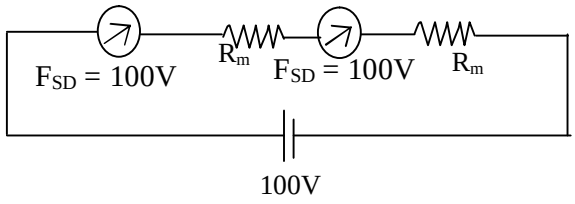
CHAPTER-3
MEASUREMENT OF VOLTAGE & CURRENT

01. Ans: (b)
Sol: In the question For a **full wave rectifier** rms = average value

= 100v

04. Ans: (d)
Sol:

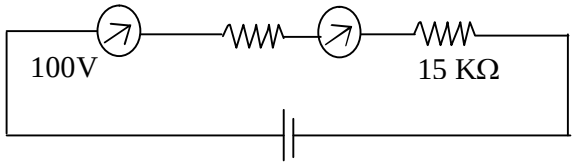


The two voltmeters are connected in series so the current is same so both the voltmeters indicate equal readings because they have same internal resistances.

05. Ans: (b)
Sol: PMMC instrument has linear scale
FSD – 0.1 mA
$\frac{1}{2}$ FSD – 0.05mA

Two mark questions

43. Ans: (c)
Sol:



Resistance of meter A is 100×100 = 10,000 = 10 KΩ
Total Resistance = $R_A + R_B$ = 10KΩ + 15KΩ = 25KΩ
Voltmeter A reading is 100v for a resistance of 10KΩ by voltage division the voltmeter B reading is 150v for a resistance of 15 kΩ
Total voltage = 100v +150v = 250 volts

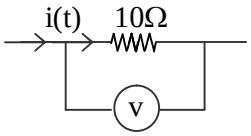
45. Ans: (d)
Sol: $u(t) = 5 + 10 \cos (314 + 30^0)$
MI instrument reads RMS value & it is used for both A.C & D.C

$V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{10}{\sqrt{2}} = 5\sqrt{2}$

Voltmeter reading = $\sqrt{5^2 + (5\sqrt{2})^2} = \sqrt{75}$ V

47. Ans: (a)

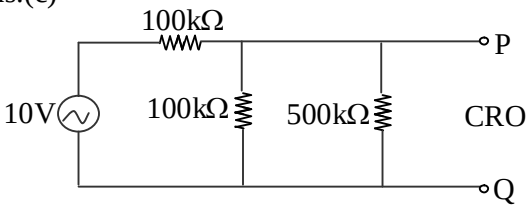
Sol: PMMC instrument measure average value

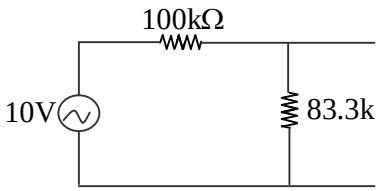


$$\frac{12\times10+5\times10}{2}=\frac{120+50}{2}=\frac{170}{2}=85\,\text{volts}$$

48. Ans:(c)

Sol:





By Voltage division

$$V_{83.3k\Omega}=\frac{10\times83.3K}{100K+83.3K}$$

$$=4.54\ \text{Volts}$$

49. Ans: (a)

Sol: N = 100

l = 10mm b = 20 mm

B = 200 mT $\theta = 90^0$

I = 50 mA

$T_d = BINA$

$= 200\times10^{-3}\times50\times10^{-3}\times100\times10\times10^{-3}\times20\times10^{-3}$

$= 200\times10^{-6}$ N-m

$= 200\ \mu$N-m

50. Ans: (b)

Sol: $T_d = 240\ \mu Nm$ $\theta = 120^0$ I = 10A

$\frac{dL}{d\theta}$ = ?

$$T_d=\frac{1}{2}I^2\frac{dL}{d\theta}$$

$$\frac{dL}{d\theta}=\frac{2T_d}{I^2}=\frac{2\times240\times10^{-6}}{10^2}=4.8\ \mu H/\text{rad}$$

53. Ans: (b)

Sol: $S_{AC\ H(w)} = \dfrac{R_{V\ H(w)}}{V_{rms}\ FSD}$

$= \dfrac{0.45\dfrac{V_{rms\ FSD}}{I_{DC\ FSD}}}{V_{rms\,FSD}} = 0.45 \times \dfrac{1}{I_{DCFSD}}$

$= 0.45\ S_{DC}$

54. Ans: (c)

Sol: $S_{V(H\omega)} = 0.45 S_{DC}$

$= 0.45 \times 10 k\Omega/V = 4.5 k\Omega/V$

55. Ans: (c)

Previous IES questions

01. Ans: (b)

Sol: (0-150)V G.A.E = 1%

$150 \times \dfrac{1}{100} = 1.5V$

$75 \times \dfrac{x}{100} = 1.5 \Rightarrow x = \dfrac{100 \times 1.5}{75} = 2\%$

12. Ans: (a)

Sol: $I = 3 + 4\sqrt{2}\ \sin 314t$

Pmmc instrument used only for D.C so I = 3A

13. Ans: (c)

Sol: Given V = 8V

$S = \dfrac{2k\Omega}{V}$ for 10V scale meter:

$\Rightarrow R_V = 2 \times 10 \Rightarrow 20\ k\Omega$

Before inserting meter

$I = \dfrac{8}{1k\Omega} \Rightarrow 8mA$

After inverting meter

$R_V || 1k\Omega = 0.9523\ k\Omega$

$\therefore V = 8 \times 10^{-3} \times 0.9523$

$= 7.62\ V$

16. Ans: (b)

Sol: $I = 2+4 \sin 314t$

Hot wire instrument are used for both A.C & D.C & measures RMS values.

$I_{rms} = \dfrac{I_m}{\sqrt{2}} = \dfrac{4}{\sqrt{2}} = 2\sqrt{2}$

$I = \sqrt{2^2 + (2\sqrt{2})^2} = 2\sqrt{3} = 3.46A$

17. Ans: (d)

Sol: (0-250)V G.A.E 1%
For 100V L.E----?

$250\times \frac{1}{100} = 2.5$ V

$100 \times \frac{x}{100} = 2.5 \Rightarrow x = \frac{2.5\times 100}{100} = 2.5\%$

21. Ans: (b)

Sol: M.I instrument $T_d \alpha I^2$, spring control
1 mA -----100V $T_C \alpha \theta$
0.5 mA-------?
All the instruments are current measuring instruments

$\frac{V_1^2}{V_2^2} = \frac{I_1^2}{I_2^2}$

$\frac{V_1}{V_2} = \frac{I_1}{I_2} \Rightarrow \frac{100}{V_2} = \frac{1\times 10^{-3}}{0.5\times 10^{-3}} \Rightarrow V_2 = 100 \times 0.5 = 50$ V

23. Ans: (a)

Sol: (0-200) V G.A.E = 1%
50 V ----- L.E = ?

$200 \times \frac{1}{100} = 2$ Volts

$50 \times \frac{x}{100} = 2 \Rightarrow x = \frac{2\times 100}{50} = 4\%$

34. Ans: (c)

Sol: A rectifier instrument measures rms value
meter reads $\rightarrow$ 100V
But indicating $\rightarrow$ 111V

35. Ans: (b)

Sol: $R_{sh} = 0.55\ \Omega$ $R_m = 5\Omega$ $I_m = 1$ mA

$R_{sh} = \frac{R_m}{m-1} \Rightarrow m-1 = \frac{5}{0.55}$

$m = \frac{5}{0.55} + 1$

$\frac{I}{I_m} = 10.09$

$I = 10.09 \times 1\times 10^{-3}$
$= 10.09$ mA.

39. Ans: (a)

Sol: PMMC will read only DC values. Sol the voltmeter reading is oscillates around zero

Previous Gate questions

03. Ans: (d)

Sol: In Pmmc instrument the current passes through Spring & the coil, when one of the spring is snap it will be an open circuit i.e I = 0

07. Ans: (d)

Sol: sensitivity = 1000Ω/volt
Full scale value = 100V
Half full scale value = 50 V

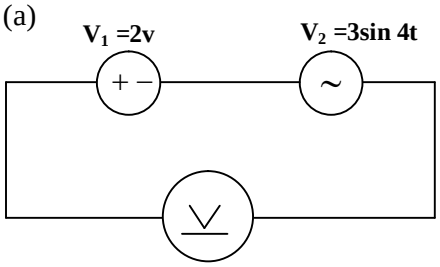
$I = \frac{V}{R}$ $\quad$ sensitivity = $\frac{1}{I_{f.s.d}}$

$I_{f.s.d} = \frac{1}{1000} = 0.1mA$

$I = \frac{50}{1000 \times 100} = 0.5mA$

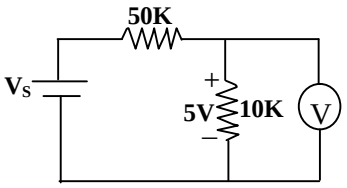
09. Ans: (a)

Sol:



Pmmc instruments are used to measure D.C only so voltmeter reads only 2V

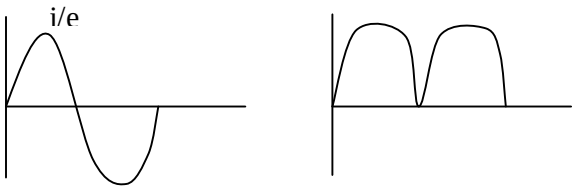
10. Ans: (a)



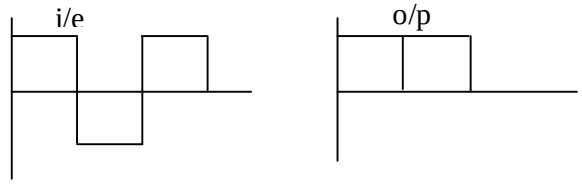
Sol: Voltmeter F.S.D = 10V
S_V = 1000Ω/volt
R_m = 1000×10 = 10 k Ω
By voltage division
For 10KΩ_____ 5V
For 50KΩ_____ 25V
So supply voltage
V_s = 5 + 25 = 30 V (∵ KVL)

11. Ans: (b)

Sol:



Form factor = 1.11



Form factor = $\frac{1}{1.11}$.

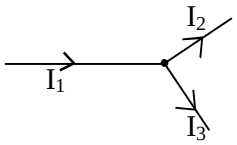
12. Ans: (c)

Sol: $I_1 = 100$ mA

$I_2 = 99$ mA

Accuracy = 1%

$I_3 = ?$



By KCL

$I_1 + (-I_2) = I_3$

$100\text{mA} \pm 1\% - 99\text{mA} \pm 1\% = I_3$

$I_3 = 1\text{mA} \pm 2\%$

15. Ans: (c)

Sol: $L = 10 + 3\theta - \frac{\theta^2}{4}\,\mu H$

$\frac{dL}{d\theta} = 0 + 3 - \frac{2\theta}{4}\,\mu H = 3 - \frac{\theta}{2}\,\mu H$

$K = 25 \times 10^{-6}$ N-m/rad

$I = 5A$

$T_d = \frac{1}{2} I^2 \frac{dl}{d\theta} \qquad T_c = K\theta$

$T_d = T_c$

$\theta = \frac{1}{k} \frac{1}{2} I^2 \frac{dL}{d\theta}$

$\theta = \frac{5^2 \times (3 - \frac{\theta}{2}) \times 10^{-6}}{2 \times 25 \times 10^{-6}}$

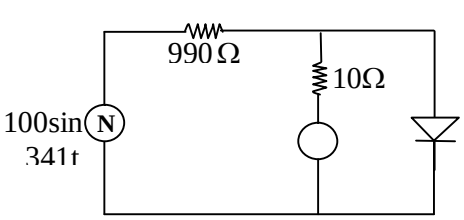
$2\theta + \frac{\theta}{2} = 3$

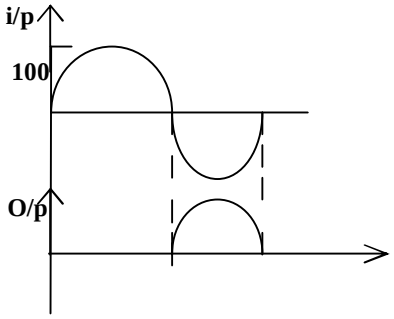
$\theta = \frac{6}{5} = 1.2$ rad

17. Ans; (c)

Sol: Under Forward bias diode resistance is Zero

Under Reverse bias diode resistance is ∞





$$V_{10\Omega} = \frac{-10\times\frac{100}{\pi}}{990+10} = \frac{1}{\pi}$$

$$I = \frac{-V}{R}$$

$$= \frac{\frac{1}{\pi}}{10} = \frac{1}{10\pi}$$

$$= -31.84 \text{ mA}$$

18. Ans: (a)

Sol: N = 100 l = 10 mm b = 20 mm

$\theta = 90^0$ B = 200 mT I = 50 mA

$T_d = BINA$

$= 200 \times 10^{-3} \times 50 \times 10^{-3} \times 100 \times 10 \times 10^{-3} \times 20 \times 10^{-3}$

$= 200\mu Nm$

21. Ans: (b)

Sol: $S_V = 500\Omega/V$

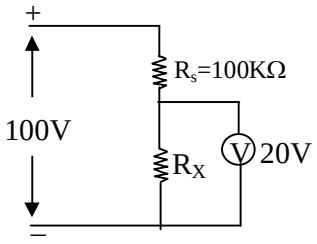
F.S.D = 100V

$R_m = 500 \times 100 = 50\ K\Omega$

Voltmeter reading = 20 v

In parallel branches voltage is same

So $R_x = 50\ k\Omega$



22. Ans: (c)

Sol: Input Ac rms = 100 v, I = 1 mA

$$V_{rms} = \frac{V_m}{\sqrt{2}}$$

$V_m = 100\sqrt{2}$ volts

For a full wave rectifier

$$V_{dc} = \frac{2V_m}{\pi} = \frac{2\times100\sqrt{2}}{\pi} = 90.063 \text{ volts}$$

Applying KVL

$90.063 = R_S (1\times10^{-3}) + 100\ (1\times10^{-3})$

$R_S = \dfrac{90.063 - 0.1}{10^{-3}} = 89.96\,k\Omega$

23. Ans: (c)

Sol: $I = \left[-6\sin 100\Lambda t + 6\sqrt{2}\cos(300t + \sqrt{2}) + 6\sqrt{2}\right]A$

$\sqrt{\left(\dfrac{-6}{\sqrt{2}}\right)^2 + \left(\dfrac{6\sqrt{2}}{\sqrt{2}}\right)^2 + \left(6\sqrt{2}\right)^2} = \sqrt{126}$

24. Ans: (a)

Sol: $R_{sh} = \dfrac{R_m}{m-1} = \dfrac{100\times10^{-3}/2}{\dfrac{10}{2}-1}$

$R_{sh} = \dfrac{50\times10^{-3}}{4} = 12.5\,m\Omega$ (Ans : a)

25. Ans: (b)

Sol: $R_m = 100\Omega$ $I_{f.s} = 1$ mA

$R_{se} = R_m (m-1)$

$= R_m \left(\dfrac{V}{V_m} - 1\right)$

$= 100\left(\dfrac{10}{0.1} - 1\right) = 9900\Omega$

$= 9.9k\Omega.$