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CMR Institute of Technology, Bangalore
DEPARTMENT OF MECHANICAL ENGINEERING
III - INTERNAL ASSESSMENT

Semester: 4-CBCS 2018
Subject: MECHANICAL MEASUREMENTS AND METROLOGY (18ME46B)
Faculty: Mr Puneeth Kumar

Date: 2 AUG 2021
Time: 01:00 PM - 02:00 PM
Max Marks: 50

SCHEME AND SOLUTION

1. What is measurement? Explain generalized measurement system with example.

Solution: The process of comparing unknown magnitude with a predefined standard is called measurement. **1 Mark**

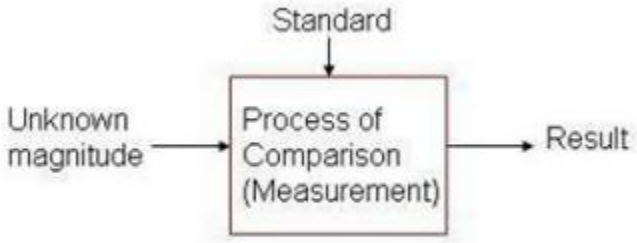


Fig- Process of measurement

Example- To measure length of bar. We make use of a scale/steel ruler (i.e. Standard) **1 Mark**

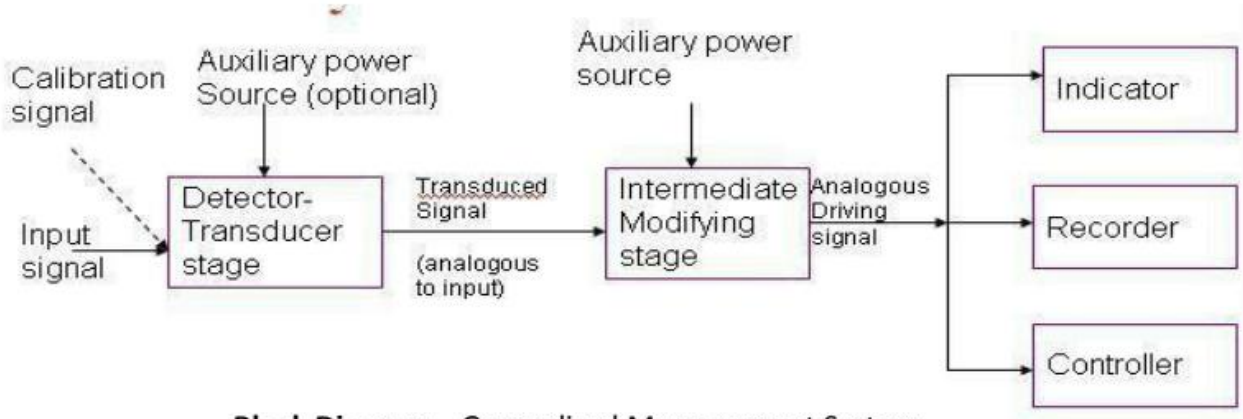
Generalized Measurement System:

It can be considered as a system that is used to measure the required quantity/parameter.

Generalized measurement system consists of the following elements:

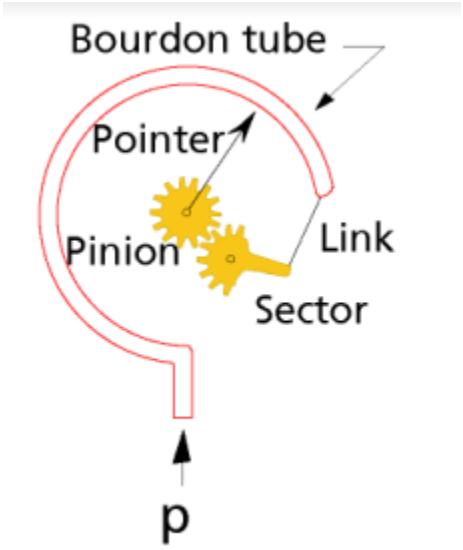
- Primary Sensing Element(detecting element) (detector-transducer element)
- Variable Conversion Element-Intermediate modifying element.
- Data Processing and Data Presentation element-Terminating stage element.

2 Marks



Block Diagram – Generalized Measurement System

2 Marks



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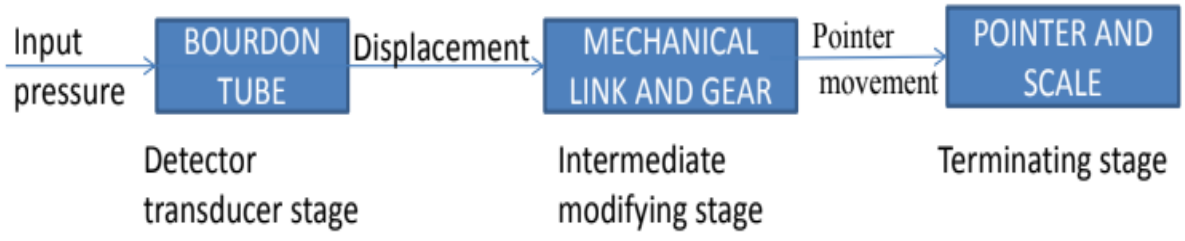


2 Marks

2. Explain mechanical comparator with neat sketch.

Solution: Comparator is an instrument used for comparing the dimensions of a component with a standard of length. Purpose of a comparator, in general, is to detect & display the small differences b/w the unknown linear dimension & length of the standard. 2 Marks

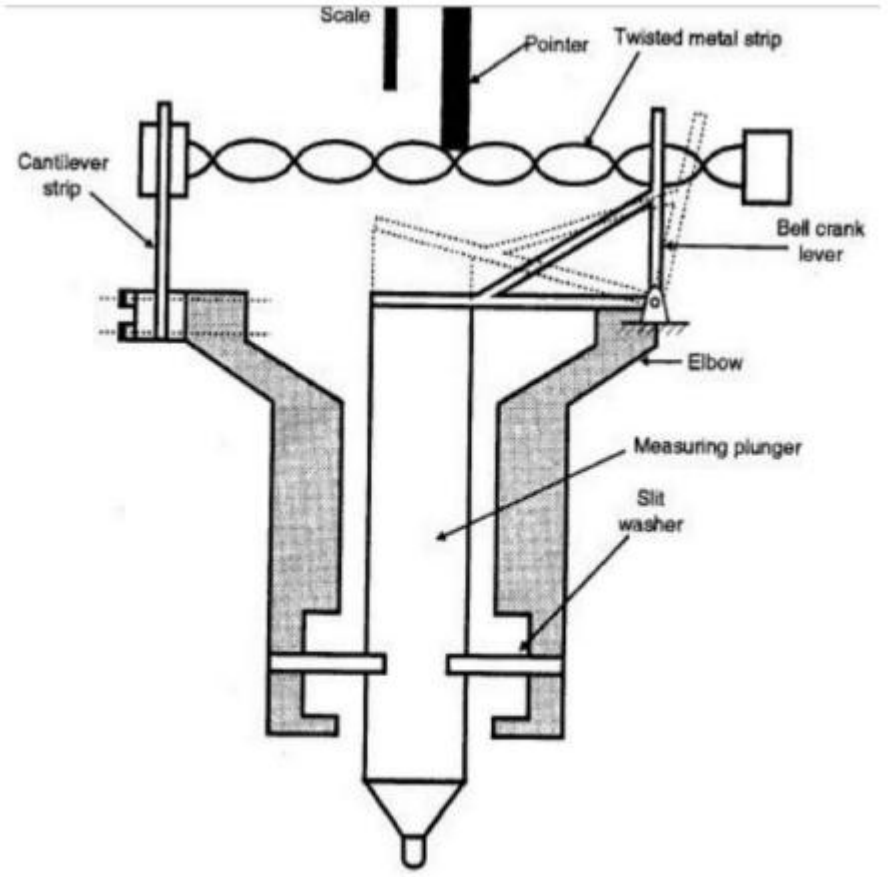


Figure: Johansson Mikrokator . 4 Marks

WORKING OF JOHANSSON MIKROKATOR:

A very thin metal strip at the center carries a light pointer made up of glass.

One end of the strip is connected to the adjustable cantilever strip and the other end is to the spring elbow, in turn connected to the plunger.

The slight movement of the plunger will make the bell crank lever to rotate.

This rotation will create tension in the strip and causes the strip to rotate thereby the strip start to twist & untwist resulting in the movement of the point.

The spring ensures that the plunger returns when the contact is removed. 4 Marks

3. **Explain LVDT with neat sketch and advantages and disadvantages of electrical comparator.**

Solution:

LVDT working on the principle of mutual induction. The non electrical i.e. mechanical energy will be converted in to electrical energy

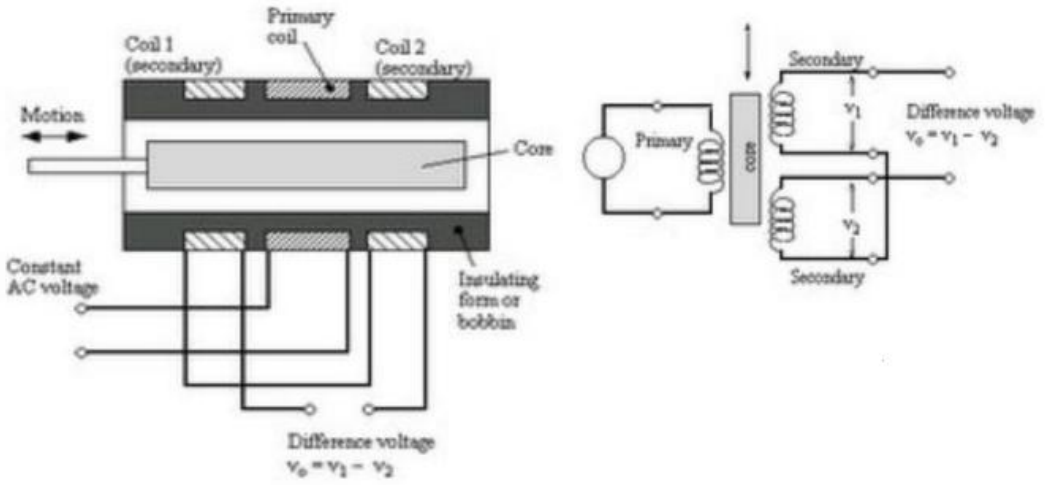
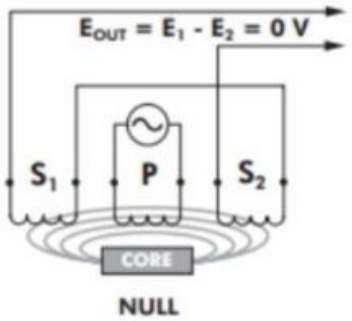


Fig - LVDT

4 Marks

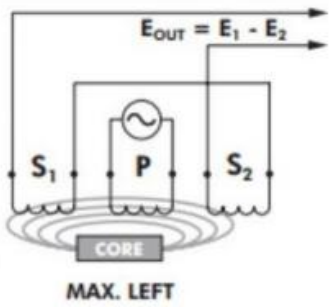
- LVDT consists of primary coil surrounded by a hollow cylindrical rod and it is connected to the AC source.
- It also consists of two secondary coil having equal number of turns and placed equal distance on either side of the primary coil.
- The secondary coil is connected in series and opposite and are represented as S1 and S2.
- Iron core is placed in the center of the cylinder which moves to and fro.

The working of LVDT circuit diagram can be divided into three cases based on the position of the iron core in the insulated former.



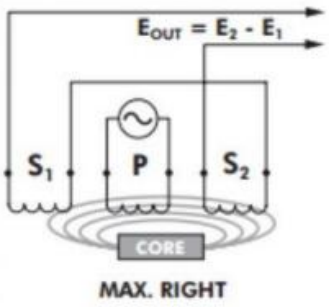
NULL

In Case-1



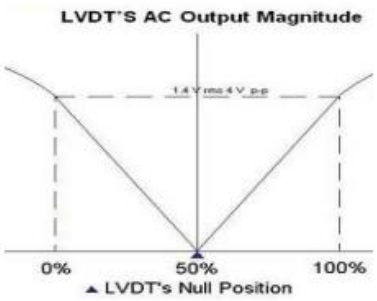
MAX. LEFT

In Case-2



MAX. RIGHT

In Case-3



4 Marks

In Case-1:

When the core of the LVDT is at the null location, then both the minor windings flux will equal, so no output. i.e. Esec1 – Esec2 = 0

In Case-2:

When the external force is applied and the steel iron core tends to move to the **left hand side** then the emf induced in the secondary coil 1 is greater than the secondary coil 2. There fore net out put will be **Esec1 – Esec2**

In Case-3:

When the external force is applied and the steel iron core tends to move to the **right hand side** then the emf induced in the secondary coil 2 is greater than the secondary coil 2. There fore net out put will be **Esec2 – Esec1**

2 Marks

4. Explain piezoelectric and photo electric transducer.

Solution:

Piezoelectric Transducers

- Certain materials can produce an electrical potential when subjected to mechanical strain like Quartz, Rochelle salt and Barium titanate.
- The fig shows a piezoelectric crystal placed between two electrodes plate and when a force 'F' is applied on the plates, a stress will be produced in the crystal and a corresponding deformation.
- The induced charge Q=d*F where 'd' is the piezoelectric constant
- The output voltage E=g*t*p where 't' is crystal thickness, 'p' is the impressed pressure & 'g' is called voltage sensitivity given by g=(d/.e), e being the strain.

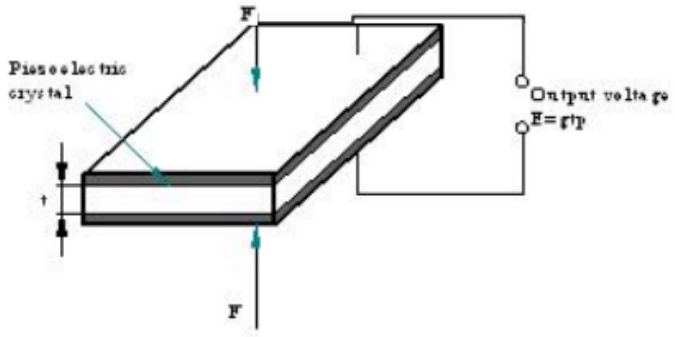


Fig- piezoelectric transducer

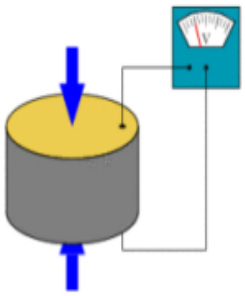


Fig- piezoelectric transducer animation

3 Explanation+ 2 Sketch =5 Marks

Photoelectric Transducers

- Photoelectric transducer converts a light beam into a usable electric signal.
- light strikes the photo emissive cathode and releases electrons, which are attracted towards the anode, thereby producing an electric current in the circuit.
- The cathode & the anode are enclosed in a glass or quartz envelope, which is filled with an inert gas.
- The photo electric sensitivity is given by I=s*f

where, I=Photoelectric current, s=sensitivity, f=illumination of the cathode.

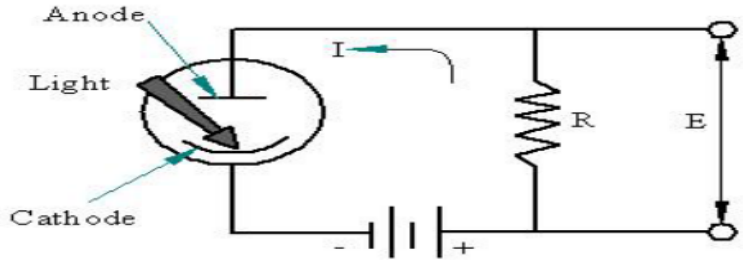


Fig -Photoelectric Transducers

3 Explanation+ 2 Sketch =5 Marks

5. Explain pressure sensitive element with neat sketch.

Solution:

Pressure Sensitive Elements

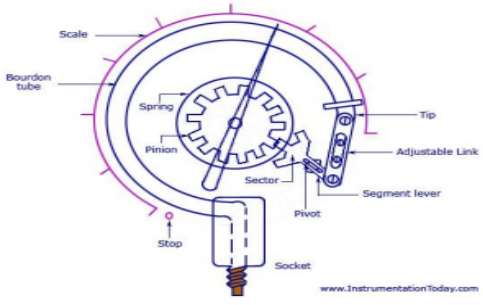
Most pressure measuring devices use elastic members to sense the pressure.
These elastic members convert pressure into displacement.

(i) Bourdon tubes
(ii) Diaphragms
(iii) Bellows.

- Bourdon tubes:

Bourdon tubes are elliptical cross section tubes bent into shapes as shown in fig.

- ✓ One end of the tube is sealed the other end is open for the fluid to enter.
- ✓ The fluid whose pressure is to be measured enters the tube and tends to straighten the tube.
- ✓ This causes the movement of the free end which can be measured.
- ✓ The commonly used materials for bourdon tubes are brass, Phosphor bronze, Beryllium copper, etc.



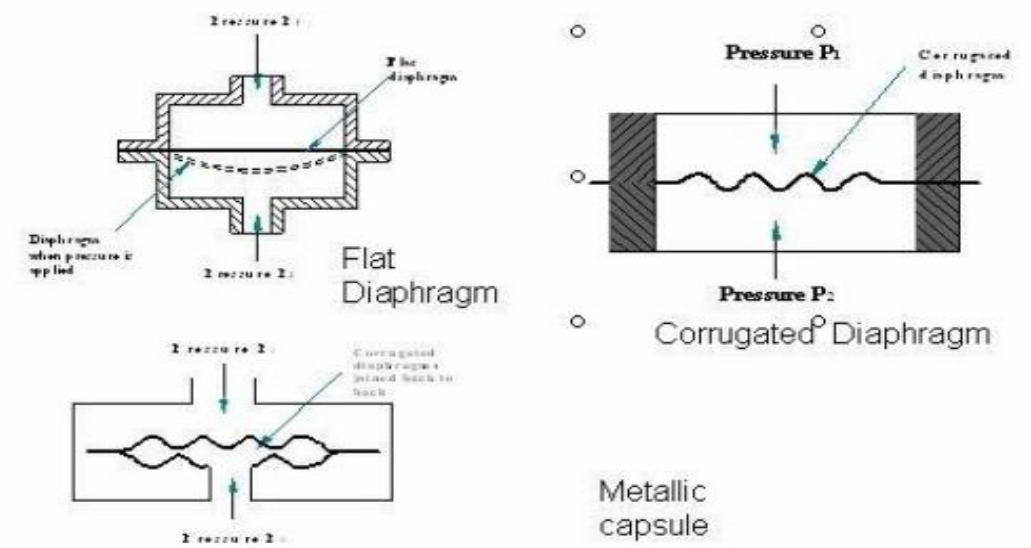
Bourdon Tube Pressure Gauge

3 Explanation+ 2 Sketch =5 Marks

➢ **Diaphragm:**

A diaphragm is a sheet of a semi-flexible material, most often round in shape. It serves either as a barrier between two chambers, moving slightly up into one chamber or down into the other depending on differences in pressure.

1 Mark

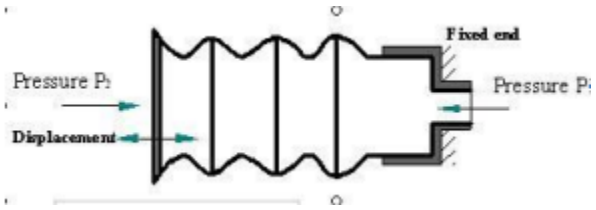


2 Marks

Bellows:

Like a diaphragm, bellows are also used for pressure measurement, Metallic bellows are thin walled tubes formed by hydraulic presses into a corrugated shape.

Made of - Brass- 80% Copper, 20% Zinc. -Phosphor bronze. - Stainless steel. Beryllium copper.



2 Marks

6. Explain strain gauge with advantages and disadvantage.

Solution:

When a system of forces or loads acts on a body, it undergoes some deformation.

This deformation per unit length is known as unit strain or simply a strain **1 mark**

Mathematically, Strain € = δl /l

Where, δl = change in length of the body

l= original length of the body.

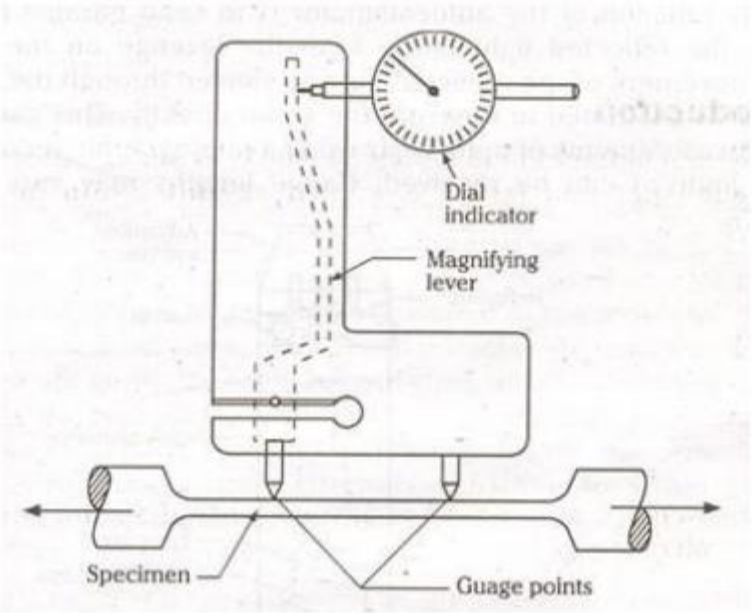
If a net change in dimension is required, then the term, total strain will be used. Since the strain applied to most engineering materials are very small they are expressed in "micro strain"

2 marks

Mechanical Strain Gauges:

This type of strain gauges involves mechanical means for magnification. Extensometer employing compound levers having high magnifications was used. Fig. shows a simple mechanical strain gauge. It consists of two gauge points which will be seated on the specimen whose strain is to be measured. One gauge point is fixed while the second gauge paint is connected to a magnifying lever which in turn gives the input to a dial indicator. The lever magnifies the displacement and is indicated directly on the calibrated dial indicator. This displacement is used to calculate the strain value. The most commonly used mechanical strain gauges are Berry-type and Huggen berger type. The Berry extensometer as shown in the Fig. is used for structural applications in civil engineering for long gauge lengths of up to 200 mm.

4 Marks



Mechanical Strain Gauge (Berry Extensometer)

3 Marks