

Alternating Current — CBSE Pattern Test 1

Class 12 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

Test 1 — CBSE Pattern (90 minutes, 40 marks)

Class 12 Physics · Alternating Current · Narayan Gurukul Academy (ClassApna)

General Instructions: (1) This paper has four sections — Section A (1×10), Section B (2×4), Section C (3×4) and Section D (5×2) — total 40 marks. Time allowed: 90 minutes.

(2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.

(3) For MCQ questions choose the single correct option; for VSA answers write a single line.

(4) Take $g = 10 \text{ m/s}^2$. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA ($10 \times 1 = 10$ marks)

- The RMS value of an alternating current is
 - $I_0/\sqrt{2}$
 - $I_0\sqrt{2}$
 - $I_0/2$
 - $2I_0$
- The inductive reactance of a coil carrying AC of frequency ω is
 - ωL
 - $1/\omega L$
 - ω/L
 - L/ω
- The capacitive reactance of a capacitor at angular frequency ω is
 - $1/\omega C$
 - ωC
 - ω/C
 - C/ω
- At resonance in a series LCR circuit, the impedance is
 - minimum and equal to R
 - maximum
 - zero
 - infinite
- The average power in an AC circuit is
 - $V_{\text{rms}} I_{\text{rms}} \cos\phi$
 - $V_{\text{rms}} I_{\text{rms}}$
 - $V_{\text{rms}} I_{\text{rms}} \sin\phi$
 - $V_{\text{rms}}/I_{\text{rms}}$
- The power factor of a purely inductive circuit is
 - zero
 - one
 - 0.5
 - 0.707
- In an LC oscillator, energy oscillates between
 - the capacitor's electric field and the inductor's magnetic field

- (B) two capacitors
- (C) two inductors
- (D) the resistor and the capacitor

8. The frequency of LC oscillations is

- (A) $1/2\pi\sqrt{LC}$
- (B) $2\pi\sqrt{LC}$
- (C) $1/LC$
- (D) $\sqrt{LC}/2\pi$

9. Define the RMS value of an alternating current.

10. Define resonance in a series LCR circuit.

Section B — Short Answer I (4 × 2 = 8 marks)

11. An AC has a peak value of 14.14 A. Find its RMS value.

12. A 0.1 H inductor is connected to a source of $\omega = 100$ rad/s. Find the inductive reactance.

13. An LCR circuit has $L = 0.5$ H and $C = 20$ μ F. Find its resonant frequency.

14. An AC circuit has $\cos\phi = 0.8$, $V_{\text{rms}} = 200$ V, $I_{\text{rms}} = 5$ A. Find the average power.

Section C — Short Answer II (4 × 3 = 12 marks)

15. Derive the expression for the RMS value of an alternating current.

16. Draw the phasor diagram for a series LCR circuit and derive its impedance and phase angle.

17. Explain resonance in a series LCR circuit and derive the resonant frequency.

18. Explain the energy changes in an LC oscillator and show the total energy is constant.

Section D — Long Answers (2 × 5 = 10 marks)

19. Draw the phasor diagram of a series LCR circuit. Derive the expression for the impedance and the phase angle, and hence discuss resonance and the variation of current with frequency.

20. Derive the expression for the average power in a series LCR circuit. Explain the power factor and show that the average power consumed by a pure inductor or capacitor over a cycle is zero.

Answer Key (Marking Scheme)

Q1 — (A) $I_0/\sqrt{2}$. Q2 — (A) ωL . Q3 — (A) $1/\omega C$. Q4 — (A) minimum and equal to R.

Q5 — (A) $V_{\text{rms}} I_{\text{rms}} \cos\phi$. Q6 — (A) zero. Q7 — (A) capacitor's electric field and inductor's magnetic field. Q8 — (A) $1/2\pi\sqrt{LC}$.

Q9 — The steady DC value that would produce the same heating effect as the AC.

Q10 — The condition $X_L = X_C$ at which the current is maximum and in phase with the voltage.

Q11 — $I_{\text{rms}} = 14.14/\sqrt{2} = 10$ A.

Q12 — $X_L = \omega L = 100 \times 0.1 = 10$ Ω .

Q13 — $f_0 = 1/2\pi\sqrt{LC} \approx 50.3$ Hz.

Q14 — $P = V_{\text{rms}} I_{\text{rms}} \cos\phi = 200 \times 5 \times 0.8 = 800$ W.

Q15 — $I_{\text{rms}} = \sqrt{\text{mean of } I_0^2 \sin^2 \omega t} = I_0/\sqrt{2}$.

Q16 — V_R along I , V_L leading by 90° , V_C lagging by 90° ; resultant V gives $Z = \sqrt{R^2 + (X_L - X_C)^2}$, $\tan\phi = (X_L - X_C)/R$.

Q17 — $X_L = X_C$ $\Rightarrow \omega_0 L = 1/\omega_0 C$ $\Rightarrow \omega_0 = 1/\sqrt{LC}$.

Q18 — Energy shuttles between $\frac{1}{2}q^2/C$ and $\frac{1}{2}Li^2$; their sum $\frac{1}{2}q_0^2/C$ is constant in the ideal case.

Q19 — See Q16–Q17; at resonance $Z = R$ (minimum), $I = V/R$ (maximum), $\phi = 0$; current peaks at ω_0 .

Q20 — $P = V_{\text{rms}} I_{\text{rms}} \cos\phi$; $\cos\phi = R/Z$; for pure L , $\phi = 90^\circ$ so $P = 0$; for pure C , $\phi = -90^\circ$ so $P = 0$.