

ALTERNATING CURRENT (AC)

Complete Formula Sheet for NEET

Revision Guide — Quick Reference

1. BASIC AC QUANTITIES

Instantaneous Values

Current	$i(t) = i_0 \sin(\omega t + \phi)$
Voltage	$v(t) = v_0 \sin(\omega t + \phi)$
Angular Frequency	$\omega = 2\pi f = \frac{2\pi}{T}$

 $i_0, v_0 = \text{Peak values}$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

Capacitive Reactance

Voltage: $V_C = I_{rms} \cdot X_C$
Phase: $\phi = -90^\circ$ I leads V
Power: $P = 0$ *Reactive only*

2. PEAK, RMS & AVERAGE VALUES

RMS Value (Root Mean Square)

$$I_{rms} = \frac{i_0}{\sqrt{2}} = 0.707 i_0$$

RMS Current

$$V_{rms} = \frac{v_0}{\sqrt{2}} = 0.707 v_0$$

RMS Voltage

RMS values are what AC meters read
Average Value (Half Period)

Current	$I_{avg} = \frac{2i_0}{\pi} = 0.637 i_0$
Voltage	$V_{avg} = \frac{2v_0}{\pi} = 0.637 v_0$

3. AC IN PURE CIRCUITS

Pure Resistive (R)

Voltage: $V_R = I_{rms} \cdot R$ *Ohm's Law*
Phase: $\phi = 0$ V & I in phase
Power: $P = I_{rms}^2 R = \frac{V_{rms}^2}{R}$

Pure Inductive (L)

$$X_L = \omega L = 2\pi f L$$

Inductive Reactance

Voltage: $V_L = I_{rms} \cdot X_L$
Phase: $\phi = +90^\circ$ V leads I
Power: $P = 0$ *Reactive only*

Pure Capacitive (C)

4. IMPEDANCE & PHASE

Impedance (Z)

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

General Form

- **R-L:** $Z = \sqrt{R^2 + X_L^2}$
- **R-C:** $Z = \sqrt{R^2 + X_C^2}$
- **L-C:** $Z = |X_L - X_C|$

Phase Difference

$$\tan \phi = \frac{X_L - X_C}{R}$$

Phase Angle

If $\phi > 0$: Inductive; If $\phi < 0$: Capacitive

5. POWER IN AC CIRCUITS

Average Power

$$P = V_{rms} \cdot I_{rms} \cdot \cos \phi$$

Average Power Dissipated

$$P = I_{rms}^2 R$$

Only Resistance Dissipates

Power Factor

$$\cos \phi = \frac{R}{Z}$$

Power Factor (pf)

- Range: $0 \leq \text{pf} \leq 1$
- $\text{pf} = 1$ (pure R), $\text{pf} = 0$ (pure L or C)
- **Higher pf \rightarrow Better efficiency**

Power Types

Apparent Power: $S = V_{rms} \cdot I_{rms}$ (VA)
 Reactive Power: $Q = V_{rms} \cdot I_{rms} \cdot \sin \phi$ (VAR)
 Relation: $P^2 + Q^2 = S^2$

3. LCR SERIES CIRCUIT

Impedance

$$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

LCR Impedance

Current

$$I_{rms} = \frac{V_{rms}}{Z}$$

RMS Current

Phase Difference

$$\tan \phi = \frac{\omega L - \frac{1}{\omega C}}{R}$$

Phase Angle

Resonance Condition

$$\omega_r = \frac{1}{\sqrt{LC}}$$

Resonant Angular Frequency

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

Resonant Frequency

At resonance: $X_L = X_C$

At Resonance ($\omega = \omega_r$)

$$Z = R \text{ (minimum)} \quad | \quad I_{max} = \frac{V_{rms}}{R}$$

$$\phi = 0 \text{ (V \& I in phase)} \quad | \quad P_{max} = \frac{V_{rms}^2}{R}$$

Quality Factor (Q)

$$Q = \frac{\omega_r L}{R} = \frac{1}{\omega_r RC} = \frac{f_r}{\Delta f}$$

Quality Factor

- **High Q:** Sharp resonance, narrow bandwidth
- **Low Q:** Broad resonance, wide bandwidth

7. TRANSFORMERS

Ideal Transformer (No Losses)

$$\frac{V_s}{V_p} = \frac{I_p}{I_s} = \frac{N_s}{N_p}$$

Turns Ratio Relation

Power is conserved: $V_p I_p = V_s I_s$

Transformer Classification

- **Step-up:** $N_s > N_p \rightarrow \uparrow V, \downarrow I$
- **Step-down:** $N_s < N_p \rightarrow \downarrow V, \uparrow I$

Efficiency

$$\eta = \frac{P_{out}}{P_{in}} \times 100\%$$

Transformer Efficiency

Ideal: $\eta = 100\%$ — Real: $\eta < 100\%$

Secondary Impedance

$$Z_p = \left(\frac{N_p}{N_s}\right)^2 Z_s$$

Impedance Transformation

8. QUICK REFERENCE SHORTCUTS

$$I_{rms} = \frac{i_0}{\sqrt{2}} \quad V_{rms} = \frac{v_0}{\sqrt{2}}$$

At resonance: $Z = R$ (minimum), $I = I_{max}$

$$\text{pf} = \cos \phi = \frac{R}{Z}$$

$X_L \propto f$ (increases) $X_C \propto \frac{1}{f}$ (decreases)

Pure L or C: $P = 0$ (all reactive)

Transformer: Power in = Power out

$$Q = \frac{f_r}{\text{bandwidth}} \text{ (sharpness)}$$

STANDARD CONSTANTS

$$\frac{1}{\sqrt{2}} = 0.707$$
$$\frac{1}{\pi} = 0.637$$

Created for Let's Play With Physics — NEET Preparation
Master these formulas for guaranteed success in AC chapter!