Control System Laboratory

Elect. Engg. Dept.
IIT Kharagpur

Experiment No – 1

<u>Study of Galvanometer</u>

Objective:

(i). Finding galvanometer Constants.
(ii). Finding Transient Response of Galvanometer.
(iii). Finding Frequency Response of Galvanometer.

(i) Finding Galvanometer Constants

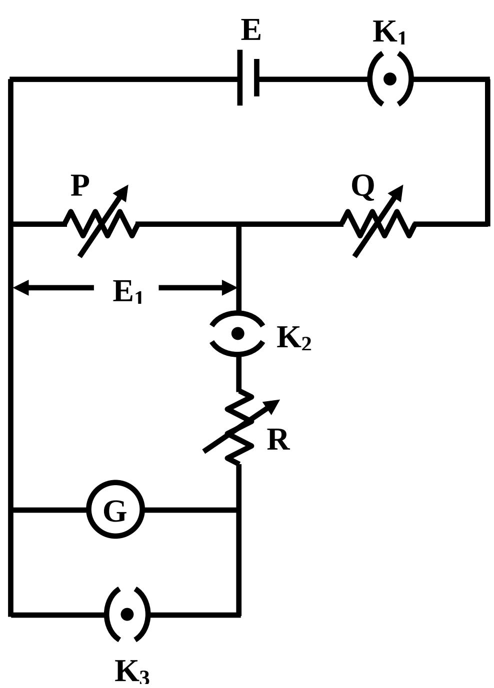

Fig. 1

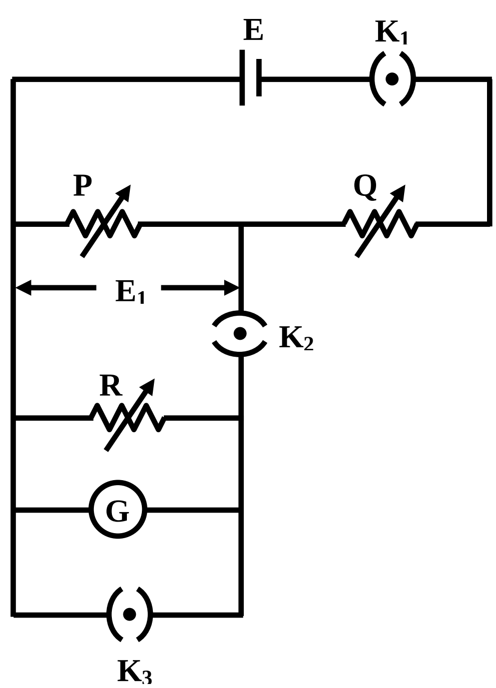

Fig. 2

a) To determine free period T of the galvanometer on open circuit, keep R = 0, and get a deflection of 20cms on the scale by adjusting P and Q in Fig. 1. Then open K_2 and find the time (in seconds) taken for a few oscillations. $\therefore$T = time/no of oscillations.

b) To determine coil resistance R_c (in ohms) of the galvanometer, keep R = 0, and get a deflection of 20cms on the scale by adjusting P and Q in Fig. 1. Then increase R gradually so that the deflection is 10cms. This of R is R_c.

c) To determine sensitivity S (in radians per ampere) of the galvanometer, keep R + R_c a convenient value in Fig. 1, get the deflections corresponding to few different values of P.

The deflection of the coil in radian measure

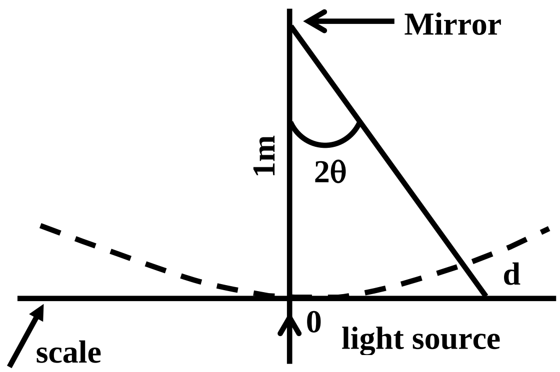

Fig. 3

is $\theta = \frac{d_{mm}}{2*1000}$ if $2\theta \leq 10^{o}$

or $\theta = \frac{1}{2}\tan{-1}\left(\frac{dmm}{1000}\right)$ if $20 < 10^{o}$

plot θ vs galvanometer current I_g. Obtain current sensitivity S from the slope of the curve. Since P<<Q

$$I_g = \frac{E_1}{R+R_c} \quad \text{Where } E_1 \square \frac{E*P}{P+Q}$$

d) To determine external resistance R_s for critical damping of the galvanometer close keys K_1 and K_2 in Fig. 2, and when the deflection is 20cms, open K_2. Now observe the movement of the light spot on the scale. First adjust R so as to obtain oscillatory motion, and then decrease R until the motion just ceases to be oscillatory. Note down the value of R for R_s.

Calculate the galvanometer constants from

Displacement constant $G = \frac{T\left(R_c + R_s\right)}{\pi S} mw - m / amp$

Roatorating constant $C = \frac{T\left(R_c + R_s\right)}{\pi S^2} nw - m / rad$

Movement of inertia of the moving system, $a = \frac{T^3\left(R_c + R_s\right)}{4\pi^3 S^2} kg - m^2$

(ii) Finding Transient Response of Galvanometer

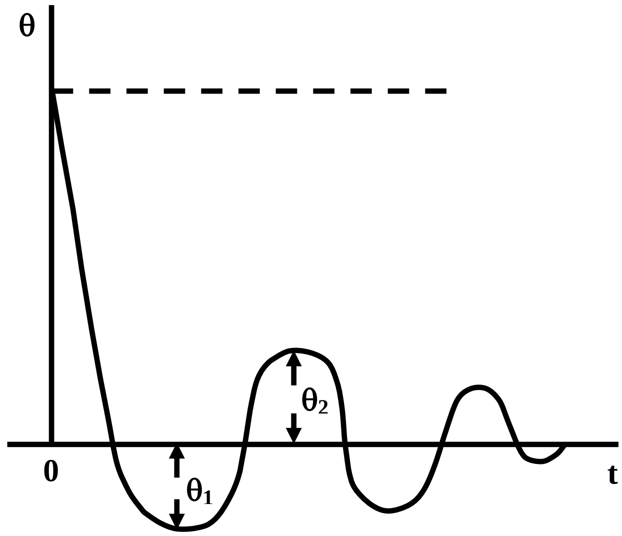

Fig. 4

(a) Refer to Figs. 1 and 4. Note deflections θ_1 and θ_2 for two consecutive swings of the galvanometer under open circuit damping ratio

$$\delta_0 = \frac{1}{\pi}\log_e\left(\frac{\theta_1}{\theta_2}\right)$$

(b) Refer to Fig. 1 and 5 set different values for damping ratio δ using the formula

$$\delta = \delta_0 + \frac{G^2/R}{2\sqrt{ac}}$$

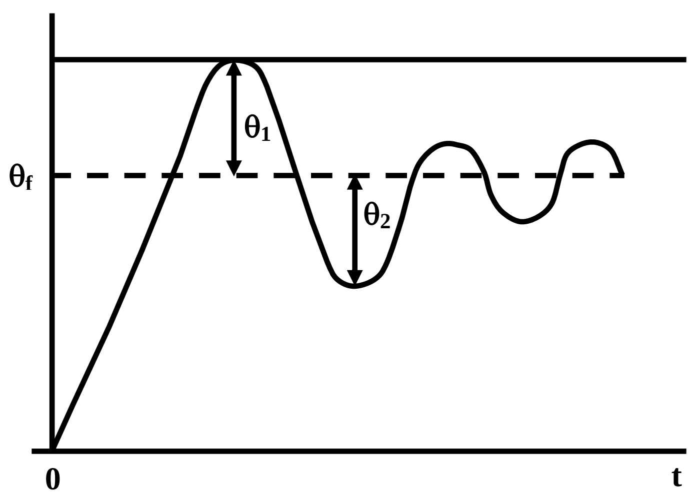

Fig. 5

and for each value of R so set, note first throw θ_1 and final steady deflection θ. In each case calculate percent maximum overshoot using the formula

percent maximum overshoot $= \dfrac{\theta_1 - \theta_f}{\theta_f} X100$

plot percent maximum overshoot verses δ

(iii) Finding frequency response of Galvanometer

Replace d.c. source by a low frequency function generator with output in sine wave mode. Natural frequency of the galvanometer is approximately given by $\omega_n = \dfrac{2_n}{T} rad/\mathrm{sec}$

(a) For $\delta = 0.2$, very frequency in the range $\dfrac{\omega_n}{20} \le \omega \le 20\omega_n$ and note amplitude of oscillation on the scale. The frequency must be varied in small steps since the amplitude of oscillations falls off sharply on either side of ω_n. Plot amplitude of oscillations verse $\log_{10}^{w}$ repeat the above for δ = 0.4, 0.6, 0.8 and 1.0.