

How to use this worksheet. Thirty-four questions, about 40 minutes. Resistance and reactance combine as perpendicular vectors, never arithmetically. Inductive reactance **rises** with frequency while capacitive reactance **falls**. The phrase “current is maximum” always means resonance.

Formula sheet

$$I_{\text{rms}} = I_0 / \sqrt{2} \quad | \quad X_L = 2\pi fL \quad | \quad X_C = 1/2\pi fC \quad | \quad Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\text{Power factor} = \cos\phi = R/Z \quad | \quad P = V_{\text{rms}} I_{\text{rms}} \cos\phi \quad | \quad \text{Resonance: } X_L = X_C, f = 1/2\pi\sqrt{LC}, Z = R$$

$$\text{Transformer: } V_p/V_s = N_p/N_s \quad | \quad I_p/I_s = N_s/N_p$$

Section A · Level 1 — Definitions, phase and reactance

Ten questions. None should take more than twenty seconds.

- The root mean square value of a sinusoidal current of peak value I_0 is:
(1) I_0 (2) $I_0 / 2$ (3) $I_0 / \sqrt{2}$ (4) $\sqrt{2} I_0$
- The average value of a sinusoidal alternating current over one complete cycle is:
(1) I_0 (2) Zero (3) $I_0 / \sqrt{2}$ (4) $2I_0 / \pi$
- The SI unit of inductance is the:
(1) Farad (2) Henry (3) Ohm (4) Weber
- Inductive reactance is given by:
(1) ωL (2) $1 / \omega L$ (3) ωC (4) $1 / \omega C$
- Capacitive reactance is given by:
(1) ωC (2) $1 / \omega C$ (3) ωL (4) $1 / \omega L$
- In a purely resistive AC circuit, the voltage and current are:
(1) 90° out of phase (2) 180° out of phase (3) In phase (4) 45° out of phase
- In a purely inductive AC circuit, the current:
(1) Leads the voltage by 90° (2) Lags the voltage by 90° (3) Is in phase with the voltage (4) Leads the voltage by 45°
- In a purely capacitive AC circuit, the current:
(1) Lags the voltage by 90° (2) Leads the voltage by 90° (3) Is in phase with the voltage (4) Lags the voltage by 45°
- The power factor of a purely inductive circuit is:
(1) 1 (2) 0.5 (3) 0 (4) $\sqrt{2}$
- A transformer works on the principle of:
(1) Self induction (2) Mutual induction (3) Electrostatic induction (4) Ohm's law

Working space — Questions 1 to 10

Write the formula before you substitute.

Section B · Level 2 — Values, reactances and impedance

Nine questions. Convert the units before you substitute.

- A transformer cannot operate on a direct current supply because:
(1) DC is too weak (2) DC produces no changing flux (3) DC damages the core (4) DC has no rms value
- The peak value of an alternating current is 10 A. Its rms value is closest to:
(1) 10 A (2) 14.1 A (3) 7.07 A (4) 5 A

13. The mains supply is quoted as 220 V rms. Its peak voltage is closest to:

- (1) 220 V (2) 311 V (3) 156 V (4) 440 V

14. The reactance of a 0.1 H inductor at 50 Hz is closest to:

- (1) 3.14 Ω (2) 31.4 Ω (3) 314 Ω (4) 0.314 Ω

15. The reactance of a 100 μF capacitor at 50 Hz is closest to:

- (1) 3.18 Ω (2) 318 Ω (3) 31.8 Ω (4) 0.318 Ω

16. A series circuit has $R = 3 \Omega$ and a net reactance of 4 Ω . Its impedance is:

- (1) 7 Ω (2) 1 Ω (3) 5 Ω (4) 12 Ω

17. Resonance in a series LCR circuit occurs when:

- (1) $X_L = X_C$ (2) $X_L = R$ (3) $X_C = R$ (4) $X_L + X_C = R$

18. The resonant frequency of a series LCR circuit is:

- (1) $1 / 2\pi LC$ (2) $1 / 2\pi\sqrt{LC}$ (3) $2\pi\sqrt{LC}$ (4) $\sqrt{LC} / 2\pi$

19. In a step-up transformer, the secondary has:

- (1) Fewer turns than the primary (2) More turns than the primary (3) The same number of turns (4) No turns

Working space — Questions 11 to 19 Write the formula before you substitute.

Section C · Level 3 — Power, resonance and transformers

Ten questions. Each needs a formula plus a piece of reasoning.

20. The average power in an AC circuit is given by:

- (1) $V_{\text{rms}} I_{\text{rms}}$ (2) $V_{\text{rms}} I_{\text{rms}} \cos\phi$ (3) $V_0 I_0$ (4) $V_{\text{rms}} I_{\text{rms}} \sin\phi$

21. At resonance in a series LCR circuit, the impedance is:

- (1) Maximum (2) Equal to R (3) Zero (4) Equal to X_L

22. At resonance, the power factor of a series LCR circuit is:

- (1) 0 (2) 0.5 (3) 1 (4) $\sqrt{2}$

23. A series LCR circuit has $L = 1 \text{ H}$ and $C = 1 \mu\text{F}$. Its resonant frequency is closest to:

- (1) 159 Hz (2) 1000 Hz (3) 50 Hz (4) 15.9 Hz

24. In an ideal transformer, the ratio of primary to secondary current equals:

- (1) N_p / N_s (2) N_s / N_p (3) 1 (4) $(N_p / N_s)^2$

25. Energy losses due to eddy currents in a transformer core are reduced by:

- (1) Using a solid iron core (2) Laminating the core (3) Increasing the supply frequency (4) Using more turns

26. A choke coil is preferred over a resistor for controlling current in an AC circuit because it:

- (1) Is cheaper (2) Consumes almost no power (3) Increases the voltage (4) Works on DC as well

27. As the frequency of the supply increases, the current through a capacitor:

- (1) Decreases (2) Increases (3) Stays the same (4) Falls to zero

28. A wattless current flows when the phase angle between voltage and current is:

- (1) 0° (2) 45° (3) 90° (4) 180°

29. An AC generator works on the principle of:

- (1) Mutual induction (2) Electromagnetic induction (3) Electrostatic induction (4) Magnetic saturation

Working space — Questions 20 to 29

Write the formula before you substitute.

Section D · Previous year questions — Straight from the AAI ATC papers

Five questions, exactly as they appeared. Four come from the 2023 papers, recovered by optical character recognition of the scanned answer sheets and independently re-solved.

30. An AC voltage is applied to a pure capacitor. The current in the capacitor _____ the voltage by _____.

[PYQ 2023 · Morning]

(1) lags, $\pi/2$ (2) leads, $\pi/2$ (3) lags, π (4) leads, π

31. A circuit consisting of an inductor (L) and a capacitor (C) oscillates at a frequency of 1.0 kHz. If $L = 50$ mH, then C is close to (consider $\pi^2 \approx 10$): [PYQ 2023 · Morning]

(1) $0.25 \mu\text{F}$ (2) $0.5 \mu\text{F}$ (3) $1.0 \mu\text{F}$ (4) $2.5 \mu\text{F}$

32. Consider an alternating current circuit consisting of a resistance R, an inductor of inductance L and a capacitor of capacitance C in series, driven by a voltage of amplitude V_m , such that the current flowing through the circuit is maximum. The current in the circuit is: [PYQ 2023 · Evening]

(1) $V_m / \omega L$ (2) $V_m / \sqrt{LC}$ (3) V_m / R (4) $V_m \omega C$

33. Consider a pure inductor of 20 mH connected to an alternating source of 240 V at a frequency of 100 Hz. The inductive reactance and rms current in the circuit are, respectively (consider $\pi \approx 3.0$): [PYQ 2023 · Evening]

(1) 24Ω , 10 A (2) 48Ω , 5 A (3) 60Ω , 20 A (4) 12Ω , 20 A

34. The input voltage across the primary coil of a transformer is 200 V and the number of turns in this coil is X. If the output voltage across the secondary coil having 1500 turns is 3000 V, then what will be the value of X? [PYQ

2025 · Shift 1]

(1) 0.01 (2) 10 (3) 100 (4) 1

Working space — Questions 30 to 34

Write the formula before you substitute.

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