

CHAPTER-8

MEASUREMENT OF POWER & ENERGY

01. Ans: (b)

Sol: $W_1 = 2000\text{watt}$ $W_2 = 500\text{w}$ $\text{Cos}\theta=?$

$$\theta = \text{Tan}^{-1} \left[\sqrt{3} \left(\frac{W_1 - W_2}{W_1 + W_2} \right) \right]$$

$$= \text{Tan}^{-1} \left[\sqrt{3} \left(\frac{2000 - 500}{2000 + 500} \right) \right] = \text{Tan}^{-1} \left[\sqrt{3} \left(\frac{1500}{2500} \right) \right]$$

$$\theta = 46.102$$

$$\text{Cos}\theta = \text{Cos } 46.102^\circ = 0.693$$

02. Ans:(a)

Sol: The electro dynamometer type of wattmeter the fixed coil or current coil is fixed.

03. Ans: (c)

Sol: For measurement of power in poly phase system with 'n' no. of conductors the no. of watt meters required are (n-1)

06. Ans: (b)

Sol: When there is no current flowing through the current coil & only pressure coil is energized & there is a continuous rotation of disc & it is due to over – compensation for friction., over voltage & vibrations.

07. Ans: (b)

Sol: Light load adjustments for energy meter are done at 5% of Full load.

10. Ans: (d)

Sol: 1 hour = 3600 sec \Rightarrow

$$\text{Meter constant (K)} = \frac{\text{revolutions}}{\text{energy}}$$

$$= \frac{10}{0.45 \times 100 / 3600} = 800\text{rev / kwh}$$

12. Ans: (c)

Sol: $\phi = 60$

$$\text{Cos}\phi = \text{Cos}60 = 1/2 = 0.5$$

As the P.F (Cos ϕ) is 0.5 one of the wattmeter reads zero & other wattmeter Indicates total power

$$I_{ph} = I_L = \frac{100\angle 0^\circ}{\sqrt{3} \times 5\angle 60^\circ} = \frac{20}{\sqrt{3}} \angle -60^\circ$$

$$\Rightarrow \phi = 60^\circ$$

$$W_1 = V_L I_L \cos(30 + \phi)$$

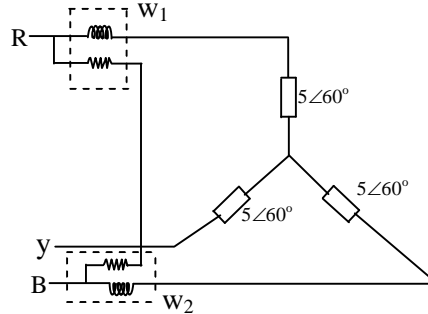
$$= 100 \times \frac{20}{\sqrt{3}} \cos 90 = 0$$

$$W_2 = V_L I_L \cos(30 - \phi)$$

$$= 100 \times \frac{20}{\sqrt{3}} \cos 30$$

$$= 100 \times \frac{20}{\sqrt{3}} \times \frac{\sqrt{3}}{2}$$

$$= 1000 \text{ W}$$



14. Ans: (b)

Sol: $A_t = VI \text{Cos}\phi$

$$= (220)(20)(0.6)$$

$$A_t = 2640$$

$$A_m = VI \text{Cos}\phi + I^2 R_{C.C}$$

$$= 2640 + (20)^2 (0.03)$$

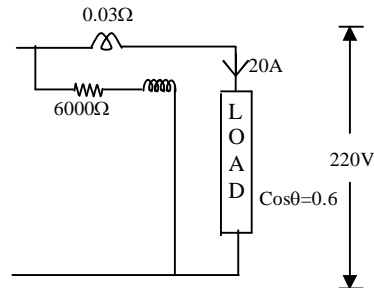
$$= 2652$$

$$\% \text{error} = \frac{A_m - A_t}{A_t} \times 100$$

$$= \frac{2652 - 2640}{2640} \times 100$$

$$= \frac{12}{2640} \times 100$$

$$= 0.45\%$$

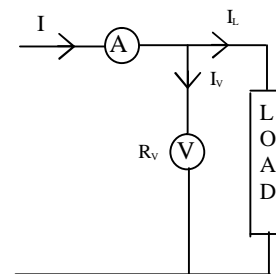


15. Ans: (a)

Sol: error = $VI \text{Sin}\phi \text{ Tan}\beta$, $\text{Cos}\phi = 0$

$$\text{Tan}\beta = \frac{\omega L}{R} = \frac{2\pi f L}{R} = \frac{2\pi(50)(5 \times 10^{-3})}{3000} = \frac{1.57}{3000}$$

$$\text{Error} = \left(\frac{1.57}{3000} \right) = 0.523 \text{ watt}$$



16. Ans: (b)

Sol: Current through voltmeter, $I_V = \frac{V}{R_V}$

$$\begin{aligned} \text{Power consumed by load} &= VI_L \\ &= V(I - I_V) \\ &= VI - \frac{V^2}{R_V} \end{aligned}$$

Power consumed by load = power Indicated by Instruments – Power loss in voltmeter

17. Ans: (b)

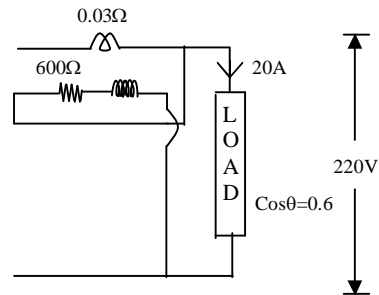
Sol: True power $A_t = VI \cos\phi$
 $= (220)(20)(0.6)$
 $= 2640$

$A_m = A_t + \text{power loss across pressure coil}$

$$\% \text{ errors} = \frac{A_m - A_t}{A_t} \times 100$$

$$\% \text{ errors} = \frac{\text{Power loss across P.C.}}{A_t} \times 100$$

$$\begin{aligned} &= \frac{V^2/R}{A_t} \times 100 = \frac{220^2/6000}{2640} \times 100 \\ &= 0.305\% \end{aligned}$$



18. Ans: (b)

Sol: Energy consumed at half load during 69 sec is.

$$\begin{aligned} VI \cos\theta \times t \times 10^{-3} &= 230 \times 5 \times 1 \times \frac{138}{3600} \times 10^{-3} \\ &= 44.08 \times 10^{-3} \text{ kwh} \end{aligned}$$

$$\begin{aligned} \text{Energy recorded} &= \frac{\text{revolutions made}}{\text{revolutions/kwh}} = \frac{80}{1800} \\ &= 44.4 \times 10^{-3} \text{ kwh} \end{aligned}$$

$$\% \text{ error} = \frac{44.44 - 44.08}{44.08} \times 100 = 0.817\% \text{ fast.}$$

20. Ans: (d)

Sol: F.S.D. = 2500W

Error = ±1% of true value

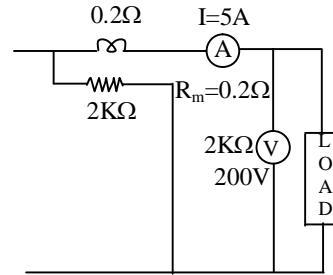
$$\begin{aligned} \text{For } 1250W \pm 1\% &= 1250 \pm 12.5 W \\ &= 1237.5 - 1262.5 W \end{aligned}$$

Previous IES Questions

01. Ans: (d)

Sol: **For M.C short**

$$\begin{aligned}
 P_m &= P_t + (\text{Power loss in c.c.} + \text{Power loss in ammeter}) \\
 &= 200 \times 5 + I^2 R_c + I^2 R_a \\
 &= 200 \times 5 + 25(0.2) + 25(0.2) \\
 &= 1010\text{W}
 \end{aligned}$$



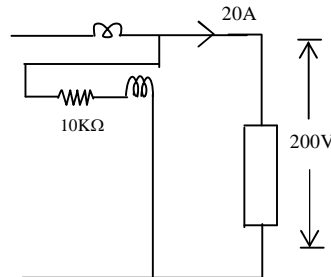
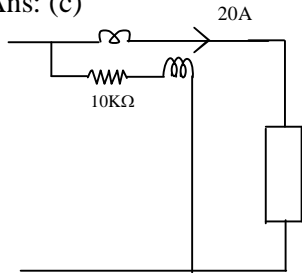
06. Ans: (a)

Sol: $w_1 = 3k\omega$ $w_2 = 1k\omega$

$$\begin{aligned}
 \phi &= \text{Tan}^{-1} \left[\sqrt{3} \left(\frac{w_1 + w_2}{w_1 - w_2} \right) \right] \\
 &= \text{Tan}^{-1} \left[\sqrt{3} \left(\frac{4}{2} \right) \right] \Rightarrow \phi = 73.89 \\
 \phi &= 0.277
 \end{aligned}$$

07. Ans: (c)

Sol



$$\begin{aligned}
 VI + I^2 R_{c.c} &= VI + \frac{V^2}{R_{p.c}} \\
 (200)(20) + (20)^2 (R_{c.c}) &= (200)(20) + \frac{200^2}{10K} \\
 R_{c.c} &= \frac{(200)^2}{(10K)(20)^2} = 0.01\Omega
 \end{aligned}$$

13. Ans: (b)

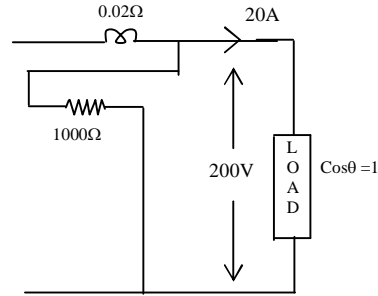
Sol: $w_2 = 2w_1$

$$\begin{aligned}
 \phi &= \text{Tan}^{-1} \left[\sqrt{3} \left(\frac{w_2 - w_1}{w_2 + w_1} \right) \right] & \phi &= \text{Tan}^{-1} \left[\sqrt{3} \left(\frac{2w_1 - w_1}{2w_1 + w_1} \right) \right] \\
 \phi &= \text{Tan}^{-1} \left(\frac{1}{\sqrt{3}} \right) \Rightarrow \phi = 30^\circ \Rightarrow \text{Cos}\phi = \text{Cos}30^\circ = \frac{\sqrt{3}}{2}
 \end{aligned}$$

Previous GATE Questions

12. Ans: (c)

$$\begin{aligned} \text{Sol: } \% \text{ error} &= \frac{A_m - A_t}{A_t} \times 100 \\ &= \frac{4000 + (20)^2(0.02) - 4000}{4000} \times 100 \\ &= 0.2 \% \text{ more} \end{aligned}$$



19. Ans: (a)

Sol: $w_2 = 0$

$$\phi = \text{Tan}^{-1} \left[\sqrt{3} \left(\frac{w_1 - w_2}{w_1 + w_2} \right) \right]$$

$$\phi = \text{Tan}^{-1} \left[\sqrt{3} \left(\frac{w_1 - 0}{w_1 + 0} \right) \right] \Rightarrow \phi = 60^\circ$$

$$\text{Cos}\phi = \text{Cos}60 = 1/2 = 0.5$$