Alternating Current

Assertion & Reason Type Questions

Directions: In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:

a. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

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

c. Assertion (A) is true but Reason (R) is false.

d. Both Assertion (A) and Reason (R) are false.

Q1. Assertion (A): Average value of AC over a complete cycle is always zero.

Reason (R): Average value of AC is always defined over half cycle.

Answer : (b) The mean or average value of alternating current or emf during a half cycle is given by

$$I_m = 0.636\ I_o \text{ or } E_m = 0.636\ E_o$$

During the next half cycle, the mean value of AC will be equal in magnitude but opposite in direction. For this reason, the average value of AC over a complete cycle is always zero. So, the average value is always defined over a half cycle of AC.

Q2. Assertion (A): AC is more dangerous than DC.

Reason (R): Frequency of AC is dangerous for human body.

Answer : (a) The effect of AC on the human body depends largely on the frequency.

Low frequency currents of 50 to 60 Hz (cycles/sec), which are commonly used, are usually more dangerous than high frequency currents and are 3 to 5 times more dangerous than DC of same voltage of ampere (current).

The usual frequency of 50 cps (or 60 cps) is extremely dangerous as it corresponds to the fibrillation frequency of the myocardium. This results in ventricular fibrillation and instant death.

Q3. Assertion (A): In a purely inductive or capacitive circuit, the current is referred to as wattless current.

Reason (R): No power is dissipated in a purely inductive or capacitive circuit even though a current is flowing in the circuit.

Answer : (a) In a purely inductive or capacitive circuit, power factor, cos ϕ = 0 and no power is dissipated even though a current is flowing in the circuit. In such cases, current is referred to as wattless current.

Q4. Assertion (A): When capacitive reactance is smaller than the inductive reactance in LCR series circuit, emf leads the current.

Reason (R): The phase angle is the angle between the alternating emf and alternating current of the circuit.

Answer : (b) The phase angle for the LCR series circuit is given by

$$\tan\theta = \frac{X_L - X_C}{R} = \frac{\omega L - 1/\omega C}{R}$$

where X_L and X_C are inductive reactance and capacitive reactance respectively. When $X_L > X_C$, then tan Θ is positive i.e., Θ is positive (between O and π/2). Hence, emf leads the current.

Q5. Assertion (A): An electric lamp connected in series with a variable capacitor and AC source, its brightness increases with increase in capacitance.

Reason (R): Capacitive reactance decreases with increase in capacitance of capacitor.

Answer :

(a) Capacitive reactance $X_C = \frac{1}{\omega C}$ when capacitance (C) increases, the capacitive reactance decreases due to decrease in its values, the current in the circuit will increase $\left(I = \frac{E}{\sqrt{R^2 + X_C^2}}\right)$ and hence brightness of source (electric lamp) will also increase.

Q6. Assertion (A): Step-down transformer increases the current.

Reason (R): Transformer obeys the law of conservation of energy.

Answer : (b) If there is no loss of energy in transformer, then instantaneous output power is equal to instantaneous input power.

From this, we get $\frac{e_S}{e_P} = \frac{I_P}{I_S}$.

So, in step-up transformer, voltage increases by decreasing the current. Similarly, step-down transformer decreases the voltage by increasing current. Therefore, transformer simply transforms the voltage and current, obeying the law of conservation of energy.

Q7. Assertion (A): The core of transformer is made laminated in order to increase the eddy currents.

Reason (R): The sensitivity of transformer increases with increase in the eddy currents.

Answer : (d) Eddy current is produced in the iron core due to induced emf. Since, resistance of the iron core is quite small, the magnitude of eddy currents is quite large. As a result, large amount of heat is produced. To avoid it, a laminated core is used in a transformer. In laminated core, iron strips are quite thin and each strip possesses very large resistance, the magnitude of eddy currents very large resistance, the magnitude of eddy currents produced is quite small and hence only a small amount of heat is produced.

Q8. Assertion (A): A step-up transformer cannot be used as a step-down transformer.

Reason (R): A transformer works only in one direction. **(CBSE 2021 Term-1)**

Answer : (d) Both Assertion (A) and Reason (R) are false.

Q9. Assertion (A): AC generator works on the principle of self induction.

Reason (R): Magnetic flux linked with armature coil during rotation is always zero.

Answer : (d) AC generator works on the principle of Faraday's law of electromagnetic (mutual) induction. When armature coil is rotated in magnetic field, the magnetic flux linked with it is always a maximum. Thus, both Assertion (A) and Reason (R) are false.

Q10. Assertion: In series LCR resonance circuit, the impedance is equal to the ohmic resistance.

Reason: At resonance, the inductive reactance exceeds the capacitive reactance.

Q11. Assertion: A capacitor is connected to a direct current source. Its reactance is infinite.

Reason: Reactance of a capacitor is given by $\chi_c = 1/\omega C$.

Q12. Assertion: Average value of ac over a complete cycle is always zero.

Reason: Average value of ac is always defined over half cycle.

Q13. Assertion: The alternating current lags behind the emf by a phase angle of, $\pi/2$ when AC flows through an inductor.

Reason: The inductive reactance increases as the frequency of AC source increases.

Q14. Assertion: The inductive reactance limits amplitude of the current in a purely inductive circuit.

Reason: The inductive reactance is independent of the frequency of the current.

Q15. Assertion: The power is produced when a transformer steps up the voltage.

Reason: In an ideal transformer VI = constant.

Q16. Assertion: A capacitor blocks direct current in the steady state.

Reason: The capacitive reactance of the capacitor is inversely proportional to frequency f of the source of emf.

Q17. Assertion: The voltage and current in a series AC circuit are given by $V = V_0 \sin\omega t$ and $i = i_0 \cos\omega t$. The power dissipated in the circuit is zero.

Reason: Power in AC circuit is given by $P=V_0 I_0 \cos\Phi / 2$

Q18. Assertion: In a purely inductive or capacitive circuit, the current is referred to as wattless current.

Reason: No power is dissipated in a purely inductive or capacitive circuit even though a current is flowing in the circuit.

Q19. Assertion: The power in an ac circuit is minimum if the circuit has only a resistor.

Reason: Power of a circuit is independent of the phase angle.

Q20. Assertion: When the frequency of the AC source in an LCR circuit equals the resonant frequency, the reactance of the circuit is zero, and so there is no current through the inductor or the capacitor.

Reason: The net current in the inductor and capacitor is zero.

Q21. Assertion: A laminated core is used in transformers to increase eddy currents.

Reason: The efficiency of a transformer increases with increase in eddy currents.

Q22. Assertion: Choke coil is preferred over a resistor to control the current in an AC circuit.

Reason: Power factor of an ideal inductor is zero.

ANSWER KEY 10 to 22

Q10 : (c) **Q11 :** (a) **Q12 :** (b) **Q13 :** (b) **Q14 :** (c)

Q15 : (a) Transformer cannot produce power, but it transfer from primary to secondary.

Q16 : (b) **Q17 :** (a) **Q18 :** (a) **Q19 :** (d)

Q20 : (d) he currents in capacitor and in inductor are opposite and so net current is zero.

Q21 : (d) Large eddy currents are produced in non-laminated iron core of the transformer by the induced emf, as the resistance of bulk iron core is very small. By using thin iron sheets as core the resistance is increased. Laminating the core substantially reduces the eddy currents. Eddy current heats up the core of the transformer. More the eddy currents greater is the loss of energy and the efficiency goes down.

Q22 : (a)