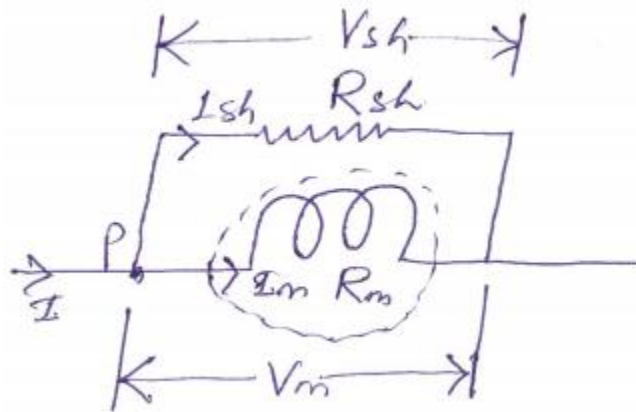**Subject** : Basic electrical engineering

Question : Discuss the use of shunt and multipliers in measuring instrument

Answer :

Shunt measuring instrument:

A low shunt resistance connected in parallel with the ammeter to extent the range of current. Large current can be measured using low current rated ammeter by using a shunt.

Let R_m = Resistance of meter

R_{sh} = Resistance of shunt

I_m = Current through meter

I_{sh} = Current through shunt

I = Current to be measure

$\therefore V_m = V_{sh}$ ...(1)

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

$$\frac{I_m}{I_{sh}} = \frac{R_{sh}}{R_m} \qquad \ldots(2)$$

Apply KCL at 'P' $I = I_m + I_{sh} \qquad \ldots(3)$

$Eq^n \left(3\right) \div by\, I_m$

$$\frac{I}{I_m} = 1 + \frac{I_{sh}}{I_m} \qquad \ldots(4)$$

$$\frac{I}{I_m} = 1 + \frac{R_m}{R_{sh}} \qquad \ldots(5)$$

$$\therefore I = I_m \left(1 + \frac{R_m}{R_{sh}}\right) \qquad \ldots(6)$$

$\left(1 + \dfrac{R_m}{R_{sh}}\right)$ is called multiplication factor

Shunt resistance is made of manganin. This has least thermoelectric emf. The change in resistance due to change in temperature is negligible.

Multiplier measuring instrument:

A large resistance connected in series with voltmeter is called multiplier. A large voltage can be measured using a voltmeter of small rating with a multiplier.
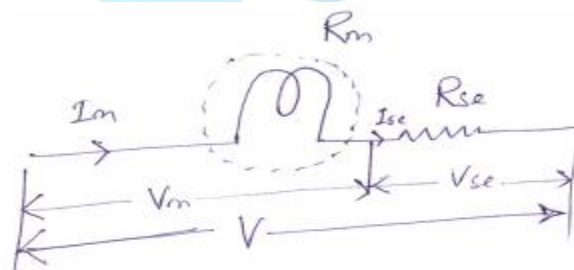
Let R_m = Resistance of meter

R_{se} = Resistance of multiplier

V_m = Voltage across meter

V_{se} = Voltage across series resistance

V = Voltage to be measured

$$I_m = I_{se} \qquad \ldots(1)$$

$$\frac{V_m}{R_m} = \frac{V_{se}}{R_{se}} \qquad \ldots(2)$$

$$\therefore \frac{V_{se}}{V_m} = \frac{R_{se}}{R_m} \qquad \ldots(3)$$

Apply KVL, $V = V_m + V_{se} \qquad \ldots(4)$

$Eqn(4) \div V_m$

$$\frac{V}{V_m} = 1 + \frac{V_{se}}{V_m} = \left(1 + \frac{R_{se}}{R_m}\right) \qquad \ldots(5)$$

$$\therefore V = V_m \left(1 + \frac{R_{se}}{R_m}\right) \qquad \ldots(6)$$

$$\left(1 + \frac{R_{se}}{R_m}\right) \rightarrow \text{Multiplication factor}$$