Exercise-1

Marked Questions can be used as Revision Questions.

OBJECTIVE QUESTIONS

Section (A) : Average, Peak And RMS Values And RMS Values

A-1. A coil of inductance 5.0 mH and negligible resistance is connected to an alternating voltage V = 10 sin (100 t). The peak current in the circuit will be :
(1) 2 amp (2) 1 amp (3) 10 amp (4) 20 amp

A-2. The peak value of an alternating e.m.f given by $E = E_0 \cos \omega t$, is 10 volt and frequency is 50 Hz. At time t = (1/600) sec, the instantaneous value of e.m.f is :
(1) 10 volt (2) $5\sqrt{3}$ volt (3) 5 volt (4) 1 volt

A-3. If the frequency of the source e.m.f. in an AC circuit is n, the power varies with a frequency :
(1) n (2) 2 n (3) n/2 (4) zero

A-4. An AC voltage of $V = 220\sqrt{2} \sin\left(100\pi t + \frac{\pi}{2}\right)$ is applied across a DC voltmeter, its reading will be:
(1) $220\sqrt{2}$ V (2) $\sqrt{2}$ V (3) 220 V (4) zero

Section (B) : Power Consumed In An Ac Circuit

B-1. The average power delivered to a series AC circuit is given by (symbols have their usual meaning) :
(1) $E_{rms}\, I_{rms}$ (2) $E_{rms}\, I_{rms} \cos\phi$ (3) $E_{rms}\, I_{rms} \sin\phi$ (4) zero

B-2. Energy dissipates in LCR circuit in :
(1) L only (2) C only (3) R only (4) all of these

B-3. A direct current of 2 A and an alternating current having a maximum value of 2 A flow through two identical resistances. The ratio of heat produced in the two resistances in the same time interval will be:
(1) 1 : 1 (2) 1 : 2 (3) 2 : 1 (4) 4 : 1

B-4 A sinusoidal AC current flows through a resistor of resistance R. If the peak current is I_p, then average power dissipated is :
(1) $I_p^2 R\cos\theta$ (2) $\frac{1}{2} I_p^2 R$ (3) $\frac{4}{\pi} I_p^2 R$ (4) $\frac{1}{\pi^2} I_p^2 R$

B-5 What is the rms value of an alternating current which when passed through a resistor produces heat, which is thrice that produced by a current of 2 ampere in the same resistor in the same time interval?
(1) 6 ampere (2) 2 ampere (3) $2\sqrt{3}$ ampere (4) 0.65 ampere

B-6 The impedance of a series circuit consists of 3 ohm resistance and 4 ohm reactance. The power factor of the circuit is :
(1) 0.4 (2) 0.6 (3) 0.8 (4) 1.0

B-7 An electric bulb and a capacitor are connected in series with an AC source. On increasing the frequency of the source, the brightness of the bulb :
(1) increase
(2) decreases
(3) remains unchanged
(4) sometimes increases and sometimes decreases

Section (C) : AC Source With R, L, C Connected In Series

C-1 A 0.21-H inductor and a 88-Ω resistor are connected in series to a 220-V, 50-Hz AC source. The current in the circuit and the phase angle between the current and the source voltage are respectively.
Use π = 22/7.
(1) 2 A, $\tan^{-1} 3/4$ (2) 14.4 A, $\tan^{-1} 7/8$ (3) 14.4 A, $\tan^{-1} 8/7$ (4) 3.28 A, $\tan^{-1} 2/11$

C-2 A 100 volt AC source of angular frequency 500 rad/s is connected to a LCR circuit with L = 0.8 H, C = 5 μF and R = 10 Ω, all connected in series. The potential difference across the resistance is
(1) $\frac{100}{\sqrt{2}}$ volt (2) 100 volt (3) 50 volt (4) $50\sqrt{3}$

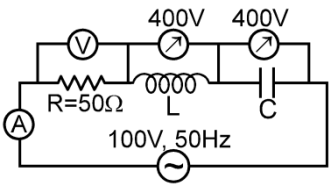
C-3 In an AC circuit, a resistance of R ohm is connected in series with an inductance L. If phase angle between voltage and current be 45°, the value of inductive reactance will be.
(1) R/4 (2) R/2
(3) R (4) cannot be found with the given data

C-4 In an AC circuit the potential differences across an inductance and resistance joined in series are respectively 16 V and 20 V. The total potential difference across the circuit is
(1) 20 V (2) 25.6 V (3) 31.9 V (4) 53.5 V

C-5. An AC voltage source V = 200 $\sqrt{2}$ sin 100 t is connected across a circuit containing an AC ammeter(it reads rms value) and capacitor of capacity 1 μF. The reading of ammeter is :
(1) 10 mA (2) 20 mA (3) 40 mA (4) 80 mA

C-6. If in a series LCR AC circuit, the rms voltage across L, C and R are V_1, V_2 and V_3 respectively, then the voltage of the source is always :
(1) equal to $V_1 + V_2 + V_3$ (2) equal to $V_1 - V_2 + V_3$
(3) more than $V_1 + V_2 + V_3$ (4) none of these is true

C-7. In the series LCR circuit as shown in figure, the voltmeter and ammeter readings are :
(1) V = 100 volt, I = 2 amp
(2) V = 100 volt, I = 5 amp
(3) V = 1000 volt, I = 2 amp
(4) V = 300 volt, I = 1 amp



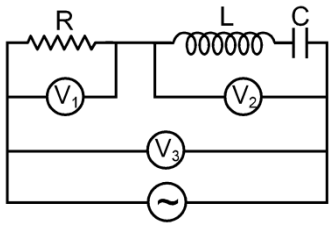
Section (D) : Resonance

D-1 The value of power factor cosϕ in series LCR circuit at resonance is :
(1) zero (2) 1 (3) 1/2 (4) 1/2 ohm

D-2 In an LCR circuit, the capacitance is made one-fourth, when in resonance. Then what should be the change in inductance, so that the circuit remains in resonance ?
(1) 4 times (2) 1/4 times (3) 8 times (4) 2 times

D-3. A series LCR circuit containing a resistance of 120 ohm has angular resonance frequency 4×10^3 rad s^{-1}. At resonance, the voltage across resistance and inductance are 60V and 40 V respectively. The values of L and C are respectively :
(1) 20 mH, 25/8 μF (2) 2mH, 1/35 μF (3) 20 mH, 1/40 μF (4) 2mH, 25/8 nF

D-4. A resistor R, an inductor L, a capacitor C and voltmeters V_1, V_2 and V_3 are connected to an oscillator in the circuit as shown in the adjoining diagram. When the frequency of the oscillator is increased, upto resonance frequency, the voltmeter reading (at resonance frequency) is zero in the case of :
(1) voltmeter V_1 (2) voltmeter V_2
(3) voltmeter V_3 (4) all the three voltmeters



Section (E) : Transformer

E-1 A power (step up) transformer with an 1 : 8 turn ratio has 60 Hz, 120 V across the primary; the load in the secondary is 10^4 Ω. The current in the secondary is
(1) 96 A (2) 0.96 A (3) 9.6 A (4) 96 mA

E-2 The overall efficiency of a transformer is 90%. The transformer is rated for an output of 9000 watt. The primary voltage is 1000 volt. The ratio of turns in the primary to the secondary coil is 5 : 1. The iron losses at full load are 700 watt. The primary coil has a resistance of 1 ohm.

(i) The voltage in secondary coil is :
(1) 1000 volt (2) 5000 volt (3) 200 volt (4) zero volt

(ii) In the above, the current in the primary coil is :
(1) 9 amp (2) 10 amp (3) 1 amp (4) 4.5 amp

(iii) In the above, the copper loss in the primary coil is :
(1) 100 watt (2) 700 watt (3) 200 watt (4) 1000 watt

(iv) In the above, the copper loss in the secondary coil is :
(1) 100 watt (2) 700 watt (3) 200 watt (4) 1000 watt

(v) In the above, the current in the secondary coil is :
(1) 45 amp (2) 46 amp (3) 10 amp (4) 50 amp

(vi) In the above, the resistance of the secondary coil is approximately :
(1) 0.01 Ω (2) 0.1 Ω (3) 0.2 Ω (4) 0.4 Ω

E-3 The core of a transformer is laminated to reduce
(1) eddy current loss (2) hysteresis loss (3) copper loss (4) magnetic loss

Exercise-2

Marked Questions can be used as Revision Questions.

OBJECTIVE QUESTIONS

1. r.m.s. value of current $i = 3 + 4 \sin(\omega t + \pi/3)$ is:
(1) 5 A (2) $\sqrt{17}$ A (3) $\frac{5}{\sqrt{2}}$ A (4) $\frac{7}{\sqrt{2}}$ A

2. An alternating voltage is given by : $e = e_1 \sin\omega t + e_2 \cos\omega t$. Then the root mean square value of voltage is given by :
(1) $\sqrt{e_1^2 + e_2^2}$ (2) $\sqrt{e_1 e_2}$ (3) $\sqrt{\frac{e_1 e_2}{2}}$ (4) $\sqrt{\frac{e_1^2 + e_2^2}{2}}$

3. The potential difference V across and the current I flowing through an instrument in an AC circuit are given by :
$V = 5 \cos\omega t$ volt
$I = 2 \sin\omega t$ ampere
The power dissipated in the instrument is :
(1) zero (2) 5 watt (3) 10 watt (4) 2.5 watt

4. By what percentage the impedance in an AC series circuit should be increased so that the power factor changes from (1/2) to (1/4) (when R is constant) ?
(1) 200% (2) 100% (3) 50% (4) 400%

5. An LCR series circuit with 100 Ω resistance is connected to an AC source of 200 V and angular frequency 300 radians per second. When only the capacitance is removed, the current lags behind the voltage by 60°. When only the inductance is removed, the current leads the voltage by 60º. Then the current and power dissipated in LCR circuit are respectively
(1) 1A, 200 watt. (2) 1A, 400 watt. (3) 2A, 200 watt. (4) 2A, 400 watt.

6. A pure resistive circuit element X when connected to an AC supply of peak voltage 200 V gives a peak current of 5 A which is in phase with the voltage. A second circuit element Y, when connected to the

same AC supply also gives the same value of peak current but the current lags behind by 90°. If the series combination of X and Y is connected to the same supply, what will be the rms value of current ?

(1) $\frac{10}{\sqrt{2}}$ amp (2) $\frac{5}{\sqrt{2}}$ amp (3) $\frac{5}{2}$ amp (4) 5 amp

7. 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 :

(1) n = 0 (2) $n < n_r$ (3) $n = r_r$ (4) $n > n_r$

8. Find the effective value of current $i = 2 + 4 \cos 100 \pi t$.

(1) $2\sqrt{3}$ (2) $2\sqrt{2}$ (3) $\sqrt{3}$ (4) $4\sqrt{3}$

9 The peak value of an alternating current is 5 A and its frequency is 60 Hz. How long will the current take to reach the peak value starting from zero?

(1) $\frac{1}{240}$s (2) $\frac{3}{240}$s (3) $\frac{1}{140}$s (4) $\frac{1}{340}$s

10. A 10 μF capacitor is connected with an ac source $E = 200\sqrt{2}$ sin (100 t) V through an ac ammeter (it reads rms value) . What will be the reading of the ammeter?

(1) 100 mA (2) 300 mA (3) 500 mA (4) 200 mA

11. If a resistance of 30Ω, a capacitor of reactance 20 Ω, and an inductor of inductive reactance 60Ω are connected in series to a 100 V, 50 Hz power source, then -

(1) A current of 2.0 A flows (2) A current of 3.33 A flows
(3) Power factor of the circuit is zero (4) Power factor of the circuit is 2/5

12. An AC voltage is given by :

$$E = E_0 \sin \frac{2\pi t}{T}$$

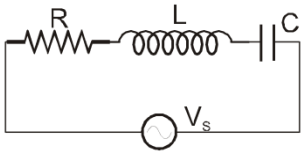
Then the mean value of voltage calculated over time interval of T/2 seconds :

(1) is always zero (2) is never zero (3) is $(2e_0/\pi)$ always (4) may be zero

PART - II : MISCELLANEOUS QUESTIONS

Section (A) : Assertion/Reasoning

A-1. **STATEMENT-1 :** In a series R,L,C circuit if V_R, V_L, and V_C denote rms voltage across R, L and C repectively and V_S is the rms voltage across the source, then $V_S = V_R + V_L + V_C$.



STATEMENT-2 : In AC circuits, kirchoff voltage law is correct at every instant of time.

(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True.

A-2. **STATEMENT-1 :** An inductor is connected to an ac source. When the magnitude of current decreases in the circuit, energy is absorbed by the ac source.
STATEMENT-2 : When current through an inductor decreases, the energy stored in inductor decreases.
(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True.

A-3. **STATEMENT-1 :** Average power consumed in an ac circuit is equal to average power consumed by resistors in the circuit.
STATEMENT-2 : Average power consumed by capacitor and inductor is zero
(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True.

A-4. **STATEMENT-1 :** The electrostatic energy stored in capacitor plus magnetic energy stored in inductor will always be zero in a series LCR circuit driven by ac voltage source under condition of resonance.
STATEMENT-2 : The complete voltage of ac source appears across the resistor in a series LCR circuit driven by ac voltage source under condition of resonance.
(1) Statement-1 is True, Statement-2 is True; Statement-2 **is** a correct explanation for Statement-1
(2) Statement-1 is True, Statement-2 is True; Statement-2 **is NOT** a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True.

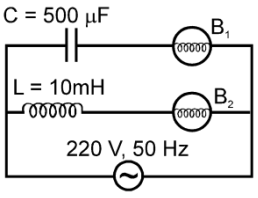
Section (B) : One or More Than One Options Correct

B-1. Average power consumed in an A.C. series circuit is given by (symbols have their usual meaning) :

(1) $E_{rms}\, I_{rms} \cos\phi$ (2) $(I_{rms})^2 R$ (3) $\frac{E_{max}^2 R}{2(|z|)^2}$ (4) $\frac{I_{max}^2 |z| \cos\phi}{2}$

B-2. An AC source supplies a current of 10 A (rms) to a circuit, rms voltage of source is 100 V. The average power delivered by the source :
(1) must be 1000 W (2) may be less than 1000 W
(3) may be greater than 1000 W (4) may be 1000 W

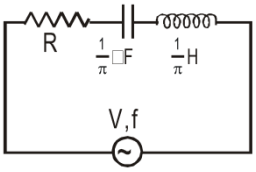
B-3. In the circuit shown in figure, if both the bulbs B_1 and B_2 are identical :



(1) their brightness will be the same
(2) B_2 will be brighter than B_1
(3) as frequency of supply voltage is increased the brightness of bulb B_1 will increase and that of B_2 will decrease.
(4) only B_2 will glow because the capacitor has infinite impedance

B-4. A circuit is set up by connecting L = 100 mH, C = 5 μF and R =100 Ω in series. An alternating emf of ($150\sqrt{2}$) volt, $\frac{500}{\pi}$ Hz is applied across this series combination. Which of the following is correct
(1) the impedance of the circuit is 141.4 Ω
(2) the average power dissipated across resistance 225 W
(3) the average power dissipated across inductor is zero.
(4) the average power dissipated across capacitor is zero.

B-5. In the AC circuit shown below, the supply voltage has constant rms value V but variable frequency f. At resonance, the circuit :



(1) has a current I given by $I = \frac{V}{R}$

(2) has a resonance frequency 500 Hz

(3) has a voltage across the capacitor which is 180^0 out of phase with that across the inductor

(4) has a current given by $I = \frac{V}{\sqrt{R^2 + \left(\frac{1}{\pi} + \frac{1}{\pi}\right)^2}}$

B-6. Power factor may be equal to 1 for :
(1) pure inductor (2) pure capacitor (3) pure resistor (4) An LCR circuit

Exercise-3

Marked Questions can be used as Revision Questions.

PART - I : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. A circuit has a resistance of 12 ohm and an impedance of 15 ohm. The power factor of the circuit will be : **[AIEEE 2005; 4/300]**
(1) 0.8 (2) 0.4 (3) 1.25 (4) 0.125

2. The phase difference between the alternating current and emf is π/2. Which of the following cannot be the constituent of the circuit? **[AIEEE 2005; 4/300]**
(1) C alone (2) R, L (3) L, C (4) L alone

3. The self inductance of the motor of an electric fan is 10 H. In order to impart maximum power at 50 Hz, it should be connected to a capacitance of : **[AIEEE 2005, 4/300]**
(1) 4μF (2) 8μF (3) 1μF (4) 2μF

4. In a series LCR circuit R = 200 Ω and the voltage and the frequency of the main supply is 220 V and 50 Hz respectively. On taking out the capacitance from the circuit the current lags behind the voltage by 30º. On taking out the inductor from the circuit the current leads the voltage by 30º. The power dissipated in the LCR circuit is **[AIEEE 2010; 4/144, –1]**
(1) 305 W (2) 210 W (3) Zero W (4) 242 W

5. An arc lamp requires a direct current of 10 A at 80 V to function. if it is connected to a 220 V(rms), 50 Hz AC supply, the series inductor needed for it to work is close to : **[JEE Main 2016; 4/120, –1]**
(1) 0.08 H (2) 0.044 H (3) 0.065 H (4) 80 H

PART - II : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

*** Marked Questions may have more than one correct option.**

1. An AC voltage source of variable angular frequency ω and fixed amplitude V connected in series with a capacitance C and an electric bulb of resistance R (inductance zero). When ω is increased : **[JEE 2010; 3/163, –1]**
(A) the bulb glows dimmer (B) the bulb glows brighter
(C) total impedence of the circuit is unchanged (D) total impedence of the circuit increases

2. A series R-C circuit is connected to AC voltage source. Consider two cases; (A) when C is without a dielectric medium and (B) when C is filled with dielectric of constant 4. The current I_R through the resistor and voltage V_C across the capacitor are compared in the two cases. Which of the following is/are true? **[JEE 2011; 4/160]**
(A) $I_R^A > I_R^B$ (B) $I_R^A < I_R^B$ (C) $V_C^A > V_C^B$ (D) $V_C^A < V_C^B$

Paragraph for Questions 3 and 4

A thermal power plant produces electric power of 600 kW at 4000 V, which is to be transported to a place 20 km away from the power plant for consumers' usage. It can be transported either directly with a cable

of large current carrying capacity or by using a combination of step-up and step-down transformers at the two ends. The drawback of the direct transmission is the large energy dissipation. In the method using transformers, the dissipation is much smaller. In this method, a step-up transformer is used at the plant side so that the current is reduced to a smaller value. At the consumers' end, a step-down transformer is used to supply power to the consumers at the specified lower voltage. It is reasonable to assume that the power cable is purely resistive and the transformers are ideal with a power factor unity. All the currents and voltages mentioned are rms values.

3. If the direct transmission method with a cable of resistance 0.4 Ω km^{-1} is used, the power dissipation (in %) during transmission is : **[JEE(Advanced)-2013; 3/60]**

(A) 20 (B) 30 (C) 40 (D) 50

4. In the method using the transformers, assume that the ratio of the number of turns in the primary to that in the secondary in the step-up transformer is 1 : 10. If the power to the consumers has to be supplied at 200V, the ratio of the number of turns in the primary to that in the secondary in the step-down transformer is : **[JEE(Advanced)-2013; 3/60]**

(A) 200 : 1 (B) 150 : 1 (C) 100 : 1 (D) 50 : 1

Answers

EXERCISE # 1

Section (A)

A-1.	(4)	**A-2.**	(2)	**A-3.**	(2)
A-4.	(4)				

Section (B)

B-1.	(2)	**B-2.**	(3)	**B-3.**	(3)
B-4	(2)	**B-5**	(3)	**B-6**	(2)
B-7	(1)				

Section (C)

C-1	(1)	**C-2**	(2)	**C-3**	(3)
C-4	(2)	**C-5.**	(2)	**C-6.**	(4)
C-7.	(1)				

Section (D)

D-1	(2)	**D-2**	(1)	**D-3.**	(1)
D-4.	(2)				

Section (E)

E-1	(4)	**E-2 (i)**	(3)	**(ii)**	(2)
(iii)	(1)	**(iv)**	(3)	**(v)**	(2)
(vi)	(2)	**E-3**	(1)		

EXERCISE # 2

PART - I

1.	(2)	**2.**	(4)	**3.**	(1)
4.	(2)	**5.**	(4)	**6.**	(3)
7.	(4)	**8.**	(1)	**9**	(1)
10.	(4)	**11.**	(1)	**12.**	(4)

PART - II

Section (A)

A-1.	(4)	**A-2.**	(1)	**A-3.**	(1)
A-4.	(4)				

Section (B)

B-1.	(1,2,3,4)	**B-2.**	(2)	**B-3.**	(2,3)
B-4.	(1,2,3,4)	**B-5.**	(1,2,3)	**B-6.**	(3,4)

EXERCISE # 3

PART- I

1.	(1)	**2.**	(2)	**3.**	(3)
4.	(4)	**5.**	(3)		

PART - II

1.	(B)	**2.**	(B,C)	**3.**	(B)
4.	(A)				