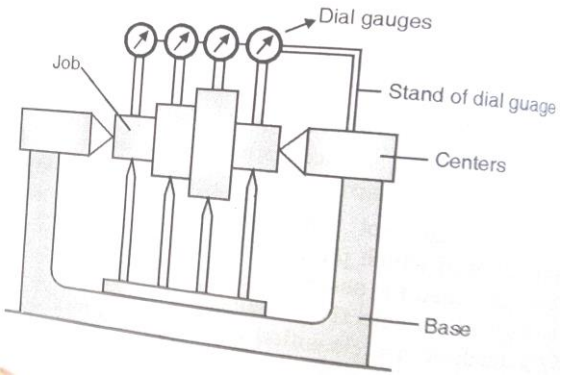
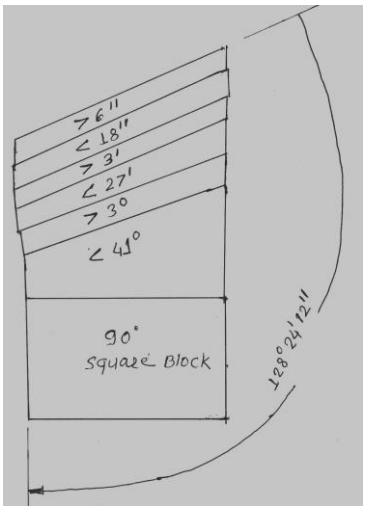
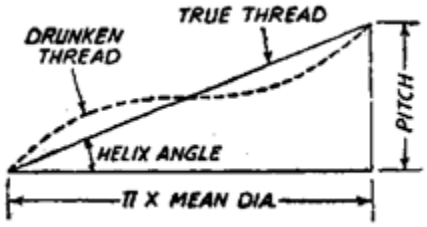
WINTER – 19 EXAMINATION

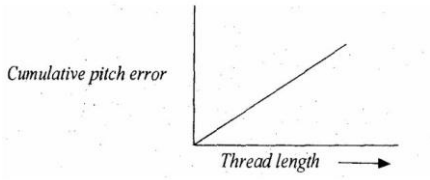
Subject Name: M.Q.C. **Model Answer** Subject Code: 17530

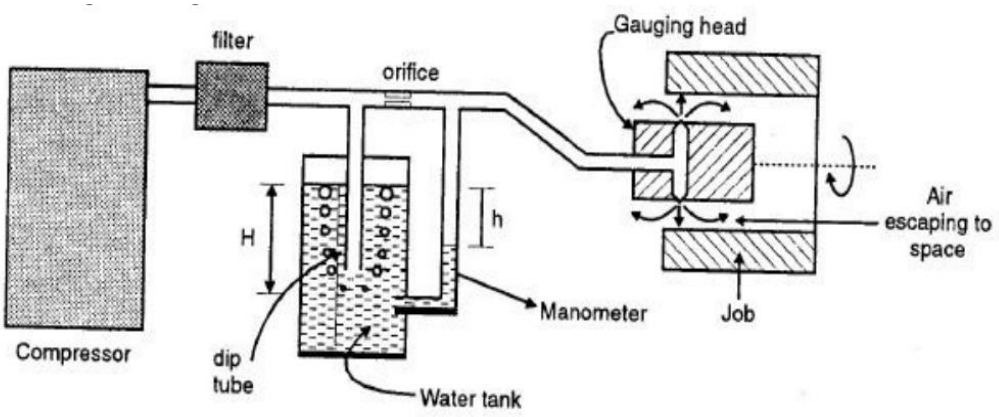
Important Instructions to examiners:

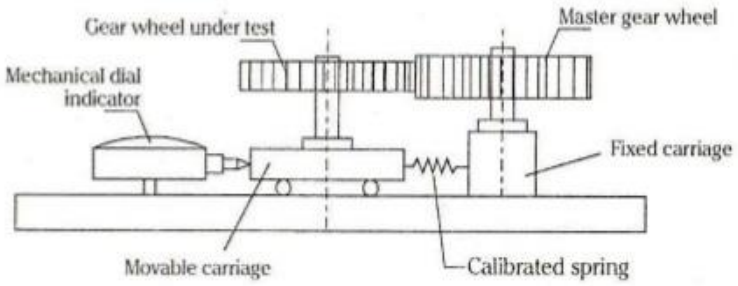
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling 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.

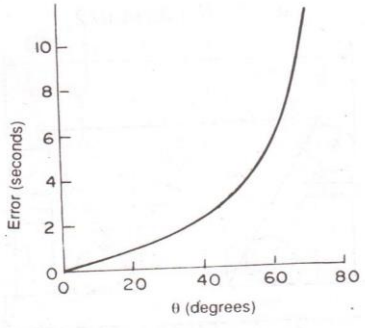
Q. No.	Sub Q. N.	Answer	Marking Scheme
Q.1 (A)	i)	**Metrology:** Metrology is the science of measurement. Metrology is primarily concerned with the establishment, reproduction, conservation and transfer of units of measurement and their standards. Objectives of Metrology:- 1) To ensure that the product 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.	**1 Mark definition** **3 Mark Objective any three**
	ii)	Multi Gauging :  **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	**01 Mark Diagram** **02 Marks**

		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. **Applications of Multi Gauging :** 1. Crank Shaft 2. Die 3. Cylinder block	**Explanation** **01 Mark Application any two**
	iii)	To build an angle of 128^0 24' 12" using a standard set of 13 pieces angle gauge and square block select the following angle gauges :-  **Minimum number of angle gauges required are 7**	**3 Marks for diagram** **1 Mark for minimum number of gauges**
	iv)	**Drunken Error:** It is error due to the irregular form of helical groove on a cylindrical surface. In this case pitch measured parallel to the axis is always same, but problem is with the thread is not cut to its true helix. Due to this flank surface will not be as a straight edge, it will be as curved form.  **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. .	**02 Marks Each**

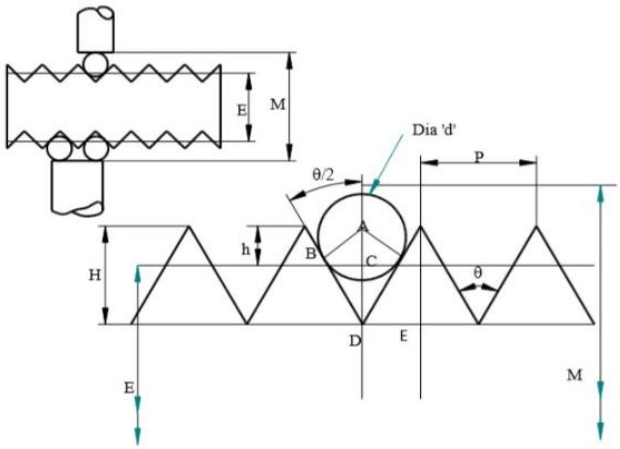


Q.1 (B)	i)	Pneumatic comparator Construction :- The pneumatic comparator consist of air compressor , air filter and a manometer with orifice. and a special designed measuring head.	**02 Marks for Diagram**
			**02 Mark Construction And working**
		Working : Water is filled in a tank and dip tube is inserted 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 1µm can be measured by using this instrument.	**1 Mark Advantage any two 1/2 mark each**
		Advantages:- 1. Very high magnification 2. Less friction, wear and inertia 3. Less measuring pressure 4. Determines ovality and taper of circular bores	**1 Mark Disadvantage any two 1/2 mark each**
		Disadvantages:- 1. Scale is generally not uniform 2. Requires compressor and accurate pressure regulator 3. Non portable 4. Less sensitivity	
	ii)	**Parkinson's Gear Tester :** 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.	**02 Mark Construction working**

		Working: As 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.   	**02 Marks working** **2 Marks Diagram**
Q.2	a)	**Needs of the inspection in manufacturing:-** 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 departments of the organization. 7) To take decision on the defective parts.	**1 Mark each** **any four points**
	b)	**characteristics of good comparator:-** 1. Robust in design and construction. 2. Linear characteristics of scale. 3. High magnification. 4. Quick response to input. 5. Minimum wear of contact point. 6. Free from oscillations. 7. Free from back lash. 8. Output must be easily readable and understandable. 9. Low in cost. 10. Less maintenance.	**1/2 Mark each any Eight points**

	c)	Selective Fit (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 according to their dimensions (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 and to get the desired relation between mating parts. 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:- Real time example can be Assembly of piston and cylinder, ball bearing	**3 Mark for Explanation** **1 Mark for Example**
	d)	**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 (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 $\sin\theta = h / L$ 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, $d\theta = \tan\theta\left(\frac{dh}{h} - \frac{dL}{L}\right)$  	**4 Marks**

		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.	
	e)	**Three wire Method:** This method is more accurate than two wire method as it ensures alignment of micrometer faces parallel to the thread axis. Here, three wires of exactly known diameters are used, one on one side & the two on the other side. The wires may be held in hand or hung from a stand. From the fig, M=diameter over the wires E= effective diameter (to be found) d= diameter of wires, h=height of wire center above the pitch line, r=radius of wire, H=depth of thread, D=major diameter of the thread.	**02 marks for explanation,**



$$From\ the\ triangle\ ABD,\ AD = AB\ \text{cosec}\frac{\theta}{2} = \frac{d}{2}\text{cosec}\frac{\theta}{2}$$

$$H = DE\cot\frac{\theta}{2} = \frac{P}{2}\cot\frac{\theta}{2} \quad \text{and CD} = \frac{\text{H}}{2} = \frac{P}{4}\cot\frac{\theta}{2}$$

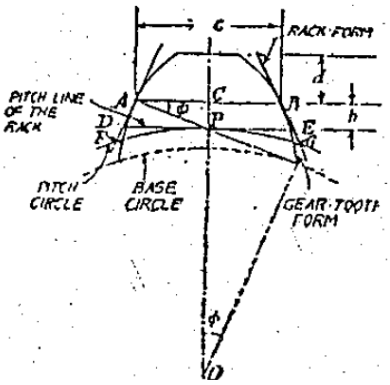
$$Further\ h = (AD - CD) = \left[\frac{d}{2}\text{cosec}\frac{\theta}{2}\right] - \left[\frac{P}{4}\cot\frac{\theta}{2}\right]$$

$$\text{Distance over the wires, M} = \text{E} + 2\text{h} + 2\text{r}$$

$$\text{i.e. M} = \text{E} + 2\left\{\text{rcosec}\frac{\theta}{2} - \frac{P}{4}\cot\frac{\theta}{2}\right\} + 2r = E + 2r\left\{1 + \text{cosec}\frac{\theta}{2}\right\} - \frac{P}{2}\cot\frac{\theta}{2}$$

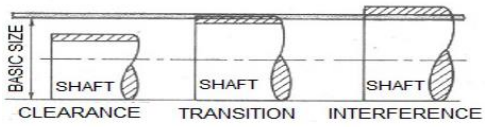
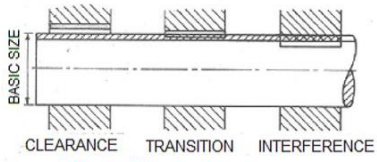
$$\text{Or M} = \text{E} + \text{d}\left\{1 + \text{cosec}\frac{\theta}{2}\right\} - \frac{P}{2}\cot\frac{\theta}{2}$$

02 marks for derivation

	f)	**Ans : Constant Chord Method :** In gear tooth calliper method, both the chordal thickness and chordal addendum are dependent upon the number of teeth. Hence, for measuring a large number of gears for set, each having different number of teeth would involve separate calculations. Thus the procedure becomes labouries and time consuming.  The costant chord method does away with these difficulties. It enables to employ one setting for all the gears having the same pitch and pressure angle irrespective of the number of teeth. Constant chord is defined as be chord joining those points, opposite faces of tooth, which make contact with the mating teeth when the line of the teeth lies on line of the gear centres. AB is known as constant chord. The value of B and its depth from the tip, where it occurs can be calculated mathematically and then verified by instruement. The advantage of the constant chord method is that for all number of teeth (of same module) value of constant chord is same. Secondly, it readily leads itself to a form of comparator which is more sensitive than the gear tooth vernier.	**01 mark for sketch** **03 marks for explanation**
Q.3	a)	**Definition:-** Krypton 86 is the most suitable element if used in a hot cathode discharge lamp maintained at a temperature of 68 K. According to this standard, meter is defined as 1,650,763.73 × wavelengths of the red–orange radiation of a krypton 86 atom in vacuum. This standard can be reproduced with an accuracy of about 1 part in 109 and can be accessible to any laboratory. **Advantages of Wavelength standard over material standard** 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. 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. 3) It is not subjected to destruction by wear and tear. 4) This standard is easily available to all standardizing laboratories and industries. 5) There is no problem of transferring standard to other standards meter and yard. 6) It gives a unit of length which can be produced consistently at all the times in all the circumstances. 7) It can be used for making comparative measurements of very high accuracy.	**01 mark for definition,** **03 marks for advantages (01 mark each any 3)**

b) **Differentiate between hole basis system and shaft basis system.**

01 mark each any four differences

Hole basis system	Shaft basis system
Size of hole whose lower deviation is zero is assumed as the basis size.	Size of the shaft whose upper deviation is zero, is assumed as the basis size.
Limits on the hole kept constant and those of shaft desired type at fit.	Limits on the shaft kept constant and those on the hot varied to have necessary fit.
The Hole basis system is referred to in mass production because it is convenient and less costing to make a hole of correct size due to availability by stand grills.	This system is not suitable for mass production because it is inconvenient and time-consuming and costly to have a shaft of the correct size.
It is more easily to vary a shaft size according to the fit required.	It is some difficult to find the hole size according to the fit required.
It requires less amount of capital and storage space.	It required large capital, storage space. for a large number of tools required to produce holes of different size.
Gauging of the shaft can be easily and conveniently done.	Being internal measurement gauging of the hole cannot be easily conveniently done.
 *Hole Basis System*	 *Shaft Basis System*

c) This is also a type of an autocollimator. It contains a small illuminated scale in the focal plane of the objective lens (collimating lens). This scale in normal position is outside the view of the microscope eyepiece. The illuminated scale is projected as a parallel beam by the collimating lens which after striking a reflector below the instrument is refocused by the lens in the field of view of the eye-piece.

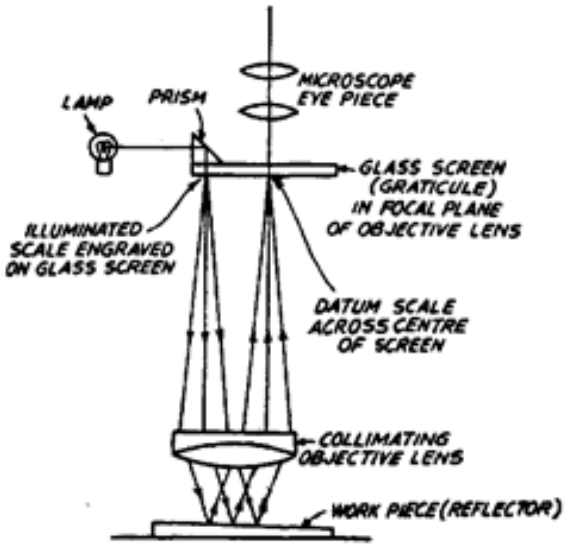
,

01 mark for explanation,

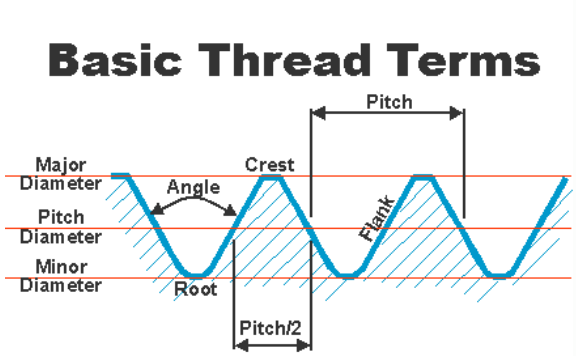
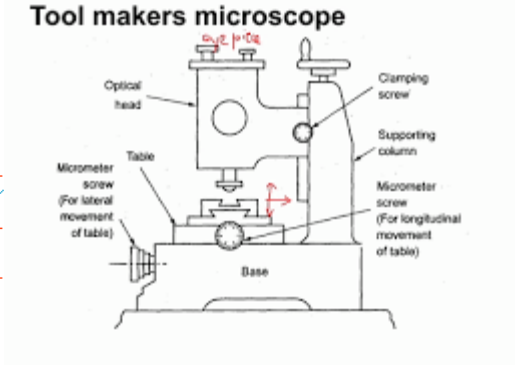
01 mark for application

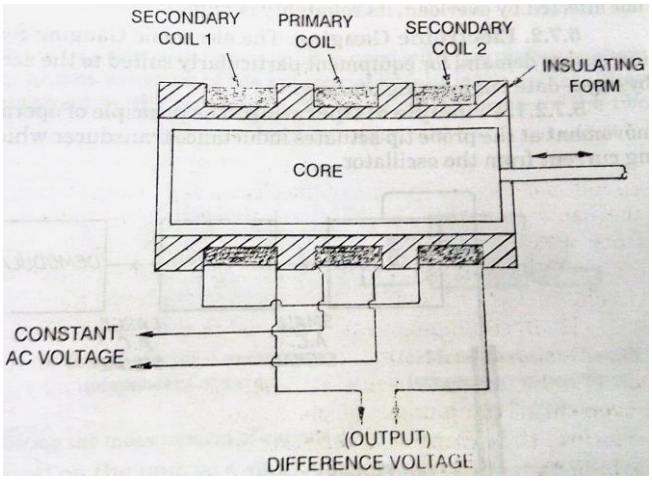
In the field of view of microscope there is another datum scale fixed across the center of screen and the reflected image of the illuminated scale is received at right angle to this fixed scale as shown in fig. and the two scales, in this position intersect each other.

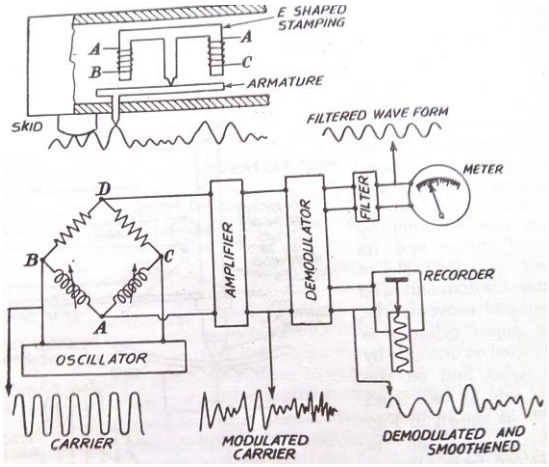
Thus the reading on the illuminated scale measures angular devotions form one axis at 90^0 to the optical axis and the reading on the fixed datum scale measures the deviation about an axis mutually perpendicular to the other two. In other words, changes in angular position of the reflector in two planes are indicated by changes in the point of intersection of the two scales. Readings from scale are read direct to 1 without the use of a micrometer.

		 Applications:- measuring the angle of an component, cheking the slopping angle of a vee block, measuring the angle of a cone or taper gauges,	**02 marks for sketch**
	d)	**Procedure to measure various screw thread parameters:-** - Place the given specimen (thread gauge shown in Fig.3) on the glass table plate. - Viewing through the eyepiece, rotate the knob for moving carrier arm on column to get the sharp image of the specimen kept on the glass plate. - Position the specimen such that the table movement in the X direction is parallel to the direction of the pitch measurement. - This is checked by ensuring the crosswire touching the tips (crests) of all the teeth during table movement in the X direction. **To measure the pitch:** Rotate micrometer head for X direction to touch the intersection point of the crosswire to the crest of the thread as seen from the eye piece. Note down the reading of the micrometer. Again rotate the micrometer head to move the specimen so that the next successive crest will come in contact with the crosswire intersection point. Note down the reading. The difference in reading will give the pitch. **To measure the thread angle:** Rotate the crosswire by the knob located behind the eye piece to match the flank of the thread with the cross wire. Make use of both the micrometer heads for X and Y direction to move the flank, and	**02 marks for sketch,** **02 marks for explanation**

		note down the angle by viewing through the lens below the eye piece. Now rotate only the crosswire to match the opposite flank and note down the angle. The difference will give the thread angle. **To measure the Major diameter:** Rotate micrometer head for y direction to touch the horizontal dotted lines touch the all crests of either side of the tread as seen from the eye piece. Note down the reading of the micrometer. Again rotate the micrometer head to move the specimen so that the all crests of other side of threads will come in contact with the horizontal dotted lines. Note down the reading. The difference in reading will give the Major diameter. **To measure the Minor diameter:** Rotate micrometer head for y direction to touch the horizontal dotted lines touch the all roots of either side of the tread as seen from the eye piece. Note down the reading of the micrometer. Again rotate the micrometer head to move the specimen so that the all roots of other side of thread will come in contact with the horizontal dotted lines. Note down the reading. The difference in reading will give the Minor diameter. **To measure the effective diameter of the thread:** Similarly rotate micrometer head for Y direction to touch the intersection point of the crosswire (along with the horizontal dotted line) to the root of the thread, as seen from the eye piece. Note down the reading of the micrometer. Again rotate the micrometer head to move the specimen so that the horizontal dotted line touches all the crests. Note down the reading. The difference in reading will give the depth of the thread. Effective Dia =major diameter - depth of thread	

		 	
	e)	The principal reasons for controlling the surface texture are 1) To improve the service life of the components 2) To improve the fatigue resistance. 3) To reduce frictional wear. 4) To have close dimensional tolerances on the parts. 5) For good appearance. 6) To reduce corrosion by minimizing depth of irregularities. For example, 1) Heat exchanger tubes transfer heat better when their surfaces are rough rather than highly finished. 2) Brake drums and clutch plates etc. work best with some degree of surface roughness. 3) The components which are subjected to high stresses and load reversals are finished highly smooth. 4) For quieter operations the surfaces should be smooth. 5) Fatigue life enhancement in rotating shaft, thereby improving the service life of the component	**01 mark each (any four points)**
	f)	**SQC: -** it is called as statistical quality control, when statistical techniques are employed to control, improve, analyse, interpretation and presentation of data. Benefits of SQC:- 1) The use of SQC ensures rapid and efficient inspection at a minimum cost. 2) Use of acceptance sampling in SQC exerts more effective pressure for quality improvement than is possible by 100 per cent inspection. 3) It reduces the number of rejects and saves the cost of material.	**01 mark for definition, 03 marks for benefits (01 mark each any 3)**

		4) SQC helps to maintain customer relations by ensuring uniformly high quality. 5) Creating quality awareness in employees. 6) Elimination of bottlenecks in the process of manufacturing. 7) Pointing out when and where 100 per cent inspection, sorting or screening is required.	
Q.4 A	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 secondary symmetrically spaced from the primary. AC carried excitation is applied to the primary and two secondary's 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 secondary in series which can be directly calibrated in terms of linear movement of core.  	**02 marks for sketch, 02 marks for explanation**
	b)	**Taylor- Hobson Talysurf:-** 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	**02 marks for sketch,** **02 marks for explanation**

		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.  	
	c)	The quality of design of a product is concerned with the tightness of the specifications for manufacture of product. -it must ensure consistent performance over a predetermined life span in terms of rated output, efficiency, and overload capacity. -it should consider possible modes of failure due to stress, wear, distortion, corrosion, shocks, vibrations, temperature, pressure, environmental conditions etc. -product design and development is a continuous process. **Factors Controlling Quality of Design** 1) Type of customers in the market – the quality of design depends upon the type of customers their needs, the price they are willing to pay for various products and services i.e rich, middle, poor etc to provide the intended function with the overall economy. 2) Intended life , environmental conditions, reliability , importance of continuity of service maintainability etc. 3) Profit Consideration- from company point of view profit is more important. 4) Environmental Conditions- it plays an important role in deciding quality of design. For example a car radiator designed for use in equatorial region should be for increased ambient temperature. 5) Special requirements of the product- generally greater the requirements for strength, fatigue resistance, life, interchangeability of manufacture of item, closer should be the tolerances to give better quality goods. It means that higher quality of design means higher cost quite often it also means higher values.	**04 marks**

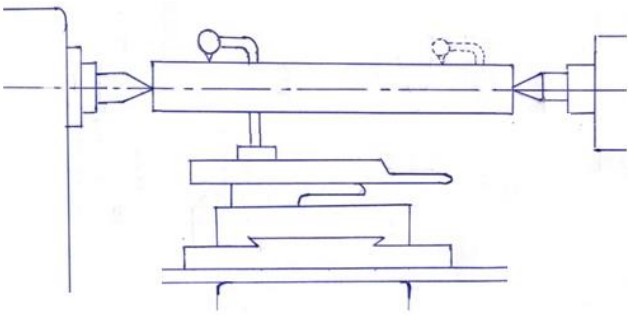
	d)		**01 mark each any four points**

Sr. No.	Variable Measurement	Attribute Measurement
1.	In this measurement the record is made of an actual measured quality characteristics such as dimensions of a part in mm, hardness in Rockwell units, temperature in degree centigrade, weight in Kg etc.	In this measurement the record shows only the number of articles conforming and the number of articles falling to confirm to any specified requirements. Such as cracks in sheet by spot welds, the number of defective pieces found in a sample.
2	Precision instruments are used to measure the quality characteristics.	The conformance or non-conformance is usually inspected with the help of Limit gauges i.e GO and NO-GO gauges.
3	It gives detailed information about the product quality characteristics.	It gives information about whether the part are acceptable or not.
4	It is time consuming	It requires less time
5	Higher measurement cost.	Inspection cost is less.
6	The data obtained is called continuous data and can have any value	The data obtained is called discrete data. It has integer value.
7	To represent the collected data X bar and R chart or X bar and 6 (standard deviation) charts are used	P and C charts are used
8	It may cause fatigue to the operator.	It does not cause fatigue to the operator.

Q.4 B	i)	**Alignment tests for lathe** 1) Straightness of saddle in horizontal direction 2) Alignment of both the centers in the vertical plane 3) True running of taper socket in main spindle 4) Parallelism of main spindle to saddle movement 5) Movement of upper slide parallel with main spindle in vertical plane 6) True running of locating cylinder of main spindle 7) True running of head stock center 8) Parallelism of tailstock sleeve to saddle movement 9) Parallelism of tail stock sleeve taper socket to saddle movement in vertical and horizontal plane 10) Test for level of installation in longitudinal and in transverse direction	**02 marks for list (1/2 mark for each type), 02 marks sketch, 02 marks for explanation (explain any one)**

Alignment testing of lathe centers in vertical plane

It is necessary to check the relative position of the axes also. Both the axes may be parallel to carriage movement but they may not be coinciding. So when a job is fitted between the centers, the axis of the job will not be parallel to the carriage movement. This test is to be carried out in vertical plane only. A mandrel is fitted between the two centers and dial gauge on the carriage. The feeler of the dial gauge is pressed against the mandrel in vertical plane as shown in fig. 16.11 and the carriage is moved and the error noted down.



True Running of Lathe Main Spindle

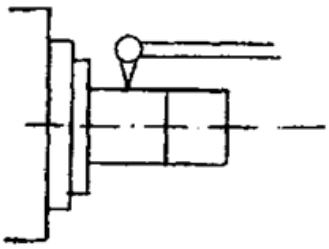
Fig. shows the arrangement of test set up.

• The test can be carried out by using a dial gauge and stand only.

• Fix the dial gauge to stand and to a carriage of lathe machine.

• Confirm that the plunger pointer touches the locating lathe spindle.

• The headstock is then rotated on its axis and the indicator should not show any variation in reading.

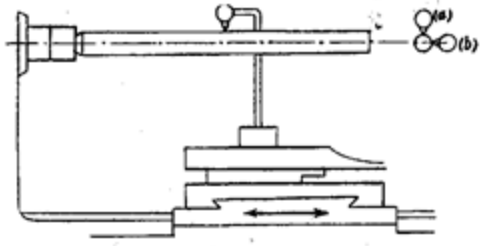


Parallelism of Main Spindle to Saddle Movement

The dial gauge is to be mounted on the saddle and the feeler of dial should touch on the mandrel which is fixed in headstock of the lathe machine.

• Move the saddle as shown in longitudinal direction and note the variation in dial gauge.

• If no variation is present, they can be called as parallel to each other.



ii) **Six Sigma:-**

06 marks for correct explanation

Six sigma is a quality improvement programme with a goal to reduce the number of defects to as low as 3.4 parts per million. Six sigma quality level is the closest to zero defect. Less than 6 sigms does not yield acceptable level of quality and more than 6σ does not yield sustainable benefits.

The goal of a six sigma quality programme is to improve customer satisfaction through reducing and eliminating defects and to continuously improve process thereby improving quality and productivity.

The methodology of six sigma consists of five steps are as follows:-

1) Define: - the primary aim is to identify within each sub process, the possibilities for defects or quality problems which can be arrived at through the use of different statistical tools such as regression analysis, design of experiments and chi- square testing.

2) Measure: - The second most important step is the establishment of the metrics that will be improved using six sigma. It is also necessary to identify and rank improvement opportunities. First the CTQ (critical to quality) characteristics of the process have to be identified in order to focus six sigma on areas that will have the greatest impact on customer satisfaction.
   The output of the process measured as multiples of its sigma under each CTQ (existing quality level) has to be recorded so that a defect per unit is estimated in PPM. These will be used as the starting points for setting new targets, and proceeding with the subsequent steps.
3) Analysis: this is the stage at which new goals are set, and the route maps created for closing the gap between current and target performance levels. It begins with bench marking key product performance against the best in class so that the sigma level.
   Analysis is a key component of any defect reducing programme. The aim is to attained by comparable process can be ascertained as the basis for new targets identify what causes the defects in each sub process so that they can be rectified, either by redesigning the product or re engineering the process.
4) Improvement:
   The objective of this phase is:
   - To confirm the key process variables
   - Quantify their effects on the CTQ
   - Identify the maximum acceptable ranges of the specifications; and then tackle the capability of the process.
   - If the exiting quality level is greater the 3σ, efforts must be directed to

		improve the processes so as to achieve at least 3σ. 5) Control: the final stage of six sigma implementation is to hold the gains that have been obtained from the improve stage. Unless there is a good control we are likely to go back to the original state.	
Q.5	a)	<table><tr><th>Inspection</th><th>Quality control</th></tr><tr><td>Inspection is a part of quality</td><td>Concerned with confirmation with specifications</td></tr><tr><td>Act of checking the components</td><td>Effective system of integration of various functions</td></tr><tr><td>Needs measuring instruments</td><td>Involves quality improvement tools</td></tr><tr><td>Measurement activity</td><td>Analysis of measurement data</td></tr></table>	**01 mark each**
	b)	Types of Quality Audit: 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 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. 3. 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.	**02 mark for types, 02 marks for explanition**
	c)	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 enlist,** **03 marks for explanation**

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

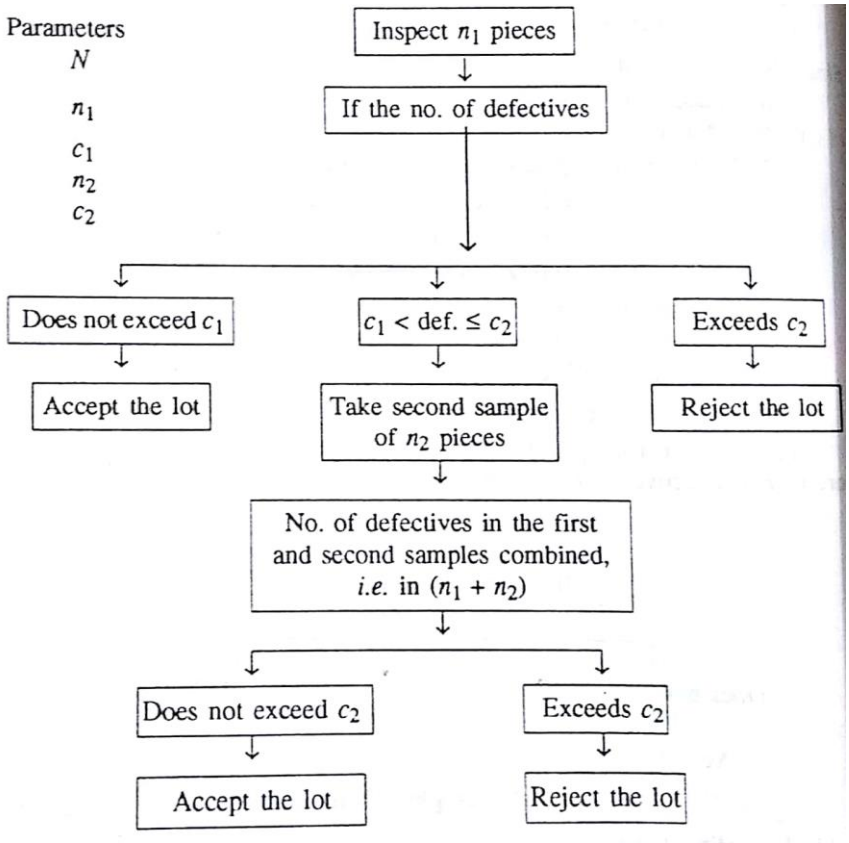
n1= number of pieces in the first sample. =35

C1= acceptance number for the first sample. =1

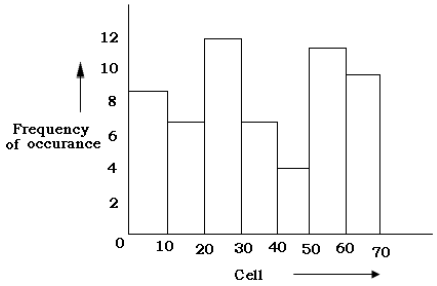
n2= number of pieces in the second sample. =50

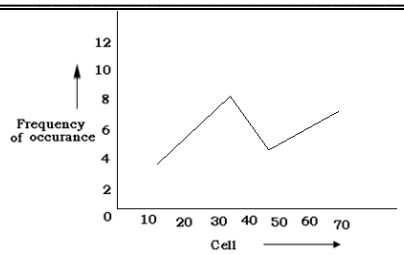
C1= acceptance number for the second sample. =4

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

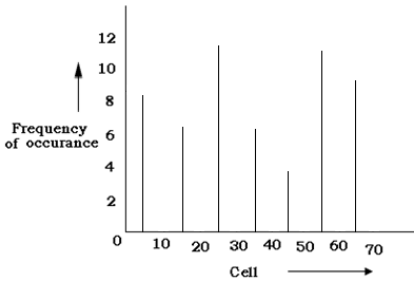
	d)	Normal distribution curve and its characteristics Normal distribution curve A bell shaped curve which is symmetrical about the average value, high at middle and diminishes gradually as the distance increases away from the average is called normal or Gaussian curve. Characteristics 1.It is symmetrical about its mean. 2. It is bell shaped. 3. It tends between ±∞ Application 1. Process capability study 2. Run charts 3. Control Charts 4. Quality improvement systems.	**02 mark each for Characteristics & Application**
	e)	Various tools of SQC are Data collection, check sheets & checklists Pareto diagrams Cause and effect diagrams Stratification Graphs and histograms Scatter diagram Control charts **Frequency Histogram** 1) In the graph, the sides of column represent the upper and lower cell boundaries and their highest are proportional to the frequencies of occurrences within the cells. 2) In drawing a histogram, it is assumed that, the frequency is centered at the mid-value of cell or class.  3) Simple construction and inspection of histogram make it an effective tool. 4) A random sample is taken from the lot and measurements are performed for the selected quality characteristic. 5) When there is a large variation in the obtained data, then it may be grouped into cell. **Frequency Polygon** 1) It consists of series of straight lines joining points, which are plotted at cell mid-points with a height proportional to cell frequency.	**01 mark for enlist,** **03 marks for explanation**



2) Frequency polygon has the advantage of plotting several distributions on the same axis, thereby making certain comparisons possible, which is not possible in case of histogram.

Bar chart

1) Bar chart is graphical representation of the frequency distribution, in which, the bars are centered at the mid-point of the cells and the heights of bars are proportional to the frequencies in the respective cells.



Control Charts

1) It is a graphical representation of the collected information.

2) The information may pertain to measure quality characteristics like length, diameter, thickness etc.

3) In general, control chart is a

1) Device to specify the state of statistical control.
2) Procedure to attain statistical control.
3) Tool to judge whether a state of statistical control is attained.

f)

Since specific component and machine is not mentioned in question, we consider general process of profile checking for any component on profile projector;

1.Clean & dry the component to be inspected
2.Select required magnification i.e 10x,20x…,
3.Poweer ON & keep the component on machine table.
4.Adjust the focus till sharp image is obtained.
5. Now moving the table in X &/or Y direction, required dimension can be measured. Image of the profile can be also traced by placing paper on the screen

04 marks for procedure

Q.6 a)

6(a)

$$\bar{c} = \frac{351}{25} = 14.04$$

UCL $\bar{c} + 3(\sqrt{\bar{c}})$

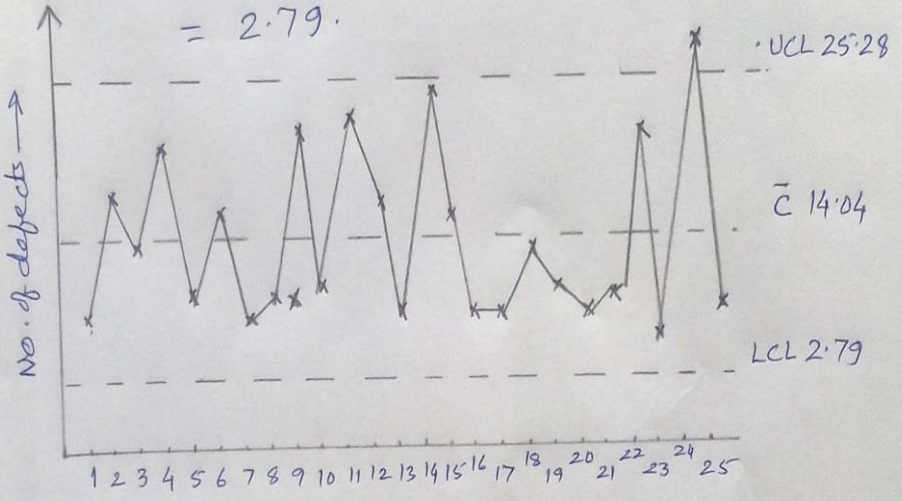
$= 14.04 + 3(\sqrt{14.04})$

$= 25.28$

LCL $\bar{c} - 3(\sqrt{\bar{c}})$

$= 14.04 - 3(\sqrt{14.04})$

$= 2.79.$



For subsequent Period value of c = 9.

Marks
Calculation of $\bar{c}$ 1 mark
UCL 2 marks
LCL 2 marks
Control Chart 2 marks
Comment on value of c 1 mark.

b)

6(b)

Important note: In given data for lot No 5, no. of defectives is 'J'. It is considered as 1.

Calculations:

(i) Total no. of defectives = 64.

Total no. of items inspected = 6000

$\bar{p} = \frac{64}{6000} = 0.010$ ——— 1 mark

n = Lot size = 400

$n\bar{p} = 400 \times 0.010 = 4.26.$

$UCL = n\bar{p} + 3(\sqrt{n\bar{p}(1-\bar{p})})$

$= 4.26 + 3(\sqrt{4.26(1-0.010)})$

$= 10.41$ ——— 1 mark

$LCL = n\bar{p} - 3(\sqrt{n\bar{p}(1-\bar{p})})$

$= 4.26 - 3(\sqrt{4.26(1-0.010)})$

$= -1.89$. (Since LCL is negative, to be considered as 0)

$= 0$ ——— 1 mark

From the data it is observed that lot number 4 & 9 fall out of control. Therefore process is not under Statistical control. ——— 1 mark

(ii) For new value of fraction defective eliminating lot 4 & 9

Total no. of defectives = $64 - (18+14) = 32$

$\bar{p} = \frac{32}{5200} = 0.0061$ ——— 1 mark

$n\bar{p} = 400 \times 0.0061 = 2.46$

$UCL = n\bar{p} + 3(\sqrt{n\bar{p}(1-\bar{p})})$

$= 2.46 + 3(\sqrt{2.46(1-0.0061)})$

$= 7.14$ ——— 1 mark

$LCL = n\bar{p} - 3(\sqrt{n\bar{p}(1-\bar{p})})$

$= 2.46 - 3(\sqrt{2.46(1-0.0061)})$

$= -2.22 \cong 0.$ ——— 1 mark

Since lot 10 is still out of limit, process out of Statistical control. 1 mark.

No. of defectives for lot no.5, take 1 instead of J

If students try to attempt the question, give them marks accordingly

c)

Criteria for comparision	Single	Double	Multiple
Avg. no of pieces inspected per lot	Large	Moderate	Low
Acceptability to producer	Less	Acceptable	Indecision is continued on long term
Prevaling Quality level	Large	Moderate	Least
Cost of operation	Low	Moderate	Large

01 mark each