A Level H2 Physics Tutorial 18: Alternating Current

Syllabus :

(a) show an understanding of and use the terms period, frequency, peak value and root-mean-square (r.m.s.) value as applied to an alternating current or voltage

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1.

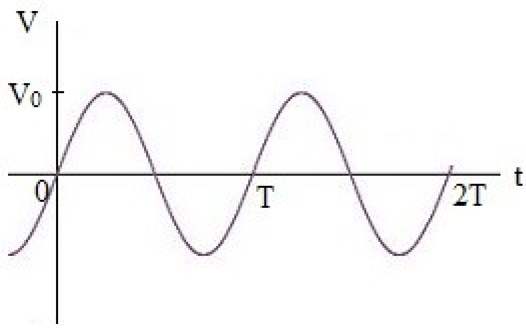

Figure 18-1

State the meanings of

(i) period,
(ii) frequency and
(iii) peak value

for an alternating voltage.

(b) deduce that the mean power in a resistive load is half the maximum (peak) power for a sinusoidal alternating current

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2. The power P dissipated at a resistor is given by I^2R, where I is current and R is resistance.

   (i) Sketch the current I versus time t graph.

   (ii) Sketch the I^2R versus time graph. What does the area under the graph represent?

   (iii) Why is the mean power equal to half the height of the peak power?

(iv) Derive an expression for the mean power.

(c) represent an alternating current or an alternating voltage by an equation of the form $x = x_0 \sin \omega t$

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3. An alternating current has a peak current of 0.5 A and a period of 0.1 s.

   (a) Sketch a graph showing the current against time.

   (b) Write and equation of the form $x = x_0 \sin \omega t$ to represent this current.

(d) distinguish between r.m.s. and peak values and recall and solve problems using the relationship $I_{rms} = I_o / 2$ for the sinusoidal case

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4(a)

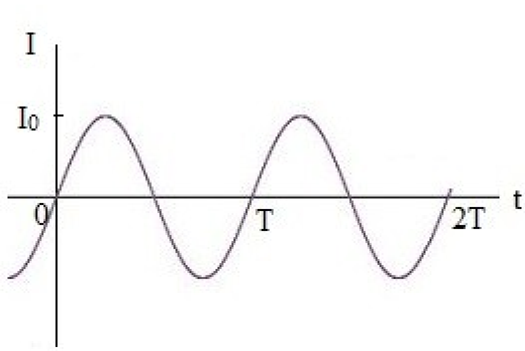

Figure 18-2

The above graph is a sine curve showing an a.c. current. What is the mean value of this current?

(b) To find a more meaningful mean, we can find the corresponding d.c. current that can give the same average power instead :

(i) Sketch the graph for I^2R against t. Sketch it for 2 periods of the a.c.

(ii) Sketch the power graph for the mean power of the a.c.

(iii) Write down an expression for the mean power P_{mean} in terms of the peak power I_0^2R..

(iv) Equate this to I_{rms}^2R, where I_{rms} is the d.c. current we need to find.

(v) Then find I_{rms} in terms of I_0.

(e) show an understanding of the principle of operation of a simple iron-core transformer and recall and solve problems using $N_s / N_p = V_s / V_p = I_p / I_s$ for an ideal transformer

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5.

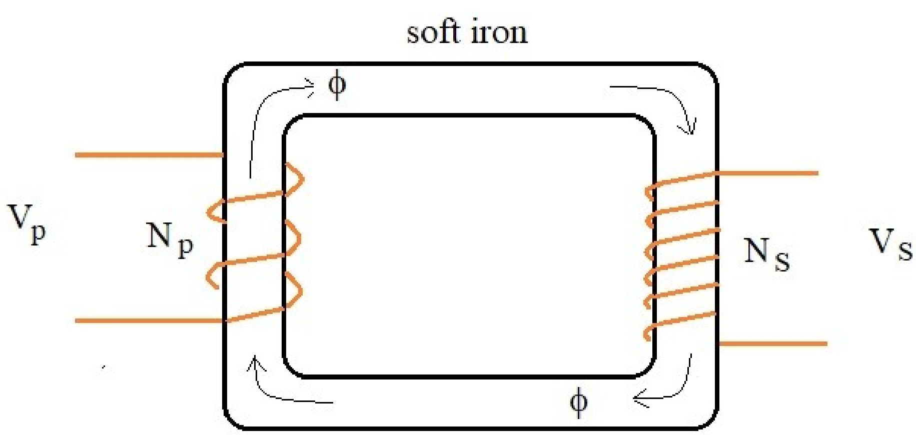

Figure 18-3

The current in the primary coil produces a magnetic field. This field is "guided" by the soft iron core through the secondary coil.

The primary coil has N_p turns, the secondary coil N_s turns. An alternating voltage V_p is connected across the primary coil. Let ϕ be the resulting magnetic flux through the iron core.

The rate of change of magnetic flux ϕ can be written as $d\phi/dt$.

(i) Using Faraday's law of electromagnetic induction, write down an expression relating V_p to $d\phi/dt$.

(ii) Assuming the ideal case, the same magnetic flux ϕ goes through the secondary coil. Write down an expression relating V_s to $d\phi/dt$.

(iii) Hence show that $N_s/N_p = V_s/V_p$.

(iv) Let I_p be the current in the primary coil, and I_s the current in the secondary coil. Assume that power coming out of the secondary coil is equal to power going into the primary coil. Show that $N_s/N_p = I_p/I_s$.

(f) explain the use of a single diode for the half-wave rectification of an alternating current.

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6. (a) Draw the symbol for a diode and explain its function.

(b) Draw a circuit diagram showing how one diode can produce a D.C. current from an A.C. voltage. Sketch the resulting output.

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