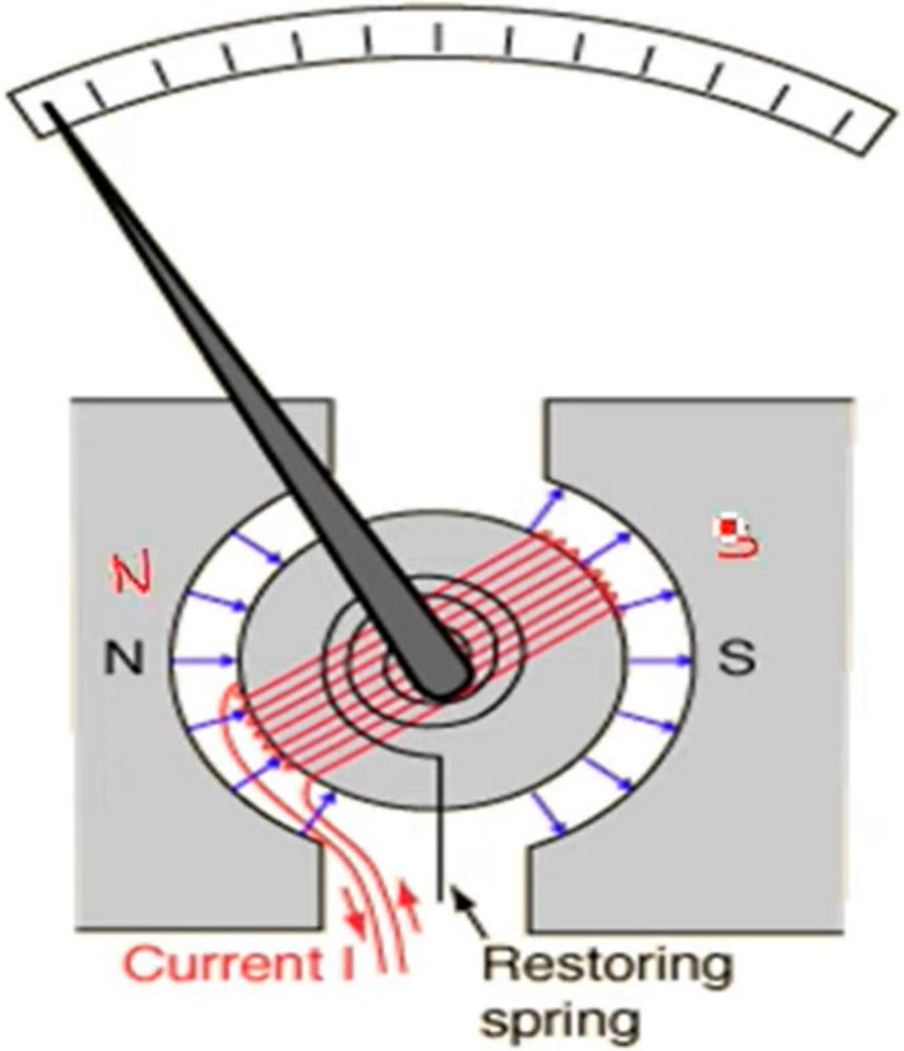
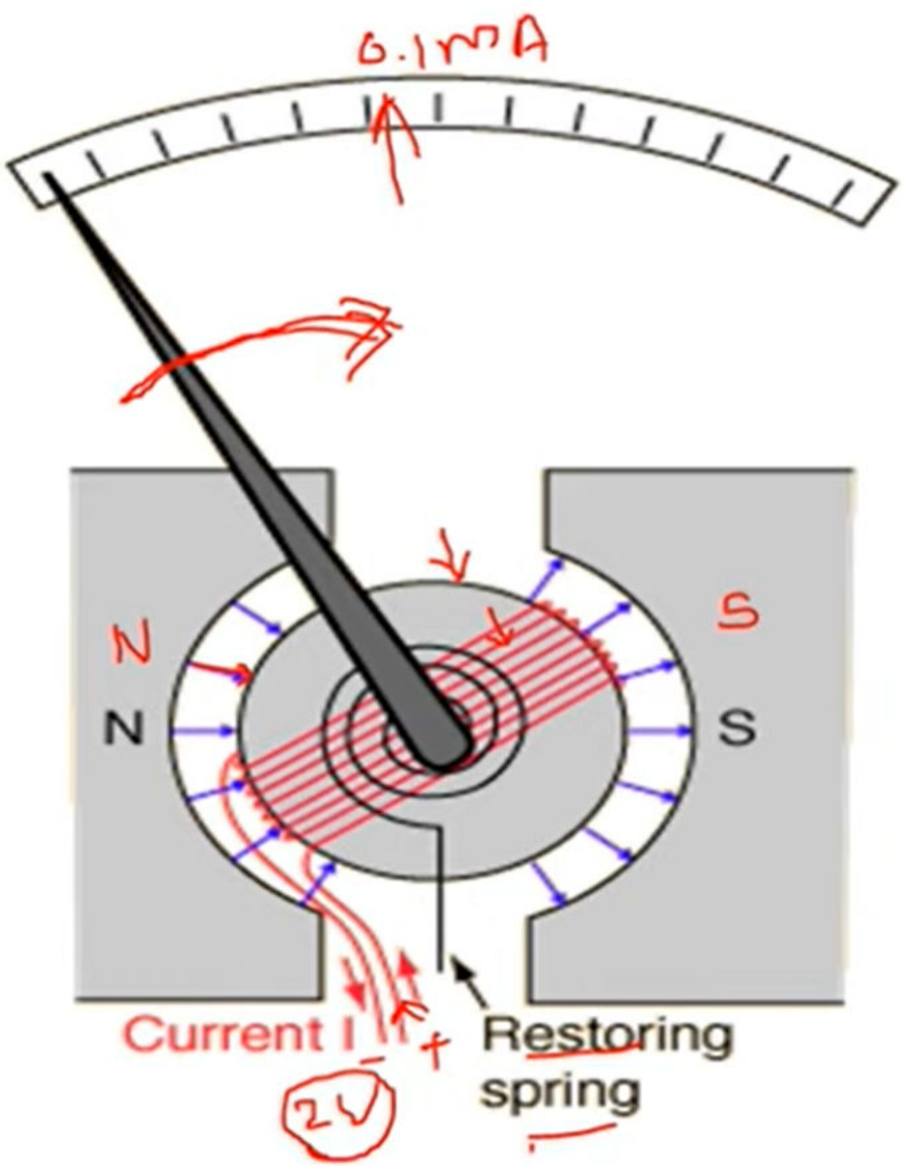
Basic meter

- D'Arsonval
- PMMC
- Galvanometer.



Basic meter



- D'Arsonval
- PMMC
- Galvanometer.

$\tau \propto A \cdot I \cdot N$

$\tau = B \times A \times I \times N$

$B \rightarrow$ flux density (wb/m^2)

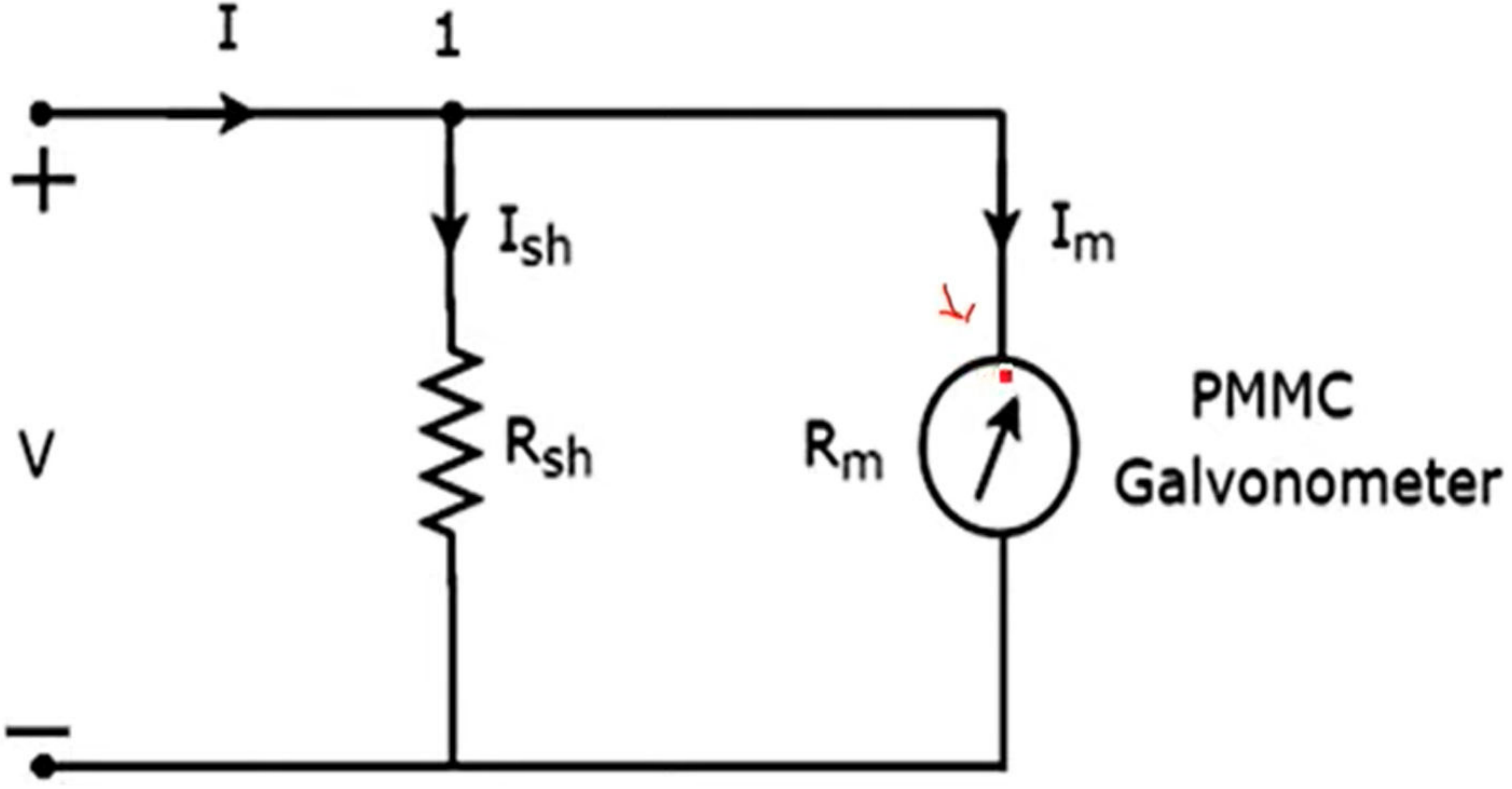
$A \rightarrow$ Area of the coil. (m^2)

$I \rightarrow$ current flowing (A)

$N \rightarrow$ no. of turns

$\tau \rightarrow wb \text{-} A.$

DC Ammeter



Referring to Fig.:

R_m = internal resistance of the movement

R_{sh} = shunt resistance

I_{sh}=shunt current

I_m= full scale deflection current of the movement

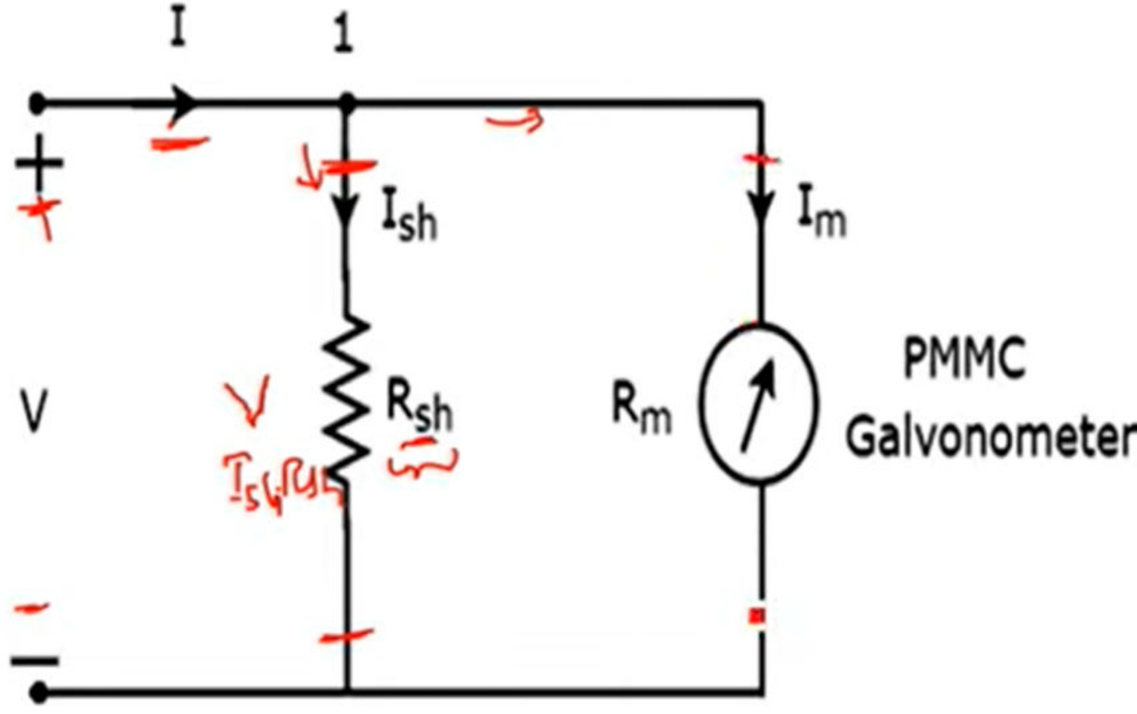
I = full scale current of the ammeter + shunt (i.e. total current)

voltage is same in parallel.

$$I_{sh} R_{sh} = I_m R_m$$

$$I_{sh} = I - I_m$$

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



Example Problem

1. A 1mA meter movement with an internal resistance of 100Ω is to be converted into a 0-100 mA. Calculate the value of shunt resistance required.

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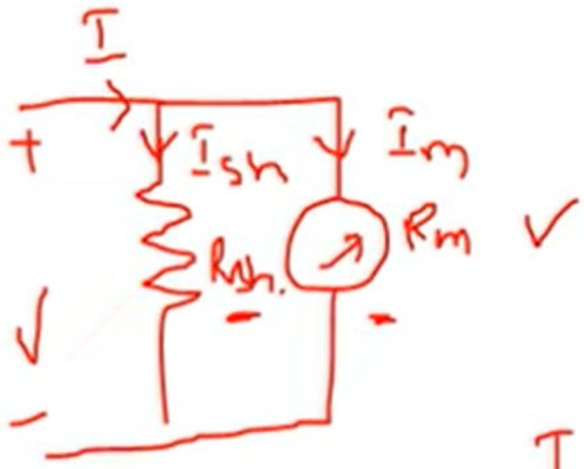
$I_m = 1mA, \quad R_m = 100\Omega, \quad I = 100\,mA.$

$$R_{sh} = \frac{I_m \cdot R_m}{I - I_m} = \frac{1\times10^{-3} \times 100}{100m - 1m} = \frac{0.1}{99m} = \underline{1.01\,\Omega}$$

$$\boxed{R_{sh} = 1.01\,\Omega}$$

DC multi-range ammeter



→ single.
↳ R_{sh}

$$I = I_{sh} + I_m$$

$$R_{sh} \downarrow \uparrow \rightarrow I_{sh} \uparrow \downarrow$$

DC multi-range ammeter

- The range of the dc ammeter is extended by a number of shunts, selected by a range switch.

- The resistors is placed in parallel to give different current ranges.

- Switch S (multi-position switch) protects the meter movement from being damage during range changing.

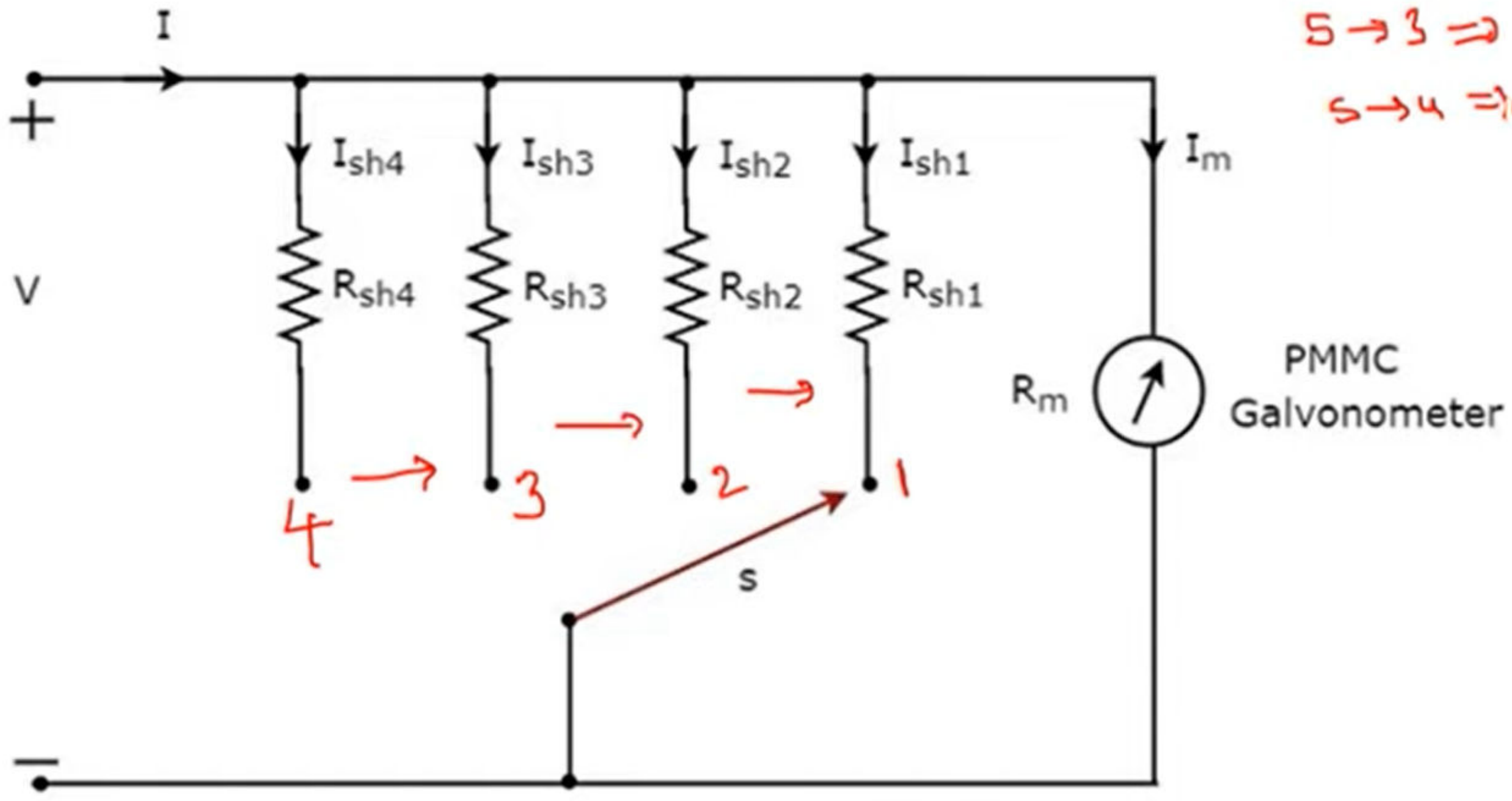
DC multi-range ammeter

$S \to 1 \Rightarrow R_{sh1}$

$S \to 2 \Rightarrow R_{sh2}$

$S \to 3 \Rightarrow R_{sh3}$

$S \to 4 \Rightarrow R_{sh4}$



Problems

1. A 1mA meter movement with an internal resistance of 100Ω is to be converted into a 0-10 mA, 50mA and 100mA. Calculate the value of shunt resistance required.

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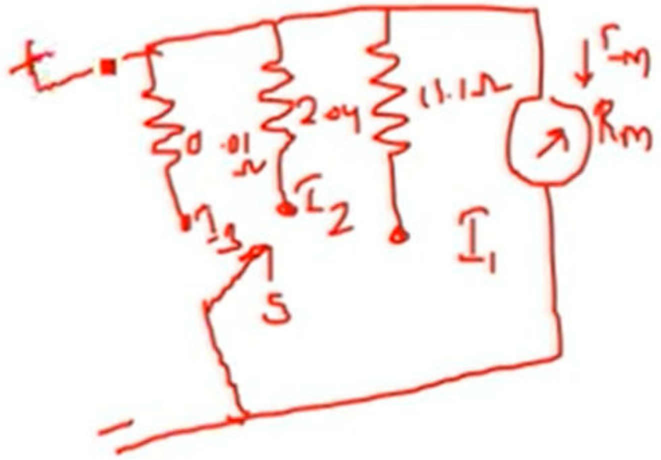
$I_m = 1mA$, $R_m = 100\Omega$, $I_1 = 10mA$, $I_2 = 50mA$, $I_3 = 100mA$.

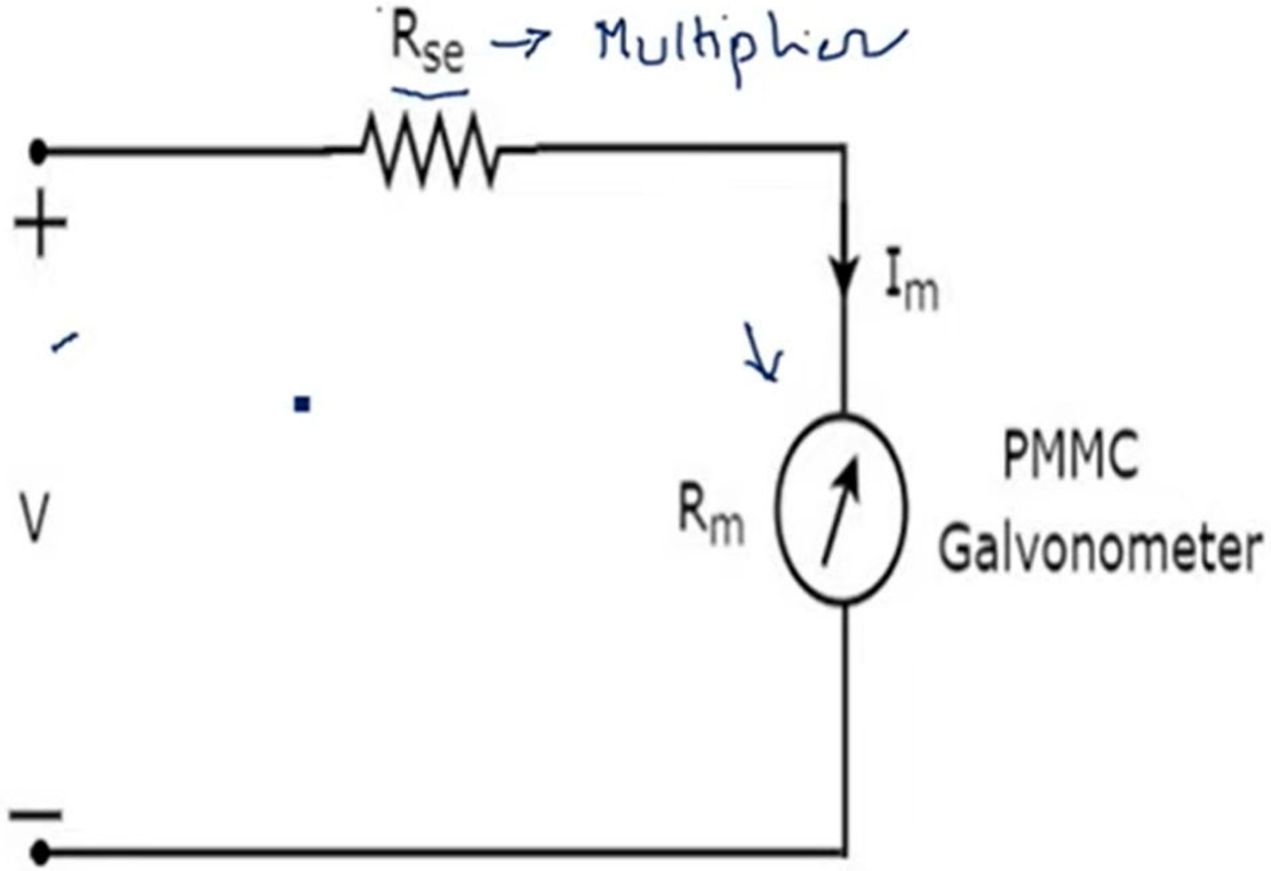


$$R_{sh_1} = \frac{I_m \cdot R_m}{I_1 - I_m} = \frac{1m \times 100}{10m - 1m} = \frac{0.1}{9m} = 11.1\Omega$$

$$R_{sh_2} = \frac{I_m \cdot R_m}{I_2 - I_m} = \frac{1m \times 100}{50m - 1m} = \frac{0.1}{49m} = 2.04\Omega$$

$$R_{sh3} = \frac{I_m \cdot R_m}{I_3 - I_m} = \frac{1m \times 100}{100m - 1m} = \frac{0.1}{99m} = 0.01\Omega.$$

DC Voltmeter



I_m =full scale deflection current the movement (I_{fsd})
R_m=internal resistance of th movement
R_s =multiplier resistance
V =full range voltage of th instrument

Calculation of Multiplier resistance

$R_{sh}(\underline{I}, I_m, R_m)$

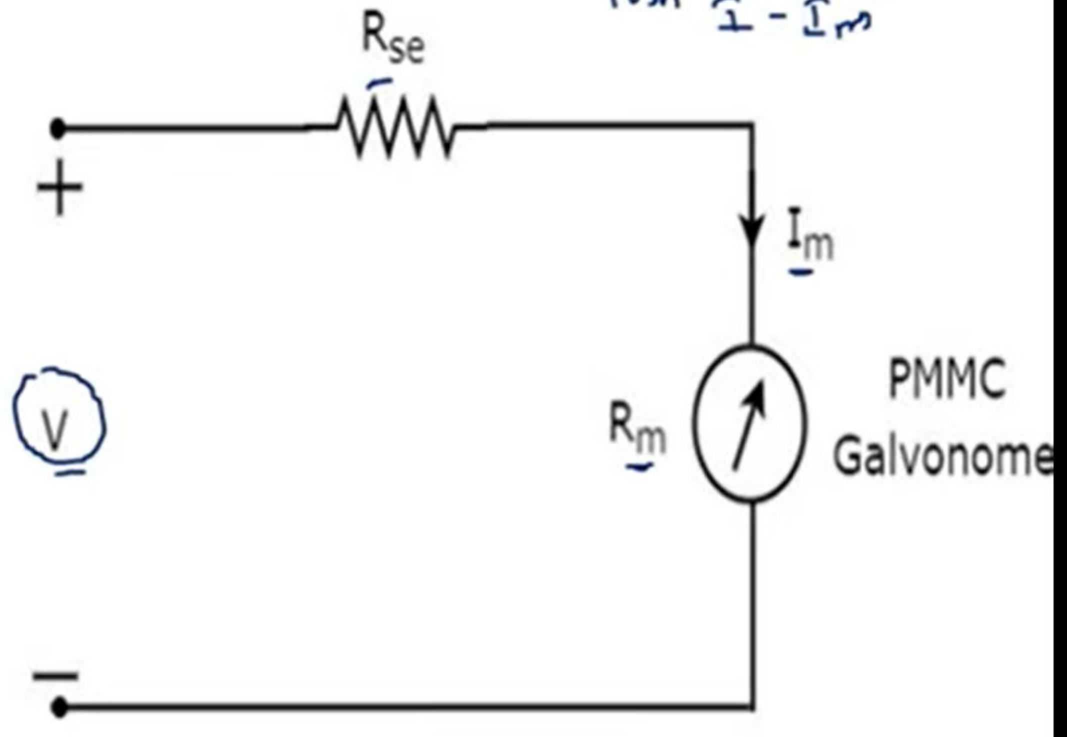
$R_{sh} = \frac{I_m \cdot R_m}{I - I_m}$

$$V = I_m(R_s + R_m)$$

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

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

$R_s(\underline{V}, I_m, R_m)$



Example problem

1. A basic D' Arsonval movement with a full-scale deflection of 50 uA and internal resistance of 500Ω is used as a DC voltmeter. Determine the value of the multiplier resistance needed to measure a voltage range of 0-10V.

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$I_m = 50\mu A$, $R_m = 500\Omega$, $V = 10V$, $R_s = ?$

$$R_s = \frac{V}{I_m} - R_m = \frac{10}{50 \times 10^{-6}} - 500$$

$$= 0.2 \times 10^{6} - 500$$

$$R_s = 199.5 K\Omega$$

$R_{sh} \rightarrow \Omega$

$R_s \rightarrow K\Omega$

Sensitivity

$S \propto \frac{1}{I_{fsd}}$ $S = \frac{1}{I_m}$

- Sensitivity and voltmeter range can be used to calculate the multiplier resistance, Rs of a DC voltmeter.

$$R_s = (S \times \text{Range}) - R_m$$

$R_s = \frac{V}{I_m} - R_m = S\underset{\text{Range}}{V} - R_m$

- From example:

$I_m = 50uA$, $R_m = 500\Omega$, Range=10V

Sensitivity,

$$S = \frac{1}{I_m} = \frac{1}{50uA} = 20k\Omega / V$$

So, $R_s = (20k\Omega/V \times 10V) - 500\ \Omega$

$= 199.5\ k\Omega$