Unit 19 · Alternating Current

HARDER PRACTICE QUESTIONS

Full marks 32

Write your answers on separate paper. Show your working.

1 Spot the error [3]

Find the mistake in the working and correct it.

Rajesh found the reactance of a 20 μF capacitor at 50 Hz:
"$X_C = 2\pi fC = 2\pi \times 50 \times 20 \times 10^{-6} = 6.3 \times 10^{-3}\ \Omega$."

2 Read the data [4]

Ashmita joined a 0.10 H coil, a capacitor C and a resistor in series to a 5.0 V rms supply and measured the current at several frequencies.

f (Hz)	200	300	400	500	600
I (mA)	13	33	100	40	23

i. About what is the resonant frequency?
ii. Find the capacitance C.
iii. Find the total resistance of the circuit.
iv. Why is the curve not the same shape on both sides of the peak?

3 Predict, then explain [3]

Write your prediction first, then explain it.

A lamp is in series with a coil on an a.c. supply. Predict what happens to the lamp when a soft iron rod is pushed into the coil. Would it be the same on a d.c. supply? Then explain.

4 Show that [3]

For a current $I = I_0 \sin \omega t$, show that the rms value is $I_0/\sqrt{2}$. (The average of $\sin^2 \omega t$ over a cycle is ½.)

5 A real setting [3]

A workshop's motor takes 10 A from the 230 V mains with a power factor of 0.80.

i. Find the power it really uses.
ii. What current would a load with a power factor of 1 need for the same power?
iii. Why do electricity companies dislike loads with a low power factor?

6 Which explanation fits? [2]

On a.c., a capacitor passes more current at a higher frequency. Gita says its plates charge and discharge more times a second, so more charge flows round the circuit each second. Pradeep says the insulator between its plates conducts better at higher frequency. Which explanation fits? Why?

7 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

Bina wrote: "The 230 V of the mains is the highest voltage it reaches. At resonance the p.d. across the capacitor is zero. The power in any a.c. circuit is $V_{rms} I_{rms}$."

8 Work backwards [3]

An FM radio's tuning circuit has a coil of 0.25 μH. What capacitance tunes it to a station at 100 MHz? To tune to a station of higher frequency, should the capacitance be made larger or smaller?

9 Design it [4]

A loudspeaker box has two 8 Ω speakers: a woofer for low notes and a tweeter for high ones. Sandesh wants to send only the high frequencies to the tweeter and only the low ones to the woofer, crossing over at 3.0 kHz.

i. Which part, a capacitor or a coil, should go in series with the tweeter, and which with the woofer? Why?

ii. Find the capacitance and the inductance whose reactance is 8 Ω at 3.0 kHz.

10 What if? [2]

What if the resistance of a series LCR circuit at resonance is doubled, everything else the same? Say what happens to the resonant frequency, the current at resonance and the sharpness of the resonance.

11 Make your own [2]

Write a problem whose answer is "the resonant frequency is 500 Hz". Solve it to show it works.