Alternating Currents

1. **The power is transmitted from a power house on high voltage ac because**

(a) Electric current travels faster at higher *volts*

(b) It is more economical due to less power wastage

(c) It is difficult to generate power at low voltage

(d) Chances of stealing transmission lines are minimized

2. **The potential difference *V* and the current *i* flowing through an instrument in an ac circuit of frequency *f* are given by $V = 5\cos\omega t$ *volts* and $I = 2\sin\omega t$ *amperes* (where $\omega = 2\pi f$). The power dissipated in the instrument is**

(a) Zero (b) 10 *W*

(c) 5 *W* (d) 2.5 *W*

3. **Alternating current(A.C.) can not be measured by D.C. ammeter because**

(a) A.C. cannot pass through D.C. ammeter

(b) Average value of complete cycle is zero

(c) A.C. is virtual

(d)A.C. changes its direction

4. **In an ac circuit, peak value of voltage is 423 *volts*. Its effective voltage is**

(a) 400 *volts* (b) 323 *volts*

(c) 300 *volts* (d) 340 *volts*

5. **In an ac circuit $I = 100\sin 200\pi t$. The time required for the current to achieve its peak value will be**

(a) $\frac{1}{100}\,sec$ (b) $\frac{1}{200}\,sec$

(c) $\frac{1}{300}\,sec$ (d) $\frac{1}{400}\,sec$

6. **An alternating current is given by the equation** $i = i_1 \cos \omega t + i_2 \sin \omega t$ **. The *r.m.s.* current is given by**

(a) $\frac{1}{\sqrt{2}}(i_1 + i_2)$ (b) $\frac{1}{\sqrt{2}}(i_i + i_2)^2$

(c) $\frac{1}{\sqrt{2}}(i_1^2 + i_2^2)^{1/2}$ (d) $\frac{1}{2}(i_1^2 + i_2^2)^{1/2}$

7. **The phase angle between e.m.f. and current in *LCR* series ac circuit is**

(a) 0 to $\pi / 2$ (b) $\pi / 4$

(c) $\pi / 2$ (d) π

8. **Current in the circuit is wattless, if**

(a) Inductance in the circuit is zero

(b) Resistance in the circuit is zero

(c) Current is alternating

(d) Resistance and inductance both are zero

9. **An alternating current of frequency** $'f'$ **is flowing in a circuit containing a resistance *R* and a choke *L* in series. The impedance of this circuit is**

(a) $R + 2\pi fL$ (b) $\sqrt{R^2 + 4\pi^2 f^2 L^2}$

(c) $\sqrt{R^2 + L^2}$ (d) $\sqrt{R^2 + 2\pi fL}$

10. **A resonant ac circuit contains a capacitor of capacitance** $10^{-6} F$ **and an inductor of** $10^{-4} H.$ **the frequency of electrical oscillations will be**

(a) $10^5\ Hz$ (b) $10\ Hz$

(c) $\frac{10^5}{2\pi} Hz$ (d) $\frac{10}{2\pi} Hz$

11. **Power delivered by the source of the circuit becomes maximum when**

(a) $\omega L = \omega C$ (b) $\omega L = \frac{1}{\omega C}$

(c) $\omega L = -\left(\frac{1}{\omega C}\right)^2$ (d) $\omega L = \sqrt{\omega C}$

12. In a *LCR* circuit having *L* = 8.0 *henry*, *C* = 0.5 μF and *R* = 100 *ohm* in series. The resonance frequency in *per second* is

(a) 600 *radian* (b) 600 *Hz*

(c) 500 *radian* (d) 500 *Hz*

13. In *LCR* circuit, the capacitance is changed from *C* to 4*C*. For the same resonant frequency, the inductance should be changed from *L* to

(a) $2L$ (b) $L/2$

(c) $L/4$ (d) $4L$

14. 4.In a series *LCR* circuit, operated with an ac of angular frequency ω, the total impedance is

(a) $[R^2+(L\omega-C\omega)^2]^{1/2}$

(b) $\left[R^2+\left(L\omega-\frac{1}{C\omega}\right)^2\right]^{1/2}$

(c) $\left[R^2+\left(L\omega-\frac{1}{C\omega}\right)^2\right]^{-1/2}$

(d) $\left[(R\omega)^2+\left(L\omega-\frac{1}{C\omega}\right)^2\right]^{1/2}$

15. For series *LCR* circuit, wrong statement is

(a) Applied e.m.f. and potential difference across resistance are in same phase.

(b) Applied e.m.f. and potential difference at inductor coil have phase difference of $\pi/2$.

(c) Potential difference at capacitor and inductor has phase difference of $\pi/2$.

(d) Potential difference across resistance and capacitor has phase difference of $\pi/2$.

16. In a purely resistive *ac* circuit, the current

(a) Lags behind the e.m.f. in phase

(b) Is in phase with the e.m.f.

(c) Leads the e.m.f. in phase

(d) Leads the e.m.f. in half the cycle and lags behind it in the other half

17. The current in series *LCR* circuit will be maximum when ω is

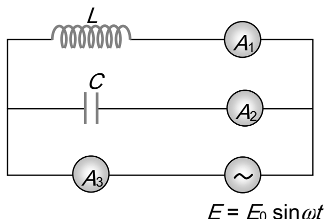
(a) As large as possible

(b) Equal o natural frequency of *LCR* system

(c) $\sqrt{LC}$

(d) $\sqrt{1/LC}$

18. An inductor *L* and a capacitor *C* are connected in the circuit as shown in the figure. The frequency of the power supply is equal to the resonant frequency of the circuit. Which ammeter will read zero ampere



(a) A_1 (b) A_2

(c) A_3 (d) None of these

19. [A]: In LCR series circuit, current is maximum at resonance.

[R]: In LCR series circuit, impedance is minimum at resonance.

a) Both Assertion and Reason are true and reason is correct explanation of Assertion.

b) Both Assertion and Reason are true but reason is not the correct explanation of Assertion.

c) Assertion is true but reason is false.

d) Both assertion and reason are false.

20. [A]: If $X_c < X_L$, the phase factor is negative.

[R]: If $X_c < X_L$; current lags behind emf.

a) Both Assertion and Reason are true and reason is correct explanation of Assertion.

b) Both Assertion and Reason are true but reason is not the correct explanation of Assertion.

c) Assertion is true but reason is false.

d) Both assertion and reason are false.

21. [A]: Electric power is transmitted over long distances through conducting wires at high voltage.

[R]: A Power loss is less when power is transmitted at high voltage.

a) Both Assertion and Reason are true and reason is correct explanation of Assertion.

b) Both Assertion and Reason are true but reason is not the correct explanation of Assertion.

c) Assertion is true but reason is false.

d) Both assertion and reason are false.

22. The voltage of an a.c source varies with time according to the relation $E = 120 \sin 100\pi t \cos 100\pi t$. Then

i) The peak voltage of the source is 120 V

ii) The peak voltage = 60 V

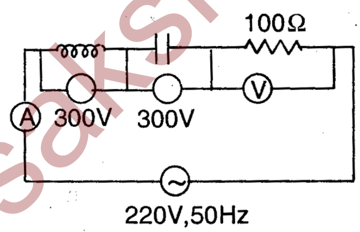
iii) The peak voltage = $120/\sqrt{2}$ V

iv) The frequency of source voltage is 100 Hz

a) i) and ii) are correct b) ii) and iii) are correct

d) ii) and IV) are correct c) i) and iii) are correct

23. In the circuit shown below what will be the reading of the voltmeter and ammeter?



a) 2.2 A b) 1.2 A c) 4.2 A d) 0.5 A

Key

1) b	2) a	3) b	4) c	5) d	6) c	7) a	8) b	9) b	10) c
11) b	12) c	13) c	14) b	15) c	16) b	17) d	18) c	19) a	20) a
21) a	22) c	23) a							

Hints

1. Power loss $\propto \frac{1}{(\text{Voltage})^2}$

2. $V = 5\cos\omega t = 5\sin\left(\omega t + \frac{\pi}{2}\right)$ and $i = 2\sin\omega t$

   Power $= V_{r.m.s.} \times i_{r.m.s.} \times \cos\phi = 0$

   (Since $\phi = \frac{\pi}{2}$, therefore $\cos\phi = \cos\frac{\pi}{2} = 0$)

3. In *dc* ammeter, a coil is free to rotate in the magnetic field of a fixed magnet.

   If an alternating current is passed through such a coil, the torque will reverse its direction each time the current changes direction and the average value of the torque will be zero.

4. Effective voltage $V_{r.m.s.} = \frac{V_o}{\sqrt{2}} = \frac{423}{\sqrt{2}} = 300\ V$

5. The current takes $\frac{T}{4}$ *sec* to reach the peak value.

   In the given question $\frac{2\pi}{T} = 200\pi \Rightarrow T = \frac{1}{100} sec$

   $\therefore$ Time to reach the peak value $= \frac{1}{400} sec$

6. $i_{rms} = \sqrt{\frac{i_1^2 + i_2^2}{2}} = \frac{1}{\sqrt{2}}(i_1^2 + i_2^2)^{1/2}$

7. (a)

8. Because power $= i^2R,$ if R = 0, then P = 0.

9. $Z = \sqrt{R^2 + X_L^2},\ X_L = \omega L$ and $\omega = 2\pi f$

$\therefore Z = \sqrt{R^2 + 4\pi^2 f^2 L^2}$

10. $\nu = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{10^{-6} \times 10^{-4}}} = \frac{10^5}{2\pi} Hz$

11. (b)

12. Resonance frequency in *radian/second* is

$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{8 \times 0.5 \times 10^{-6}}} = 500\ rad/sec$

13. $\omega = \frac{1}{\sqrt{L_1 C_1}} = \frac{1}{\sqrt{L_2 C_2}} \Rightarrow L_2 = \frac{L_1}{4}$

14. (b)

15. (c)

16. (b)

17. At resonant frequency current in series *LCR* circuit is maximum.

18. (c)

19. **a**

20. **a**

21. **a**

22. **c**

23. $V = \sqrt{V_R^2 + (V_L - V_C)^2}$

$220 = \sqrt{V_R^2 + (300 - 300)^2} \Rightarrow V_R = 220V$

So reading in voltmeter = 220V

V = i R $\Rightarrow 220 = i \times 100 \Rightarrow$ i = 2.2 A.

D.C Circuits

1. **Why the current does not rise immediately in a circuit containing inductance**

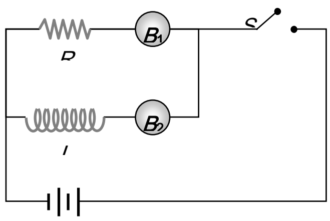
(a) Because of induced emf

(b) Because of high voltage drop

(c) Because of low power consumption

(d) Because of Joule heating

2. **The adjoining figure shows two bulbs B_1 and B_2 resistor R and an inductor L. When the switch S is turned off**



(a) Both B_1 and B_2 die out promptly.

(b) Both B_1 and B_2 die out with some delay.

(c) B_1 dies out promptly but B_2 with some delay.

(d) B_2 dies out promptly but B_1 with some delay.

3. **In L-R circuit, for the case of increasing current, the magnitude of current can be calculated by using the formula**

(a) $I = I_0 e^{-Rt/L}$ (b) $I = I_0(1 - e^{-Rt/L})$ (c) $I = I_0(1 - e^{Rt/L})$ (d) $I = I_0 e^{Rt/L}$

4. **A capacitor is fully charged with a battery. Then the battery is removed and coil is connected with the capacitor in parallel, current varies as**

(a)Increases monotonically (b) Decreases monotonically

(c)Zero (d) Oscillates indefinite

5. **The time constant of an LR circuit represents the time in which the current in the circuits**

(a) Reaches a value equal to about 37% of its final value

(b) Reaches a value equal to about 63% of its final value

(c) Attains a constant value

(d) Attains 50% of the constant value

6. **The resistance and inductance of series circuit are 5Ω and 20H respectively. At the instant of closing the switch, the current is increasing at the rate 4A-s. The supply voltage is**

(a) 20 V (b) 80 V (c) 120 V (d) 100 V

7. **In inductance L and a resistance R are first connected to a battery. After some time the battery is disconnected but L and R remain connected in a closed circuit. Then the current reduces to 37% of its initial value in**

(a) RL sec (b) $\frac{R}{L}\,sec$ (c) $\frac{L}{R}\,sec$ (d) $\frac{1}{LR}\,sec$

8. **In an LR-circuit, time constant is that time in which current grows from zero to the value (where I_0 is the steady state current)**

(a) $0.63\,I_0$ (b) $0.50\,I_0$ (c) $0.37\,I_0$ (d) I_0

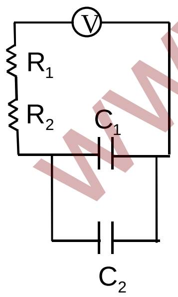
9. **A solenoid has an inductance of 60 henrys and a resistance of 30 ohms. If it is connected to a 100 volt battery, how long will it take for the current to reach $\frac{e-1}{e} \approx 63.2\%$ of its final value?**

(a)1 second (b) 2 seconds (c) e seconds (d) 2e seconds

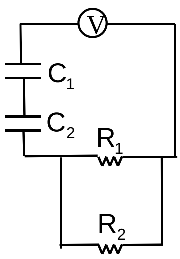
10. **A coil of inductance 300 mH and resistance 2Ω is connected to a source of voltage $2V$. The current reaches half of its steady state value in**

(a) 0.15 s (b) 0.3 s (c) 0.05 s (d) 0.1 s

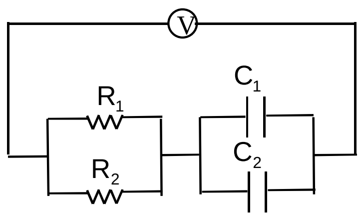
11. **Find the time constant (in μs) for the given RC circuits in the given order respectively.** $R_1 = 1\Omega$, $R_2 = 2\Omega$, $C_1 = 4\mu F$, $C_2 = 2\mu F$



I)



II)



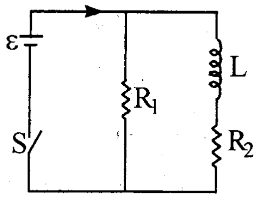
III)

a) 18, 4, $\frac{8}{9}$ b) 18, $\frac{8}{9}$, 4 c) 4, 18, $\frac{8}{9}$ d) 4, $\frac{8}{9}$, 18

12. An ideal coil of 10 Henry is joined in series with a resistance of 5 ohm and a battery of 5 volt. 2 second after joining, the current flowing in ampere in the circuit will be

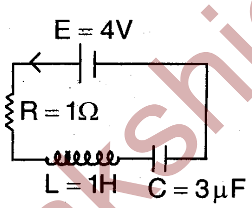
1) e^{-1} 2) $(1-e^{-1})$ 3) $(1-e)$ 4) e

13. An inductor of L = 400 mH and two resistors of $R_1 = 2\Omega$ and $R_2 = 2\Omega$ are connected to a 12V battery as shown in the figure. The internal resistance of the battery is negligible. The switch is closed at time t = 0. The potential drop across 'L' as a function of time is



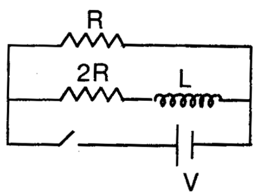
1) $\frac{12}{t}e^{-3t}V$ 2) $6\left(1-e^{-t/0.2}\right)V$ 3) $12e^{-5t}V$ 4) $6e^{-5t}V$

14. **The current in the given circuit is increasing with a rate 4 amp/ s. The charge on the capacitor at an instant when the current in the circuit is 2 amp will be**



1) $4\mu C$ 2) $5\mu C$ 3) $6\mu C$ 4) $3\mu C$

15. The ratio of time constants in charging and discharging in the circuit shown in figure is



1) 1:1 2) 1:2 3) 3:2 4) 2:3

Key

1) **a**	2) **c**	3) b	4) d	5) **b**
6) b	7) c	8) a	9) b	10) d
11) b	12) b	13) c	14) c	15) c

Hints

6. (b) $i = i_0\left(1 - e^{-\frac{Rt}{L}}\right) \Rightarrow \frac{di}{dt} = -i_0\left(-\frac{R}{L}\right)e^{-\frac{Rt}{L}} = \frac{i_0 R}{L}.e^{-\frac{Rt}{L}}$

At t = 0; $\frac{di}{dt} = \frac{i_0 R}{L} = \frac{E}{L} \Rightarrow 4 = \frac{E}{20} \Rightarrow E = 80\ V$

7. (c) When battery disconnected current through the circuit start decreasing exponentially according to $i = i_0 e^{-Rt/L}$

$\Rightarrow 0.37 i_0 = i_0 e^{-Rt/L} \Rightarrow 0.37 = \frac{1}{e} = e^{-Rt/L} \Rightarrow t = \frac{L}{R}$

8. (a) Current at any instant of time t after closing an L-R circuit is given by $I = I_0\left[1 - e^{\frac{-R}{L}t}\right]$

Time constant $t = \frac{L}{R}$

$\therefore I = I_0\left[1 - e^{\frac{-R}{L}\times\frac{L}{R}}\right] = I_0(1 - e^{-1}) = I_0\left(1 - \frac{1}{e}\right)$

$= I_0\left(1 - \frac{1}{2.718}\right) = 0.63 I_0 = 63\%$ Of I_0

9. (b) $t = \tau = \frac{L}{R} = \frac{60}{30} = 2\ \text{sec}$.

10. (d) $i = i_0\left(1 - e^{\frac{-Rt}{L}}\right) \Rightarrow$ For $i = \frac{i_0}{2}$, $t = 0.693\frac{L}{R}$

$\Rightarrow t = 0.693 \times \frac{300\times 10^{-3}}{2} = 0.1\ sec$

11. t = CR

$$t_1=(C_1+C_2)(R_1+R_2)=18\mu s$$

$$t_2=\frac{C_1C_2}{C_1+C_2}\times\frac{R_1R_2}{R_1+R_2}=\frac{8}{9}$$

$$t_3=(C_1+C_2)\frac{R_1R_2}{R_1+R_2}=4$$

12. $i=i_0\left(1-e^{-\frac{R}{L}t}\right)$

$$i=\frac{5}{5}\left(1-e^{-\frac{5\times2}{10}}\right)$$

. $i=(1-e^{-1})A$

13. $i_0=\frac{12}{2}=6$, $p.d=v-i_0\left(1-e^{-\frac{R}{L}t}\right)R$

$$p.d=12-\frac{12}{2}\left[1-e^{-\frac{2}{400\times10^{-3}}t}\right]2$$

p.d = 12 e^{-5t} volt.

14. E $=iR+L\frac{di}{dt}-\frac{q}{c}$

$4 = 2 + 4 - \frac{q}{3}$

$q=6\mu c$

15. $\frac{\lambda_1}{\lambda_2}=\frac{R_2}{R_1}=\frac{2R+R}{2R}$ Or $\frac{\lambda_1}{\lambda_2}=\frac{3}{2}$