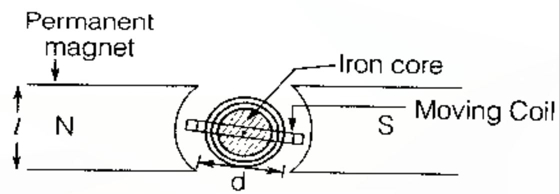
3

Galvanometers

D' Arsonval Galvanometer



- Deflecting torque

$$T_d = BiNA = Gi$$

where, B = Flux density in air gap; Wb/m^2
i = Current through moving coil; A
N = Number of turns in coil
A = ld = Area of coil; m^2
l, d = Length of vertical and horizontal side (width) of coil respectively; m
G = Displacement constant of galvanometer

- Controlling torque

$$T_c = K\theta_f$$

where, K = Spring constant of suspension; Nm/rad
θ_f = Final steady deflection of moving coil; rad

- Final steady deflection

$$\theta_f = \left(\frac{NBA}{K}\right)i = \left(\frac{G}{K}\right)i$$

Dynamic behaviour of Galvonometers

Torques in Galvonometers

- Inertia torque

$$T_j = J\frac{d^2\theta}{dt^2}$$

where, J = moment of inertia of moving system about the axis of rotation; $kg\text{-}m^2$,
θ = deflection at any time t; rad.

- Damping torque

$$T_D = D\frac{d\theta}{dt}$$

where, D = damping constant

- Controlling torque

$$T_C = K\theta$$

where, K = control constant

- Deflecting Torque

$$T_d = Gi$$

- Equation of motion

$$T_j + T_D + T_C = T_d$$

$$J\frac{d^2\theta}{dt^2} + \frac{Dd\theta}{dt} + K\theta = Gi$$

Note:

- If $D^2 < 4\,kJ$, galvanometer is underdamped.
- If $D^2 = 4\,kJ$, galvanometer is critically damped.
- If $D^2 > 4\,kJ$, galvanometer is overdamped.

- Total resistance of galvanometer circuit for critical damping

$$R = \frac{G^2}{2\sqrt{KJ}}$$

- External series resistance required for critical damping

$$R_e = R - R_g = \frac{G^2}{2\sqrt{KJ}} - R_g$$

where, R_g = Resistance of galvanometer

Sensitivity

- Current sensitivity

$$S_i = \frac{\theta_f}{i} = \frac{G}{K} \text{ rad/A}$$

$$S_i = \frac{d}{i \times 10^6} \text{ scale divisions/}\mu\text{A}$$

$$S_i = \frac{2000\,G}{K \times 10^6} \text{ mm/}\mu\text{A}$$

- Voltage sensitivity

$$S_v = \frac{d}{iR_g \times 10^6} \text{ scale division/}\mu\text{V}$$

- Megohm sensitivity

$$S_o = \frac{d}{i \times 10^{-6}} \text{ M}\Omega\text{/scale division}$$

Remember:

Sensitive galvanometer is one which produces a large deflection for a small current.