A LEVEL PHYSICS 9702 · A LEVEL · TOPIC 21 · ~3 MIN READ

Alternating currents

Describing sinusoidal alternating currents, peak and root-mean-square values, mean power in a resistor, and rectification with one diode, a bridge of four diodes, and smoothing with a capacitor.

Period, frequency, peak value | $I = I_o \sin \omega t$ | r.m.s. values | Mean power = $\frac{1}{2} I_o^2 R$ | Half-wave rectification | Full-wave bridge rectifier | Smoothing capacitor | Ripple

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Paper tag = **where it is examined** DATA & FORMULAE given in the exam C1 A1 B1 how marks are awarded

highlight = comes up again and again Test yourself at the end

IN 30 SECONDS

- **Sinusoidal a.c.:** $I = I_o \sin \omega t$ and $V = V_o \sin \omega t$, with $\omega = 2\pi f$.
- **r.m.s. value = peak ÷ √2.** It's the steady direct current that would dissipate the same mean power in a resistor.
- **Mean power in a resistor = $\frac{1}{2} I_o^2 R = I_{rms}^2 R$** (half the peak power).
- **Rectification:** one diode gives half-wave; a bridge of four diodes gives full-wave. A capacitor in parallel with the load smooths the output; a larger RC gives less ripple.

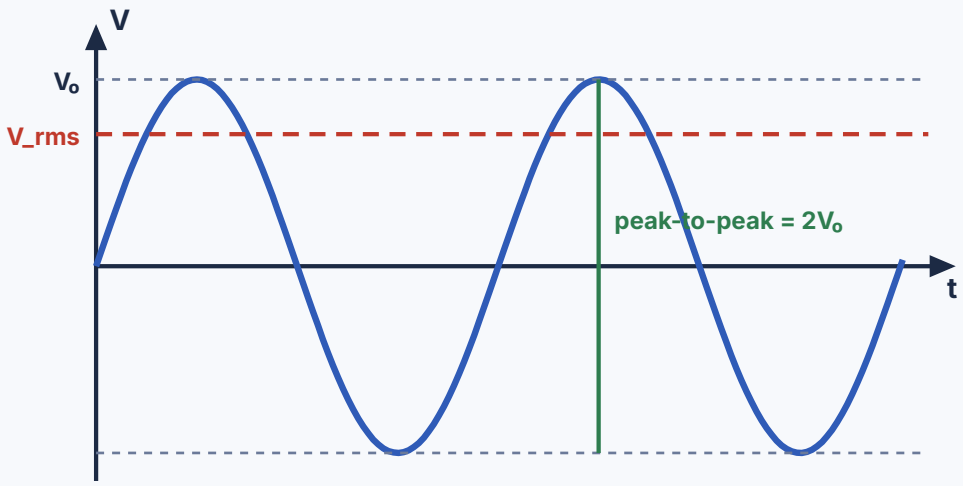
BY THE END YOU CAN

- Understand period, frequency, peak value and root-mean-square values of alternating current and voltage.
- Use $I = I_o \sin \omega t$ and $V = V_o \sin \omega t$.
- Use $I_{rms} = I_o/\sqrt{2}$ and $V_{rms} = V_o/\sqrt{2}$, and mean power = ½ × maximum power for a resistive load.
- Explain half-wave and full-wave rectification and the effect of a smoothing capacitor.

Riyaz Sir

1 Describing a.c.

Peak and r.m.s.



V_rms = $V_o/\sqrt{2}$: the steady d.c. voltage giving the same mean power in a resistor.

$$V_{rms} = V_o/\sqrt{2} \approx 0.71V_o.$$

Root-mean-square value — the value of the steady direct current (or voltage) that would produce the same mean power in a resistor.

$$I = I_0 \sin \omega t \; ; \; I_{rms} = I_0/\sqrt{2} \; ; \; V_{rms} = V_0/\sqrt{2}$$ DATA & FORMULAE

$$\omega = 2\pi f$$

- **Mains in India:** 230 V r.m.s. at 50 Hz, so the peak voltage is 230√2 = 325 V and the period 0.020 s.

WORKED EXAMPLE

A supply V = 12 sin(100πt) is connected across a 6.0 Ω resistor. Find the frequency, the r.m.s. current and the mean power.

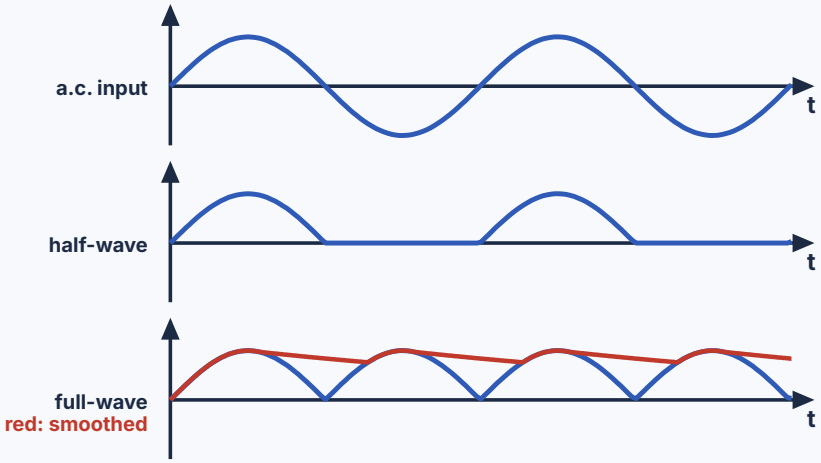
1. ω = 100π ⇒ f = **50 Hz** A1
2. I_o = 12/6.0 = 2.0 A ⇒ I_{rms} = **1.4 A** A1
3. **mean power = ½I_o^2R = ½ × 4.0 × 6.0 = 12 W** A1

COMMON MISTAKE

Using V_o^2/R for mean power. That gives the peak power, twice the mean.

2 Rectification and smoothing

Diodes and capacitors



A diode blocks one half; a bridge flips it; a capacitor smooths the ripple.

Half-wave keeps alternate halves; full-wave flips the negative halves; the capacitor fills in the gaps.

- **Half-wave:** a single diode conducts only in one direction, so the negative half-cycles are lost.
- **Full-wave:** a bridge of four diodes routes current through the load in the same direction during both half-cycles.
- **Smoothing:** the capacitor charges near each peak and discharges through the load in between. Larger C or larger load R (larger time constant RC) means smaller ripple.

COMMON MISTAKE

Drawing the smoothed output dropping to zero between peaks, or getting the bridge diode directions wrong. Practise drawing the bridge: both diodes on the output + side point towards it.

LINKING QUESTION

Capacitor discharge is in Capacitance; diodes are introduced in Electricity; and generating a.c. by induction is in Magnetic fields.

Test yourself — cover the answers first

QUICK CHECK

1. Find the r.m.s. value of a voltage with peak 20 V.
2. How many diodes in a bridge rectifier?
3. What does a smoothing capacitor do?
4. Mean power is what fraction of peak power in a resistor?
5. Find the period of 50 Hz a.c.

EXAM-STYLE

6. An a.c. supply delivers 60 W (mean) to a 15 Ω resistor. Find the peak current.
7. Explain why increasing the load resistance reduces the ripple.

8. Write the equation for a 50 Hz current with r.m.s. value 3.0 A.

Show answers

1. 14.1 V
2. four
3. reduces the ripple of the rectified output
4. one half
5. 0.020 s
6. I_rms = 2.0 A ⇒ I_o = 2.83 A
7. the time constant RC increases, so the capacitor discharges more slowly between peaks
8. I = 4.24 sin(100πt)

Stuck on a question?

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Want regular help? Send this to your parent →

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