Modified

CBCS SCHEME

USN | | | | | | | | | | |

17ME46B/17MEB406

Fourth Semester B.E. Degree Examination, June/July 2019
Mechanical Measurements and Metrology

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. What is Metrology? What are the objectives of metrology? **(07 Marks)**
b. Explain Subdivision of Standards. **(08 Marks)**
c. Define Wavelength Standard. What are the advantages of wavelength standard? **(05 Marks)**

OR

2 a. Explain the Wringing Phenomena of Slip gauges. **(05 Marks)**
b. With a neat sketch, explain the working of Sine bar and mention its limitations. **(08 Marks)**
c. With a neat sketch, explain the working of Auto collimator. **(07 Marks)**

Module-2

3 a. Explain the principle of Interchangeability and Selective assembly. **(08 Marks)**
b. With neat sketches, explain different types fit. **(07 Marks)**
c. State and explain Taylor's principle of gauge design. **(05 Marks)**

OR

4 a. Define Comparator. What is the need of a comparator? **(05 Marks)**
b. With a neat sketch, explain Dial Indicator. What are the advantages? **(07 Marks)**
c. Sketch and explain the working of LVDT. **(08 Marks)**

Module-3

5 a. With a neat sketch, explain screw thread terminology. **(06 Marks)**
b. Derive an expression for Best wire size for screw thread measurement. **(07 Marks)**
c. With a neat sketch, explain the working of Tools maker's microscope. **(07 Marks)**

OR

6 a. With a neat sketch, explain Gear teeth terminology. **(06 Marks)**
b. With neat sketch, explain the working of laser interferometer. **(07 Marks)**
c. With a neat sketch, explain the working of co-ordinate measuring machine. **(07 Marks)**

Module-4

7 a. Explain Generalized measurement system, with block diagram. **(07 Marks)**
b. Define : i) Accuracy ii) Threshold iii) Calibration iv) Hysteresis v) Error. **(05 Marks)**
c. What is Transducer? Sketch and explain the principle of Electronic Transducer. What are the advantages of Electronic transducers? **(08 Marks)**

OR

8 a. With a circuit diagram, explain Ballast circuit. **(08 Marks)**
b. With a block diagram, explain Telemetring system. **(06 Marks)**
c. With a neat sketch, explain stylus type Oscillography. **(06 Marks)**

Module-5

9 a. With a neat sketch, explain working of Prony brake dynamometer. What are its limitations? **(10 Marks)**

b. With a neat sketch, explain McLeod gauge. **(10 Marks)**

OR

10 a. Define Strain gauge. With a neat sketch, explain wheat stone bridge circuit. **(10 Marks)**

b. Define Thermocouple. State the law's of thermocouple and explain. **(06 Marks)**

c. Write a note on :

i) Thermo couple materials ii) Advantages and disadvantages of thermocouples . **(04 Marks)**

* * * * *

2b.

B.E. Degree Examination June/July 2019

SUB → Mechanical measurements and Metrology (17ME46B/36B)

Scheme and solution

1.a. What is metrology? what are objectives of metrology? 7M

1M

Ans 1.a.

Metrology is science of Measurement

Objectives of metrology 6M (min 5 pts)

- To provide the required accuracy at minimum cost
- Through evaluation of newly developed products & to ensure that components are within specified dimensions
- To determine process capabilities
- To reduce cost of inspection.
- TO reduce cost of rejection & rework by applying statistical quality control techniques.
- To asess the measuring instrument capabilities.

1b. Explain subdivision standards.

Ans:- i. Primary standards: For precise definition of unit. Imperial standard yard or International prototype me it is essential that should be one & only one material

ii. Secondary standard: These are close copies of primar Standards with respect to design, material & length these are made, as far as possible exactly similar to primary standard.

An error existing in these standards is recorded by comparison with primary standard after long intervals.

iii. Tertiary standard: The primary or secondary standard exist as the ultimate controls for reference at labora. Internal tertiary standards are reference Standards employed by NPL

iv. Working standard: These standards are similar in design to primary, secondary & tertiary standards but being less in cost & are made of low grade materials

2b.

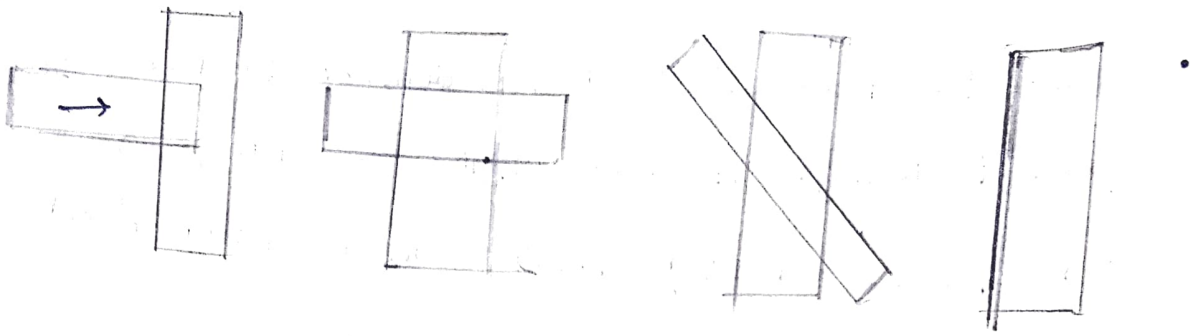
1c. Define wavelength standard. what are Advantages of OSM wavelength standard?

- wavelength standards of meter defined as meter as equal to 1650763.73 wavelengths of orange radiations of krypton-86 isotope in vacuum maintained at 63K. -1M -1M
- Advantages stas wavelength standard
  - → length does not change
  - → It can be reproduced easily if destroyed
  - → This primary unit can be accessible to any physical laboratory
  - → wavelength can be reproduced easily.

2a.

2a. Explain the wringing phenomena of slip gauges 05M

Ans→ 1m



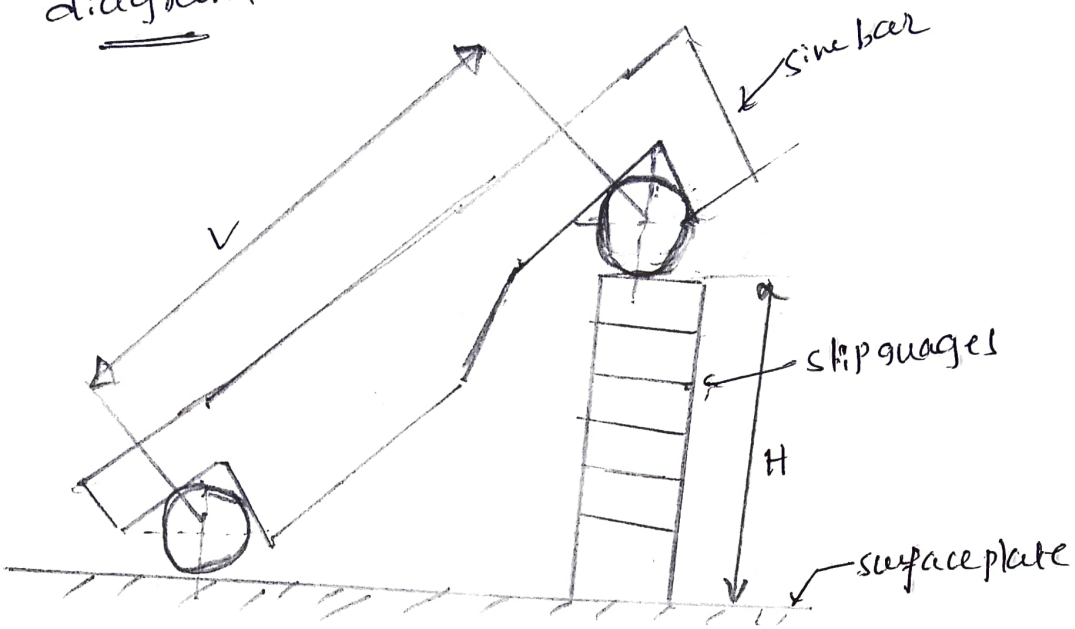
4M

→ procen of wringing

1. Wiping a clean guage block across an oiled pad.
2. Wiping any extra oil off the guge block using dry pad.
3. The block is then slid flat across the other block while applying moderate pressure until they form a cruciform
4. The phenomenon of wringing occurs due to molecular adhesion between liquid film.
5. Finally, the block is rotated until it is fully with the other block.

Total (7M)

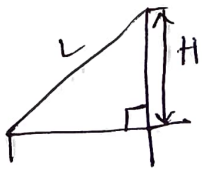
diagram → (2M)



Working principle operation

- The principle of operation of sine bar is based on the trignometry
- one of the rollers of sine bar is placed on the surface plate and the combination of slip guages is inserted under second roller for setting given angle
- If 'H' is the height of combination of slip guages & L is the distance bet the rollers

$$\sin\theta = \frac{H}{L}$$



(3M)

- as measured angle is function of sine, this device known as sine bar

Ver.

Ver. BNo. 5

(4M)

2b. Limitations of sine bar — 2M

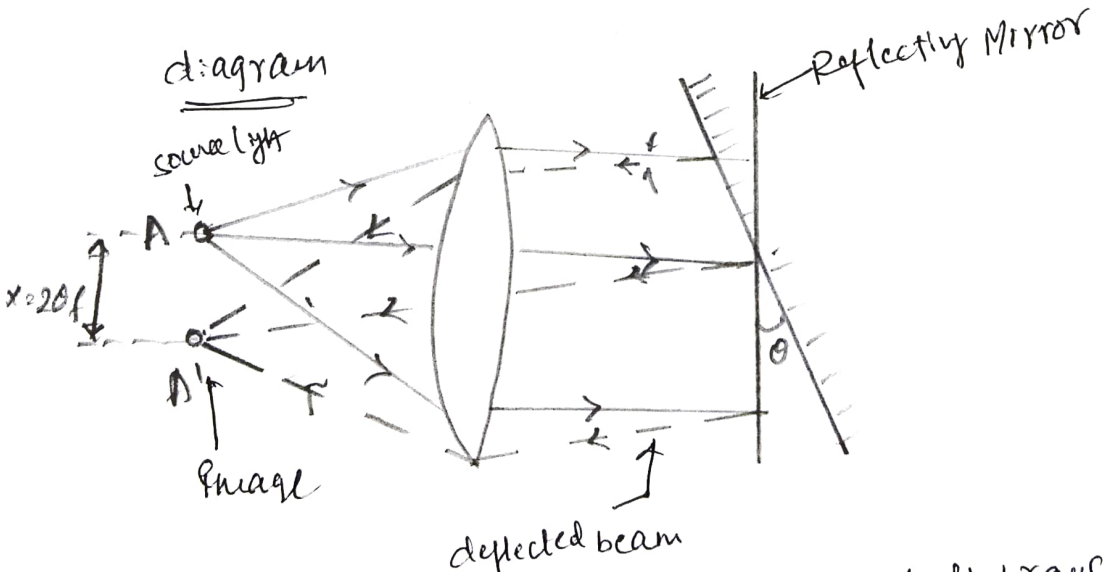
- Value of error increases for angle measurement more than 45°
- difficult to operate with combination of slipguage
- Fixed length between the cylinders limit the application of sine bar.

2c. (Total 7M)

Principle of working of Autocollimator

- Basically auto collimator is telescope used for collimating other instrument.
- collimating lens used to convert light rays into paiallel beam of ligth.

diagram



- A collimating lens is used to convert the light rays in to parallel beam of light
- let A be the point source of light placed at the principle focus of a collimating lens

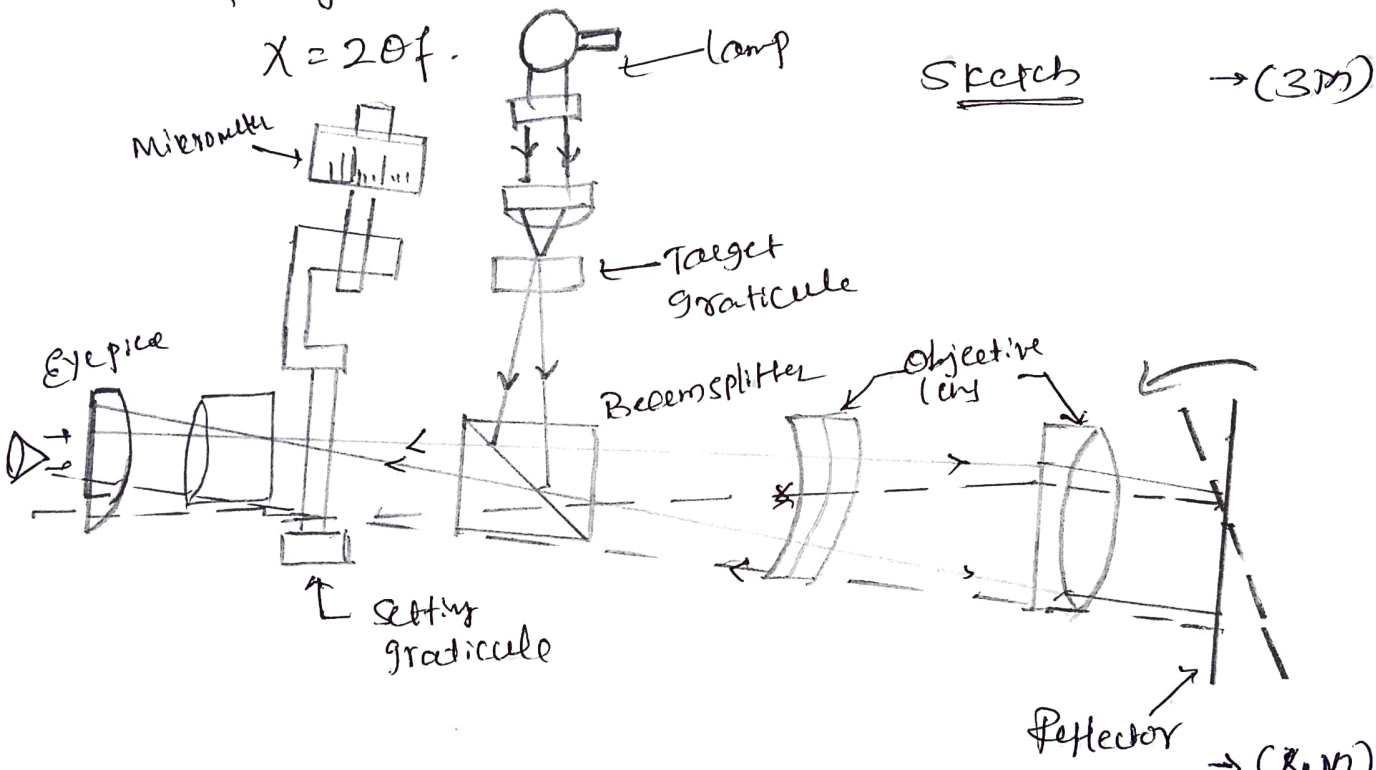
Page No. 6

2c. The light rays when incident on collimating lens it travels parallel to the lens

- After striking the reflecting mirror, the rays are reflected back along the same path & again concentrate at source point A.
- If the reflecting mirror is tilted an angle θ then the reflected ray from it will concentrate at same point A' & rays will deflected through angle 2θ.

$X = 2\theta f$.

Sketch → (3M)



→ (2+1M)

→ Above diagram shows arrangement of autocollimator It consist of three main parts viz, micrometer, light unit & collimating lens

→ A target graticule situated at one side of instrument on axis of right angle to main axis

→ A 45° transparent beam splitter reflects the light from graticule towards the reflector

→ The rays are reflected back & get focussed in eye piece of Microscope

Ref. Pg.No-7

3a. Explain the principle of interchangeability & selective assembly 8M

4M

Ans:→ Interchangeability assembly:

→ Interchangeability occurs when one part in an assembly can be substituted for a similar part which has been made to the same drawing

→ suppose are 100 parts with hole & 100 parts of shaft which have to fit into any holes

→ If there is interchangeability then any one of the 100 shaft should fit into any of holes & their required kind of fit can be obtained.

→ Interchangeability is possible only when certain standard are strictly followed.

Selective Assembly: 4M

→ Selective assembly the parts are graded according to the size & only matched grades of mating parts are assembled.

4b cont/-

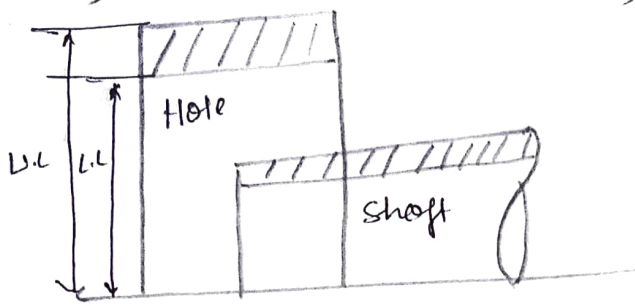
Working of sigma comparator (4M)

3b. Types of fit (Total 7M)

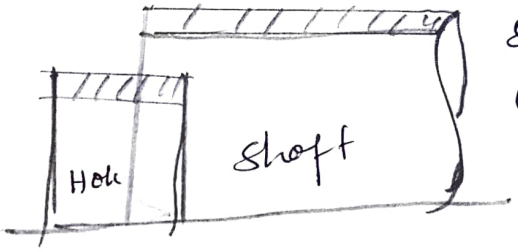
i) clearance fit ii) interference fit iii) transition fit.

→ (3M)

i)



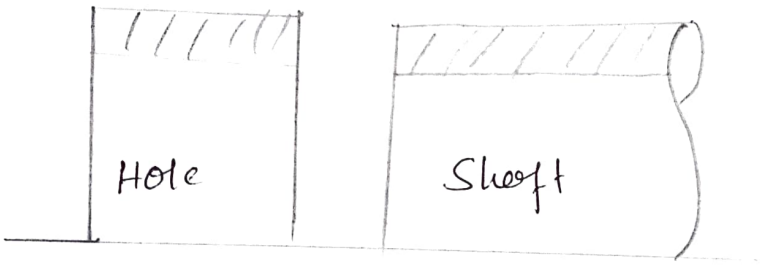
ii)



Each fit (2M)

(2+2+3=7 M)

iii)



i) clearance fit → dimensions of shaft is less than dimension of Hole specimen

ii) interference fit: Dimension of shaft is greater than the dimensions of the Hole component.

iii) Transition fit: Dimension of hole and shaft almost equal or largest hole diameter greater than the smallest diameter of hole, but smallest dia of hole is smaller than largest diameter of the shaft.

→ This technique is most suitable where close fit of two component assembles are required.

→ This results in complete protection against non-confor-ming assemblies & reduces machining costs, since close tolerance can be maintained.

→ The selective assembly, however enables such tolerances to be achieved without actually being produced.

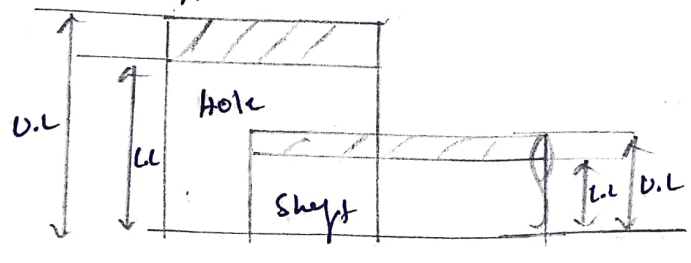
3C. State & explain Taylor's principle of gauge design 05M

Ans→: States that Go and No-Go guages should be designed to check maxm & minm material limit. 1M

-4M

Go-limit: corresponds to maxm material limit considerations i.e upper limit of shaft & lower limit of hole. The form of Go guage should be such that it can check on feature of component in one pass.

No-Go limit: This designition is applied to that limit of size which corresponds to minm material condn. i.e lower limit of shaft and upper limit of Hole.



4a. Total (05M)

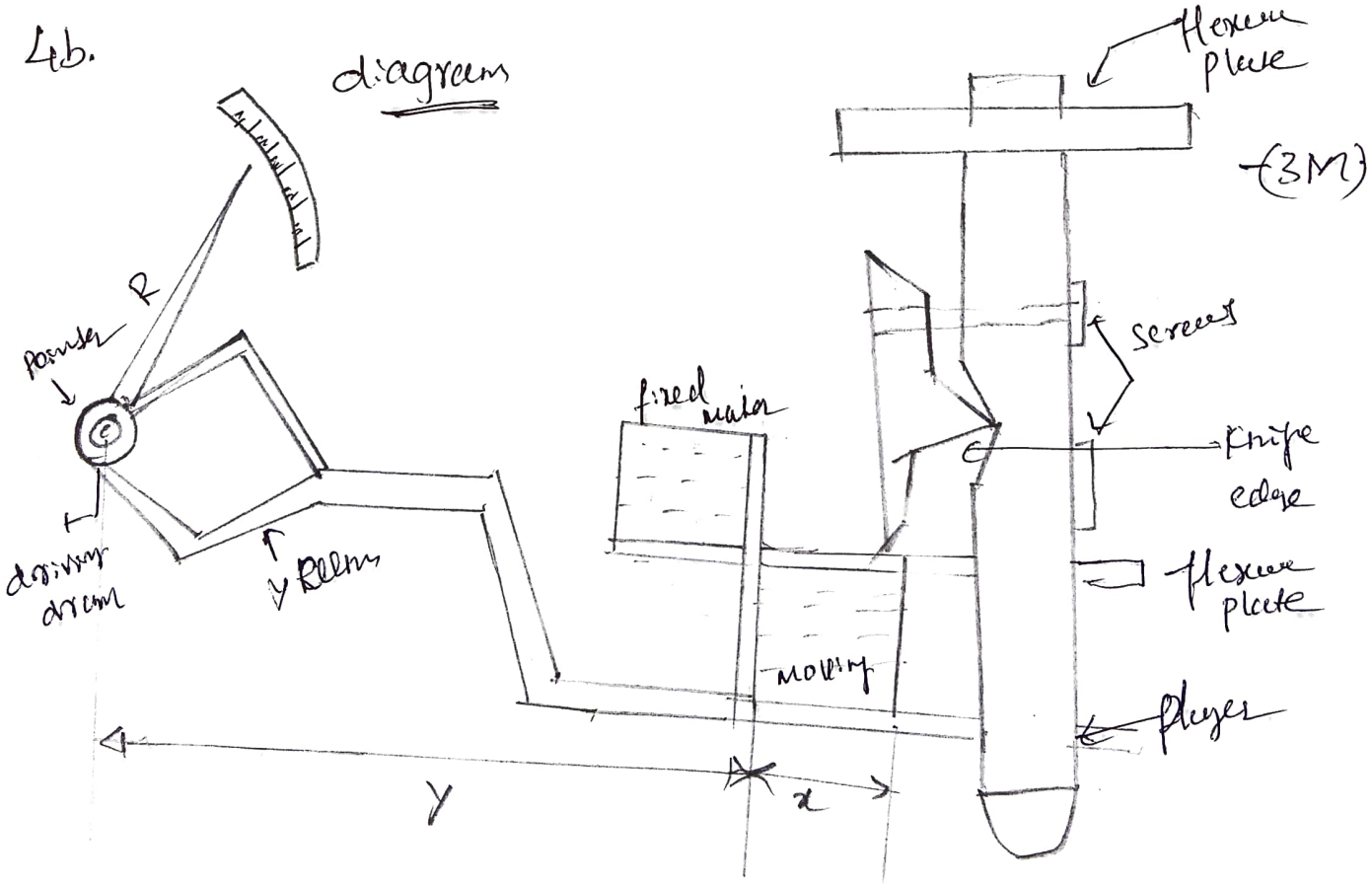
Comparator is a precision type of instrument which enables a comparision between the part being measured & length standard. (2M)

→ (3M)

Need of comparator

- In mass production it is important to manufacture component to close dimensional tolerances
- In case of vernier micrometer for accurate results require high degree of skill & need more time.
- Reduce require time once can use comparator.
- Reduce Rejections & Rework in production.

4b. diagram



P.T.O

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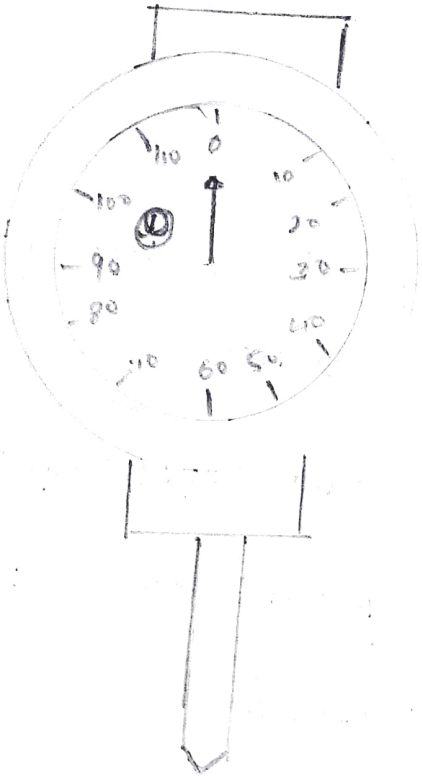
4b. With neat sketch, Explain dial indicator. what are advantages? 07M



02M

-3M

It is most commonly used mechanical comparator

- Dial indicator also known as dial gauges & probe indicators are instruments used to accurately measure small linear distances
- Dial indicator consist of a robust base whose surface is perfectly flat and a pillar carrying a bracket in which encorporated a spindle fitted with a pinion & dial scale
- The linear movement of plunger is magnified by means of racks & pinion train into sizable rotation of pointer on to dial scale.
- The dial scale is set to zero by the use of slip guages

- representing the basic size of the part. This generally used for inspection of small precision machined parts.

Advantages

- Mechanical comparator cheaper when compared to other amplifying devices
- Mechanical comparator do not require external sources
- Usually the comparators have linear scale
- Robust & easy to handle.

cont/-

4c. Working of LVDT (4M)

- It consist of three symmetrical spaced coils wound insulated bobbin. A primary coil is wound on bobbin & two identical secondary coils are wound on bobbin on symmetry distance of primary
- An core is centrally placed at the middle pos^n of two secondary coils voltage is introduced in each secondary coil will be same & opposite zero.
- when core moves on left or right side two voltages Secondary coils S_1 & S_2 there is change emf.
- the differential voltage appears across secondary is series which is further calibrated in terms of linear movement of core.

Module-3

(Total (6M))

5a. i) **pitch** - It is distance measured parallel (2M) to the axis of screw from point on on thread to corresponding point on adjacent thread

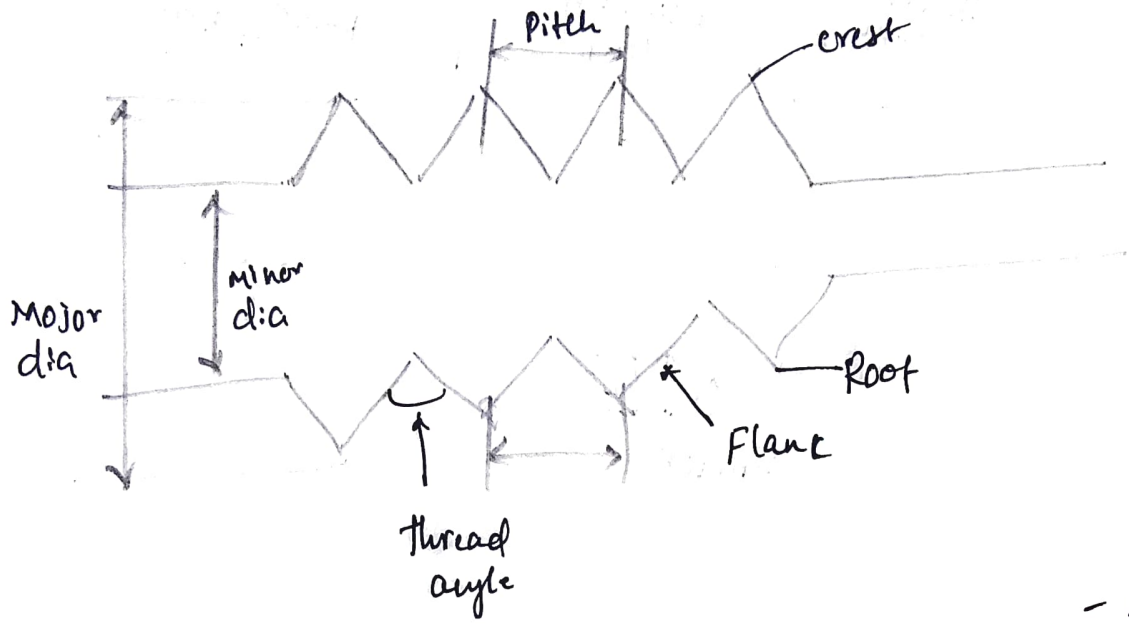
ii) **lead**: It is distance measure ||el axis screw (2M) which the nut u advance in one revolution of the screw.

iii) **Crest of the thread**: which joins the two sides (2M) of external screw thread.

5a. With Neat sketch, Explain ~~Gear~~ Screw thread terminology 6M

Ans:-

- 2M

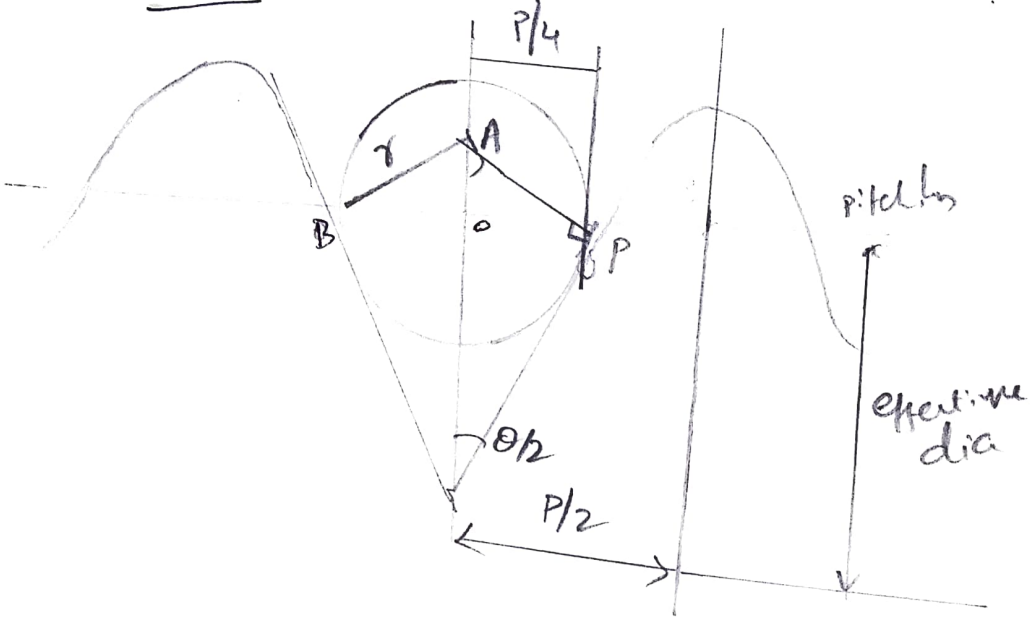


- 4M

- Major diameter: It is diameter of major cylinder
- Minor diameter: It is diameter of minor cylinder co-axial with screw touch root of the external thread.
- pitch → Distance betn consecutive crest or root
- crest → crest is prominent part of thread which joins the two sides of External thread.
- → lead → It is angle made by the helix of thread with plane ⊥ar to axis of screw
- → Thread angle: It is angle betn flanks of thread measured in axial plane.

Ref.

5b. diagram (FOR = 7M)



(3M)

Best wire size is the one which makes contact at the pitch line or effective diameter of the screw thread. In other words, as shown in fig OB is ⊥lr to plane portion of the thread. (4M)

from A'le OAB $\sin B\hat{O}A = \frac{AB}{OB}$

$\sin(90-\theta/2) = AB/OB$, $OB = \frac{AB}{\sin(90-\theta/2)}$

$OB = \frac{AB}{\cos\theta/2} = AB \sec\theta/2$

But OB = radius of wire = 1/2 x dia of best wire

$D_b = 2 \times OB = 2 \times AB \sec\theta/2$

$AB = P/4$

$\therefore D_b = 2 P/4 \sec\theta/2$

$\Rightarrow \frac{P}{2}\sec\theta/2$

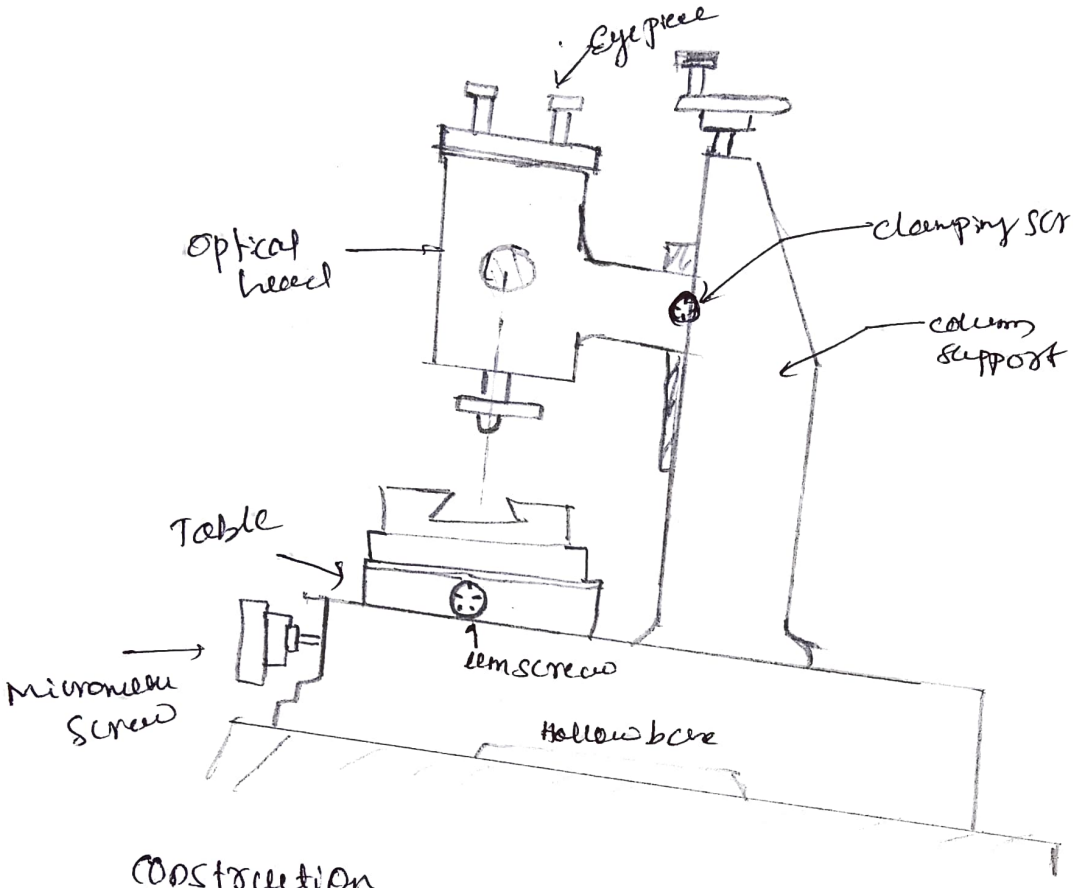
14

Pg. No-16

5C.

Tool makers microscope

Total (7M)



(3M)

Construction

(4M)

→ It consist of heavy hollow base for accommodating the illuminating unit. The table mounted on the base & it is equipped with micrometer screws to move it in mutually ⊥ directions in horizontal plane.

→ This table can be rotated through 360° & angular rotation can be read on fixed vernier scale

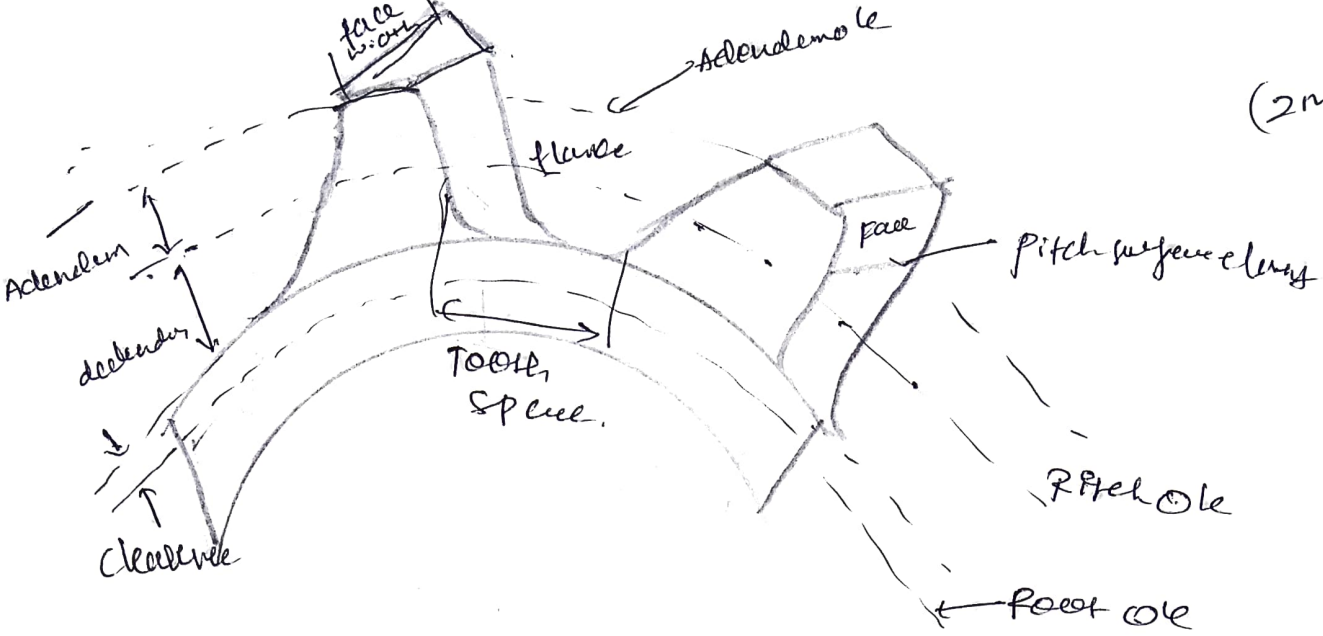
Working: Component is mounted on glass plate kept on table

- A light beam passes through condenser glass plate & shadow image of workpiece passed through objective of optical head.
- By tilting measuring head, the dirn of light source can be tilted with respect to work piece
- Measurement purpose, the cross-lines marked on glass screen It rotated through 360° & angle measured.

Pg.no-15

6 Q.

(2M)



Terminology of gear

(4M)
(4 points)

1. Pitch Circle : Imaginary circle on gear which by pure rolling action would produce the same motion as actual gear

2. Module : It is ratio of PCD to No. of gear teeth

$$M = \frac{\text{PCD of gear}}{\text{No. of teeth gear}}$$

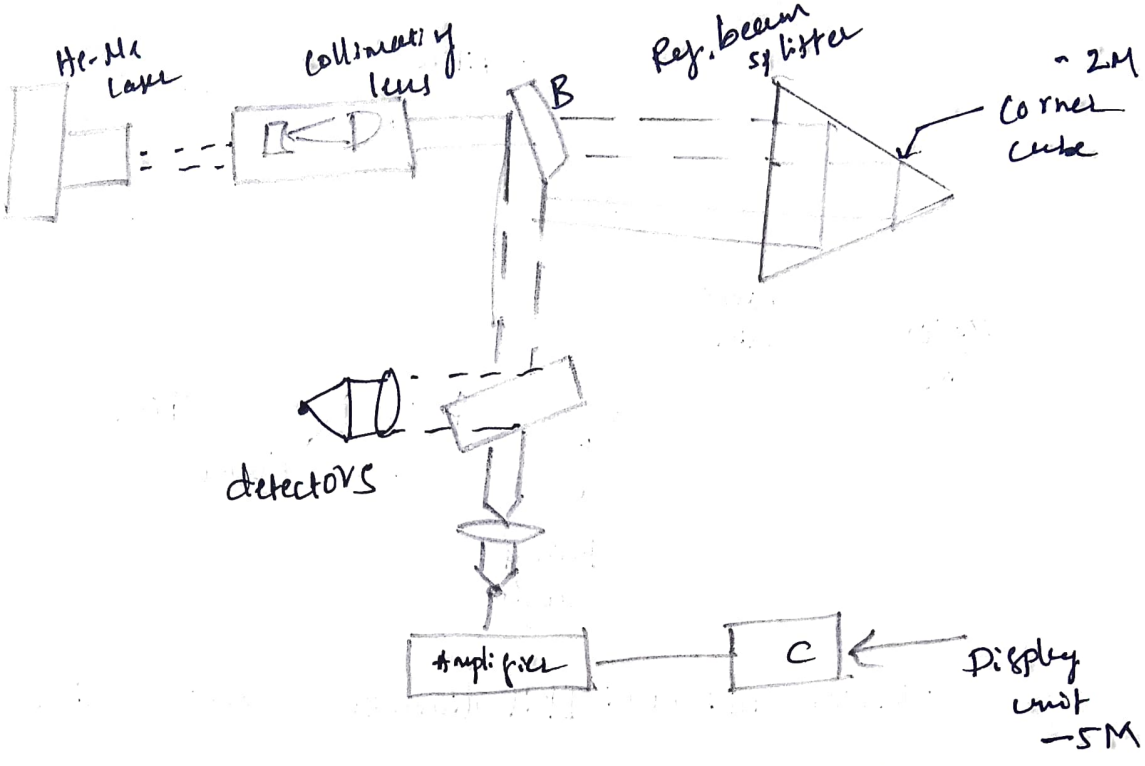
3. Circular pitch : It is measure along the circumference of the pitch circle from point on one tooth to corresponding to next tooth.

4. Addendum : It is radial distance of gear tooth from pitch circle to top of the gear tooth.

5. Dedendum : It is radial distance of gear tooth from the pitch circle to the bottom of the gear tooth.

6. Flank of tooth : It is part of the tooth surface which below the pitch surface.

6b. With Neat Sketch, Explain Laser interferometer 7M



- The measuring capacity of interferometers with lamp as source of light is limited due to size of the lamp. It is difficult to maintain the sharpness of interference fringes beyond certain distance
- TO overcome this drawback of lamp interferometers, lasers can be used as source of light.
- With this laser arrangement, it is possible to perform measurements over longer distance because it is possible to maintain the quality of interference fringe.
- laser generates by continous train of light waves which results in to high coherence compared with light emitted by the lamp.

6 C. 07M

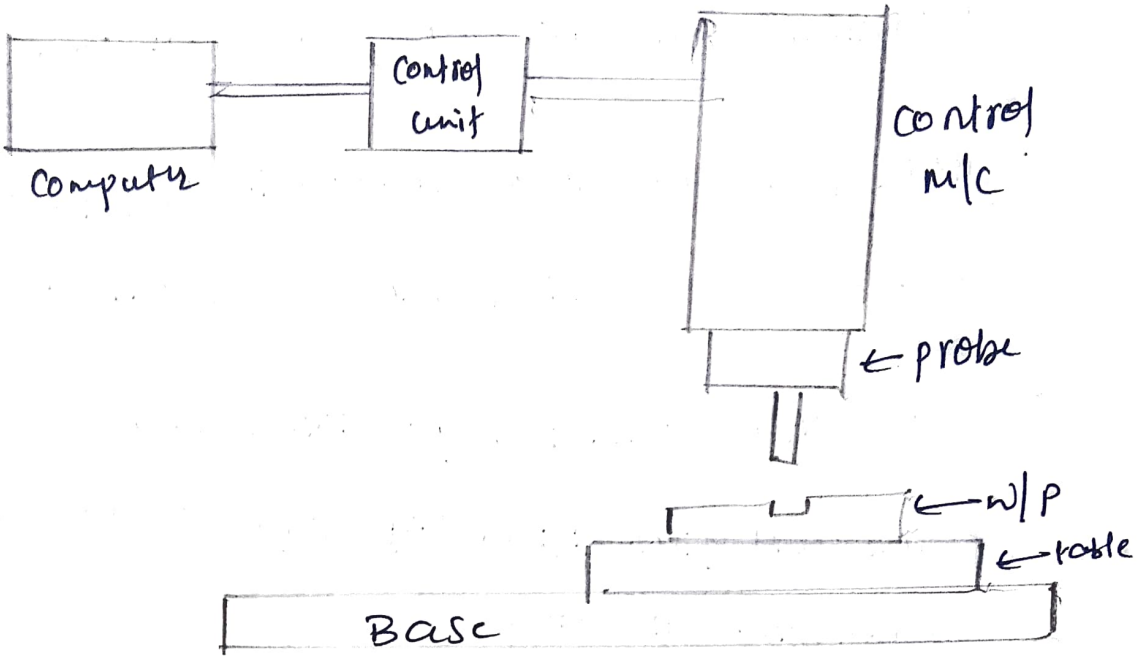
Co-ordinate measuring machine diagram 2M

5M

- CMM have precise movements in x, y & z co-ordinates which can be easily measured & controlled
- Each slide consist of precision linear measurement transducers gives digital display & also senses positive or negative directions
- These m/c are manufactured in both manual & computer controlled models & available in wide ranges of sizes
- The measuring head of CMM consist of probe tip which can be different types like ball tip taper tip
- To measure the distance bet two holes the workpiece is mounted on table & aligned mutually [ten x, y, z measuring slides.
- In special CMM, the m/c can measure various features of parts having shapes like cones, & cylinders.

Ans

6.C. Sketch of CMM 2m



Module-4

7a (Total 6M)

i) Accuracy: The accuracy of an instrument indicates the deviation of the reading from known input (1M) each any

ii) precision: measures reproducibility of instrument given fixed value of quantity or degree of exactness for which instrument intended to perform

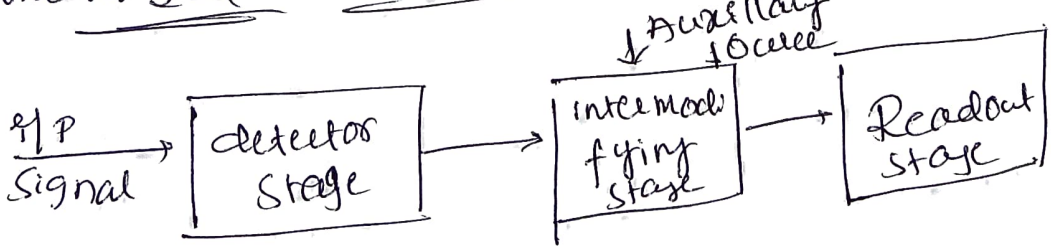
iii) loading effect: The incapability of system to faithfully measure the i/p signal is undistorted from is called loading effect

iv) Calibration: Ability to measure reliably for that procedures is adopted is called calibration.

v) Error: difference b/t measured value & true value

vi) Repeatability: is defined as ability of instrument to reproduce a group of measurement of same measured quantity under same conditions.

7b Generalized measurement system (Total (8M))



(2M)

Page no 19

Contd-

7b. (4M)

Stage 1: detector stage

The important function of the first stage is to detect or sense input signal.

Stage 2: Intermodifying stage.

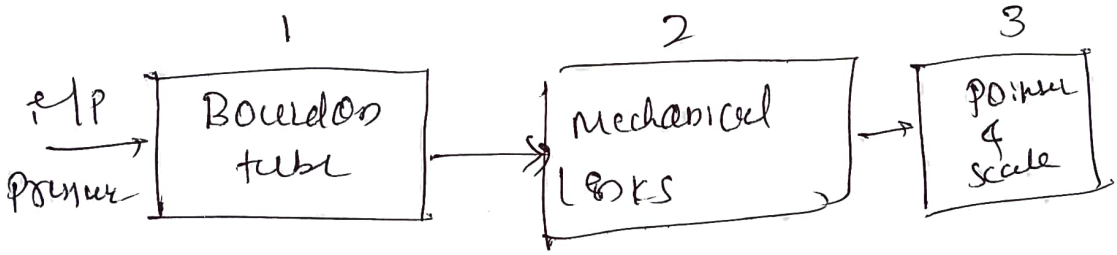
The purpose of second stage of generalized measurement system is to modify the transduced information so that it is acceptable to the last stage

Stage 3: Terminating stage

It provides the information required in a form which can be understood by human sense

Ex → Bourdon tube

(2M)



7c (6M)

Significance of measurement system

- Measurement provides fundamental for R&D
- development is final stage of design procedure involve measurement of values quantities to performing to operation.
- Measurement also fundmental element to any controlproces which measured discrepancy bet actual & desired.
- Many operations require measurement for proper performance

Pg no 20

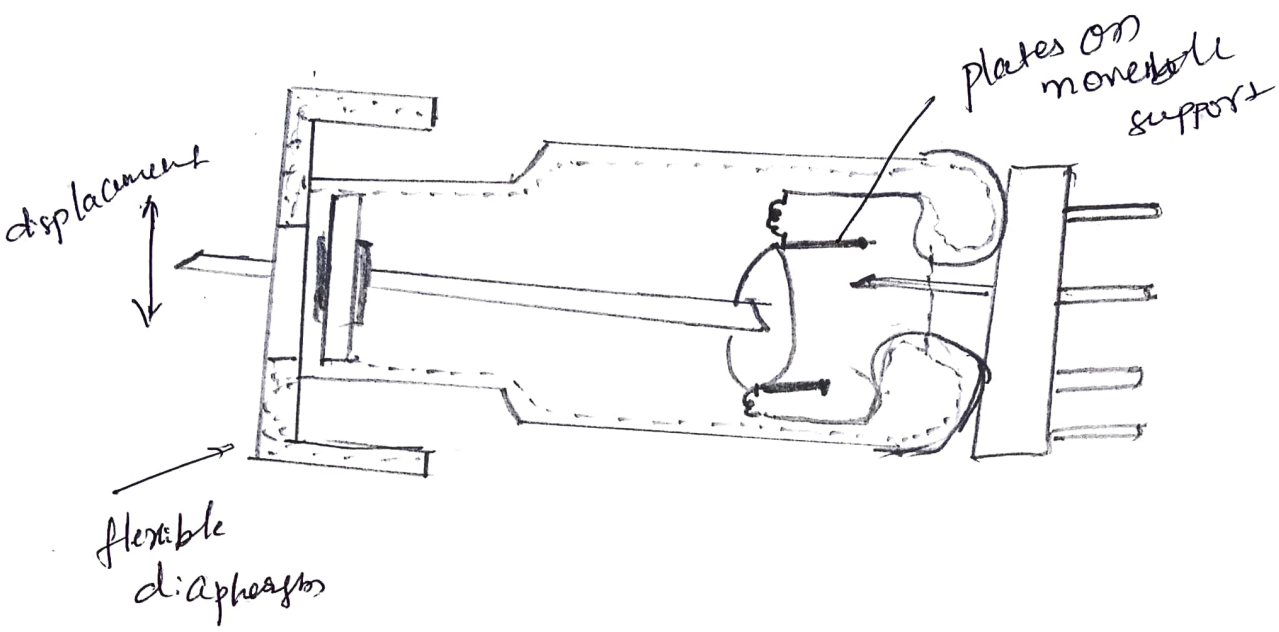
(8M)

Q7.

7c. 2019 Transducer is device which transforms one form of energy into another form -(1M)

Electronic transducer

(2M)



(4M)

→ The schematic diagram of an electronic transducer element which is basically an electronic tube in which one of the element's cell movable

→ Here, plates are mounted on an arm which extends through a flexible diaphragm in the end of tube.

→ Mechanical movement applied to external end of the rod is transferred to the plate with in the tube thereby changing the characteristics of the tube

(1M)

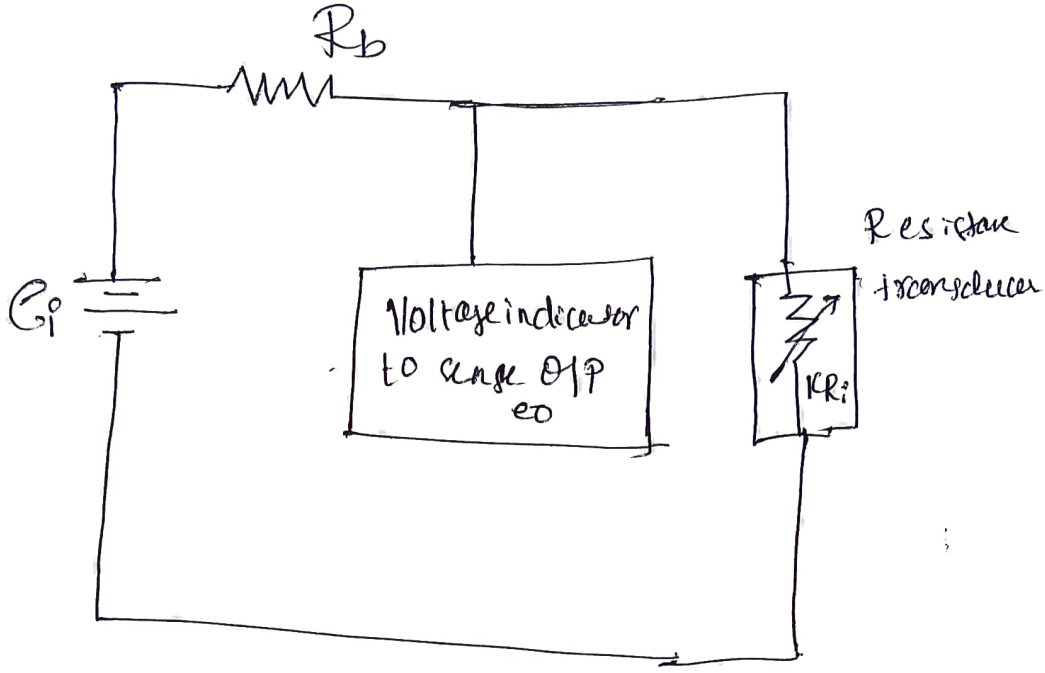
Advantages

- Electronic transducer element is used as surface roughness indicator, pressure & force measurement.

8b. Ballast circuit

Total (6M)

8a 2019



(2M)

(4M)

- Instead of current sensitive indicator or recorder through which current flows, a voltage sensitive device is connected across the transducer is used.
- A Ballast resistor R_b is the resistance of the measuring circuit excluding the transducer
- In the absence of ballast resistor, the voltage indicator will always record the full source voltage e_i & hence some value resistance R_b is always necessary for proper functioning circuit.

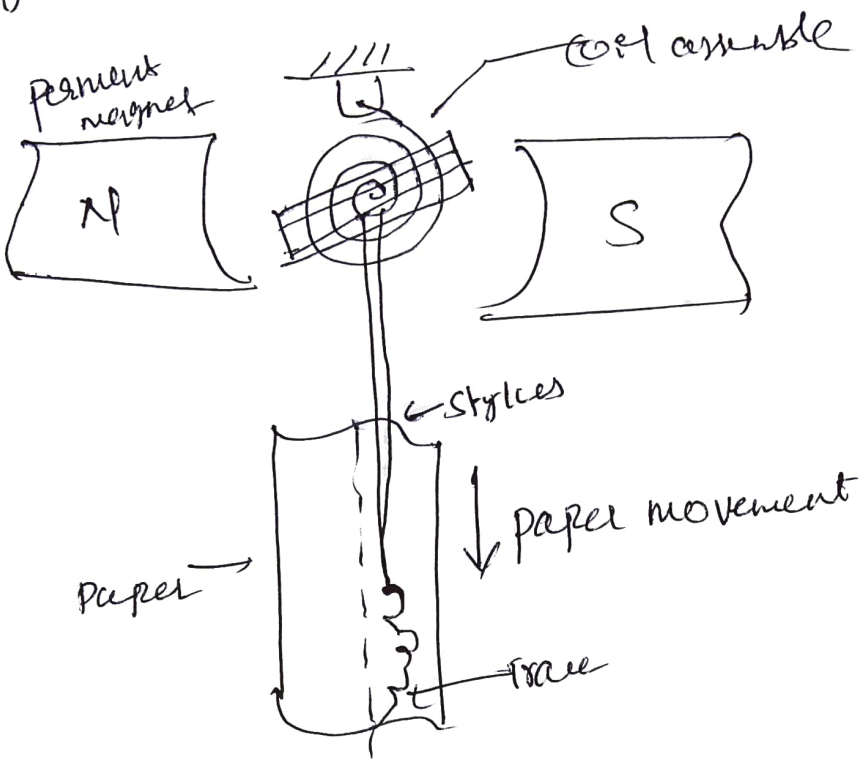
By Ohm's law, o/p current i_0,

$$i_0 = \frac{e_i}{R_b + R_t}$$ If e_0 is voltage across R_t

Part NO

Stylus type oscillography

Total (6M)

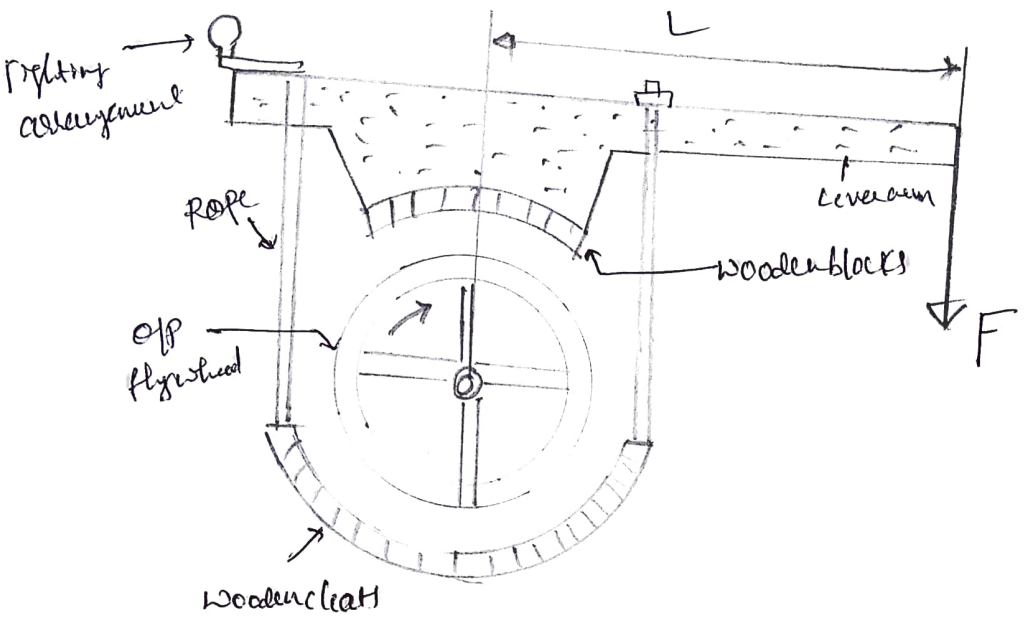


It works on principle of D'Arsonval meter movement

- This uses several form of styluses which directly contacts a moving paper
- Different forms of stylus types may be had, based on whether the recording is accoplished through the use of ink or by a heated stylus on a treated paper
- Figure shows direct writing stylus consisting of a current sensitive movement and a paper drive mechanism
- Stylus is deflected by i/p signal, paper is moved under known rate.
- The frictional drag betn paper & pen of the stylus needs significantly more driving torque.

9b. prony brake dynamometer.

qa (11)



→ (3M)

→ (4M)

- Two wooden blocks are mounted diametrically opposite on flywheel attached to the rotating shaft whose power is to be measured
- one block carries a lever arm & an arrangement is provided to tighten the rope which is connected to the arm.
- The Rope is tightened as so to increase the frictional resistance between the blocks & the flywheel.
- The Torque exerted by prony brake is $T = F \cdot L$
- The power dissipated in the brake is calculated by following eqn.

$$P = \frac{2\pi NT}{60} = \frac{2\pi FLN}{60} \text{ watts}$$

$\because$ F = Force in N, L = Length of arm in m

N is angular speed in rpm & P in watts

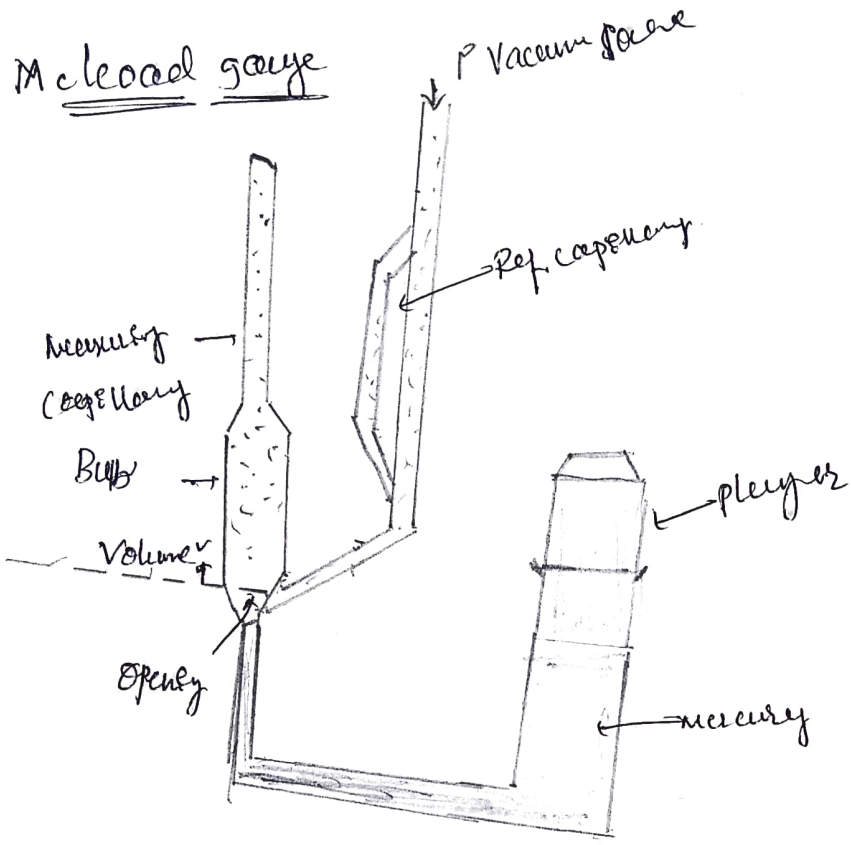
- The prony brake dynamometer is expensive, but it is difficult to adjust & maintain specific load.

Total (7M)

9.c

Mcleod gauge

9.b



(3M)

(4M)

- The operation of Mcleod gauge is based on Boyle's law

$$P_1 = \frac{P_2 V_2}{V_1}$$

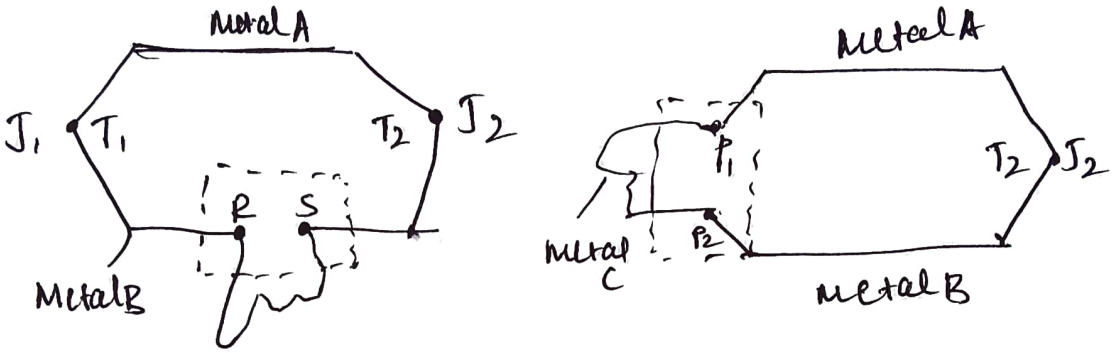
- when P_1 & P_2 are pressure at initial level & final conditions respectively & V_1 & V_2 are volumes.
- To start process of measurement, Plunger is withdrawn locally the level of mercury below the opening thereby admitting the gas at unknown pressure P.
- The bulb & measuring capillary are then at the same pressure as the vacuum pressure. when plunger is pushed in, mercury level goes up. sealing off gas sample of known volume V in the bulb & measuring capillary.
- Further motion of Plunger causes compression of the sample & motion of plunger is continued until the level of mercury is at zero mark in ref. capillary
- a Mcleod gage is scientific instrument used to measure very low pressure. down to 10^{-6} Torr (mm)

Total 6M

10 a. Thermocouple is type of temperature sensor, which is made by joining of two dissimilar metals at one end.

10 a. Laws of thermocouple

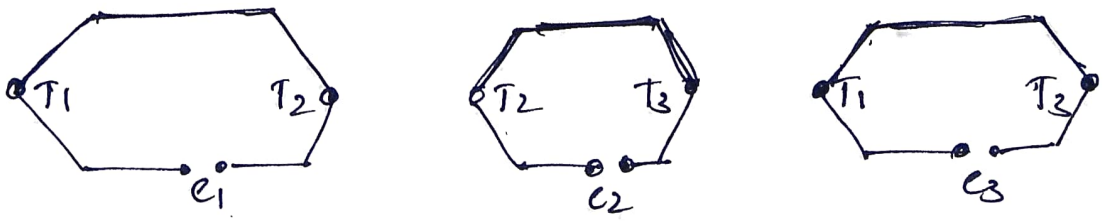
i) law of intermediate metals → (3M)



It states that insertion of an intermediate metal into thermocouple circuit will not effect net emf, provided the two junctions introduced by third metal at identical temperatures.

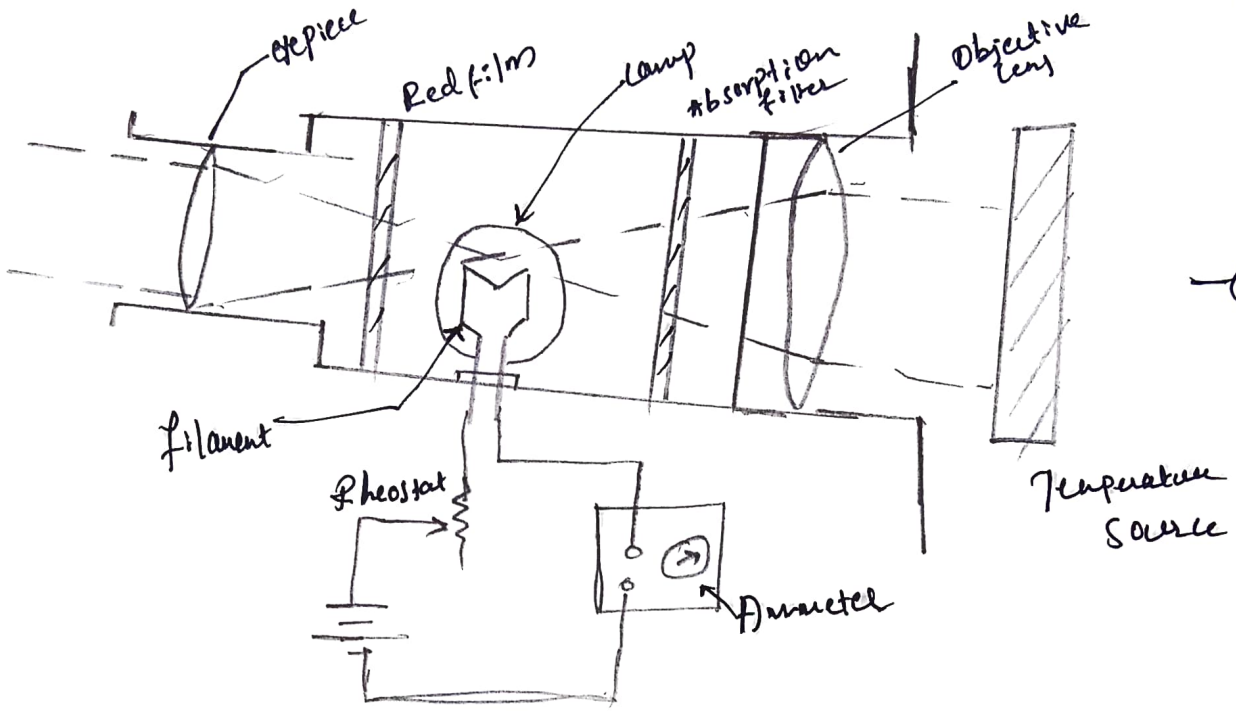
ii) Law of intermediate temperatures: It states that if a single thermocouple circuit develops an emf e_1 when junctions are T_1 & T_2 and an emf e_2 when it junctions are at Temperatures T_2 & T_3 Then same circuit will develop an emf $e_3 = e_1 + e_2$ when it's junction are at temperature T_1 & T_3

→ 3M



Total (8M)

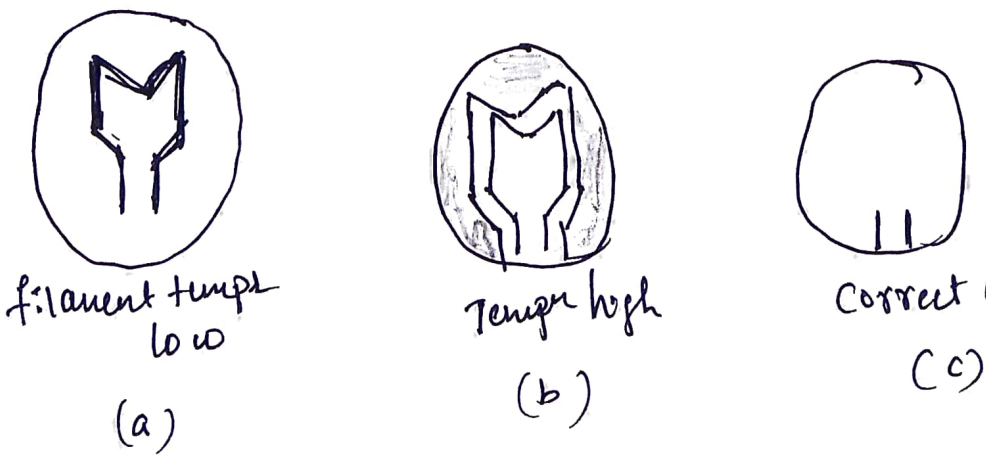
10 b.



b. (3M)

Optical pyrometer (5M)

- The pyrometer is positioned towards an unknown temperature such that the objective lens focused & source in the plane of lamp filament
- The eye piece is then adjusted such that the filament & source appear superimposed
- The filament appear either hotter or colder than unknown source
- When current passing through filament is too low the filament will emit radiation of lesser intensity than that of source it will thus appear dark against background. as shown in figure



4M

10c. Write Note on :

1) Thermocouple materials
2) Advantages & disadvantages of thermocouple

2M

Ans- Thermocouple are manufactured from various combination of base metals copper & iron, the base-metal alloys of Alumel (Ni|Mn|Al|Si), chromel (Ni|Cr), constantan (Cu|Ni) Nicrosil (Ni|Cr|Si) & Nisil (Ni|Si|Mn), the noble metals platinum & tungsten, & the noble-metal alloys of platinum/rhodium & tungsten/Rhenium.

R type - platinum-Rhodium, K type - chromel (Ni, Cr)

Advantages & disadvantages of thermocouple 2M

- Inexpensive
- No resistance lead wire problem
- Fastest Response
- Simple & Rugged
- high temperature operation

Disadvantages

1. least Sensitive
2. Non-linear
3. Low voltage
4. least stable, Repeatable.

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Staff.

H.O.D.

Dean, Academics