RMS

1. A sinusoidal alternating voltage displayed on a cathode ray oscilloscope is seen to have a peak value of 268V. What reading would be observed with a voltmeter indicating RMS voltage?

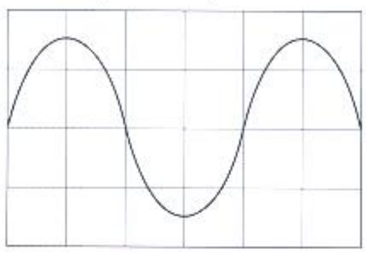
Remaining Questions #24.1, 24.2, 24.3, 24.4, 24.10

Also, don't forget he bonus question…

Short questions

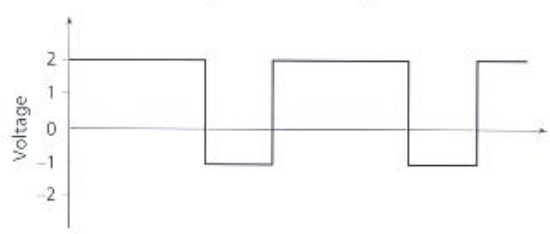
24.1 An oscilloscope is used to measure the voltage wave form across a 500 ohm resistor in an a.c. circuit. The wave form is shown in the diagram below. Given that the time base of the oscilloscope is set at 5 ms cm^{-1}, and its Y-gain is set at 0.5 V cm^{-1}, determine

(a) the time period and hence the frequency,
(b) the peak to peak voltage and hence the r.m.s. voltage,
(c) the r.m.s. current through the resistor,
(d) the mean power dissipated in the resistor.

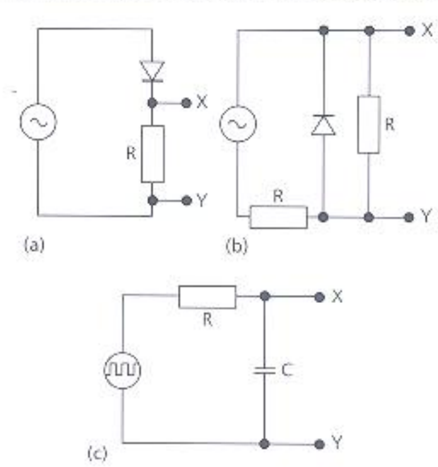


24.2 Determine the r.m.s. value for each of the following.

(a) A sinusoidal current with a peak value of 2.0 A.
(b) A full-wave rectified current with a peak value of 3.0 A.
(c) A square-wave current with a frequency of 1 Hz, which is at 0.1 A for one-half cycle and −0.1 A for the next half-cycle.
(d) An uneven square wave voltage as below.



24.3 Sketch the wave form for the alternating p.d. between points X and Y in each of the circuits below.



24.4 A sinusoidal current has a peak value of 5 A and its frequency is 50 Hz. Given that the current is represented by the equation

$I = I_0 \sin \omega t,$

use a phasor diagram to determine the current at time t equal to (a) 4 ms, (b) 12 ms, (c) 22 ms.

24.5 Prove that the current through a capacitor is $\frac{1}{4}$-cycle ahead of the capacitor voltage. Show that the reactance of a capacitor is equal to $1/(2\pi fC)$, where f is the frequency and C is the capacitance. Use this result to explain why capacitors act as filters for blocking low-frequency signals.

24.6 Explain, in terms of power, the difference between a resistive and a reactive component.

In an experiment to measure the reactance of a capacitor, the r.m.s. current is measured at 10 mA using an a.c. milliammeter. The p.d. across the capacitor terminals is measured at the same time using an oscilloscope, giving a peak voltage of 16 V. Calculate

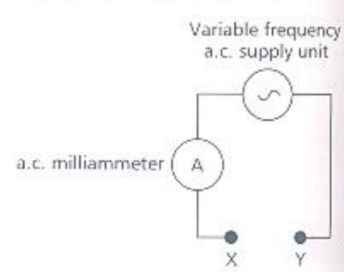
(a) the reactance of the capacitor,
(b) the capacitance C, given that the frequency is 100 Hz.

24.7 Sketch curves on the same axes to show how the current through and the p.d. across an inductor vary with time when the inductor is in an a.c. circuit. Assume the inductor has negligible resistance. On the same axes, sketch the power curve for the inductor, and indicate the direction of energy transfer over one full cycle. Use your power curve to explain why an inductor does not dissipate power.

24.8 A 12 V lamp bulb is connected in series with an air-cored inductor and a low-voltage a.c. supply unit. The output from the supply unit is adjusted until the lamp is at normal brightness. Explain why the lamp brightness is reduced when a solid iron bar is inserted into the core of the inductor.

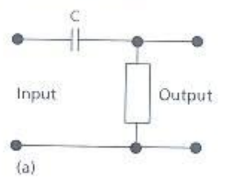
24.9 For the circuit shown below, the peak supply p.d. is kept fixed at 10 V but the supply frequency can be varied continuously over the range from 10 Hz to 1000 Hz. For each of the following components in turn connected between X and Y in the circuit, sketch a graph to show the variation of r.m.s. current with frequency over the full range.

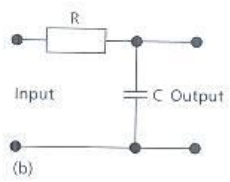
(a) A 100 ohm resistor connected between X and Y.
(b) A 100 μF capacitor connected between X and Y.
(c) A coil of resistance 8 ohms and inductance 5 mH connected between X and Y.



RMS

24.10 A student decides to make a filter to supply a suitable loudspeaker with high frequency signals only from an amplifier. He decides to use a resistor and a capacitor in series and considers two arrangements as shown below. Which one would you choose, and why?





24.11 A coil X in a d.c. circuit passes a current of 1.0 A when the p.d. across its terminals is 9.0 V. The same coil in an a.c. circuit operating at 50 Hz passes an r.m.s. current of 0.1 A when the r.m.s. p.d. across its terminals is 4.1 V. Use this information to calculate

(a) the resistance,

(b) the inductance of the coil.

24.12 A resistor and a capacitor are connected in series with one another and an a.c. milliammeter. The combination is then connected to the output terminals of a variable frequency generator. The output voltage of the generator is monitored using an a.c. voltmeter connected across the output terminals. At frequency $f = 50$ Hz, the milliammeter reads 0.025 A and the voltmeter reads 4.7 V; at $f = 100$ Hz, the voltmeter reads 3.2 V for the same current as before. Use this information to calculate the resistance and the capacitance.

24.13 A capacitor C, a resistor R and an inductor L are connected in series with one another, and then the combination is connected to the output of an a.c. supply unit. The resistance of R is known to be 120 Ω. A voltmeter reading r.m.s. values is then used to measure the p.d. across each component in turn. Its readings are 12 V across R, 15 V across L and 20 V across C.

(a) Use the resistor voltage to calculate the r.m.s. current.

(b) Calculate the r.m.s. value of the supply p.d. and sketch a phasor diagram to show how the voltage readings are related to one another.

(c) Given the frequency is 50 Hz, calculate the capacitance of C and the inductance of L.

24.14 A coil has an inductance of 30 mH and a resistance of 5.0 Ω. It is to be connected into a circuit in series with a capacitor C and an a.c. supply unit with an output of 12 V r.m.s. at 40 Hz.

(a) What value of capacitance for C would give resonance?

(b) What would be the r.m.s. current at resonance?

(c) What would be the r.m.s. p.d. across the coil at resonance?

24.15 The coil in question **24.14** is connected in parallel with a 0.01 μF capacitor. Sketch a graph to show how the impedance of the parallel combination varies with frequency.

Bonus Question:

Is our universe unique, or are there many universes?