CHAPTER – 2
INDICATING INSTRUMENTS

01. Ans: (c)

Sol: $I_m = 10mA$ $R_m = 1000\,\Omega$ m=?

$R_{sh} = \frac{R_m}{m-1} \Rightarrow m-1 = \frac{R_m}{R_{sh}} = \frac{1000}{100} = 10$

m = 10 +1 = 11

02. Ans: (b)

Sol: Because of aging effect the magnetic field intensity $\left(\vec{H}\right)$ in the permanent magnet gets reduced.

03. Ans: (c)

Sol: In PMMC instrument current passes through springs & Aluminum frame.

06. Ans: (b)

Sol: The Torque/weight ratio of an indicating instrument must be high, the higher the ratio the better will be its performance.

07. Ans: (a)

Sol: $T_d \propto I$ballistic Galvanometer is similar to D'arsonval galvanometer

09. Ans: (d)

Sol: Jewels are made up of sapphire from the bearings.

10. Ans: (b)

Sol: Indicating instrument must have damping of little less than under damp & little more than critical damped.

11. Ans: (a)

Sol: $R = \frac{V}{I}$ for m.c. $T_d \,\alpha\, I$

So $R \,\alpha\, \frac{1}{I}$ So hyperbolic

12. Ans: (b)

Sol: To get high accuracy meter should have linear scale (hand drawn scale).

13. Ans: (b)

Sol: The two helical springs are made up of phosphor bronze which is having less coefficient of temperature, so it compensates for temperature changes.

14. Ans: (c)

Sol: $T_c = 0$ $(0-10)A$ m.c

Moving parts are free to rotate the pointer will rotate continuously.

16. Ans: (d)

Sol: If meter works on the principle of magnetic field eddy current damping (PMMC) or electromagnetic damping is used.

17. Ans: (b)

Sol: Fluid friction damping is used for vertically mounted instruments otherwise fluid will comes out.

19. Ans: (b)

Sol: wrong data in question $T_c = K\theta \Rightarrow K = \dfrac{Ebt^3}{12l}$; E = Young's modulus

$\ell = 370 \times 10^{-9}$ m b = width of spring

t = 0.51 × 10^{-3} m, $E = 112.8 \times 10^9 \dfrac{N}{m^2}$ t = thickness of spring

$\theta = 90^o$ $b = 0.51 \times 10^{-3}$ m d = length of the spring

$$K = \frac{Ebt^3}{12l} = \frac{7.6311 \times 10^{-2}}{2 \times 370 \times 10^{-9}} = 0.0103 \times 10^7$$

$$T_c = k\theta$$

$$= 0.0103 \times 10^7 \times \frac{\pi}{2}$$

20. Ans: (b)

Sol: $w = 5\,gms = \dfrac{5}{1000} = 5kg$

$\theta = 60^o$ $T_d = T_c$

$wl \sin\theta = 1.13 \times 10^{-3}$

l = 260.96mm

21. Ans: (b)

Sol: $I = 1\mu A$; $K = 2 \times 10^{-6} \dfrac{Nm}{rad}$; $G = 2\dfrac{Nm}{A}$

$T_c = T_d$

$K\theta = GI$ (Where K is in meters)

$\theta = 2000 \dfrac{GI}{K} = \dfrac{2000 \times 2 \times 1 \times 10^{-6}}{2 \times 10^{-6}}$ (Where K is in millimeter)

$= 2000$mm

22. Ans: (c)

Sol: logarithmic decrement $\lambda = \dfrac{\Pi \xi}{\sqrt{1-\zeta^2}}$

$$\lambda = \frac{\Pi(0.8)}{\sqrt{1-(o.8)^2}} = 4.186$$

All the best urs venugopal

24. Ans: (d)

Sol: Critical damping $G_C = 2\sqrt{KJ}$

25. Ans: (a)

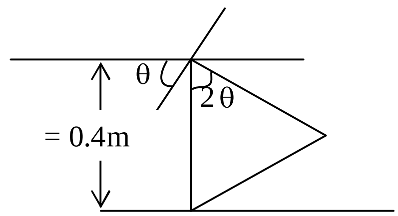
Sol: A ballistic galvanometer should have long time period usually 10 to 15 sec. The moment of inertia 'J' of the moving system should be large control constant of suspension 'k' is small damping of galvanometer should be small, the amplitude of first swing is large and later the coil comes to rest by electromagnetic damping.

27. Ans: (a)

Sol: $d = 1000\,\text{mm} \times 2\theta$

$d = 0.4 \times 10^3 \times 2\theta$

$\theta = \frac{44}{800} = 55 \times 10^{-3}\,\text{rad}$



28. Ans: (b)

Sol: $k\theta = G\,i$

$k = \frac{G\,i}{\theta}$

$\theta = \frac{1}{2r} = \frac{1}{2} \times \frac{1}{1000} = 0.5 \times 10^{-3}\,\text{rad}$

$k = \frac{5 \times 10^{-3} \times 0.001 \times 10^{-6}}{0.5 \times 10^{-3}} = 10 \times 10^{-9}\ \frac{\text{N-m}}{\text{rad}}$

36. Ans: (e)

Sol: The spring used should be

(1) non-magnetic

(2) low specific resistance

(3) low temperature coefficient

(4) not be subjected to fatigue

43. Ans: (d)

Sol: $T_c = 16 \times 10^{-6}\ \text{N} - \text{m}$ $\qquad \theta = 120^{\text{O}}$

b & l are double, t is half

$T_c = k\theta$

$T_c = \frac{Ebt^3}{121}\theta$

$T_c\ \alpha\ \frac{bt^3}{\ell}$

$\frac{T_{c1}}{T_{c2}} = \frac{b_1 t_1^3 / \ell_1}{b_2 t_2^3 / \ell_2} \Rightarrow \frac{16 \times 10^{-6}}{T_{c2}} = \frac{b_1 t_1 / \ell_1}{2b_1 t_1 12 / 2\ell_1}$

$\frac{T_{c1}}{T_{c2}} = \frac{b_1 t_1^3}{\ell_1} \times \frac{\ell_2}{b_2 t_2^3}$

$$\frac{16\times10^{-6}}{T_{c2}}=\frac{b_1t_1^3}{\ell_1}\times\frac{2\ell_1}{2b_1\frac{t_1^3}{8}}$$

$T_{c2} = 2 \times 10^{-6}$ N -m

46. Ans: (c)

Sol: $T_d = T_c$

$T_d = BINA \qquad T_c = k\theta$

$k\theta = BINA = GI$

$10\times10^{-6}\theta = 2\times10^{-6}\times2$

$\theta = \frac{4}{10} = 215 = 0.4$

47. Ans: (a)

Sol: $f = \frac{1}{2\pi}\sqrt{K/J}$

$K/J = (2\pi f)^2 = (314)^2 = 98596$

49. Ans: (a)

Sol: Current sensitivity with scale 1m away is 100 mm/μA

$S_v = \frac{d}{i\times Rg\times10^{-6}}\,mm/\mu v$

$= \frac{100}{1\times10^{-6}\times200\times10^{-6}} = \frac{1}{2} = 0.5\,mm/\mu v$

Current required for a deflection of 1mm is 0.01 μA

Mega ohm sensitivity $= \frac{1}{0.01\times10^{-6}} = 100\,M\Omega/mm$

50. Ans: (c)

Sol: G = NBA = NBld

$= 300\times0.1\times20\times10^{-6}\times25\times10^3 = 15\times10^3$

For critical damping $D = 2\sqrt{KJ}$

$= 2\sqrt{0.2\times10^{-6}\times0.15\times10^{-6}}$

$= 0.346\times10^{-6}$ N – m / rad sec

If this electromagnetic damping $D = \frac{G^2}{R}$

$R = \frac{G^2}{D} = \frac{(15\times10^{-3})^2}{0.346\times10^{-6}} = 650\ \Omega$

External resistance for critical damping is $R - R_g$ = 650-200
= 450 Ω

51. Ans: (b)

Sol: G = NBA = NBld

$= 250 \times 0.1 \times 30 \times 30 \times 10^{-6}$

$= 22.5 \times 10^{-3}$

i) for critical damping

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

$$R = \frac{\left(22.5\times10^{-3}\right)^2}{2\sqrt{0.15\times10^{-6}\times0.2\times10^{-6}}} = 1460\Omega$$

External resistance required is = R – Rg

= 1460 – 460

= 1 kΩ

ii) for relative damping

$$\varepsilon = \frac{D}{D_c} = \frac{G^2/\text{resisance of ckt}}{G^2/R\ \text{for Critical damping}} = \frac{\left(22.5\times10^{-3}\right)^2 \big/ (1970+460)}{\left(22.5\times10^{-3}\right)\big/1460}$$

$$= \frac{1460}{2430} = 0.6008$$

52. Ans: (b)

Sol: $T_d = T_c$

$$K\theta = B\,I\,N\,\ell\,d$$

$$\theta = \frac{10\times10^{-3}\times1\times10^{-6}\times200\times16\times10^{-3}\times16\times10^{-3}}{12\times10^{-9}}$$

$$= 0.0427\,\text{rad}$$