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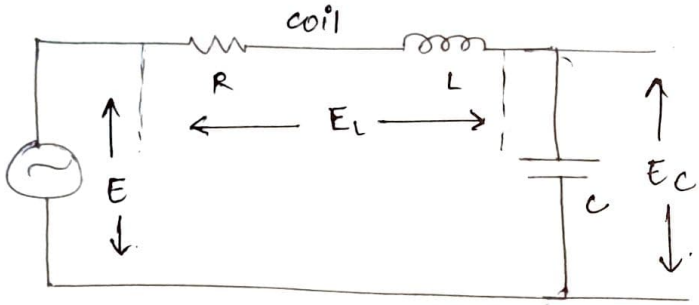
Section - 3A.

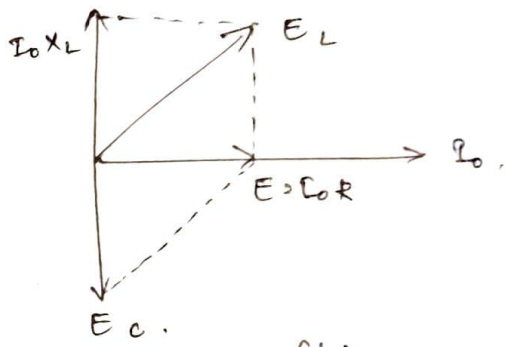
Q3. The Q-meter is an instrument which is designed to measure the value of Q directly and as such is very useful in measurement the characteristics of coils and capacitors.

PRINCIPALE OF WORKING.

based on characteristics of a resonat series R, L, C ckt.



(a)



(b)

The figure (a) shows a coil of Resistance R and an inductance L with capacitance C in series.

At resonant freq. f_0 we have,

$$X_C = X_L.$$

where $X_C = \frac{1}{2\pi f_0 C} = \frac{1}{\omega_0 C}$.

and $X_L = 2\pi f_0 L = \omega_0 L$.

resonant frequency $f_0 = \frac{1}{2\pi\sqrt{LC}}$ and current

at resonance $I_0 = E/R$.

The phasor diagram is shown in fig. (b). voltage across capacitor, $E_c = I_0 X_c = I_0 X_L = I_0 \omega_0 L$

Input voltage $E = I_0 R$ $\therefore \frac{E_c}{E} = \frac{I_0 \omega_0 L}{I_0 R} = \frac{\omega_0 L}{R} = Q.$

$\therefore \frac{E_c}{E} = Q = \frac{E_0}{E} = Q.$

or $E_0 = QE.$

Thus the input voltage E is magnified, Q times if the input voltage E is kept constant, the voltage appearing across the capacitor is Q times E and the voltmeter connected across the capacitor can be calibrated to read the value of Q directly.

Applications.

① Measurement of Q.

a) The oscillator is set to the desired frequency and the tuning capacitor is adjusted for max value of E_0. as $Q = \frac{E_0}{E}$ and if voltage is kept constant the voltmeter connected across the capacitor may be calibrated to read the value of Q directly.

This measured value of Q is commonly regarded as the Q of the coil under test. However, this is an error. There are also errors caused due to Shunt resistance,

Correction for shunt resistance.

Measured value, $Q_{meas} = \frac{\omega_0 L}{R + R_{sh}}$.

True value = $Q_{true} = \frac{\omega_0 L}{R}$.

$\therefore Q_{true} = Q_{meas}\left[1 + \frac{R_{sh}}{R}\right]$.

Thus, the measured value of Q is less than the true of value of Q. Now if the coils of high resistance are being measured, the difference between the two values may be negligible

In the fig (a), it shows that a coil resistance R and an inductance L in series with a capacitor C.

At resonant freq. f_0, we have.

$X_C = X_L$.

where $X_C = \frac{1}{2\pi f_0 C} = \frac{1}{\omega_0 C}$.

and $X_L = 2\pi f_0 L = \omega_0 L$.

resonant freq: $f_0 = \frac{1}{2\pi\sqrt{LC}}$ and current.

at resonance $I_0 = E/R$.

In the phasor diagram (b), voltage across capacitor,

$E_C = I_0 X_C = I_0 X_L = I_0 \omega_0 L$.

Input voltage $E = I_0 R$

$\therefore \frac{E_C}{E}, Q = \frac{E_0}{E} = Q$ or $E_0 = QE$.

(2) Measurement of inductance: The value of inductance is given by $L = \frac{1}{4\pi^2 f_0^2 C}$, the value of f_0 and C are known. therefore the value of inductance may be computed.

(3) Measurement of effective Resistance:

The value of effective resistance may be computed from the relation,

$$R = \frac{\omega_0 L}{Q_{true}}.$$

(4) Measurement of self capacitance: The self-capacitance is measured by making two measurements at different frequencies.

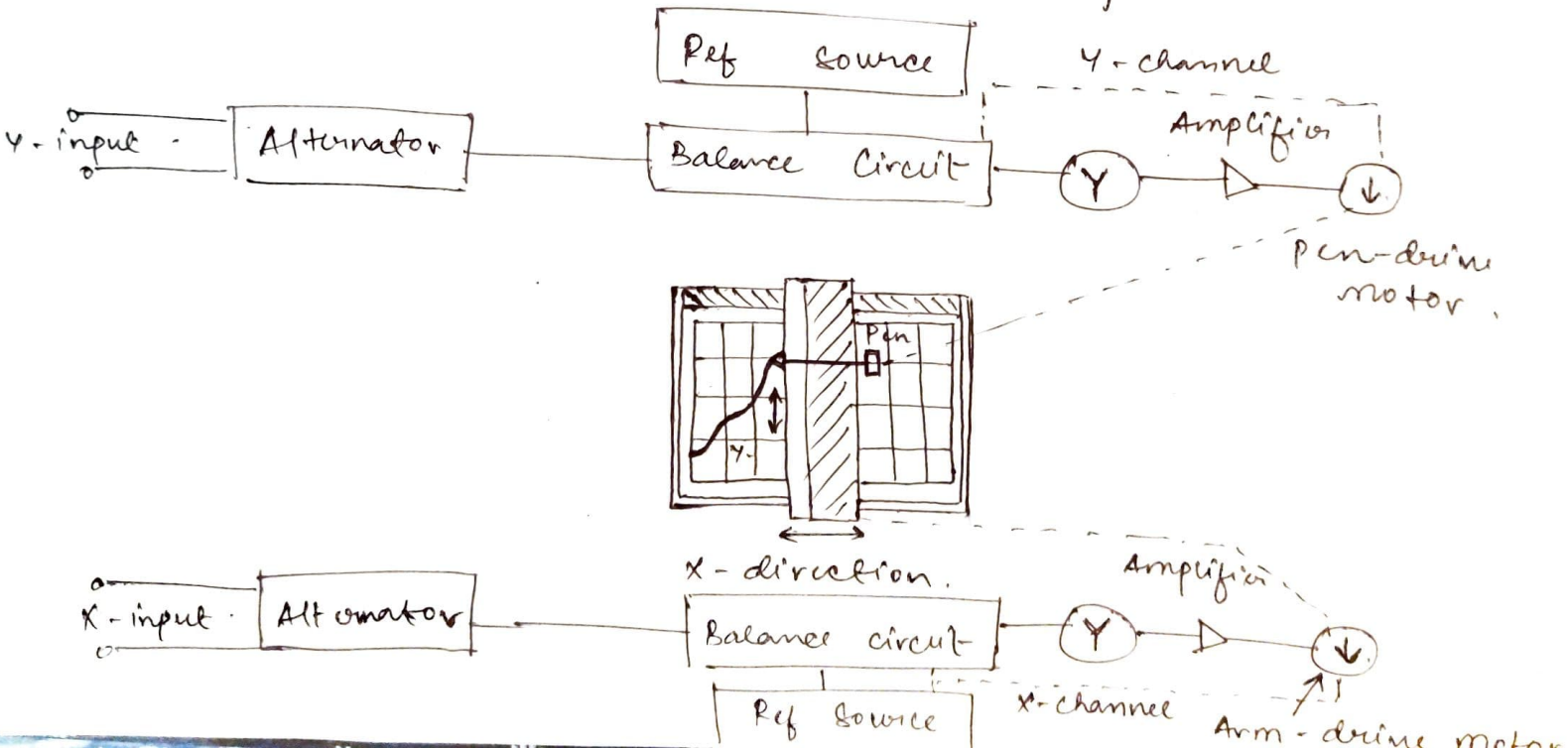
(5) Measurement of Bandwidth — The bandwidth is given by, $Q = \frac{\omega_0 L}{R}$.

(6) Measurement of capacitance: The capacitance is measured by $\therefore C_T = C_1 - C_2$.

The capacitor under test is C_T here and C_1 and C_2 are the capacitors resonated by varying the value of the tuning capacitor.

Q4. → In X-Y recorders, an emf is plotted as a (5) function of another emf.

→ This is done by having self-balancing potentiometer control the position of the rolls while another self-balancing potentiometer controls the position of the recording pen. In some X-Y recorders, one self-balancing potentiometer circuit moves a recording pen, ~~In some X-Y recorders, one self-balancing potentiometer circuit moves~~ in a X direction while another ~~self~~ self-balancing potentiometer, circuit moves the recording pen in the Y direction at right angles to the X-direction while the paper remains stationary.



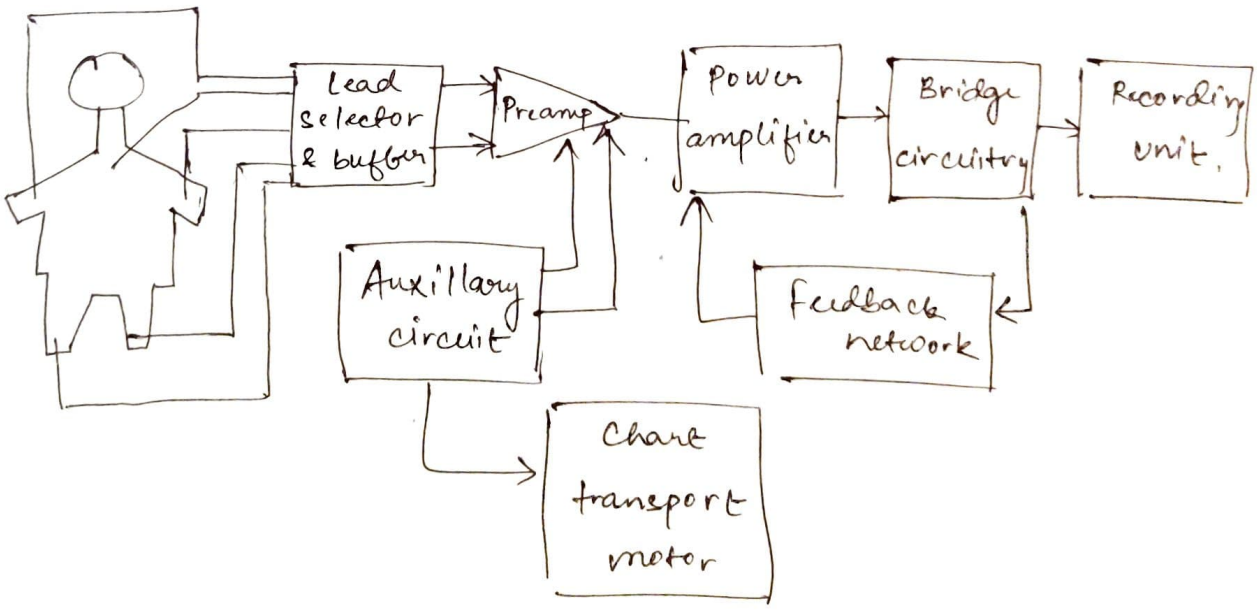
ECG:

An electro cardio graph also known as ECG is an instrument which records the electrical activity of the heart over a period of time using electrode placed over a skin.

It detects the tiny electrical change on the skin that arises from heart muscle's electro-physiological pattern.

ECG provides the wide range of valuable information of the heart such as the presence of inactive part or an enlargement.

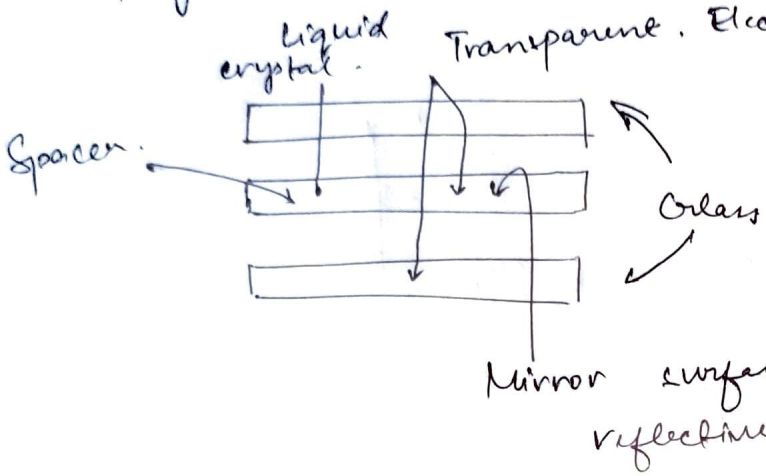
The principle of the ECG is that the stimulation of muscle action. the electrical potential of muscle cardiac cells, unlike other cells have a property known as automatically, which is the capacity to spontaneously initiate impulses.



Q1. a) L.C.D.

→ Liquid crystals diodes popularly known as LCD's.

→ Liquid crystals cell displays are used in similar application where Led's are used. These applications are display of numeric and alpha-numeric character in dot matrix and segmented display.



(LCD).

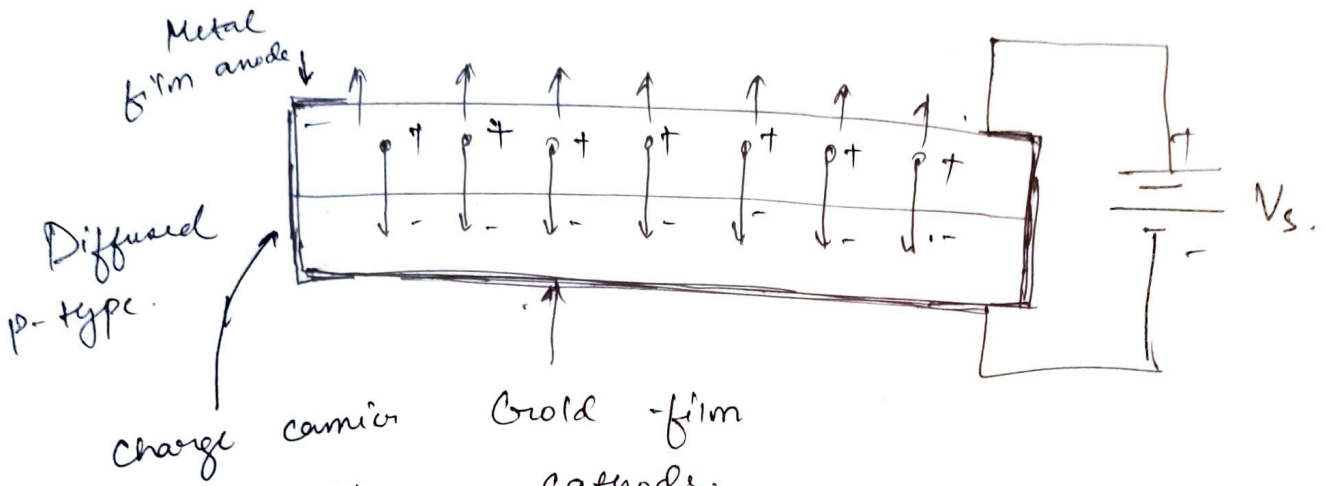
→ The liquid crystals material may be an organic compound which exhibit optical properties of a crystal through they remain in a liquid form.

→ Liquid crystal is layered between glass sheets and transparent electrode deposited on the inside faces.

→ when the liquid is activated the molecular turbulence causes light to be scattered in all directions and cell appears bright and when its not active it is transparent. This is dynamic scattering.

b) LED's.

→ A light emmiting diode is a semi-conductor light source that emits light when current flows through it. Electrons in semi-conductor, recombine with electron holes, releasing energy in the form of protons.

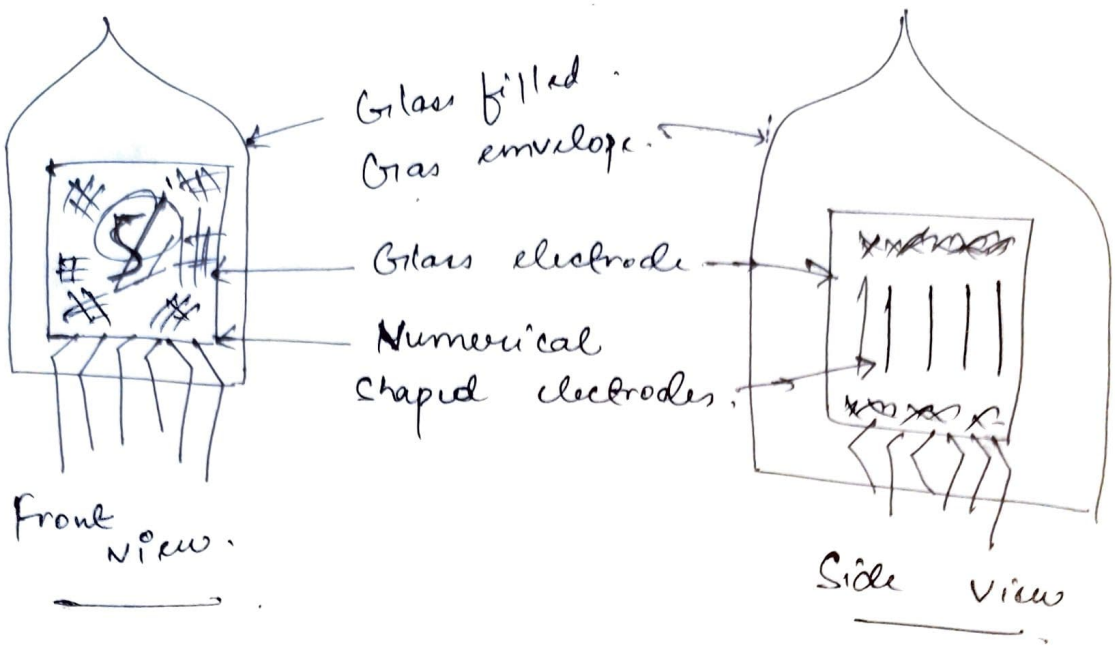


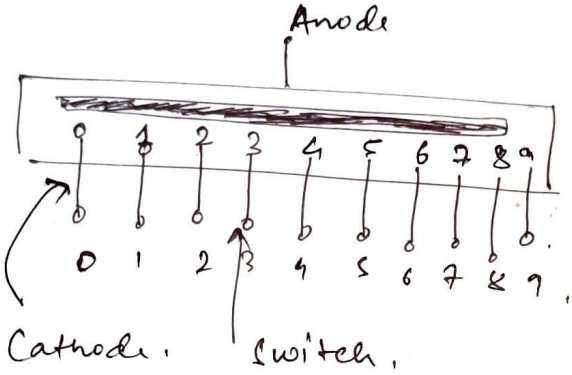
→ The holes lie in the valance band while the free electrons are in the conduction band.

→ When the movement of free electron takes place, there is a change in energy level as the voltage drops from the conduction band to the ~~valo~~ valence band.

→ The entire process is known an electro luminance and the diodes are known as light emmiting diode.

c) NIXIE TUBE.





Schematic symbol of Nixie.

→ It is non-planar device. It is a gaseous glow tube having a set of electrode, each shaped in the form of digit.

→ The selected electrode is surrounded by a gaseous discharge or glow when the digit is selected.

→ It works on the principle that when a gas break down, a glow discharge is produced.

→ High voltage (150-200v) are required.

Q2. A strip chart recorder is an instrument which is used to record various process and electrical signals. (10)

Strip chart recorder consists of a roll or strip of paper that passes clearly beneath one or more pens.

PRINCIPLE:

The recorder records the variation of one or more variables with respect to time.
It consists of a pen which is used for making marks on a movable paper, driving system, vertically moving roll of chart paper, chart paper drive mechanism, speed selector switch.

The chart speed is of 1-100 mm/sec.

Two types of strip chart:

(1) Galvanometer type - Depends on the deflection of the pointer ~~beco~~ because of the current flowing through it.

(2) Null type: This operates on camparision basis

The data on strip chart can be recorded by various method:

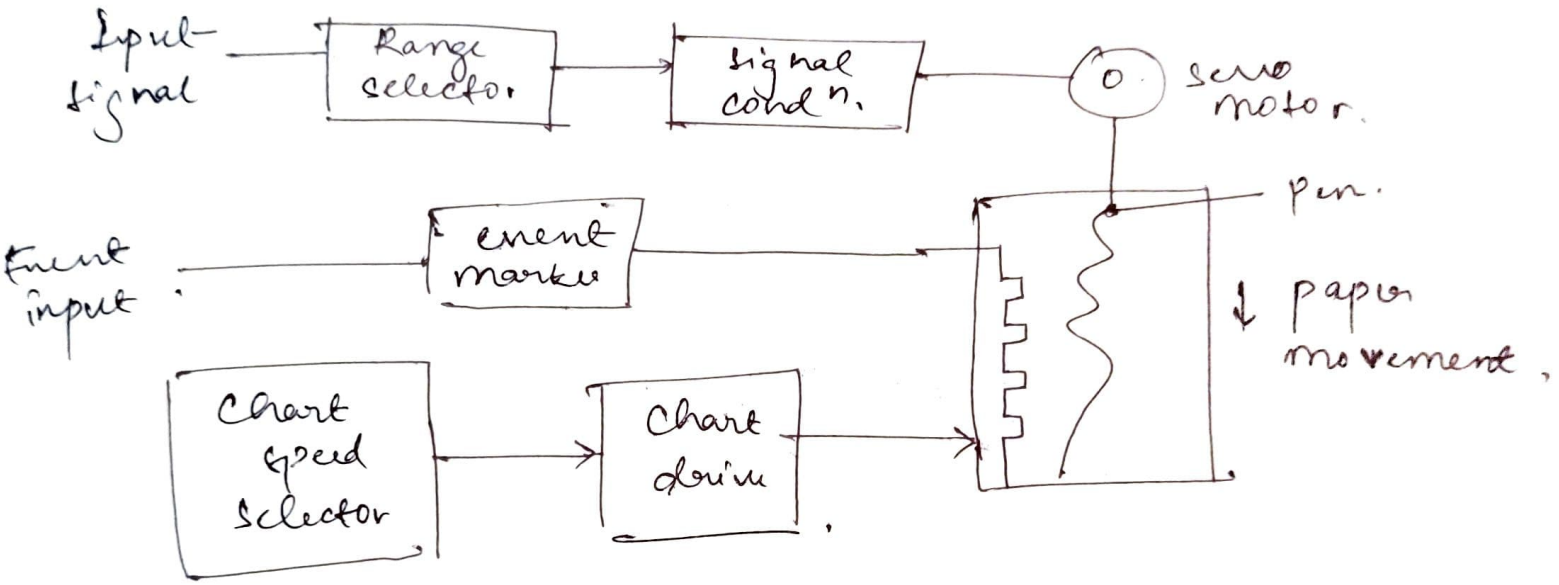
(1) Pen Ink stylus
(2) Impact writing
(3) Thermal writing.

(iv) Electric writing.

(v) Optical writing.

The period is recorded as:

$$\text{Period} = \frac{\text{Time/cycle}}{\text{Chart speed}} = \frac{\text{Time base}}{\text{Chart speed}}.$$

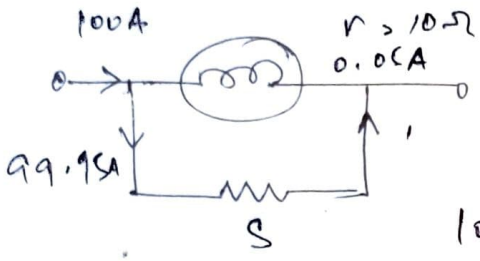


The paper drive system should move the paper at uniform speed.

A synchronous motor is used for driving the paper.

Q5. a) As Ammeter:

Current range of the meter can be extended using a shunt across it.

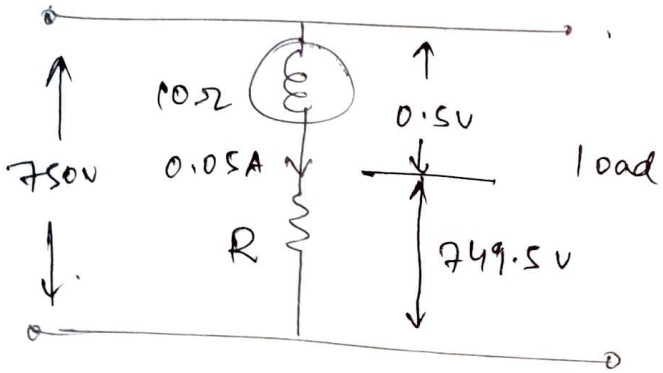


$10 \times 0.05 = S \times 9.95$.

$S = 0.005\ \Omega$

b) As voltmeter.

In this case, the range can be extended by using a high resistance R in series with it.



R must drop a voltage of (750 - 0.5), = 749.5 V while carrying 0.05A.

$\therefore 0.05R = 749.5$ or $R = 14.990\ \Omega$.