MEASUREMENT DEVICES

- Types Of Error

  1. Gross Error
  2. Systematic Error
  3. Random Error
  4. Absolute Error
  5. Relative Error

- Absolute Error

$$e = |Y_n - X_n|$$

e = Absolute Error
Y_n = Expected Value
X_n = Measured Value

- Relative Error

$$Relative\ Error = \frac{Absolute}{Expected\ Value}$$

$$Relative\ Error = \left|\frac{Y_n - X_n}{Y_n}\right|$$

$$Relative\ Error = \left|\frac{e}{Y_n}\right|$$

- Standard Used In Measurement

  a. International Standards
  b. The Primary Standards
  c. Secondary Standards
  d. Working Standards

- Principle Operation Of PMMC

    1. Deflecting System
    2. Controlling System
    3. Damping System

- Deflecting Torque Equation

$$Td = BANI$$

Td = deflecting Torque (Nm)
B = flux density in air gap $\left({}^{Wb}/_{m^2}\right)/T$
N = number of turns of the coil
A = effective coil area (wxl) (m^2)
I = Current in the moving coil (A)

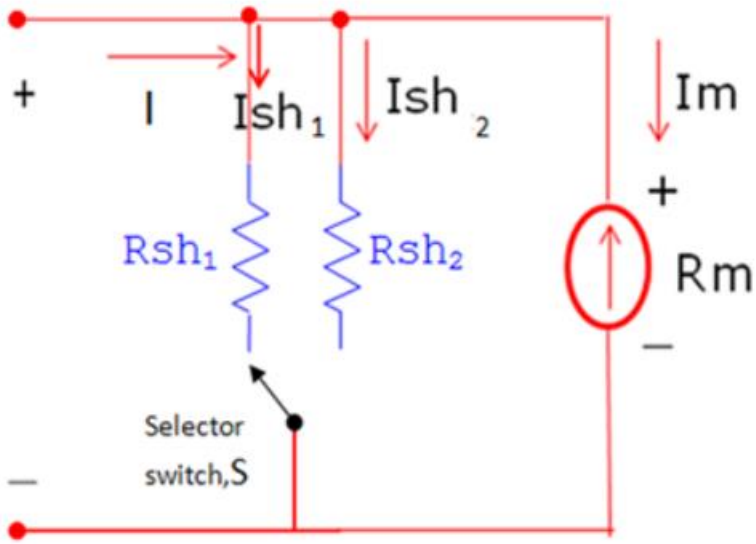
- Single Range DC Ammeter
- Voltage Equation

$$R_{SH} = \frac{I_m R_m}{I_{SH}}$$

- Current Equation

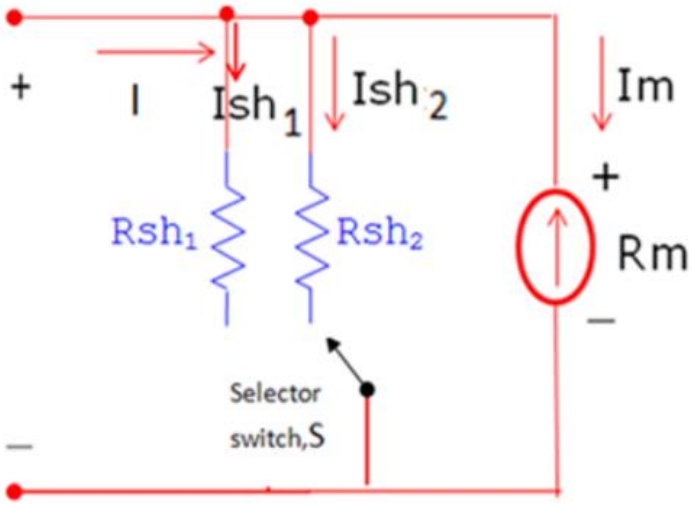
$$R_{SH} = \frac{I_m R_m}{I - I_m}$$

- Two Range DC Ammeter



$$V_m = voltage\ drop\ across\ the\ R_m\ IS\ EQUAL$$
$$V_{sh1} = voltage\ drop\ across\ the\ R_{sh1}$$

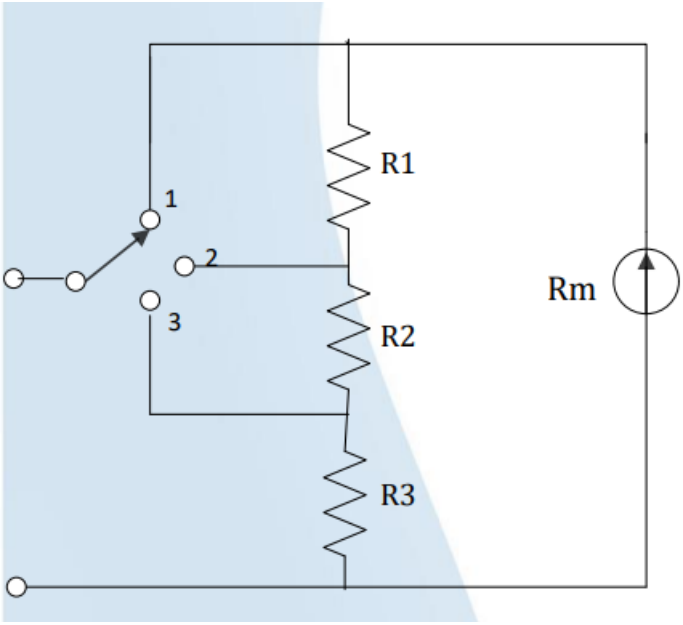
$$R_{sh1} = I_m R_m \,/\, I_1 - I_m$$



$$V_m = voltage\ drop\ across\ the\ R_m\ IS\ EQUAL$$
$$V_{sh2} = voltage\ drop\ across\ the\ R_{sh2}$$

$$R_{sh2} = I_m R_m \,/\, I_2 - I_m$$

- Two Range DC Ammeters (Ayrton Shunt)



- If the input connect to position 1,

$$(I - I_m)(R_1 + R_2 + R_3) = I_m R_m$$

- If the input connect to position 2,

$$(I - I_m)(R_2 + R_3) = I_m(R_m + R_1)$$

- If the input connect to position 3,

$$(I - I_m)(R_3) = I_m(R_m + R_1 + R_2)$$

- Voltage Kirchoff Law

$$R_S = \frac{V}{I_m} - R_m$$

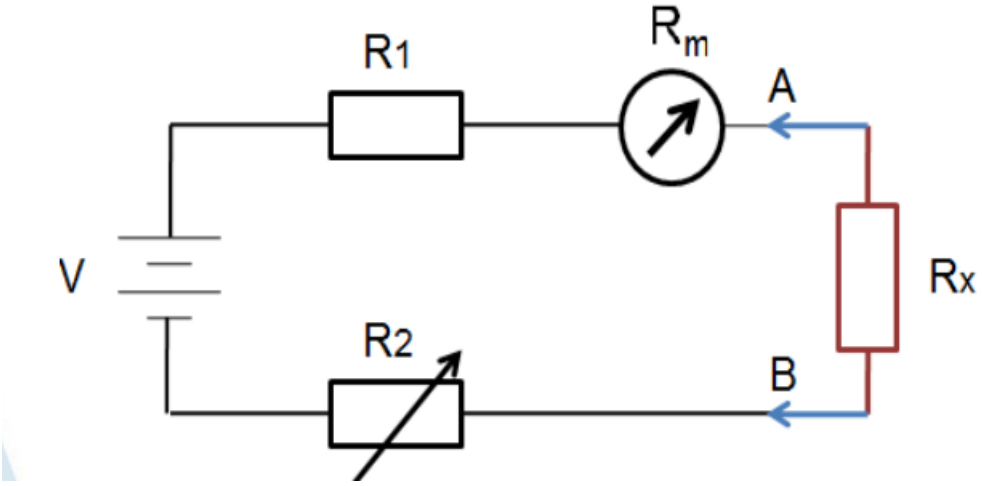
- Resistance Load

$$R_L = \frac{V}{I}$$

- Sensitivity Voltmeter

$$R_m = S \times V$$

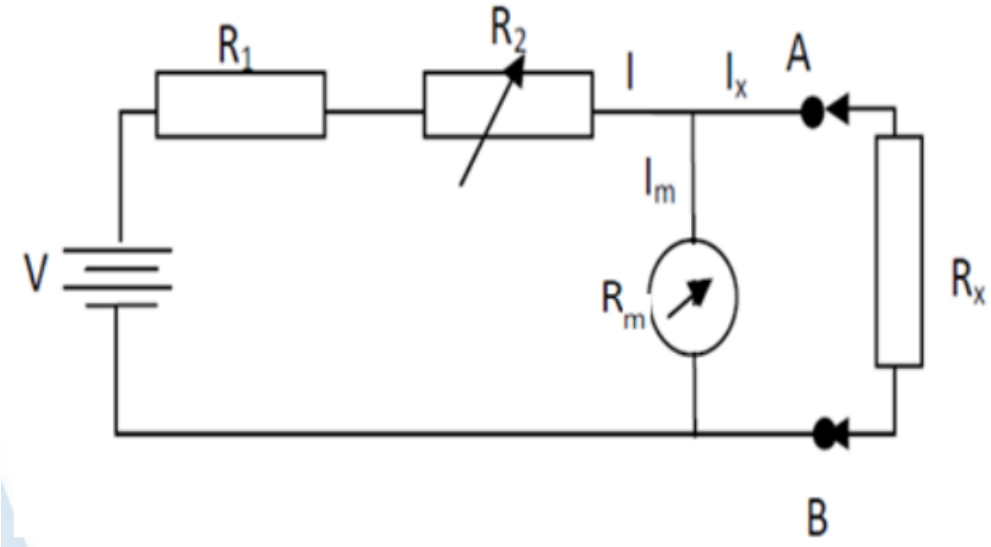
- Derivation Equation For Series Ohmmeter



$$R_T = R_m + R_1 + R_2 + R_X$$

$$R_X = R_T - R_m - R_1 - R_2$$

- Derivation Equation For Shunt Ohmmeter



$$VKL \ldots V_m = V_x$$

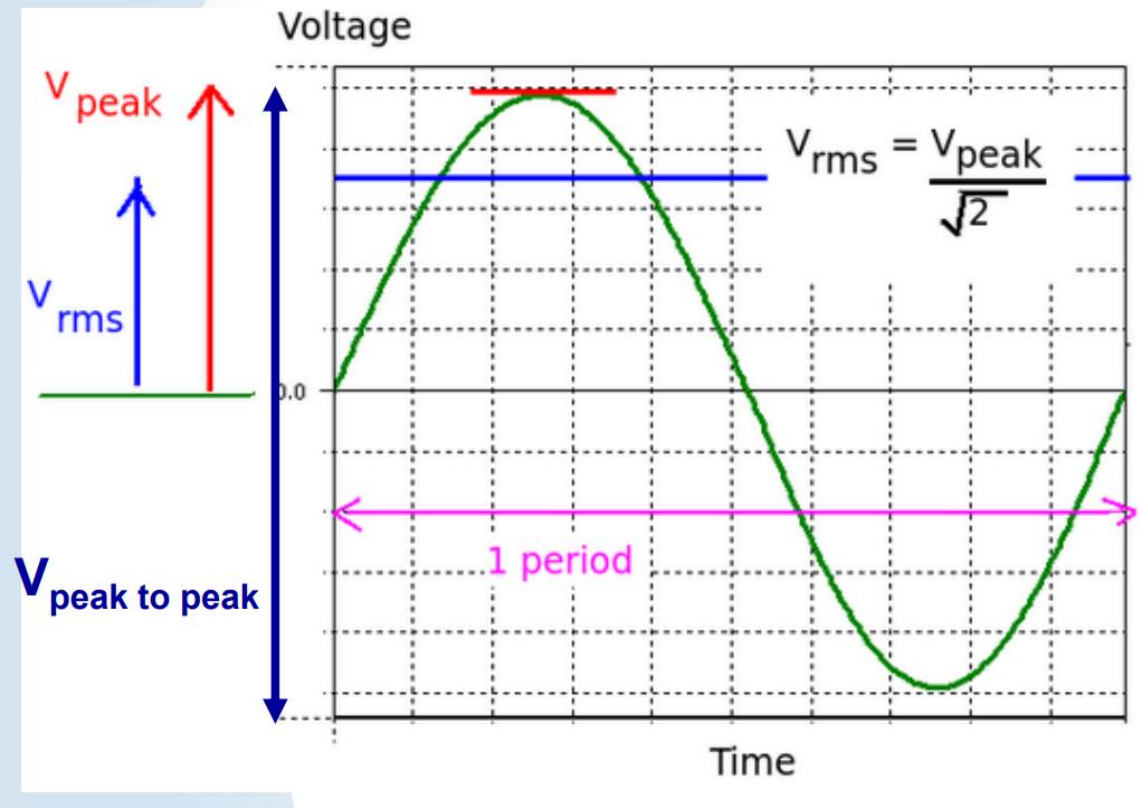
$$V_x = I_x R_x$$

$$V_m = I_m R_m$$

$$CKL \ldots \frac{I_m R_m}{I_x}$$

$$I_x = I - I_m$$

- AC Measurement



- Voltage Peak, Vp

$$No.of\ Div_{(peak)} \times \left({}^{volt}/_{div}\right)$$

- Voltage Peak to Peak, Vpp

$$No.of\ Div_{(peak\ to\ peak)} \times \left({}^{volt}/_{div}\right)$$

- Voltage Root Mean Square, Vrms

$$\frac{V_p}{\sqrt{2}} = 0.707Vp$$

- Frequency

$$f = \frac{1}{T}$$

(Unit : Hz)

- Time

$$No.of\ Division \times \left({time}/{_{div}}\right)$$

(Unit : s)

- Phase Measurement

$$\theta = \frac{\Delta t}{T} \times 360°$$

- Phase Different in XY Mode (Lissajous figure)

$$Phase\ Angle, \theta = \sin^{-1}\left(\frac{A}{B}\right)$$

A = peak to peak vertical height of the ellipse
B = is the intercept on the Y-axis

- Power

$$P = IV, \qquad P = I^2R, \qquad P = \frac{V^2}{R}$$

- Energy

$$Power \times time(joules)$$