Measurement System

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tutorial 2

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example 1

A 100 μA meter movement with an internal resistance of 800 Ω is used in 0-100 mA ammeter. Find the value of the required shunt resistance.

Here,

$$R_{sh} = \frac{I_m \cdot R_m}{I_{sh}}$$

$$R_{sh} = \frac{100 \times 10^{-6} \times 800}{100 \times 10^{-3} - 100 \times 10^{-6}}$$

$$R_{sh} = \frac{8 \times 10^{4} \times 10^{-6}}{100 \times 10^{-3} [1 - 1 \times 10^{3}]}$$

$$R_{sh} = \frac{8 \times 10^{-2}}{100 \times 10^{-3} \times 0.999}$$

$$R_{sh} = \frac{8 \times 10^{-2}}{0.99}$$

$$R_{sh} = \frac{8.080 \times 10^{-2}}{}$$

$$= 0.808 \text{ m}\Omega$$

Example 2

A PMMC instrument gives full scale deflection reading 25 mA when a potential difference across its terminal is 75 mV. show how it can be used (a) as an ammeter for the range of 0-100 A (b) as a voltmeter for the range of 0-750 V. Also find the multiplying factor of shunt & voltage amplification.

Instrument resistance Rm =

$$\frac{\text{Potential drop across terminals}}{\text{instrumental current}}$$

$$\therefore \frac{75 \times 10^{-3}}{25 \times 10^{-3}} = 3.\ \Omega.$$

a] current to be measured I = 100 mA.

Multiplying power of shunt Im =

$$= \frac{100}{25 \times 10^{-3}} = \underline{\underline{4000}}$$

shunt resistance required for full scale deflection 100 A:

$$R_{sh} = \frac{R_m}{m-1} = \frac{3}{3999}$$

$$= 7.5 \times 10^{-4}.$$

$$R_{sh} = 0.75\ m\Omega$$

b] Voltage to be measured V = 750 V

$$R_{se} = \frac{V}{I_m} - R_m = \frac{750}{20 \times 10^{-3}} - 3 = 29.997$$

Voltage application $= \frac{750}{75 \times 10^{-3}} = 10000$

Q3. A moving coil instrument gives a FSD. of 10 mA & potential difference across its terminal is 100 mV.

cal. (a) shunt resistance for FSD corresponding to 200 A (b) series resistance for full reading consumption to 1000 V.

Ans:-

Instrumen resistance Rm.

$$\text{potential drop across terminal} \over \text{instrument current}.$$

$$= \frac{100 \times 10^{-3}}{10 \times 10^{-3}} = 10\ \Omega.$$

a) shunt resistance required for FSD corresponding is 200 A.

$$R_{sh} = \frac{R_m}{\frac{I}{I_m} - 1} = \frac{10/200}{\frac{200}{100 \times 10^3} - 1}.$$

$$= -5.00025 \times 10^{-4}\ \Omega.$$

A series resistance required for fsd corresponding to 1000 V

$$R_{se} = \frac{V}{I_m} - R_m = \frac{1000}{10 \times 10^{-3}} - 10$$

$$= 99.990\ \Omega$$

Q.4 A Moving coil instrument having internal 50 Ω indicate fsd with a (current of 10 mA) How can it be made to work as 1> a voltmeter to read 100 V on full scale deflection
2> an ammeter of 1 A on full scale

internal resistance = 50 Ω
current flowing through the instrument fsd I_m = 10 mA = 0.01 A

series resistance required to measure $R_{se} = \frac{V}{I_m} - R_m$

$= \frac{100}{0.01} - 50$

$= 9950\ \Omega$

(ii) shunt required to measure 1 A current

$R_{sh} = \frac{R_m}{\frac{1}{I_m} - 1} = \frac{50}{\frac{1}{0.01} - 1} = 0.5050\ \Omega$

Q.5 A moving coil instrument has a resistance of 2 Ω & it leads upto 250 V when a resistance of 5000 Ω is connected in series with it find the current language other instrument when it is used as ammeter with the coil connected across a shunt resistance of 2 milli Ω

Ans:-

Resistance of the instrument coil 2Ω current flowing through the instrument for FSD

$$I_m = \frac{\text{full scale reading}}{R + \text{series resistance}}$$

$$= \frac{250}{2 + 35000}$$

$$= 0.04998 \text{ A}$$

shunt resistance $R_{sh} = 2 \times 10^{-3} \Omega$

current through shunt resistance

$$I_{sh} = \frac{I_m R_m}{R_s} = \frac{49.98 \times 10^{-3}}{2 \times 10^{-3}}$$

$$= 49.98$$

current range of instrument = full scale

Ans:- Resistance of the instrument coil 2Ω current flowing through the instrument for FSD

$$I_m = \frac{\text{full scale reading}}{R + \text{series resistance}}$$

$$= \frac{250}{2 + 5000}$$

$$= 0.04998 \text{ A}$$

shunt resistance $R_{sh} = 2 \times 10^{-3} \Omega$

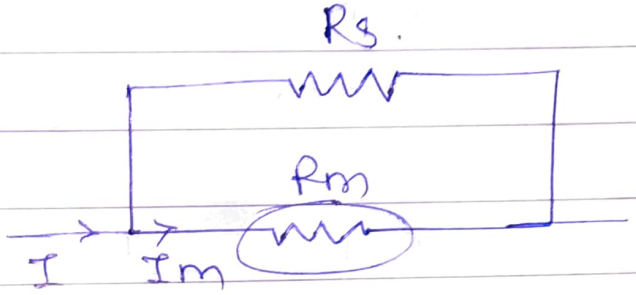
current through shunt resistance

$$I_{sh} = \frac{I_m R_m}{R_s} = \frac{49.98 \times 10^{-3}}{2 \times 10^{-3}}$$

$$= 49.98$$

current range of instrument = full scale.

Deflection current.



$= Im + I$

$= 0.04998 + 49.98$

$= 50\ A$.

Q.6 A moving coil ammeter gives fsd with 15 mA & has a resistance of 5Ω calculated the resistance to be calculated is as parallel to enable the instrument to read upto 1 A b) series to enable it to read upto 10 V.

instrument resistance Rm = 5Ω

fsd current $Im = 15\ mA = 15 \times 10^{-3} A$

current to be measured 1 A.

shunt resistance to be connected in parallel.

$$R_{sh} = \frac{R_m}{\frac{1}{I_m} - 1} = \frac{5}{\frac{1}{15 \times 10^{-3}} - 1} = 0.07614\ \Omega$$

voltage to be measured $V = 10V$

series resistance required

$$R_{se} = \frac{V}{I_m} - R_m$$

$$= \frac{10}{15 \times 10^{-3}} - 5$$

$$= 661.667\ \Omega$$