Alternating Current

SET Self Evaluation Test - 24

1. A bulb and a capacitor are in series with an ac source. On increasing frequency how will glow of the bulb change

(a) The glow decreases (b) The glow increases

(c) The glow remain the same (d) The bulb quenches

2. The *r.m.s.* current in an ac circuit is 2 *A*. If the wattless current be $\sqrt{3}A$, what is the power factor

(a) $\frac{1}{\sqrt{3}}$ (b) $\frac{1}{\sqrt{2}}$

(c) $\frac{1}{2}$ (d) $\frac{1}{3}$

3. $\frac{2.5}{\pi}\mu F$ capacitor and 3000-*ohm* resistance are joined in series to an ac source of 200 *volt* and $50\,sec^{-1}$ frequency. The power factor of the circuit and the power dissipated in it will respectively

(a) 0.6, 0.06 *W* (b) 0.06, 0.6 *W*

(c) 0.6, 4.8 *W* (d) 4.8, 0.6 *W*

4. The self inductance of a choke coil is 10 *mH*. When it is connected with a 10*V* dc source, then the loss of power is 20 *watt*. When it is connected with 10 *volt* ac source loss of power is 10 *watt*. The frequency of ac source will be

(a) 50 *Hz* (b) 60 *Hz*

(c) 80 *Hz* (d) 100 *Hz*

5. In an *LCR* circuit $R = 100$ *ohm*. When capacitance *C* is removed, the current lags behind the voltage by $\pi/3$. When inductance *L* is removed, the current leads the voltage by $\pi/3$. The impedance of the circuit is

(a) 50 *ohm* (b) 100 *ohm*

(c) 200 *ohm* (d) 400 *ohm*

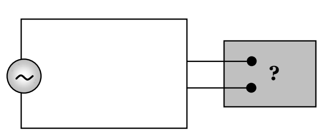
6. A group of electric lamps having a total power rating of 1000 *watt* is supplied by an ac voltage $E = 200\sin(310t + 60°)$. Then the *r.m.s.* value o the circuit current is

(a) 10 *A* (b) $10\sqrt{2}\,A$

(c) 20 *A* (d) $20\sqrt{2}\,A$

7. Following figure shows an ac generator connected to a "block box" through a pair of terminals. The box contains possible *R*, *L*, *C* or their combination, whose elements and arrangements are not known to us. Measurements outside the box reveals that

e = 75 sin (sin ω t) *volt*, i = 1.5 sin (ωt + 45°) *amp* then, the wrong statement is



(a) There must be a capacitor in the box

(b) There must be an inductor in the box

(c) There must be a resistance in the box

(d) The power factor is 0.707

8. A resistor *R*, an inductor *L* and a capacitor *C* are connected in series to an oscillator of frequency *n*. if the resonant frequency is n_r, then the current lags behind voltage, when

(a) $n = 0$ (b) $n < n_r$

(c) $n = n_r$ (d) $n > n_r$

9. If power factor is 1/2 in a series *RL* circuit $R = 100\,\Omega$. ac mains is used then *L* is

(a) $\frac{\sqrt{3}}{\pi}$ *Henry* (b) π *Henry*

(c) $\frac{\pi}{\sqrt{3}}$ *Henry* (d) None of these

10. What will be the self inductance of a coil, to be connected in a series with a resistance of $\pi\sqrt{3}\,\Omega$ such that the phase difference between the emf and the current at 50 *Hz* frequency is 30°

(a) 0.5 *Henry* (b) 0.03 *Henry*

(c) 0.05 *Henry* (d) 0.01 *Henry*

11. The phase difference between the voltage and the current in an ac circuit is $\pi/4$. If the frequency is 50 *Hz* then this phase difference will be equivalent to a time of

(a) 0.02 *s* (b) 0.25 *s*

(c) 2.5 *ms* (d) 25 *ms*

12. The instantaneous values of current and emf in an ac circuit are $I = 1/\sqrt{2}\sin 314\,t$ *amp* and $E = \sqrt{2}\sin(314\,t - \pi/6)V$ respectively. The phase difference between *E* and *I* will be

(a) $-\pi/6$ *rad* (b) $-\pi/3$ *rad*

(c) $\pi/6$ *rad* (d) $\pi/3$ *rad*

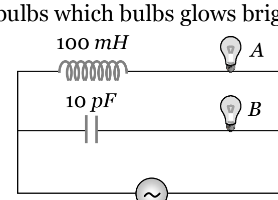
13. If *A* and *B* are identical bulbs which bulbs glows brighter

(a) *A*

(b) *B*

(c) Both equally bright

(d) Cannot say



14. The instantaneous values of current and voltage in an ac circuit are $i = 100\sin 314\,t$ *amp* and $e = 200\sin(314\,t + \pi/3)V$ respectively. If the resistance is 1Ω then the reactance of the circuit will be

(a) $-200\sqrt{3}\,\Omega$ (b) $\sqrt{3}\,\Omega$

(c) $-200/\sqrt{3}\,\Omega$ (d) $100\sqrt{3}\,\Omega$

15. What is the *r.m.s.* value of an alternating current which when passed through a resistor produces heat which is thrice of that produced by a direct current of 2 amperes in the same resistor

(a) 6 *amp* (b) 2 *amp*

(c) 3.46 *amp* (d) 0.66 *amp*

Answers and Solutions

(SET -24)

1. (b) This is because, when frequency ν is increased, the capacitive reactance $X_C = \frac{1}{2\pi\nu C}$ decreases and hence the current through the bulb increases.

2. (c) $i_{WL} = i_{rms}\sin\phi \Rightarrow \sqrt{3} = 2\sin\phi \Rightarrow \sin\phi = \frac{\sqrt{3}}{2}$

$\Rightarrow \phi = 60^o$ so p.f. $= \cos\phi = \cos 60^o = \frac{1}{2}$.

3. (c) $Z = \sqrt{R^2 + \left(\frac{1}{2\pi\nu C}\right)^2} = \sqrt{(3000)^2 + \frac{1}{\left(2\pi \times 50 \times \frac{2.5}{\pi} \times 10^{-6}\right)^2}}$

$\Rightarrow Z = \sqrt{(3000)^2 + (4000)^2} = 5 \times 10^3\,\Omega$

So power factor $\cos\phi = \frac{R}{Z} = \frac{3000}{5 \times 10^3} = 0.6$ and power $P = V_{rms}i_{rms}\cos\phi = \frac{V_{rms}^2\cos\phi}{Z} \Rightarrow P = \frac{(200)^2 \times 0.6}{5 \times 10^3} = 4.8W$

4. (c) With dc : $P = \frac{V^2}{R} \Rightarrow R = \frac{(10)^2}{20} = 5\,\Omega$;

With ac : $P = \frac{V_{rms}^2 R}{Z^2} \Rightarrow Z^2 = \frac{(10)^2 \times 5}{10} = 50\,\Omega^2$

Also $Z^2 = R^2 + 4\pi^2\nu^2L^2$

$\Rightarrow 50 = (5)^2 + 4(3.14)^2\nu^2(10 \times 10^{-3})^2 \Rightarrow \nu = 80\,Hz$.

5. (b) When C is removed circuit becomes RL circuit hence

$\tan\frac{\pi}{3} = \frac{X_L}{R}$ .....(i)

When L is removed circuit becomes RC circuit hence

$\tan\frac{\pi}{3} = \frac{X_C}{R}$ .....(ii)

From equation (i) and (ii) we obtain $X_L = X_C$. This is the condition of resonance and in resonance $Z = R = 100\Omega$.

6. (b) $P = \frac{1}{2}V_0 i_0\cos\phi \Rightarrow 1000 = \frac{1}{2} \times 200 \times i_0 \cos 60^o$

$\Rightarrow i_0 = 20\,A \Rightarrow i_{rms} = \frac{i_0}{\sqrt{2}} = \frac{20}{\sqrt{2}} = 10\sqrt{2}\,A$.

7. (b) Since voltage is lagging behind the current, so there must be no inductor in the box.

8. (d) The current will lag behind the voltage when reactance of inductance is more than the reactance of condenser. Thus, $\omega L > \frac{1}{\omega C}$ or $\omega > \frac{1}{\sqrt{LC}}$

or $n > \frac{1}{2\pi\sqrt{LC}}$ or $n > n_r$ where n_r = resonant frequency.

9. (a) $\cos\phi = \frac{1}{2} \Rightarrow \phi = 60^o$ $\tan 60^o = \frac{\omega L}{R} \Rightarrow L = \frac{\sqrt{3}}{\pi}H$

10. (d) $\tan\phi = \frac{X_L}{R} = \frac{2\pi\nu L}{R} \Rightarrow \tan 30^o = \frac{2\pi \times 50 \times L}{\pi\sqrt{3}} = 0.01\,H$.

11. (c) Time difference $= \frac{T}{2\pi} \times \phi = \frac{(1/50)}{2\pi} \times \frac{\pi}{4} = \frac{1}{400}s = 2.5\,m\text{-}s$

12. (a) Phase difference relative to the current

$\phi = (314\,t - \frac{\pi}{6}) - (314\,t) = -\frac{\pi}{6}$

13. (a) $\because (X_C) >> (X_L)$

14. (b) $V_0 = i_0 Z \Rightarrow 200 = 100\,Z \Rightarrow Z = 2\Omega$

Also $Z^2 = R^2 + X_L^2 \Rightarrow (2)^2 = (1)^2 + X_L^2 \Rightarrow X_L = \sqrt{3}\Omega$

15. (c) Heat produced by ac = 3 × Heat produced by dc

$\therefore i_{rms}^2 Rt = 3 \times i^2 Rt \Rightarrow i_{rms}^2 = 3 \times 2^2$

$\Rightarrow i_{rms} = 2\sqrt{3} = 3.46\,A$

***