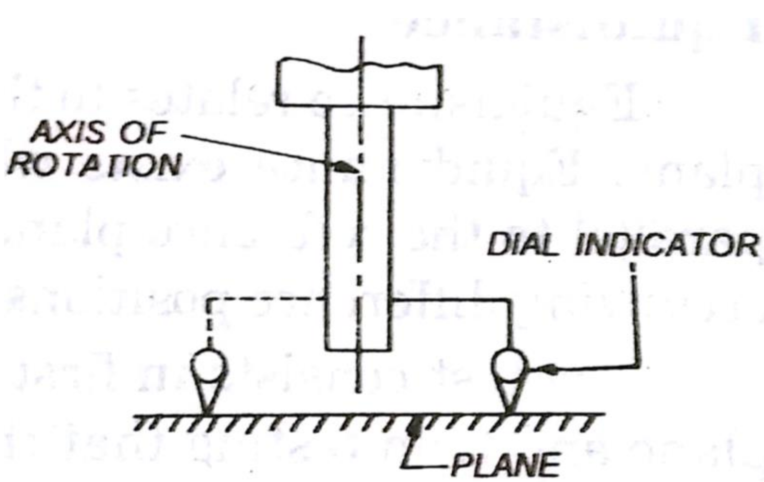
2. Root mean Square value (R.M.S.):- RMS value is defined as a square root of mean of the squares of the ordinates of the surface measured from the mean line.

Therefore $h_{r.m.s.} = \sqrt{\dfrac{h_1 + h_2^2 + h_3^2 + ... + h_n^2}{n}}$



3. Centerline average method (C.L.A.):- This is defined as the average height from the mean line for all ordinates of the surface regardless of the sign.

1 mark for list, 1 ½ marks for each explanation on any two types.

		Therefore CLA= h1+h2+h3+……..+h_n/n This is very complicated job to measure in this way by using planimeter area of any curve is find out and CLA can be written as A1+A2+…….+A3/L  	
4	**a** **i)**	**Squareness of an axis of rotation with a given plane:-** Assuming that squareness of axis of rotation of a spindle with a plane is to be tested. A dial indicator is mounted on the arm attached to the spindle. The feeler (plunger) of the dial indicator is adjusted parallel to the axis of the rotation of the spindle, so that as the spindle revolves, the plane of rotation of free end of the plunger is perpendicular to the axis of rotation. Now the plunger of the dial indicator is made to touch the plane under test. The spindle is slowly revolved and readings are noted at various positions. The variations in the readings of the instrument represents the deviation of parallelism between the plane of free end of the plunger and the plane under test or deviation in the squareness of the axis of rotation of the spindle with the plane under test.  	2 marks for explanation, 2 marks for sketch
	ii)	**Assignable Causes:** The important and larger variations are generated by faults in the production process, which by themselves adversely affect the quality of the product. The factors responsible for such large differences quality, which are known as assignable causes. These variations possess greater magnitudes as compared to those due to chance causes and can be easily traced or detected. **Example:- change in working conditions, lack of quality mindness , variation in material etc.** **Chance Causes: -** It is certain that some small variations are inherent in the production process and cannot be removed altogether, however, refined our machinery may be. These are generated by numerous independent factors, which	2 marks for explanation(1 marks each) and 2 marks for example (½ mark each any

		are generally known as chance causes. **Example: a little paly between nut and bolt,**	two for each)
	iii)	Meaning of $40H_7i_7$: 40 – is the Basic size. H – is the basic hole . i - is the basic shaft. 7- is tolerance grade for hole and shaft is given the same. IT_7.	1 mark for each
	iv	**Factors to be considered for achieving a reliable design:** 1) Simplicity of product 2) De-rating 3) Redundancy. 4) Safe operation 5) Protection from extreme environmental conditions 6) “Maintainability” and “Serviceability”	
	b) **i)**	i) **Quality of Design:-**The quality of design of a product is concerned with the tightness of the specifications for manufacturing of the product. For example, a part which has a drawing tolerance of ±0.001 mm. would be considered to have a better quality of design than another with a tolerance of ±0.01. A good quality of design must ensure consistent performance over its stipulated life span stated in terms of rated output, efficiency, overload capacity, continued or intermittent operation for specified application or service. **- Factors Controlling Quality of Design** 1) Type of customers in the market 2) Intended life , environmental conditions, reliability , maintainability etc. 3) Profit Consideration 4) Environmental Conditions 5) Special requirements of the product 6) Higher quality higher cost **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. **- Factors Controlling Quality of performance** 1) Quality of design 2) Quality of conformance	4 marks for explanation (2 marks each) 2 marks for factors (1 mark each)

ii) **Double sampling plan:-**In double sampling plan the decision on acceptance or rejection of the lot is based on two samples

Example:-

Parameters, N= lot size = 500

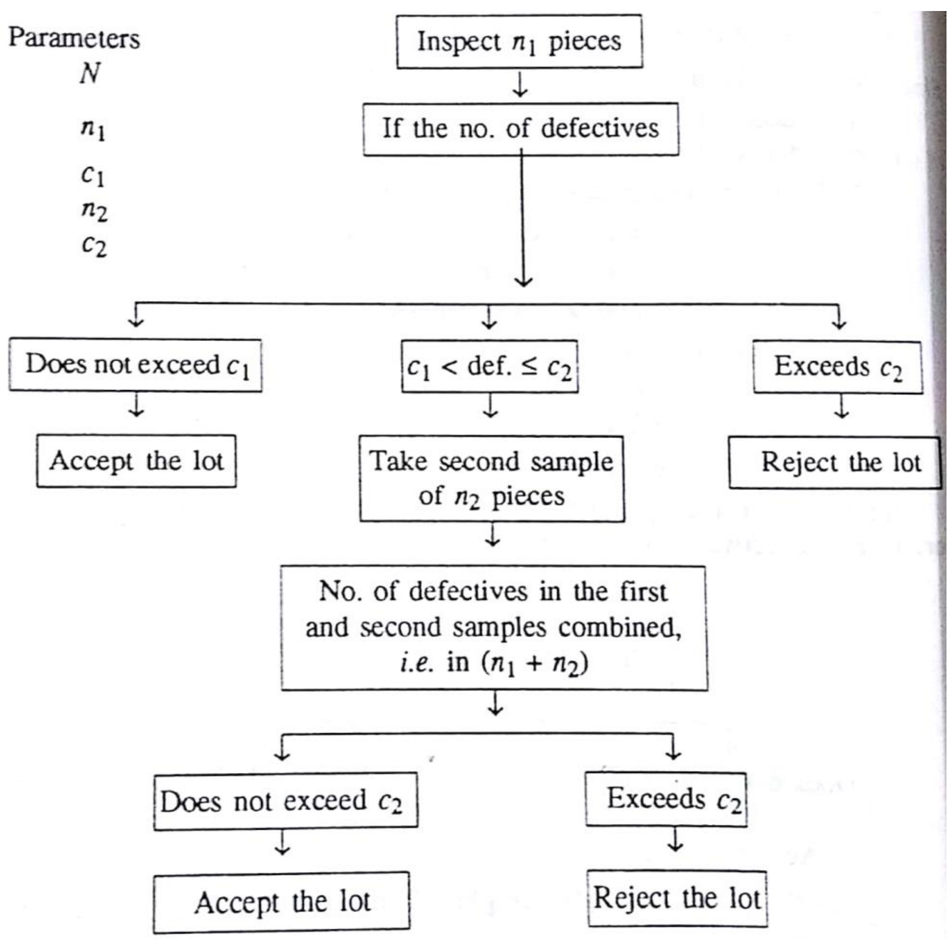
n_1= number of pieces in the first sample. = 35

C_1= acceptance number for the first sample. = 1

n_2= number of pieces in the second sample. = 50

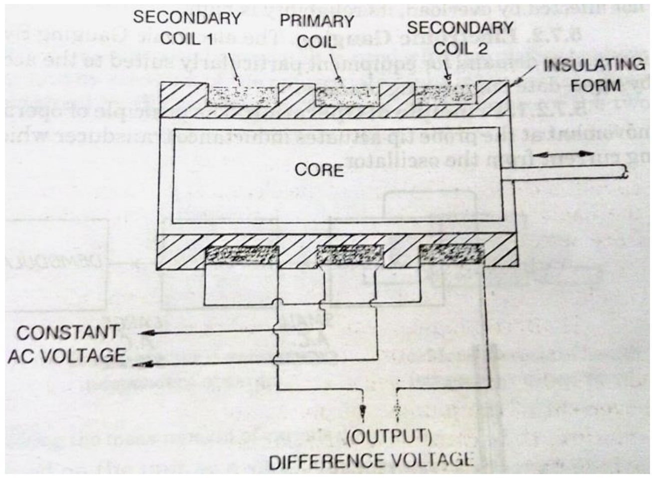
C_1= acceptance number for the second sample. = 4

1. Take a first sample of 35 items from a lot of 500 and inspect.
2. Accept the lot on the basis of first sample, if it contains 0 or 1 defective.
3. Reject the lot on the basis of first sample if it contains more than 4 defectives.
4. Take a second sample of 50 items if the first sample contains 2,3 0r 4 defectives.
5. Accept the lot on the basis of first and second sample combined, if the combined sample of 85 items contains 4 or less defectives.
6. Reject the lot on the basis of combined sample if the combined sample contains more than 4 defectives.



Double Sampling Plan

3 marks for explanation, 3 marks for block diagram

5	a	**LVDT :-** LVDT is the inductive transducer used to translate linear motion into electrical signal.(displacement)  Explanation: LVDT works on mutual inductance principle. It is a transformer consisting of three symmetrically spaced coils carefully wound on an insulated bobbin. It consists of a primary coil wound on an insulated bobbin and two identical secondaries symmetrically spaced from the primary. AC carried excitation is applied to the primary and two secondaries are connected externally in a series opposition circuit. There is non-contacting magnetic core which moves in the center of these coils. Motion of this core varies the mutual inductance of each secondary to the primary, which determines the voltage induced from the primary to each secondary. If the core is centered in the middle of the two secondary windings, then the voltage induced in each secondary winding will be identical and 180^0 out of phase and the net output will be zero. If the core is moved off middle position, then the mutual inductance of the primary with secondary will be greater than the other, and a differential voltage will appear across the secondaries in series which can be directly calibrated in terms of linear movement of core. **Applications:-** - Hydraulic cylinder displacement measurement. - Servo valve positioning. - Automotive suspension system - Force, displacement, pressure measurement.	3 marks for explanation, 3 marks for sketch, 2 marks for application (1 mark each any two)

b

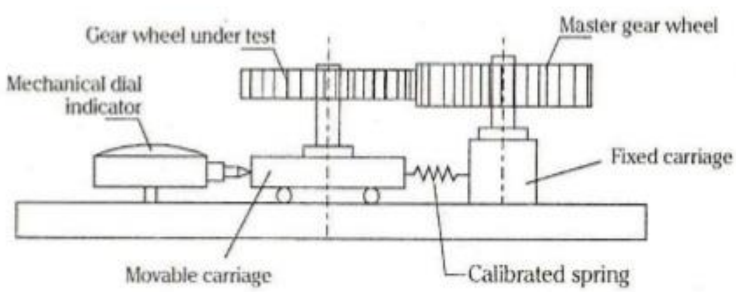
Construction: 1. One fixed spindle and other movable spindle is mounted on a flat base.

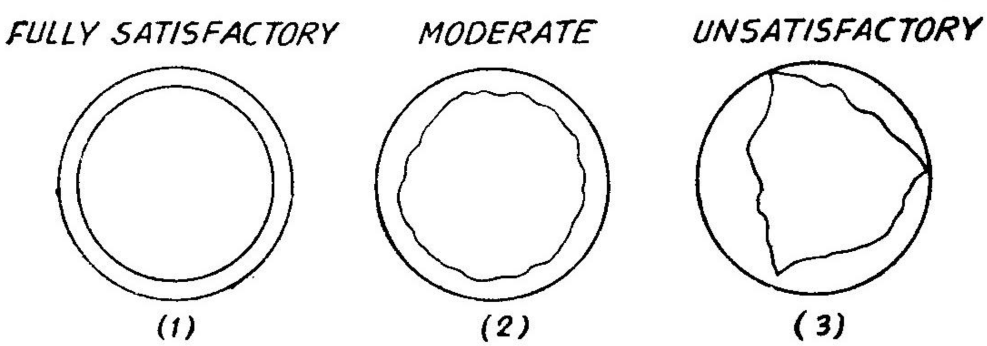
2. The movable spindle moves along with base by rolling action on the main base plate.

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

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

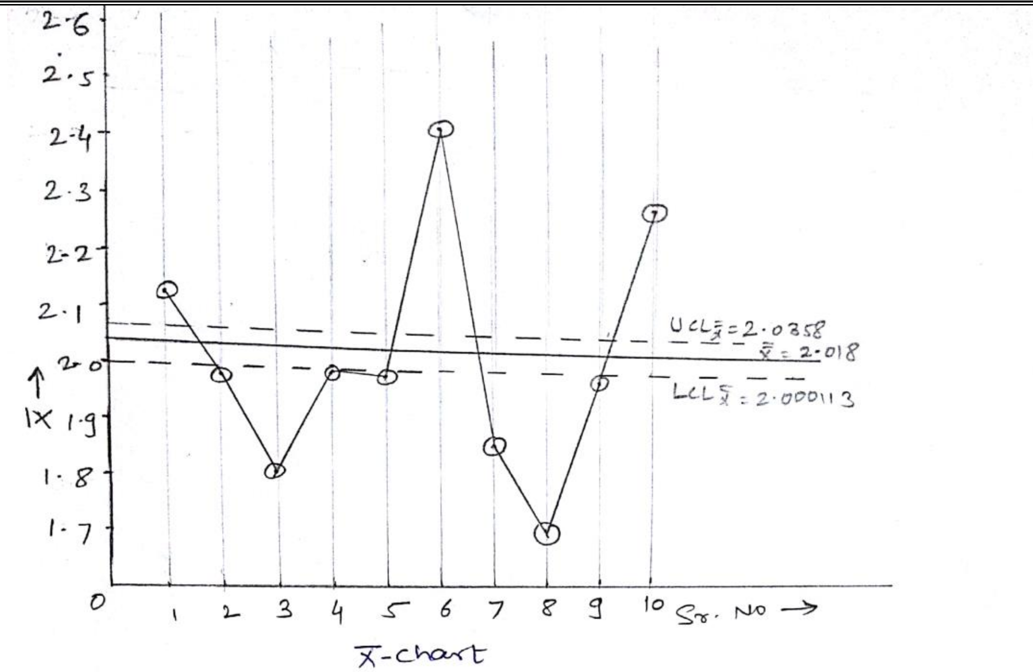
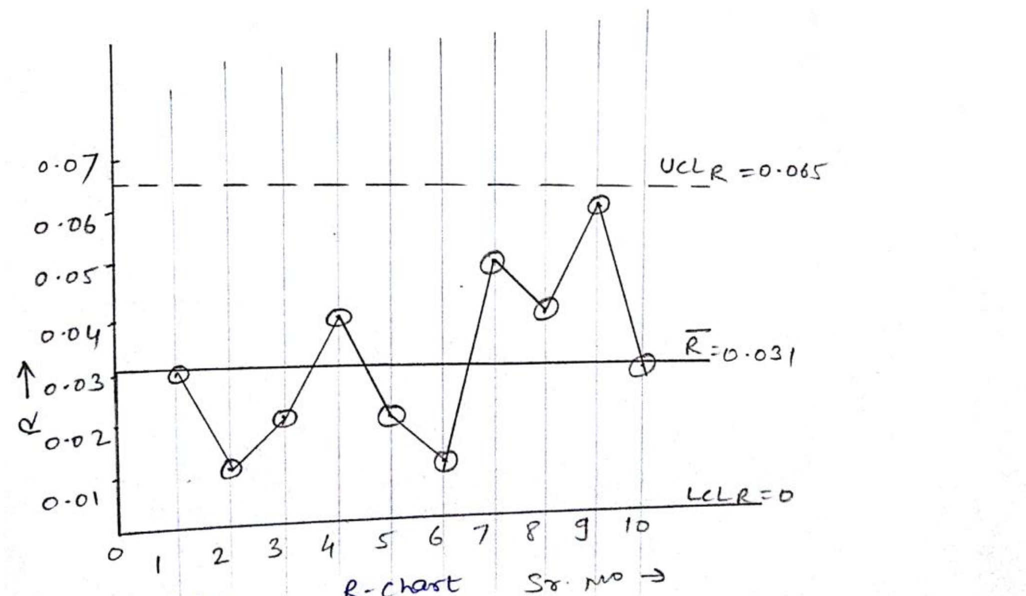
Working: when master gear is rotated slowly, a gear to be tested will also get rotation movement because of their meshing. Errors in the manufactured gear cause the gear to move away from the centerline of spindle. When gear to be tested moves the floating body also moves by the same distance. Because of displacement of floating body dial gauge gives displacement. The variation in the readings can be observed and plotted in the graphical format. A recorder can be fitted in the form of waved circular or rectangular chart and records made of the irregularities in the gear under test .below fig shows a reproduction of a few typical charts with a reduced scale and the magnified radial errors. Gear 1 is an unsatisfactory, Gear 2 is moderate gear and Gear 3 is fully satisfactory.

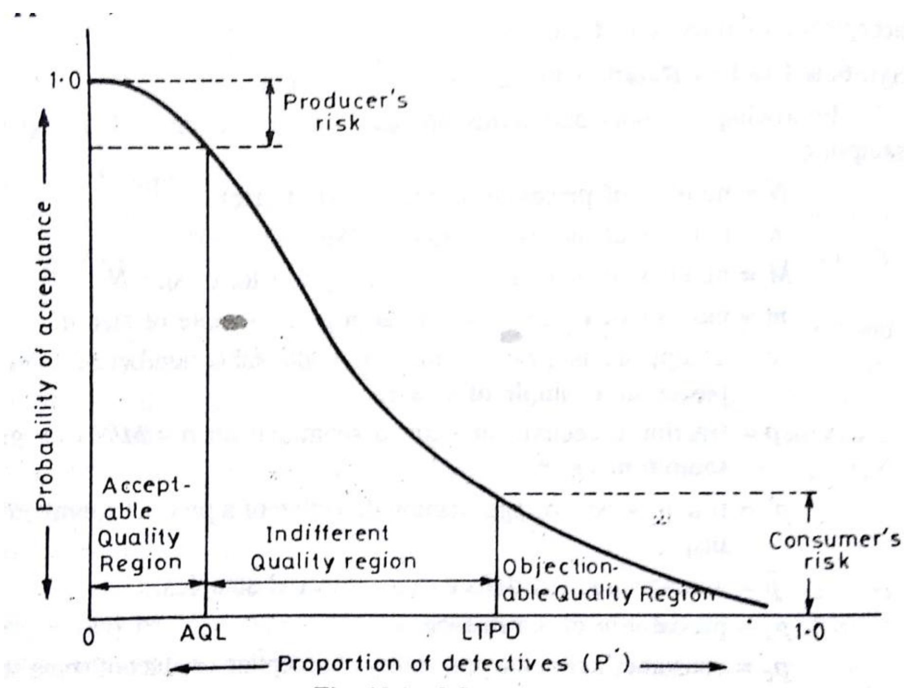


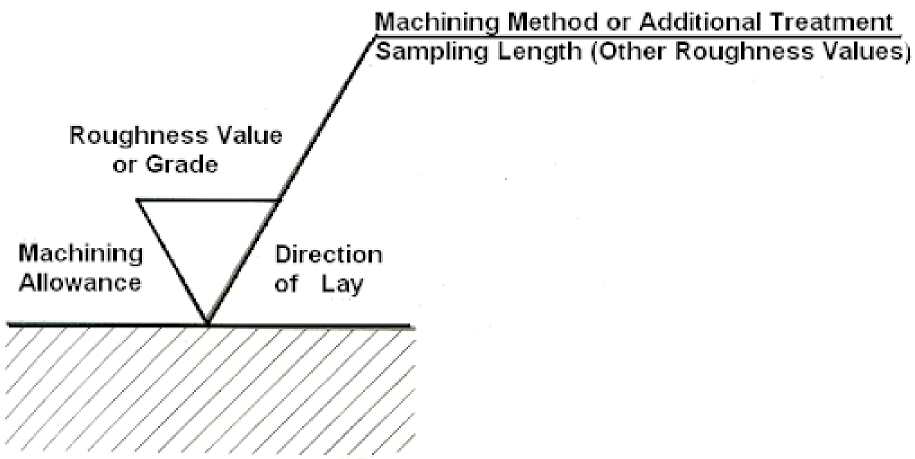
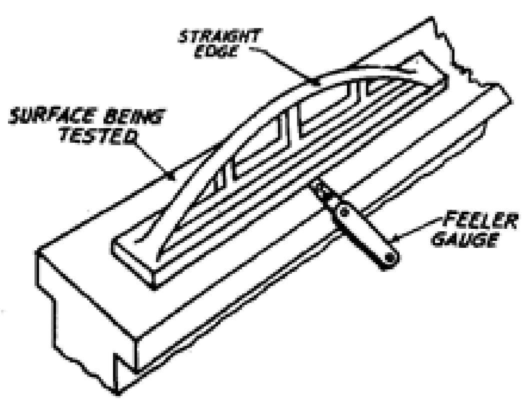


5 marks for explanation , 3 marks for sketch.

	c	Q. 5 c) Ans:- $\bar{\bar{X}} = \frac{\sum \bar{X}}{N} = \frac{20.18}{10} = 2.018$ $\bar{R} = \frac{\sum R}{N} = \frac{0.31}{10} = 0.031$	1 mark
		$UCL_{\bar{X}} = \bar{\bar{X}} + A_2\bar{R}$ $= 2.018 + (0.577 \times 0.031)$ $= 2.0358$	1 mark
		$LCL_{\bar{X}} = \bar{\bar{X}} - A_2\bar{R}$ $= 2.000113$	1 mark
		$UCL_R = D_4\bar{R} = 2.11 \times 0.031 = 0.0654$	1 mark
		$LCL_R = D_3\bar{R} = 0 \times 0.031 = 0$	1 mark

			1 mark
			1 mark
		Conclusion :- In $\bar{x}$ chart all the points are out of UCL and LCL, in R chart all the points are within the control limits. The process is out of control.	1 mark
6	**a)**	(i) Producers risk : It is the probability that a good lot will be rejected by the sampling plan. In some plans this risk is fixed at 0.05 ; in others it varies from about 0.01 to 0.10. (ii) Consumers risk : It is the probability of defective lots being accepted which otherwise would have been rejected. iii) Acceptable quality Level (AQL) :- it represents the maximum proportion of defectives which the consumer finds definitely acceptable. As an AQL is an acceptable quality level, the probability of acceptance for an AQL lot should be high.	1 mark for each definition (any four)

		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. AS RQL is an unacceptable quality level the probability of acceptance for an RQL lot should be low. 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. 	4 marks for sketch
	b)	For plotting control charts generally ±3σ limits are selected and they are termed as control limits. They present a band within which the dimensions of the components are expected to fall. With 3σ limits since 99.7 percent of the samples from a given population will fall within these limits. The remaining 0.3 percent will fall outside the limits. This means that, in the long run, 3 samples out of every 1000 will fall outside the ±3σ limits even if no change takes place in the population average. Since three out of thousand is a very small risk, ±3σ limits have been found to give good practical results. So long as the sample average is within 3σ limits it is assumed that any variation between the sample average and the desired population average is due to chance causes that is no assignable causes of variation are present. however as soon as the sample average varies from the desired population average by 3σ or more or the mean it is assumed that the variation is due to assignable causes and that a shift has taken place in the population average. if a sample average falls exactly at one of the 3σ points, it is assumed that no change has taken place but it is absolutely essential to take another sample soon after to verify this assumption.	4 marks for explanation, 4 marks for certification (1 mark each any four)

		6σ certifications are:- 1) Yellow belt certification 2) Green Belt certification 3) Black belt certification 4) Master black belt certification.	
	c) **i)**		4 marks (2 marks for sketch, 2 marks for labeling)
	ii)	Flatness of a work table on a milling machine can be measured using straight edge. Straightedges are used in the automotive service and machining industry to check the flatness of machined mating surfaces. An engineer's straight edge can be used to check that a work table on a milling machine is flat by being placed across its surface By shining a light behind the straight edge, any gaps between the work table on a milling machine and straight edge will be visible. The light is easier to see, the thinner the straight edge is, so knife edge straight edges are the most accurate for this task, although you do have to hold them, as they will not stand up on their own. Any gaps should then be measured using a feeler gauge. 	2 marks for explanation, 2 marks for sketch