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CLASS 12 PHYSICS — FBISE

AC Circuits & Electromagnetic Induction

Important MCQs & Short Questions with Answers

SECTION A: MULTIPLE CHOICE QUESTIONS (MCQs)

1. The period of an alternating current is related to its frequency by:

A) T = f
B) T = 1/f
C) T = 2πf
D) T = f²

✔ *Answer: (B) — Period and frequency are reciprocals: T = 1/f.*

2. The peak value of an alternating voltage V is related to its r.m.s. value by:

A) V■ = V_rms × √2
B) V■ = V_rms / √2
C) V■ = V_rms
D) V■ = 2 × V_rms

✔ *Answer: (A) — Peak value = r.m.s. value × √2, so V■ = V_rms√2.*

3. The r.m.s. value of current I■ (peak) is:

A) I_rms = I■√2
B) I_rms = I■/2
C) I_rms = I■/√2
D) I_rms = 2I■

✔ *Answer: (C) — I_rms = I■/√2 ≈ 0.707 × I■.*

4. The mean power dissipated in a resistive AC circuit equals:

A) P = V■I■
B) P = ½ V■I■
C) P = V■I■/√2
D) P = 2V■I■

✔ *Answer: (B) — Mean power P = ½V■I■ = V_rms × I_rms for a purely resistive load.*

5. In a sinusoidal AC, the instantaneous current is expressed as:

A) i = I■ cos(ωt)
B) i = I■ sin(ωt)
C) i = I■ tan(ωt)
D) i = I■ e^(ωt)

✔ *Answer: (B) — Standard form: i = I■ sin(ωt), where ω = 2πf.*

6. A half-wave rectifier uses:

A) Two diodes
B) Four diodes
C) One diode
D) A capacitor only

✔ *Answer: (C) — A single diode conducts only on one half-cycle.*

7. A full-wave bridge rectifier uses:

A) One diode
B) Two diodes
C) Three diodes
D) Four diodes

✔ *Answer: (D) — Four diodes arranged in a bridge allow both half-cycles to contribute.*

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8. The purpose of a capacitor in a rectifier filter circuit is to:

A) Increase peak voltage
B) Smooth the pulsating DC output
C) Block DC
D) Rectify AC

✔ *Answer: (B) — A capacitor charges to peak and discharges slowly, smoothing the output.*

9. Phase difference between voltage and current in a purely resistive AC circuit is:

A) 90°
B) 45°
C) 0°
D) 180°

✔ *Answer: (C) — In a pure resistor, voltage and current are in phase (0° difference).*

10. In an AC circuit, a choke (inductor) is used to:

A) Increase current
B) Present high resistance to AC
C) Rectify current
D) Store charge

✔ *Answer: (B) — An inductor (choke) has high inductive reactance $X_L = \omega L$ for AC.*

11. The inductive reactance X_L of an inductor L at frequency f is:

A) $X_L = 1/(2\pi fL)$
B) $X_L = 2\pi fL$
C) $X_L = L/f$
D) $X_L = f/L$

✔ *Answer: (B) — $X_L = \omega L = 2\pi fL$.*

12. The capacitive reactance X_C of a capacitor C at frequency f is:

A) $X_C = 2\pi fC$
B) $X_C = fC$
C) $X_C = 1/(2\pi fC)$
D) $X_C = C/(2\pi f)$

✔ *Answer: (C) — $X_C = 1/(\omega C) = 1/(2\pi fC)$.*

13. Impedance Z in a series RLC circuit is expressed as:

A) $Z = R + X_L + X_C$
B) $Z = \sqrt{(R^2 + (X_L - X_C)^2)}$
C) $Z = R \times X_L \times X_C$
D) $Z = R^2 + X_L^2 + X_C^2$

✔ *Answer: (B) — $Z = \sqrt{[R^2 + (X_L - X_C)^2]}$ using phasor (vector) addition.*

14. The unit of impedance is:

A) Farad
B) Henry
C) Ohm
D) Siemens

✔ *Answer: (C) — Impedance is measured in ohms (Ω), like resistance.*

15. Self-inductance L is defined such that the induced EMF is:

A) $e = L \times I$
B) $e = -L\ (dI/dt)$
C) $e = L/t$
D) $e = L \times Q$

✔ *Answer: (B) — By Faraday's law for an inductor: $e = -L(dI/dt)$.*

16. The unit of mutual inductance M is:

A) Ohm

B) Farad
C) Henry
D) Tesla
✔ *Answer: (C) — Both self-inductance (L) and mutual inductance (M) are measured in henry (H).*

17. In a phase diagram (phasor), voltage across an inductor leads current by:
A) 0°
B) 45°
C) 90°
D) 180°
✔ *Answer: (C) — Inductor voltage leads current by 90° (π/2 radians).*

18. Voltage across a capacitor in an AC circuit lags the current by:
A) 180°
B) 90°
C) 45°
D) 0°
✔ *Answer: (B) — Capacitor voltage lags behind current by 90°.*

19. At resonance in a series RLC circuit:
A) $X_L > X_C$
B) $X_L < X_C$
C) $X_L = X_C$
D) $Z = \infty$
✔ *Answer: (C) — At resonance, $X_L = X_C$ and impedance $Z = R$ (minimum).*

20. The graphical difference between half-wave and full-wave rectification is:
A) Half-wave has two peaks per cycle; full-wave has one
B) Half-wave has one peak per cycle; full-wave has two
C) Both are identical
D) Full-wave produces AC output
✔ *Answer: (B) — Half-wave: one pulse per AC cycle; full-wave: two pulses per AC cycle.*

21. During which half-cycle does a half-wave rectifier conduct?
A) Both half-cycles
B) Only the positive half-cycle
C) Only the negative half-cycle
D) Neither half-cycle
✔ *Answer: (B) — A single diode conducts only when forward-biased (positive half-cycle).*

22. The frequency of the output of a full-wave rectifier is:
A) Same as input
B) Half the input frequency
C) Double the input frequency
D) Four times the input frequency
✔ *Answer: (C) — Full-wave output has twice the input frequency (both halves used).*

23. Mutual inductance M between two coils depends on:
A) Current only
B) Geometry and relative position of coils
C) Resistance of coils
D) Capacitance
✔ *Answer: (B) — M depends on coil geometry, number of turns, and their relative positioning.*

24. The r.m.s. voltage of household AC in Pakistan (230 V) means the peak voltage is approximately:
A) 163 V
B) 230 V

C) 325 V
D) 460 V
✔ *Answer: (C) — V■ = V_rms × √2 = 230 × 1.414 ≈ 325 V.*

25. The phase angle ϕ in a series RL circuit is given by:
A) tan ϕ = R/X_L
B) tan ϕ = X_L/R
C) tan ϕ = X_L × R
D) tan ϕ = R² + X_L²
✔ *Answer: (B) — Phase angle: tan ϕ = X_L/R for a series RL circuit.*

SECTION B: SHORT QUESTIONS WITH ANSWERS

Q1. Define alternating current (AC). What is meant by its period and frequency?
Alternating current (AC) is an electric current that periodically reverses direction. The period (T) is the time taken for one complete cycle, measured in seconds. Frequency (f) is the number of complete cycles per second, measured in hertz (Hz). They are related by: T = 1/f.

Q2. Write the equation of a sinusoidally alternating voltage and identify each term.
The equation is: v = V■ sin(ωt), where:

- v = instantaneous voltage
- V■ = peak (maximum) voltage
- ω = angular frequency = 2πf
- t = time

Q3. What is the root-mean-square (r.m.s.) value of an alternating current? Give its formula.
The r.m.s. (root-mean-square) value is the equivalent DC value that produces the same heating effect in a resistor. For a sinusoidal current:

I_rms = I■/√2 = 0.707 I■

Similarly, V_rms = V■/√2.

Q4. Prove that the mean power in a resistive AC circuit is P = ½ V■I■.
For a pure resistor, v = V■ sin(ωt) and i = I■ sin(ωt).

Instantaneous power: p = vi = V■I■ sin²(ωt).

Mean value of sin²(ωt) = ½.

Therefore: P_avg = ½ V■I■ = V_rms × I_rms.

Q5. Distinguish between peak value and r.m.s. value of AC.

- Peak value (V■ or I■): The maximum value reached by the alternating quantity in each cycle.
- R.M.S. value: The effective value equal to a steady DC that produces the same power/heat.

Relationship: V_rms = V■/√2 and I_rms = I■/√2.

Q6. Explain the working of a half-wave rectifier with a diagram description.
A half-wave rectifier uses a single diode in series with the load.

- During the positive half-cycle: diode is forward-biased → current flows through load.

• During the negative half-cycle: diode is reverse-biased → no current flows.

Output is a pulsating DC with only positive half-cycles present.

Q7. How does a bridge rectifier achieve full-wave rectification?

A bridge rectifier uses four diodes (D1–D4) in a bridge arrangement.

• Positive half-cycle: D1 and D3 conduct → current flows through load in one direction.

• Negative half-cycle: D2 and D4 conduct → current still flows through load in the SAME direction.

Result: both half-cycles contribute → pulsating DC at twice the input frequency.

Q8. What is the role of a capacitor in smoothing rectified output?

A filter capacitor is connected in parallel with the load resistance.

• When output voltage rises: capacitor charges to peak voltage.

• When output voltage falls: capacitor slowly discharges through load, maintaining voltage.

This reduces the ripple and produces a nearly steady DC. Larger capacitance → smoother output.

Q9. Analyze the effect of varying capacitance and load resistance on smoothing.

• Larger capacitance (C): stores more charge → slower discharge → less ripple → smoother DC.

• Larger load resistance (R_L): less current drawn → capacitor discharges more slowly → better smoothing.

• Smaller R_L (heavier load): faster discharge → more ripple → less effective smoothing.

Q10. Define self-inductance (L) and mutual inductance (M). State their SI unit.

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Self-inductance (L): property of a coil by which it opposes any change in its own current; defined by $e = -L(dI/dt)$. Unit: Henry (H).

Mutual inductance (M): property of two coils whereby a change in current in one coil induces an EMF in the other; defined by $e_2 = -M(dI_1/dt)$. Unit: Henry (H).

Q11. What is a choke (inductor) and why is it used in AC circuits?

A choke is an inductor (coil of wire, often with an iron core) that presents high inductive reactance $X_L = 2\pi fL$ to AC while having low DC resistance.

It is used to: limit AC current without significant power loss (unlike a resistor), filter high-frequency signals, and control current in fluorescent lights.

Q12. Define the phase of AC and explain what is meant by phase lead and lag.

Phase is the fraction of the time period (or angle in radians/degrees) that has elapsed since the quantity last passed through zero in the positive direction.

• Phase lead: one quantity reaches its maximum BEFORE another (e.g., V leads I in inductor by 90°).

• Phase lag: one quantity reaches its maximum AFTER another (e.g., V lags I in capacitor by 90°).

Q13. Define capacitive reactance and inductive reactance. How do they depend on frequency?

• Inductive reactance: $X_L = 2\pi fL$ (ωL). X_L increases with increasing frequency.

• Capacitive reactance: $X_C = 1/(2\pi fC)$. X_C decreases with increasing frequency.

Both have units of ohms (Ω). At high frequencies, X_L dominates; at low frequencies, X_C dominates.

Q14. What is impedance? Write its formula for a series RLC circuit.

Impedance (Z) is the total opposition offered by a circuit to the flow of AC. It combines resistance and reactance as vectors (phasors).

For a series RLC circuit: $Z = \sqrt{[R^2 + (X_L - X_C)^2]}$

Phase angle: $\tan \phi = (X_L - X_C)/R$. Unit: ohm (Ω).

Q15. Describe impedance as vector summation of resistance and reactance.

In an AC circuit, R (resistive) and X (reactive) are not added algebraically but as perpendicular phasors (vectors):

- Resistance R is along the horizontal axis (in phase with current).
- X_L is along +vertical axis (leads current by 90°).
- X_C is along –vertical axis (lags current by 90°).

Impedance $Z = \sqrt{[R^2 + (X_L - X_C)^2]}$ is the resultant vector.

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