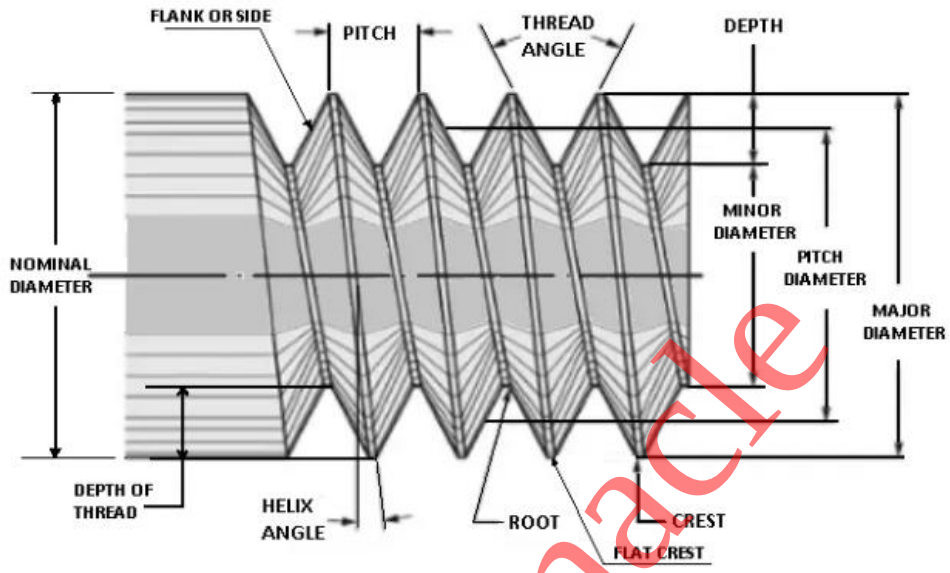
WINTER– 18 EXAMINATION

Subject Name: Engineering Metrology **Model Answer** **Subject Code:** 22342

Important Instructions to examiners:

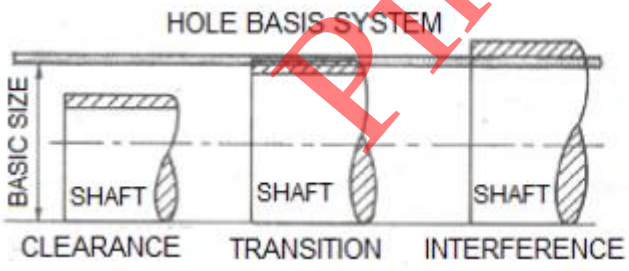
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling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

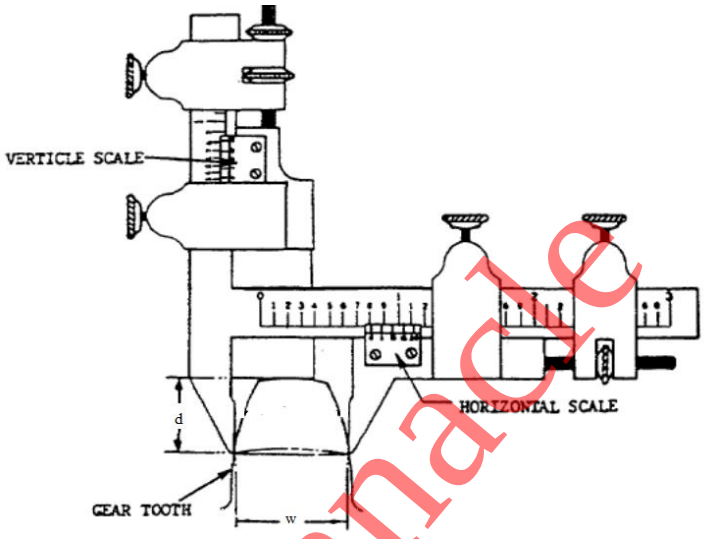
Q. No.	Sub Q. N.	Answer	Marking Scheme
1	a)	**Attempt any five** **Define metrology.** Metrology is the science of measurement which deals with the measuring instruments, measuring techniques and measuring standards. Metrology is defined by the International Bureau of Weights and Measures as "the science of measurement, embracing both experimental and theoretical determinations at any level of uncertainty in any field of science and technology".	**2 Marks**
	b)	**State any four advantages of optical comparator.** • Maximum magnification can be obtained, • No need of electric supply • It is a non contact types of measurement hence no wear and tear. • Instruments are more accurate	**½ Mark each**

	c)	**State the term selective assembly.** In selective assembly, the parts are classified into several groups as per size and mating parts are also classified in same number of groups. Assemblies are made as per the sizes from corresponding groups with little or no further machining. Selective assemblies results in reduced cost of production without affecting the quality of the product.	**2 Marks**
	d)	**Draw neat sketch of metric screw thread profile.**  	**2 Marks**
	e)	**List down instruments used for angular measurement.** Bevel protractor, sine bar, angle gauges, autocollimator, angle dekkor, clinometers, sprit level	**Any four,** **½ Marks each.**
	f)	**Define sampling length.** It is the length of profile necessary for the evaluation of the irregularities to be taken into account. It is measured in a direction parallel to the general direction of the profile. The sampling length is usually defined as the cut-off length (λc) of the filter used to separate roughness and waviness.	**2 Marks**
	g)	**Define straightness,** In metrology a line is said to be straight over a given length if its deviations w. r. t. to the ideal reference line are within specified tolerance limit. Or if the variations of the distances of its points from two planes perpendicular to each other and parallel to the general direction of the line remain within specified tolerance limit.	**2 Marks**

2	a)	**Attempt any Three of the following:** **Differentiate between systematic errors and random errors.**	**Any four points,** **1 Mark each.**

Basis For Comparison	**Random Error**	**Systematic Error**
Definition	The random error occurs in the experiment because of the uncertain changes in the environment.	It is a constant error which remains same for all the measurements.
Causes	Environment, limitation of the instrument, etc.	Incorrect calibration and incorrectly using the apparatus
Minimize	By repeatedly taking the reading.	By improving the design of the apparatus.
Magnitude of Error	Vary	Constant
Direction of Error	Occur in both the direction.	Occur only in one direction.
Types	Do not have	Three (Instrument, Environment and systematic error)
Reproducible	Non-reproducible	Reproducible

	b)	**Define wavelength standard. State advantages and disadvantages.** wavelength standard : Using wavelength of monochromatic light which is natural and invariable unit of length, the working standard is no more dependent upon the physical standard. Rather the definition of a standard of length relative to the metre is expressed in terms of the wavelength of the red radiation of cadmium. Thus for all practical purposes the use of phenomenon of the interference of light waves to provide working standard may be accepted. **it was decided that Kr 86 is used in a hot-cathode discharge lamp maintained at 68 °K temperature generates orange radiation can be used as ultimate wavelength standard.** **Advantages:** • Since wavelength standard is not a physical one, it need not be preserved. • This is reproducible standard of length, and the error of reproduction can be of the order of 1 part in 100 million. • Used for comparison with high accuracy. **Disadvantages**: Maintenance cost is high. Requires accurate wavelengths of spectral radiations.	**Definition 2 Marks,** **Advantages and Disadvantages 2 Marks.**
	c)	**Explain with neat sketch hole basis system.** Hole basis system :  **HOLE BASED SYSTEM** **Size of the Hole is kept constant, Shaft size is varied to get different fits** In this system, the design size of hole, whose lower deviation (fundamental deviation) is zero. Hole is assumed as basic size and different clearances and interferences are (to have Different fits) obtained by varying the limits of the shafts. In other words, the limits of the hole kept constant and those of the shaft are varied to obtain the necessary fit. For a standard manufacturing process where hole is manufactured by drilling, reaming, etc. and the shaft by turning, etc., go for the hole base system, because altering the hole diameter by a small amount is not possible for such cases, and on the other, shaft diameter can be varied.	**Sketch 2 Marks,** **description 2 Marks.**

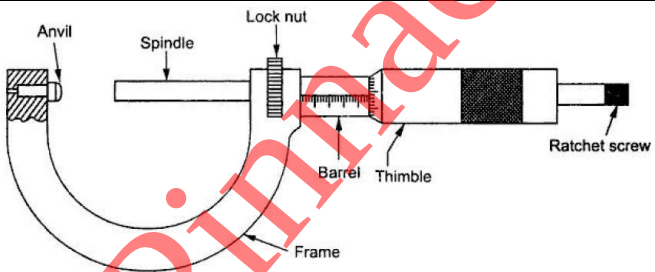
	d)	**Explain the principle of measurement of tooth thickness by gear tooth vernier caliper.** **Gear Tooth vernier calipers** Gear Tooth vernier calipers is designed to measure 0.02mm the thickness of gear teeth at the pitch line (the chordal thickness of the teeth) using the distance from the top of a tooth to the chord. For the same purpose, it can also be used for measuring hobs, from and thread tools etc. The thickness of a tooth at the pitch line is measured by an adjustable tongue. Each of these is adjusted independently by screws on the graduated bars.  **Gear Tooth vernier caliper** The tooth thickness is generally measured at pitch circle and is, therefore, referred to as pitch-line thickness of tooth. The gear tooth vernier has two vernier scales and they are set for the width (w) of the tooth and the depth (d) from the top, at which w occurs. Considering one gear tooth, the theoretical values of w and d can be found out which may be verified by the instrument.	**Sketch 2 Marks,** **Description 2 Marks.**

3 **Attempt any Three:** — **Any 4 point,**

a) — **1 Mark Each**

Sr. No.	Alignment Test	Performance Test
01	Alignment test are carried out for various parts of machine like its spindle, slides, holding table etc.	Performance test are carried out to access the performance of machine tool in working condition.
02	Alignment test are also called geometrical test.	Performance test is also called as practical test.
03	These tests are carried out loaded and unloaded condition.	These tests are carried out in working condition.
04	It is done to check the grade of manufacturing of machine tool.	These tests are carried out to check the accuracy of finished product.
05	It consists of checking the relationship between various machine elements when the machine tool idle and unloaded.	It is carried out to know whether machine tool is capable of producing the part within the specified element or not.

b) — **Sketch 2 Marks,**



Explanation 2 Marks.

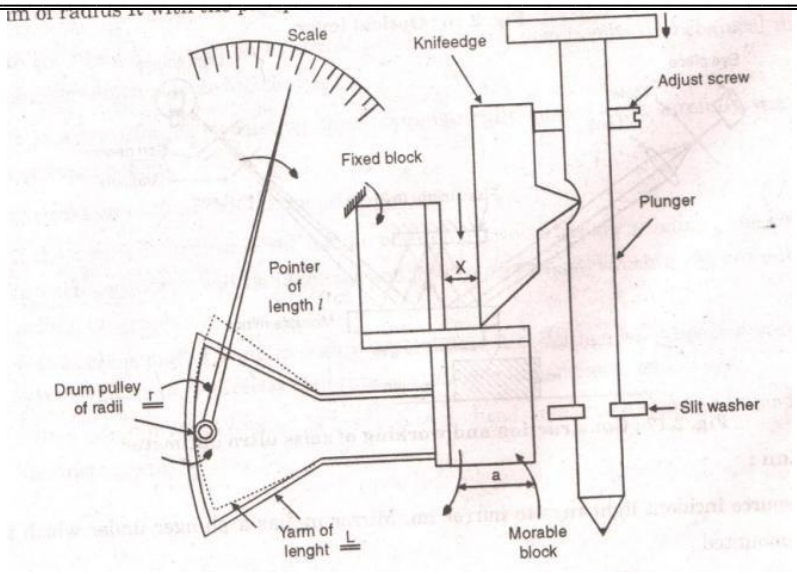
Working :- Micrometer works on the principle of screw and nut. When a screw is turned through nut through one revolution, it advances by one pitch distance i.e. one rotation of screw corresponds to a linear movement of a distance equal to pitch of the thread. if the circumference of the screw is divided into number of equal parts say "n" its rotation through one division will cause the screw to advance through (pitch/n) length.

First of all calculate the Least Count (L.C.) = Smallest division on main scale/ No. of Divisions on circular scale

For measuring the particular dimension, hold the work between the faces of the anvil and spindle then move the spindle by rotating the thimble until the anvil and spindle touches the work surface. Make fine adjustment with the ratchet. Now take the reading on the main scale(M.S.R.) taking into account the division below the reference line. then take thimble reading which coincides with the reference line on the sleeve known as (V.S.R.).

Then total Reading = M.S.R + (V.S.R. X L.C.)

c)



Working :- When the component which is to be inspected is kept below the plunger according to dimension w.r.t. the standard value the plunger will move upward or downward. as the plunger moves knife edge gives motion to the moving block. This motion of moving block w.r.t. fixed block and cross strip hinge , gives motion to the Y arm . As the end of Y arm moves it causes the phosper bronze wire to rotate the driving drum. Driving drum gives motion to the pointer , which shows reading on the scale. and according to the reading the size of component w.r.t. standard is compared.

Sketch 2 Marks,

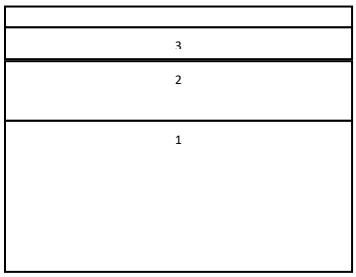
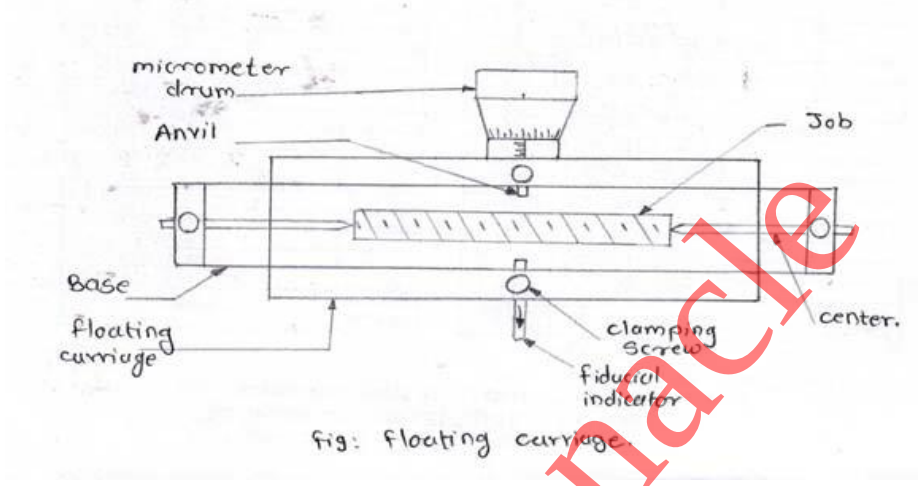
Working 2 Marks.

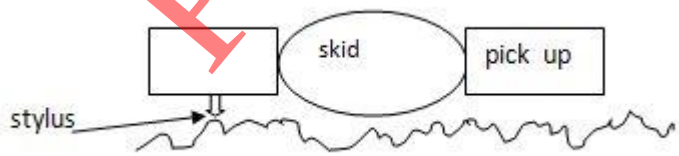
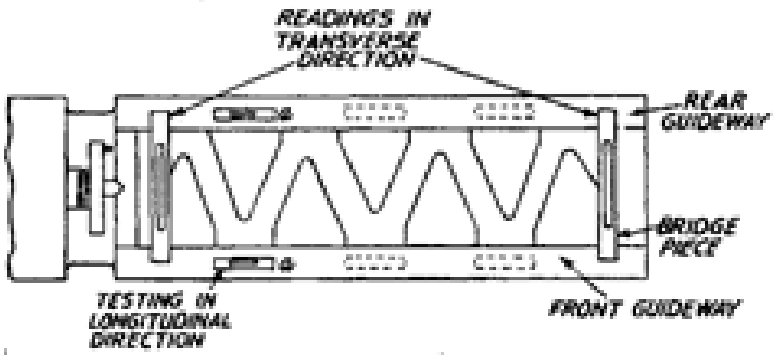
d)

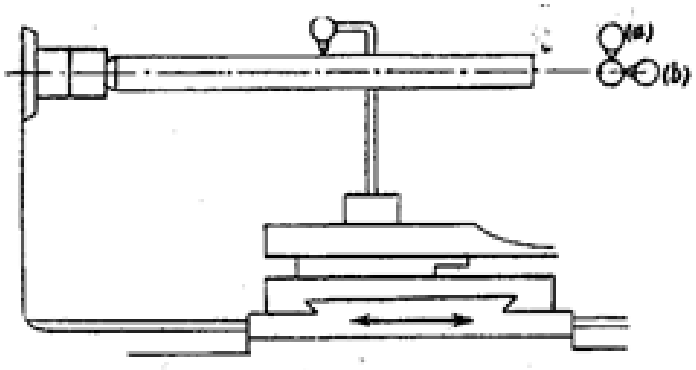
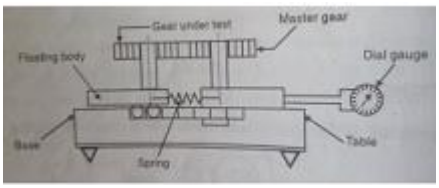
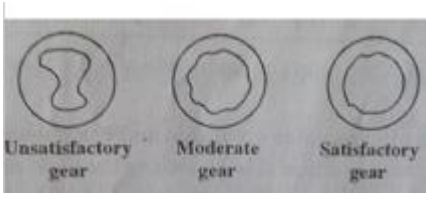
Sr. No.	Tolerance	Allowance
01	It is the permissible variation in dimension of a part (Either a hole or shaft) .	It is the prescribed difference between the dimensions of two mating parts (hole and shaft) .
02	It is the difference between higher and lower limits of a dimension of a part.	It is the intentional difference between the lower limits of hole and higher limit of shaft .
03	The tolerance is provided on a dimension of a part as it is not possible to make a part to exact specified dimension .	Allowance is to be provided on the dimension of mating parts to obtain desired type of it.
04	It has absolute value without sign.	Allowance may be positive (Clearance) or negative (Interference).

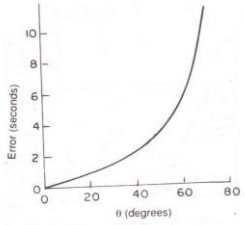
4 points,

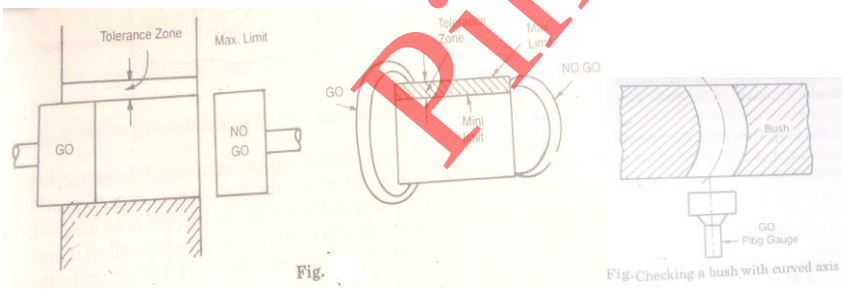
1 Mark Each

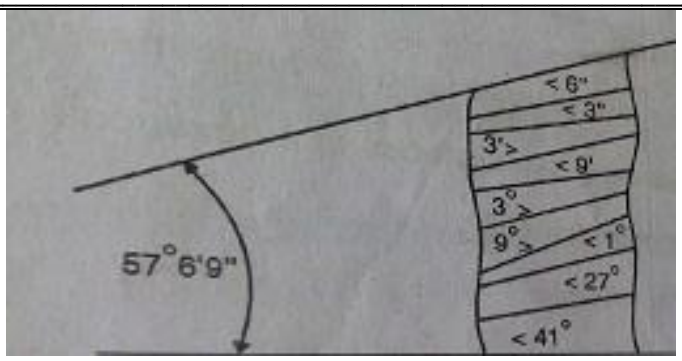
4	a)	**Attempt any Three:** 58.975 - 1.005 ← 1 57.97 - 1.47 ← 2 56.5 - 6.5 ← 3 50.00 - 50.00 ← 4  58.975	**Sketch 2 Marks,** **Correct No. of Slip Gauges 02 Marks**
	b)	 fig: floating carriage. Floating carriage micrometer is also called screw thread measuring machine or bench micrometer. **Principle of floating carriage**: It works on Principle of Nut & Bolt /Screw threads. As drum of micrometer rotates by one revolution, it will move forward by one pitch of interval thread. The movement will be measured using number of division on drum and main scale i.e. Micrometer principle. Floating carriage consist of 1)Two centers held on pillars of base 2) These centers are used for holding the job. 3) Lower slide is kept on the base, and the top slide is placed over the lower slide 4) Top slide has two pillars. 5) One pillar consists of micrometer drum having least count of 0.0002 mm. 6) The other pillar consists of a fiducial indicator which senses the pressure applied on the anvil end. **Applications :-** 1) Measurement of Major diameter of screw thread 1) Measurement of Minor diameter of screw thread 1) Measurement of Effective diameter of screw thread	**Sketch 1 Marks,** **Principle 2 Marks** **Application 01 Mark**

	c)	1) Major diameter: It is the diameter of an imaginary co-axial cylinder which touches the crests of an external thread and the root of an internal thread. 2) Minor diameter: It is the diameter of an imaginary co-axial cylinder which touches the roots of external threads. 3) Pitch: It is the distance measured parallel to the screw threads axis between the corresponding points on two adjacent threads in the same axial plane. 4) Effective diameter: It is the diameter at which the thread space and width are equal to half of the screw thread. 5) Angle of the thread: It is the angle between the flanks or slope of the thread measured in an axial plane. 6) Lead: The axial distance advanced by the screw in one revolution is the lead.	**Any Four** **1 Mark Each**
	d)	Principle of Stylus Probe type direct measuring instruments used for surface finish: In this instrument a skid or shoe is drawn slowly over the surface by hand or by motor drive. This skid which is moved over the surface, follows its general contours and provides a datum for the measurement. In some cases where directly probe is used, this probe traces the actual profile of the work piece i.e. crest and valleys on the work piece as it passes over the sampling length. Then with the help of some mechanical arrangements or microprocessor based arrangements this profiles are magnified and by doing calculations the surface finish is measured. 	**Principle 03 Marks** **Diagram 01 Marks**
	e)	**1) Leveling of Lathe Machine:** 	**Each Diagram 02 Marks**

		2)Parallelism of Main Spindle to Saddle movement:  	
5	a)	**Attempt any TWO:** **Describe with neat sketch the working of Parkinson gear tester** 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. **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.   	**Working 03M** **Sketch 03 M**
	b)	**Define accuracy. Enlist any four factors affecting accuracy of instrument.** **Accuracy:-** " The closeness of the measured value with the true value" **Factors affecting accuracy of instrument** 1. Handling of instruments. 2. Errors in instrument.	**Definition 02 M,** **01 mark each any four points**

		3. Wear of different components of instrument. 4. Operating conditions.	
	C)	**Why sine bar can't be used above 45^0 angle.** Sine bar is not used for measurement of angle greater than 45^0 : We know that angle is measured by using sine bar is based on sine principle, $\sin \theta = h / l$ Where, h = Required slip gauge combination l = center distance of rollers. The relationship between the angular setting accuracy (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, $d\theta = \tan \theta \left(\frac{dh}{h} - \frac{dL}{L} \right)$  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 sine bar for measuring angles greater than **45** ° if high accuracy is required	**04 marks for description,** **02 mark for sketch.**

6		**Attempt any Two:**	
	a)	**Taylors Principle of Gauge design:-** It states that 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. GO gauges should check all the related dimensions (roundness, size, location ect). Simultaneously whereas NO-GO gauge should check only one element of the dimension at a time. For example the bush to be inspected has a curved axis and a short GO plug gauge is used to check it. The short plug gauge will pass through all the curves of the bent bushing. This will lead to wrong result that the workpiece (hole) is within the prescribed limits. Actually such a bushing with curved hole will not mate properly with its mating parts and thus defective. A go plug gauge with adequate length will not pass through a curved bushing and the error will be detected. A long plug gauge will thus check the cylindrical surface not in one direction but in a number of sections simultaneously.  Fig. Fig.-Checking a bush with curved axis **Note:- figure not essential if drawn will be given advantage**	**03 marks for principle** **03 marks for example**
	b)	Angle to be developed $57^0 6' 9''$ $57^0 = 41^0 + 27^0 - 9^0 + 1^0 - 3^0$ (5 angle slips) $6' = 9' - 3'$ (2 angle slips) $9'' = 6'' + 3''$ (2 angle slips)	**Calculations 04 M**



Sketch 02 m

c) **Optical Flats**

Principle: The wave length of sodium yellow light is 1/160th of a cm and with this as reference it is possible to examine the flatness of a surface to high degree. The flatness to this degree is said to be optically flat

Principle &Working 03 M

Sketch 03 M

Working : The optical flat consists of a special glass disc of about 12 to 20 mm thick and diameter ranging from 38 to 75 mm with their surface finished flat. For testing purpose a sodium discharge lamp is used. The surface to be tested must be sufficiently polished to reflect light. The optical flat is placed on the surface to be tested. Sodium yellow light is the directed on to the flat surface through optical flat. The reflection observed is termed as 'Fringes'. The nature of surfaces viewed through optical flat are given below