ME 8501 - METROLOGY AND MEASUREMENT

UNIT - I - BASICS OF METROLOGY

PART-A

1. What do you mean by Sensitivity of a measuring Instruments?

* Sensitivity of an instrument is defined as the ratio to the magnitude of input signal. It denotes the smallest change in the measured variable to which the instrument responds.

$$\text{Sensitivity} = \frac{\text{Infinitesimal Change of output signal}}{\text{Infinitesimal Change of input signal}} = \frac{\Delta q_o}{\Delta q_i}$$

2. Define "Errors" and Explain the causes of Error with suitable Examples.

* The Error in the measurement is the difference between measured value and true value of measured dimensions.

* Error in measurement = Measured value - True value

Causes of Error: Error due to deflection
Error due to misalignments
Error due to contact pressure
Error due to poor contact
Error due to vibration.
Error due to dirt
Error due to wear in gauges
Error due to looseness.

7) What are the factors affecting the measuring system?

* Coefficient of thermal expansion
* Elastic properties of a materials
* Stability with time
* Calibration interval
* Geometric Compatibity.

8) What are the important Element of measurements?

* Reference
* Comparator
* Measurand.

9) Define Traceability.

The term traceability is used to refer to an unbroken chain of comparisons relating an instrument's measurements to a known standard.

10) What is systematic Errors?

Systematic Errors are Errors associated with a fault in the Equipment or in the design of the experiment.

11)

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Part -B

1) Elaborate on different Method of Measurement :-

(i) Direct or Primary Measurement :-

* The parameters to be measured is directly compared to a standard parameters with the help of calibration systems without any calculation.

* This methods are quite common for the measurement of physical quantities such as length, mass and time.

eg:- Scale, Vernier Calipers, Micrometer for linear measuremets etc.

(ii) Indirect Measurements :-

* The value of quantity to be measured is obtained by measuring other quantities which are functionally related to be the required value.

eg:- Measurement by Sine bar, Shaft power by dynamometer, measurement of discharge of fluid using Venturimeter etc.

(iii) Absolute or Fundamental Method :-

* It is based on the measurement of the base quantities used to define the quantity.

(eg) Measuring a quantity direct in accordance with the definition of the quantity to be measured.

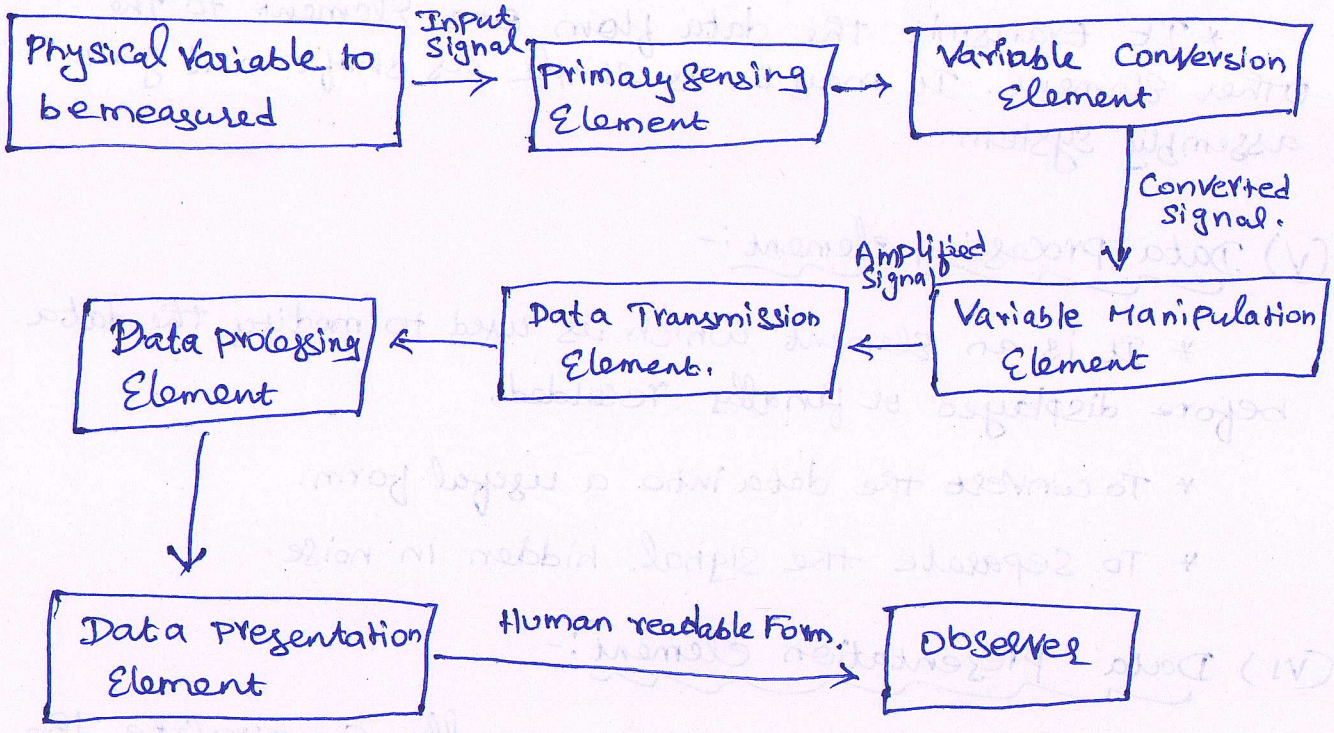
(iv) Comparative Method :-

* In this Method the value of the quantity to be measured is compared with known value of the same quantity or other quantity practically related unit. So, in this method only derivations from a mater gauge are determine.

(eg) dial indicator or other comparators.

2) Draw the block diagram of generalized measurement System and explain the different stages with examples.

* A number of measuring instruments is used in practice. Therefore, it is necessary identify the common features or basic Element of a generalized measuring System.



(i) Primary Sensing Element :-

* Element which receives input signal from the measured medium. It converts the input signal to a suitable form (Electrical, mechanical or other form).

(ii) Variable conversion Element :-

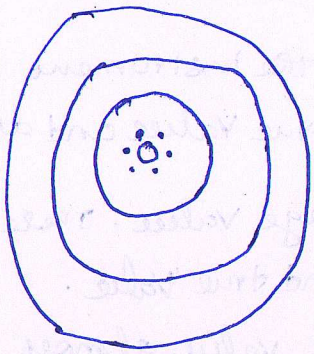
* It convert the output of the primary Sensing Element into a more suitable.

3) With a suitable example, Explain the difference between precision and Accuracy.

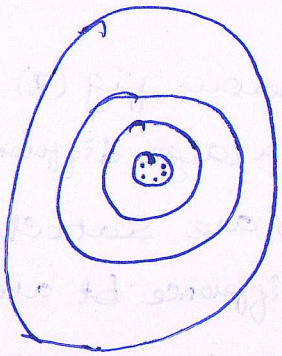
* precision is defined as the degree of Exactness for which an instrument is designed or intended to perform.

* Accuracy may be defined as the ability of an instrument to respond to a true value of a measured variable Under the reference condition.

* The difference between the concepts of Accuracy versus precision using a dartboard analogy that show four different scenarios that contrast these two terms.



High accuracy and High precision.
(a)



High accuracy and Poor precision.
(b)

* (a) Six darts hit the target center and are very close together which refers High Accuracy and high precision.

* (b) Six darts hit the target center but they are not very close together which refers high accuracy and low precision.

4) Distinguish between and give appropriate Example in each case (i) Respeatability (ii) Reproducibility :-

* Repeatability may be defined as the closeness of agreement among the number consecutive measurement of the output for the same value of input under the same operating conditions by the same operator with the same intrument.

* It is used to describe its ability to give the same output for the repeated application of the same input value.

* Reproducibility may be defined as the closeness of agreement among the repeated measurement of output for the same value of input under different conditions over a period of time by different operators / method / instrument.

* Both reproducibility and repeatability are the measure of the closeness with which a given input may be measured again and again.

Reproducibility may be defined by the following two terms:-

(i) Stability,

(ii) Constancy.

* Stability means reading of an instrument repeated on different occasions separated by interval of time which are long enough as compared to the time taken.

* Constancy means reading an instrument when a constant input is presented continuosly and conditions of tests vary within specified limits.

* There are many kinds of instromental Errors. they are:-

* Errors of a physical measure.
* Errors of a measuring mechanism
* Zero Errors.
* Calibration Errors
* complementary Errors.
* Errors of indication of a measuring instroments.
* Errors due to temperature.
* Errors due to friction
* Errors due to inertia.
* Loading Errors.

*(ii) Observation Errors:-

* Reading Errors:- It is due to incorrect reading of the indication by measuring instroment.

* Parallax errors:- Index at a certain distance from the surface of scale, the reading is not made in the direction of observation provided for the instrument used.

* Interpolation Errors:- Inexact evaluation of the positions of the index with regard to two adjacent graduation mark between which index is located.

(C) Environmental Errors:- Effect due to change in temperature, humidity, barometric pressure, humidity, dust, vibration or External magnetic (or) Electrosatic field.

6) Define "errors" and Explain the causes of those errors with suitable examples.

* It is never possible to measure the true value of a dimension. There are always error incurred in measurement.

* The errors in the measurement is the difference between measured value and true value of measured dimensions.

Errors in measurement = Measured Value − True Value.

*Absolute errors:- Absolute errors is the algebraic difference between the measured value and the true value of the quantity measured.

(a) True absolute errors:- The algebric difference between the measured average value and the conventional true value of the quantity measured.

(b) Apparent absolute Errors:- While taking series of measurement, the algebraic difference between one of the measured value of the series of measurement and arithmetic mean of all measured values as same series.

* Relative errors:-

* Relative errors occurs as the result of the absolute errors and value of comparison used for the calculation of the absolute errors. The comparison may be a true value or conventional true value.

Absolute errors = True Value − Measured value.

$$\text{Relative errors} = \frac{\text{Absolute errors}}{\text{Measured Value}}.$$

(e) Errors due to Vibrations:-

* Locating the Lab away from Source of Vibration.
* Keeping slipping cork, felt, rubber pad.
* Mounting the gauge pedestal.
* Putting a guage on a Surface plate resting in turn on a heavy plate.

(f) Errors due to dirt:-

* foreign matters such as dirt, chip are present between datum and workpiece Surface, the errors will be introduced in the reading taken.

(g) Errors due to wear:-

* Surface of the instrument occurs due to repeated use.

(h) Errors due to looseness:-

* Tested by Setting the gauge Contact on gauge anvil and Zeroing the meter and then apply finger Pressure or a light tab to location where looseness might noted the reading again.

7) Explain the classification of Various Standard:-

* Measurement Standard:-

* In a physical representation of unit of measurement A known accurate measure of Physical quantity is termed as Standard.

* Different Standard have been developed for various unit including fundamentals as well as derived unit.

* All these Standard are present at the International Bureau of weight and measures of Sevres.

UNIT-2

LINEAR AND ANGULAR MEASUREMENTS

Part-A

1) What are the various types of linear measuring Instruments?

* Vernier Caliper
* Micrometer.
* Slip gauge (or) Gauge blocks
* Comparator.

2) What are precautions to be carried while using Vernier calipers?

* The jaws should not be used as a wrench or hammer because the Vernier Caliper is not a rugged instruments.
* These instruments should also be kept in a box and it should not be suddenly dropped and turned up and down.
* During measurement, the Vernier Caliper should not be used with oil, grit and chips in part to be measured.
* One hand of the operator should be placed on the stationary jaw and the other hand for supporting the movable jaw while measuring.

3) What is the use of Thread Micrometers?

* The Thread Micrometer is used to measure thread pitch diameter within a certain range of thread pitches. Any given micrometer is required to measure the range of thread of different pitches.

8) What are the types of limit gauges based on the Element to be checked?

* Hole gauge:- It is used to check the dimensions of the hole present in the Elements.

* Shaft gauge:- It is used to check the dimensions of the shafts.

* Taper gauge:- It is used to check the dimensions of the tapers.

* Thread gauge:- It is used to check the dimensions of the threading Element.

9) Define Tolerance and Zero line.

* Tolerance is the amount of Variation Permitted to a basic size or the difference between maximum and Minimum limits of size.

* The line at which the Measurement are done is Zero line. It is simply a reference line for the Measurement.

10) Write Short Notes on interchangeability:-

* A Part which can be substituted for the Component Manufactured to the same shapes and dimensions is known as an interchangeable part. The operation of substituting the part for the similar Manufactured components of the same shape and dimensions is known as interchangeability.

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PART – B

1) What is a Comparator? Discuss the different type
2) of Comparators and its applications.

* Comparators are one form of linear measurement devices which are quick and more convenient for checking the large number of identical dimensions.

* Comparators normally will not show the actual dimensions of the workpiece.

The Comparators are classified according to the Principle used for obtaining the range of magnification.

(a) Mechanical Comparators :-

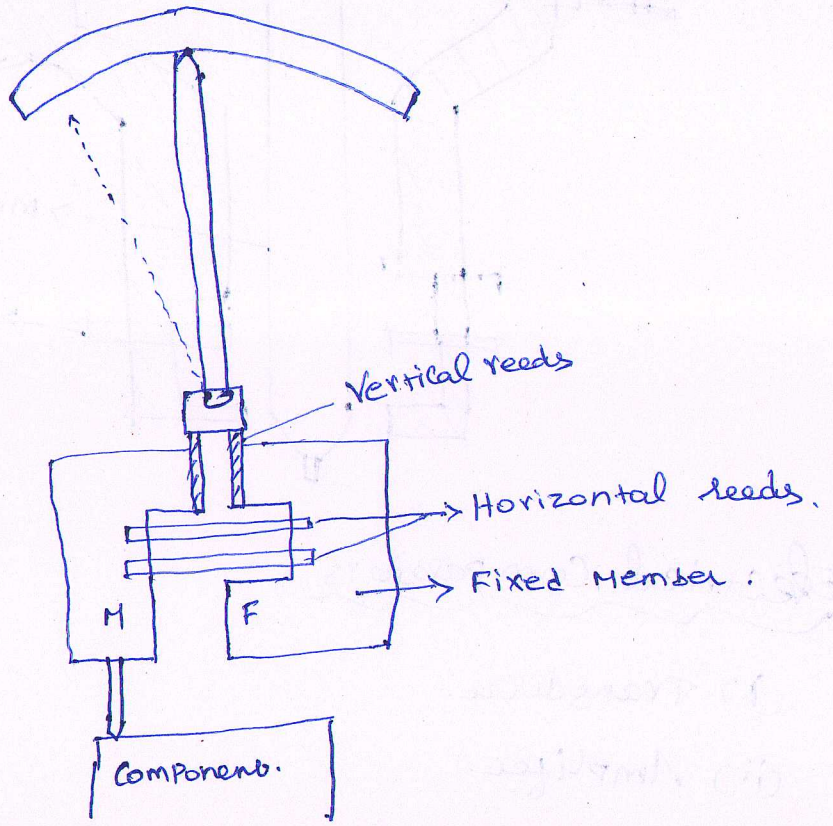
A Mechanical comparator employs mechanical means for magnifying small deviation.

(i) Dial Indicators type comparators :-

* The Instrument is a small dial with a plunger projecting at the bottom as shown in fig.

* A very slight upward movement of the Plunger moves its upward and the movement indicated by the dial Pointer.

* The dial is graduated into 100 divisions. A full revolution of the Pointer about this scale corresponds to 1mm travel of the plunger.

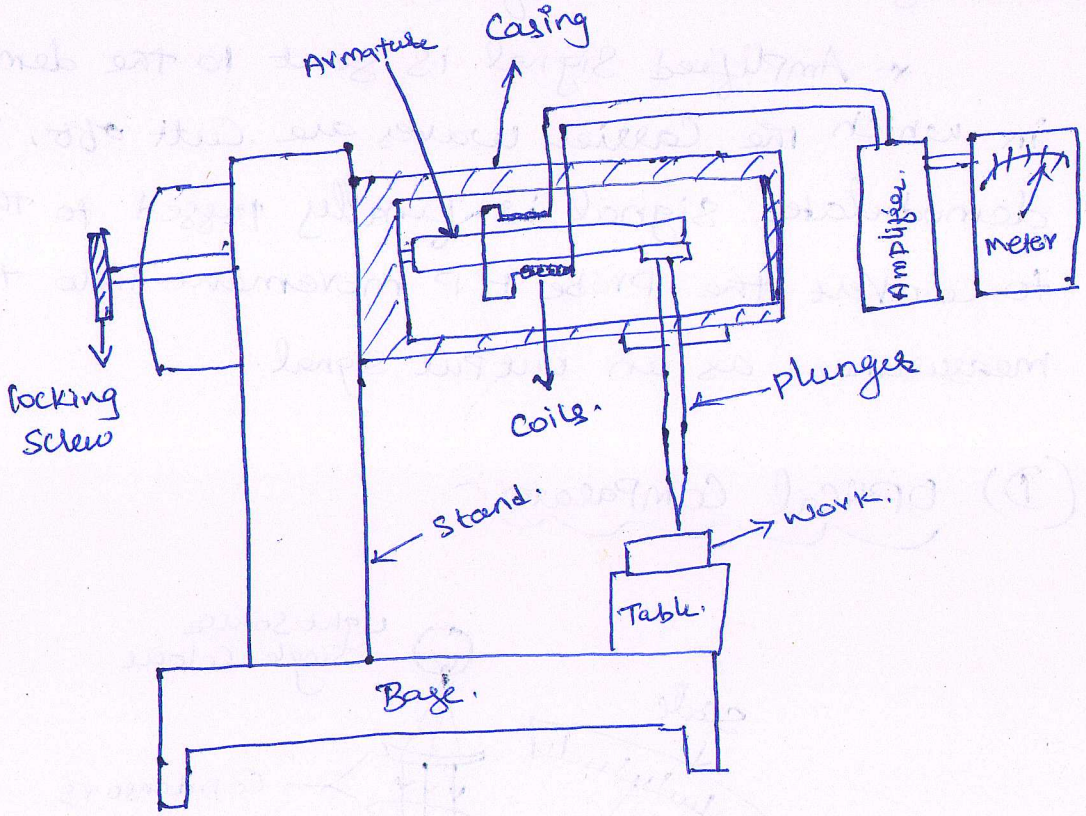


(iii) Johansson Mikrokator Comparators :-

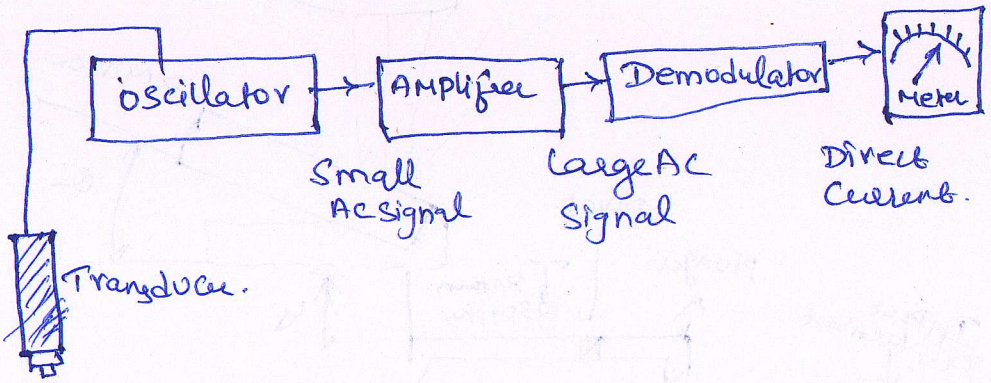
* It is used to obtain a mechanical magnification of the difference in length as compared to a standard length.

* It works on the principle of a button spinning on a loop of string. A twisted thin metal strip holds a pointer which shows the reading on a suitable scale.

* Since there is no friction involved in the transfer of movement from the strip to the pointer, it is free from backlash.



(C) Electronic Comparator:-



* The work to be measured is placed under the plunger of the electronic comparator. Both work and comparator are made to rest on the surface plate.

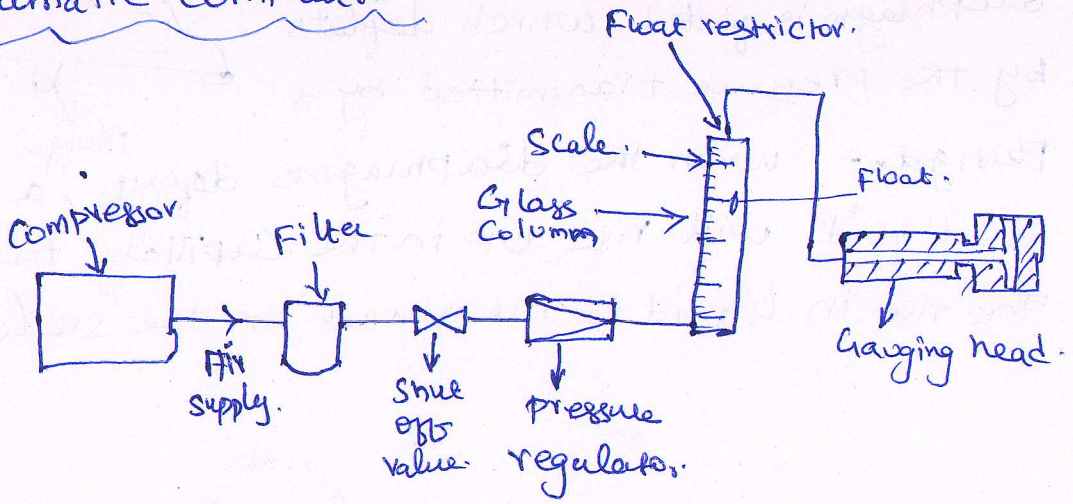
* The linear movement of the ~~plate~~ plunger is converted into Electrical signal by a suitable transducer.

* The vertical displacement of the plunger is magnified by the ration of the level arm. The level tilts the mirror about its hinge to again magnify.

* The light rays from the lamp are condensed by a condensing lens. Then the condensed light falls on objective lens. Here the light ray are converted into parallel beam.

* Parallel beam of light ray fall on the mirror. This mirror reflects the light rays on a screen. The image of the work placed on the table will be reflected. This type of comparator can also be used for inspecting small parts such as screw teeth, cutting tool, needles, cam etc.

(e) Pneumatic Comparator:-



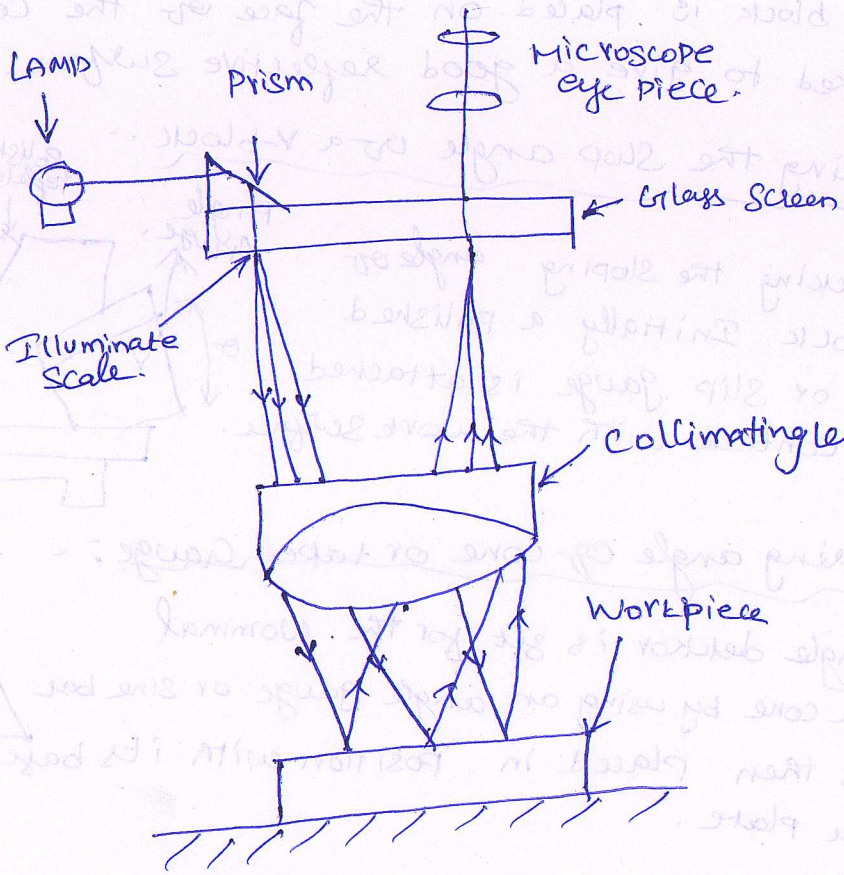
(Flow or Velocity type)

Q) Explain the working principle of Angle Dekkor with a neat sketch. Also write the application of Angle Dekkor.

* It is also a type of autocollimator. In this system, there is an illuminated scale in the focal plane of the collimating lens outside the field of view of a microscope eyepiece.

* Projected as a parallel beam by the collimating lens and it strikes a plane reflector below the instrument,

* It is reflected and refocused by the lens so that its image is in the field of view of the eyepiece. In the field of view of the microscope, there is another datum scale fixed across the center of a screen.



Angle dekkor

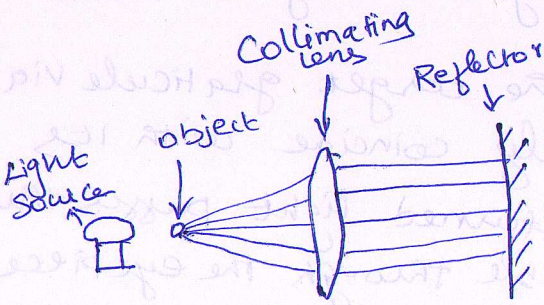
5) Explain with the help of neat sketches, the Principle and Construction of an auto collimator.

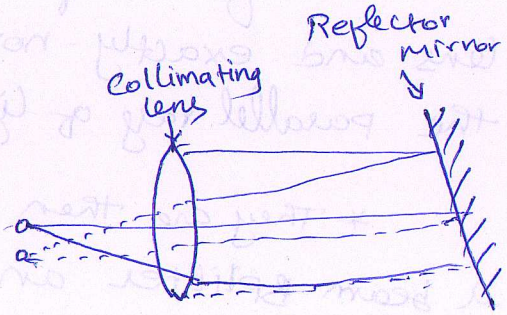
* Autocollimator is an optical instrument used for the measurement of small angular difference, change of deflection, plane surface inspection etc.

* It is essentially an infinity telescope and a collimator is combined into one instrument. It is alignment, detection of angular movement, verification of angle standard and angular monitoring over a long period.

Principle :-

If a point source of light is placed at the prime focus of a collimating lens, it will be projected as a parallel beam of light. When this beam is made to strike a plane reflector and kept normal to the optical axis, it is reflected back along its own path and it is brought to the same focus.





Working of Auto-collimator :-

* Micrometer Microscope
* Lighting unit,
* Collimating lens.

6) Why are Sine bar not used for measuring larger angles?

* The sine bar inherently become increasingly impractical and inaccurate as the angle exceeds 45° because of following reason.

* The Sine bar is physically clumsy to hold in position.

* The body of the sine bar obstructs the gauge block stack even if relieved.

* Slight errors of the sine bar cause large angular errors.

* Long gauge stacks are not nearly as accurate as shorter gauge block.

* A difference deformation occurs at the point of roller contact to the support surface and to the gauge blocks because at higher angles, the weight load is shifted more toward the fulcrum roller.

* The size of gauge, instrument or part that a sine bar can inspect is limited since it is not designed to support large or heavy objects.

7) Write notes on 'interchangeability':-

*A part which can be substituted for the component manufactured to the same shape dimensions is known as an interchangeable part. When one component assembles properly with any mating component, both chosen at random, then it is known as inter-changeability.

* The Interchangeable parts manufactured by any company or industry at any corner of the world can be interchangeable.

* In an 'interchangeable system, every operator is concerned only with a limited portion of overall work. He can easily specialise himself in that work and give the best results leading to superior quality.

* He does not require to waste his skill in fitting the components by hit and trial and assembly time is reduced considerably.

(a) Universal or full or complete Interchangeability:-

* under full interchangeability the part which go into an assembly may be selected randomly from a large number of parts.

* In this type of interchangeability any component will mat with any other mating components without doing any minor alteration to mat them.