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Alternating current, LCR circuits and resonance

Formulas and units, JEE Main. Status: Reviewed on 2026-11-20.

Result	Formula	Units or note
Instantaneous ac voltage	v = V0 sin(w t); w = 2 pi f Valid when: sinusoidal supply; w = 2 pi f with f in Hz	V (rad/s)
rms value	V rms = V0/sqrt2; I rms = I0/sqrt2 Valid when: sinusoidal ac only	V (A)
Inductive reactance	XL = w L Valid when: ideal inductor, w in rad/s	ohm
Capacitive reactance	XC = 1/(w C) Valid when: ideal capacitor, w in rad/s	ohm
Impedance (series LCR)	Z = sqrt(R^2 + (XL - XC)^2) Valid when: series LCR circuit, sinusoidal steady state	ohm
Current and phase	I = V/Z; tan(phi) = (XL - XC)/R Valid when: series LCR circuit; phi is the angle by which voltage leads current	A (degrees)
Resonant frequency	w0 = 1/sqrt(LC); f0 = w0/(2 pi) Valid when: series LCR circuit; w0 in rad/s, f0 in Hz	rad/s (Hz)
Equal-current frequencies	w1 w2 = w0^2 Valid when: series LCR circuit; two frequencies giving the same current	rad/s
Quality factor	Q = w0 L/R = (1/R) sqrt(L/C) Valid when: series LCR circuit at resonance	dimensionless
Bandwidth	dw = R/L = w0/Q Valid when: series LCR circuit; half-power bandwidth between points where Z = root 2 R	rad/s
Voltage at resonance	VL = VC = Q V Valid when: series LCR circuit exactly at resonance	V

Full lesson with worked examples:
https://www.engineeringrise.in/learn/learn/jee-main/physics/electromagnetic-induction-and-alternating-currents/alternating-current-lc

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