H2 Physics Revision Topic : Alternating Current

Structured Questions Name: ______________________

1 **(a)** The output of a power supply is represented by:

$$V = 9.0 \sin 20t$$

where V is the potential difference in volts and t is the time in seconds.

Determine, for the output of the supply:

(i) the root-mean-square (r.m.s.) voltage, $V_{r.m.s.}$

$V_{r.m.s.}$ = ...V [1]

(ii) the period T.

T = ...s [1]

(b) The variations with time t of the output potential difference V from two different power supplies are shown in Fig. 7.1 and Fig. 7.2.

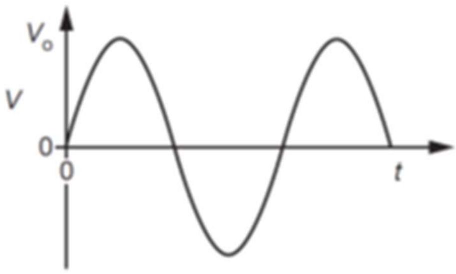

Fig. 7.1

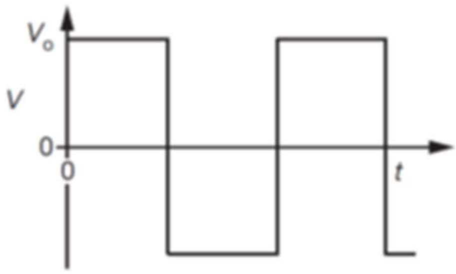

Fig. 7.2

The graphs are drawn to the same scale.

State and explain whether the same power would be dissipated in a 1.0 Ω resistor connected to each power supply.

....

....

....[1]

1

(c) **(i)** The power supply in **(a)** is connected to a transformer. The input power to the transformer is 80 W.

The secondary coil is connected to a resistor. The r.m.s. voltage across the resistor is 120 V. The r.m.s. current in the secondary coil is 0.64 A.

Calculate the efficiency of the transformer.

efficiency = ... [2]

(ii) State **one** reason why the transformer is not 100% efficient.

....

.... [1]

[Total: 6]

2 An ideal transformer is shown in Fig. 6.1.

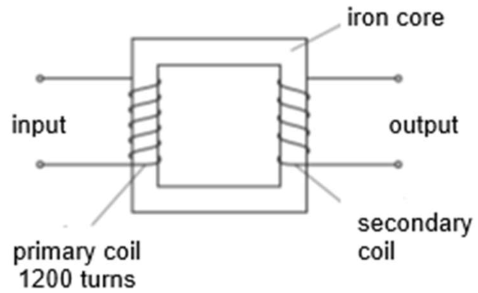

Fig. 6.1

(a) **(i)** State why the transformer has an iron core, rather than having no core.

....

.... [1]

(ii) Explain why an electromotive force (e.m.f.) is not induced at the output when a constant direct voltage is at the input.

....

....

.... [2]

(b) An alternating voltage of peak value 150 V is applied across the 1200 turns of the primary coil. The variation with time *t* of the e.m.f. *E* induced across the secondary coil is shown in Fig. 6.2.

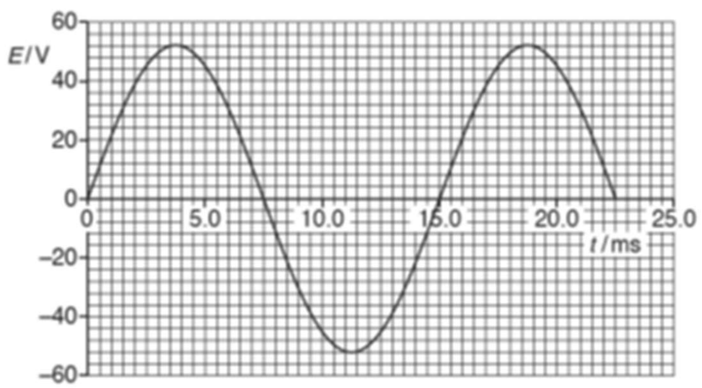

Fig. 6.2

Use the data from Fig. 6.2 to

2

(i) calculate the number of turns of the secondary coil,

number = ... [2]

(ii) state one time when the magnetic flux linking the secondary coil is a maximum.

time = ... ms [1]

(c) A resistor is connected between the output terminals of the secondary coil. The mean power dissipated in the resistor is 1.2 W. It may be assumed that the varying voltage across the resistor is equal to the varying e.m.f. E shown in Fig. 6.2.

(i) Calculate the resistance of the resistor.

resistance = ... Ω [2]

(ii) On Fig. 6.3, sketch the variation with time t of the power P dissipated in the resistor for t = 0 to t = 22.5 ms.

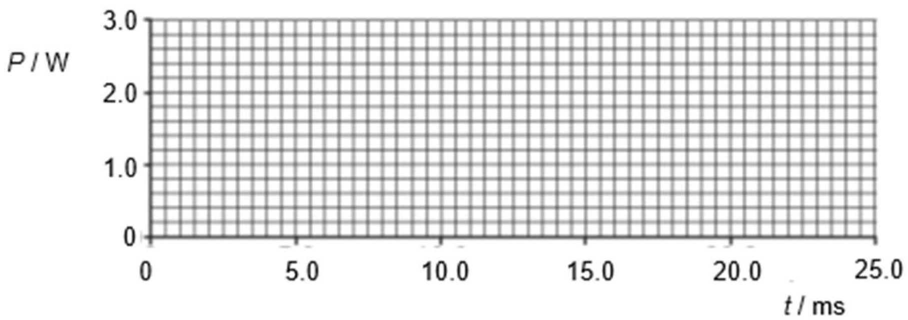

Fig. 6.3

[3]

3 Fig. 7.1 shows an iron-cored transformer that is 90% efficient. The primary coil of the transformer has 2700 turns and is connected to a 240 V r.m.s. supply. The secondary coil has 450 turns and is connected, through an ideal diode to resistors X and Y.

Resistor X dissipates energy at a mean rate of 90 W and the resistance of Y is twice of X's.

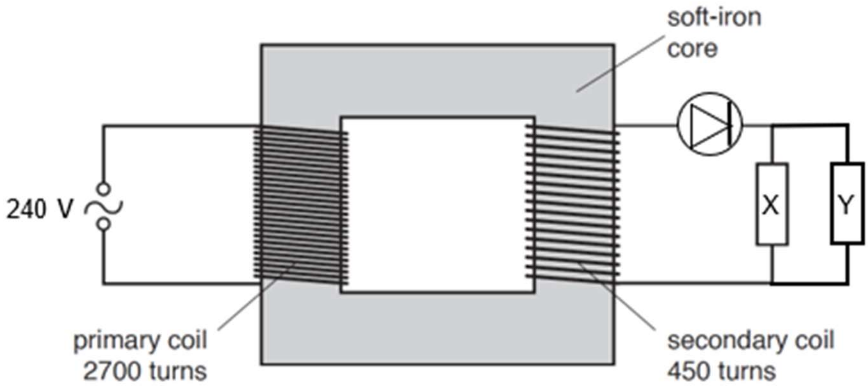

Fig. 7.1

(a) Calculate

(i) the peak voltage across the secondary coil,

peak voltage = ... V [2]

(ii) the r.m.s. voltage across X,

r.m.s. voltage = ... V [1]

3 **(iii)** the r.m.s. current in the primary coil.

r.m.s. current = ... A [3]

(b) On Fig 7.2, show the variation with time t of the power P dissipated in resistor X for two periods of the alternating voltage supply. The alternating voltage supply has period T.

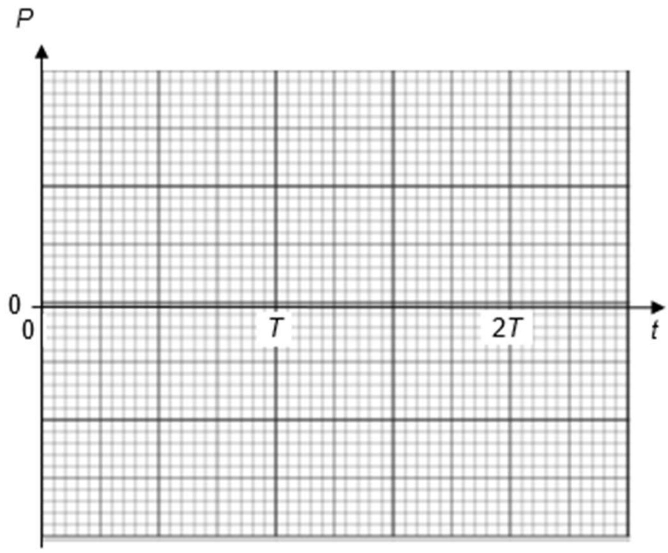

Fig. 7.2

[2]

[Total: 8]

4 An a.c. power supply is connected to a resistor *R*, as shown in Fig. 7.1.

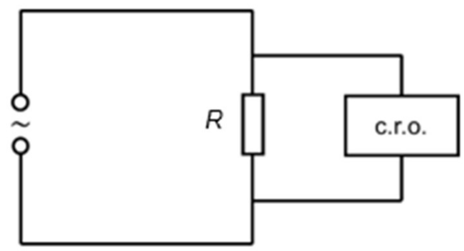

Fig. 7.1

A cathode ray oscilloscope (c.r.o.) is used to show the potential difference (p.d.) across *R*. The screen of the c.r.o. displays the variation with time of the p.d. across *R*, as shown in Fig. 7.2.

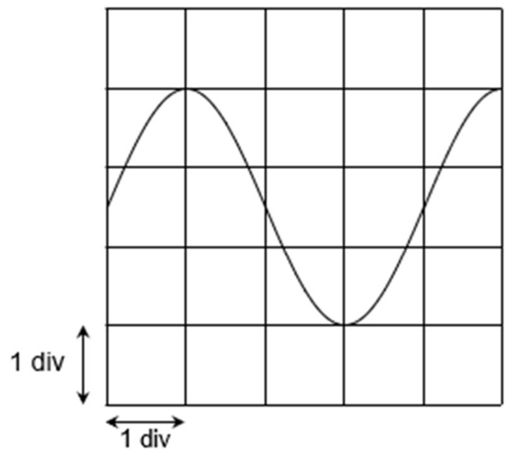

Fig. 7.2

(a) The power supply's voltage *V* is given by the expression

$$V = 6.0 \sin(314t)$$

The voltage *V* is measured in volts and the time *t* is measured in seconds.

Determine the Y-gain and time-base of the c.r.o.

Y-gain = ... V / div [1]

time-base = ... ms / div [2]

4 **(b)** Now, a diode is connected in series with the resistor *R*, as shown in Fig. 7.3.

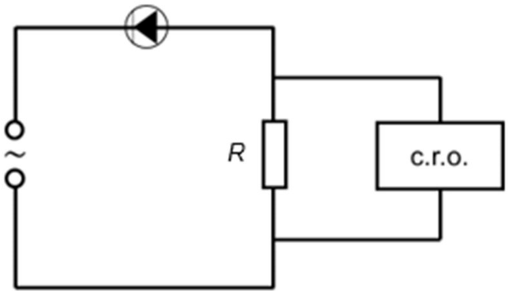

Fig. 7.3

(i) Sketch in Fig. 7.4 the variation with time of the power *P* dissipated in *R* when *R* is 20 Ω. Indicate the peak power value in your sketch.

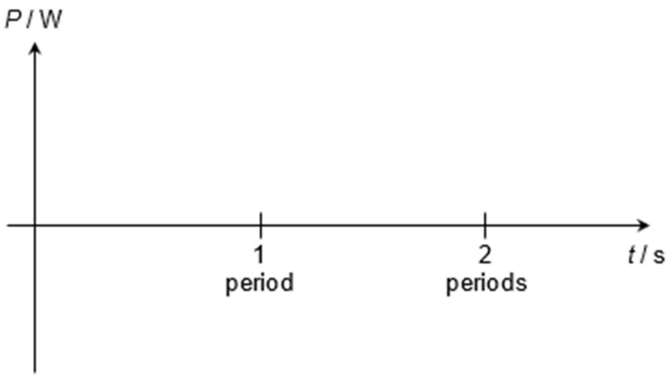

Fig. 7.4

[2]

(ii) Draw a line in Fig. 7.4 to represent the average power dissipated in *R*.

Hence, show that the root-mean-square current in *R* is 0.15 A.

[2]

5 **(a)** State Faraday's law of electromagnetic induction.

....

....

.... [2]

(b) An iron-core transformer is illustrated in Fig. 6.1.

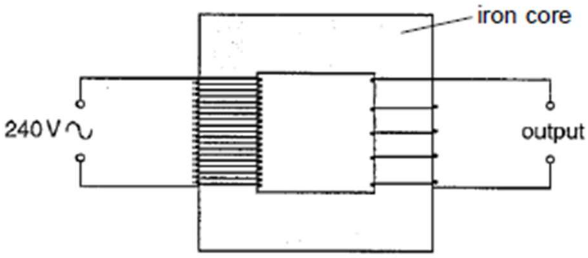

Fig. 6.1

The input potential difference is 240 V r.m.s. The **maximum** output potential difference is 24 V. There are 260 turns of wire on the secondary coil.

(i) Explain what is meant by an ideal transformer.

....

.... [1]

(ii) Calculate the number of turns of wire on the primary coil.

number of turns = ... [3]

5 **(iii)** There is power loss in the transformer.

If the input rms current is 350 mA and the output rms current is 3.5 A, calculate the efficiency of this transformer.

efficiency = ... % [2]

(iv) Suggest and explain one way to reduce the power loss of the transformer.

....

....

....

.... [2]

[Total: 10]

6 A power supply is connected across a load as shown in Fig. 6.1.

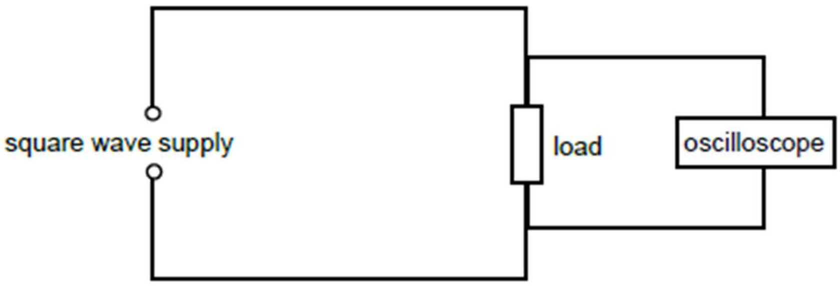

Fig. 6.1

The power supply provides a square wave voltage that cycles between + 7.0 V and – 7.0 V as shown on the oscilloscope display in Fig. 6.2.

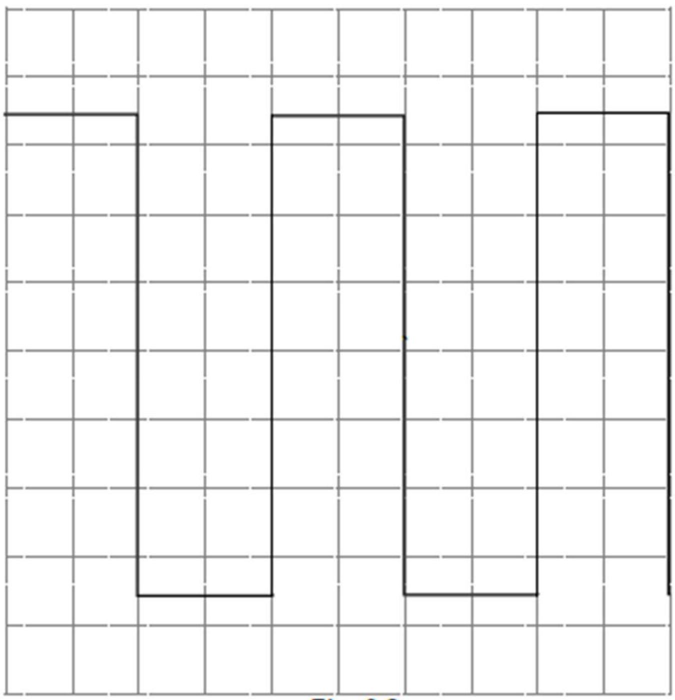

Fig. 6.2

(a) Determine the Y-gain for the oscilloscope based on the waveform shown in Fig. 6.2

Y-gain = ... V / div [2]

6 **(b)** Determine the frequency of the square wave given that the time base is 5.0 ms / div.

frequency of square wave = ... Hz [1]

(c) The root-mean-square value for the square wave in Fig. 6.2 is 7.0 V. Explain the significance of this value.

....

....

.... [1]

(d) A diode is used to achieve rectification of the square wave.

On Fig. 6.3, sketch the new waveform. The original waveform in Fig. 6.2 has been reproduced as the grey line shown. [1]

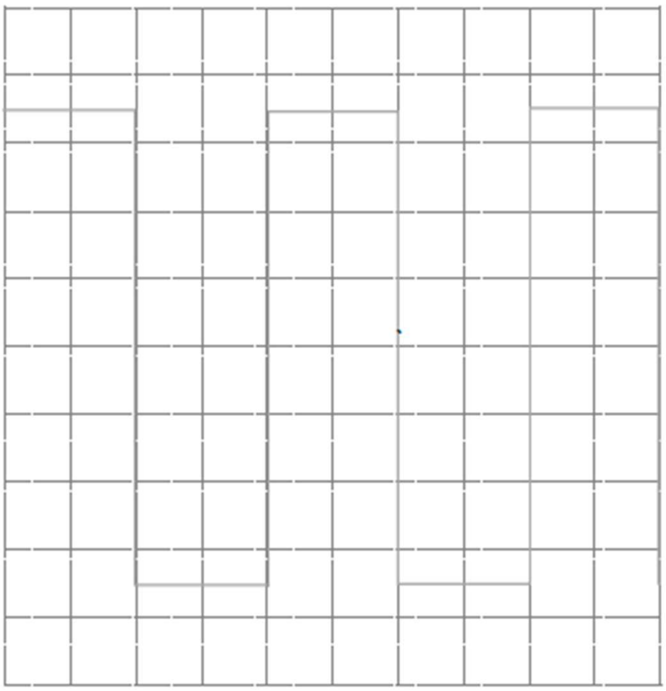

Fig. 6.3

6

(e) With the diode still in place, the power supply is replaced by another one which is sinusoidal. Determine the value of the peak voltage such that the average power dissipated in the load remains the same as the value given in **(c)**.

peak voltage = ... V [2]

[Total: 7]

7

Fig. 7.1 shows an ideal transformer. The primary coil of the transformer has 4000 turns and is connected to a sinusoidal a.c. supply. The secondary coil has 200 turns and is connected to a 4.8 Ω load resistor and a diode.

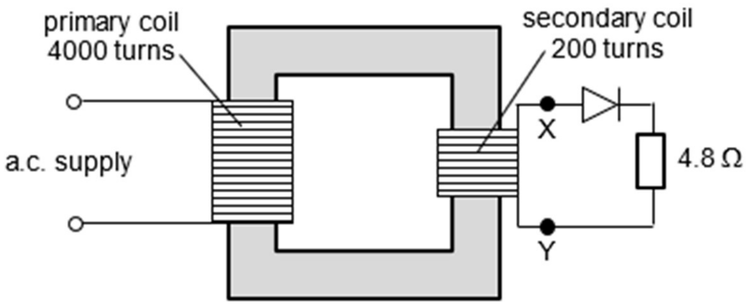

Fig. 7.1

V_{XY} is the potential of X with respect to Y. The variation with time t of V_{XY} is shown in Fig. 7.2.

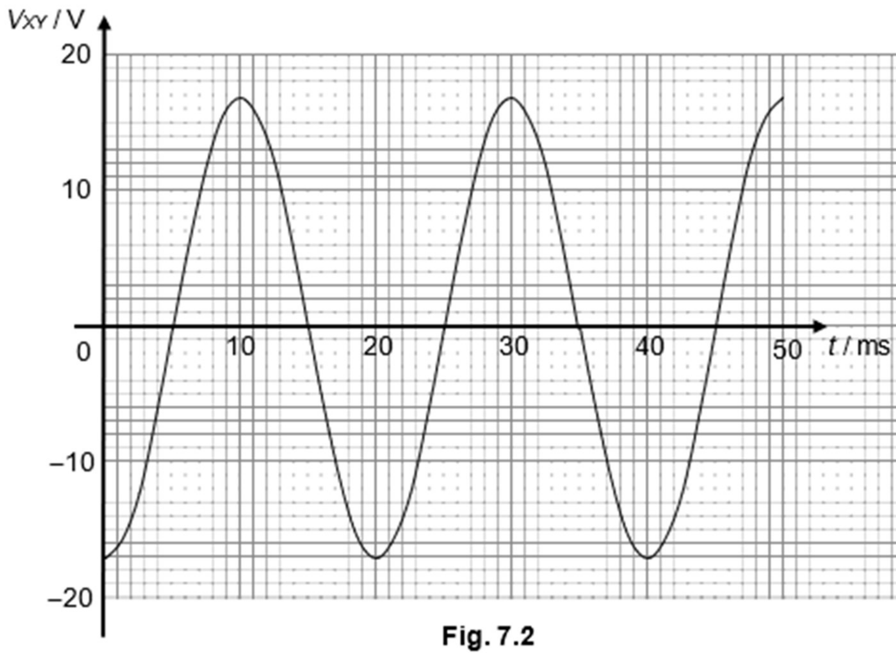

Fig. 7.2

(a) Determine the frequency of the a.c. supply.

frequency = ... Hz [1]

7

(b) Calculate the root-mean-square value of V_{XY}.

root-mean-square value of V_{XY} = ... V [1]

(c) Determine the root-mean-square voltage of the a.c. supply.

root-mean-square voltage = ... V [2]

(d) Determine the mean power dissipated in the load resistor.

mean power = ... W [2]

(e) With reference to Fig. 7.2, describe and explain how the potential difference across the load resistor varies with time.

....

....

....

.... [2]

8 A graph of the voltage input to an ideal transformer is shown in Fig. 5.1. The 45:1 step-down transformer has a mean input power of 25 W.

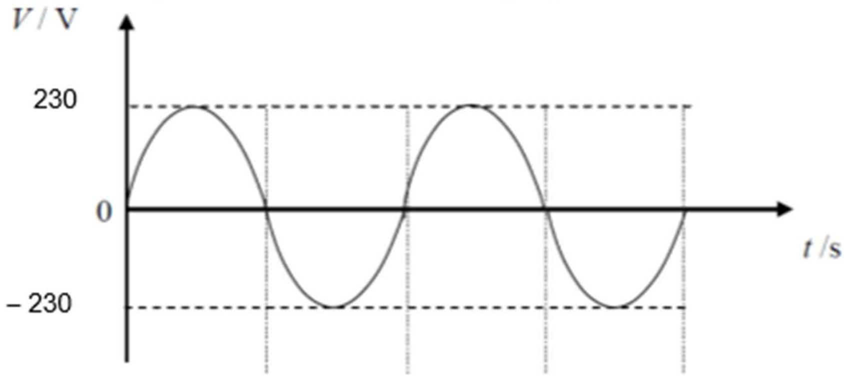

Fig. 5.1

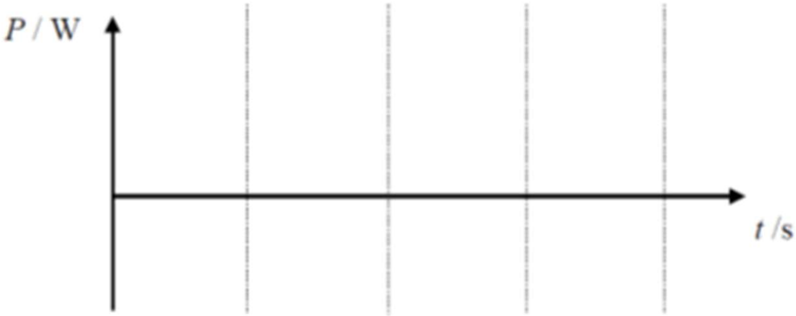

Fig. 5.2

(a) On the *P*-*t* graph in Fig. 5.2, sketch the variation of power input to the transformer with time for two complete cycles. Indicate the value for the maximum input power. [2]

(b) Calculate the r.m.s. value of the output voltage.

r.m.s. value of output voltage = ... V [3]

9 A transmission line is used to deliver power in a high voltage a.c. transmission system.

Fig. 4.1 shows the variation with time t of the voltage V across the transmission line.

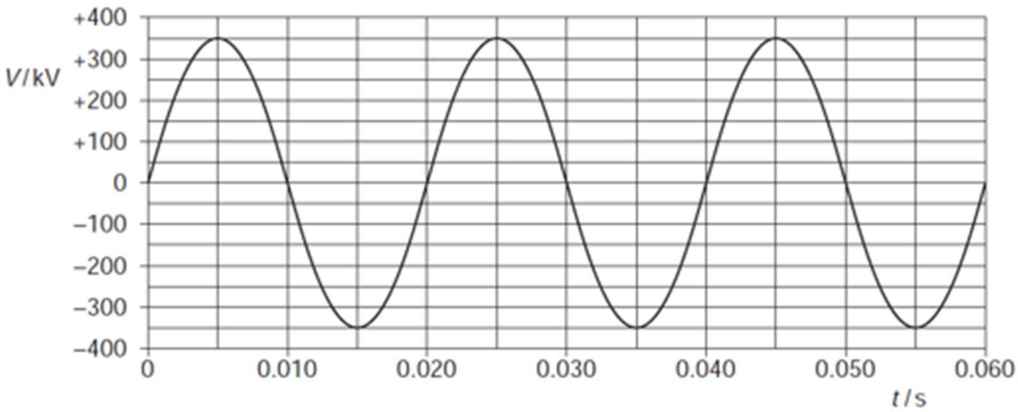

Fig. 4.1

Fig. 4.2 shows the variation with time t of the current I in the transmission line.

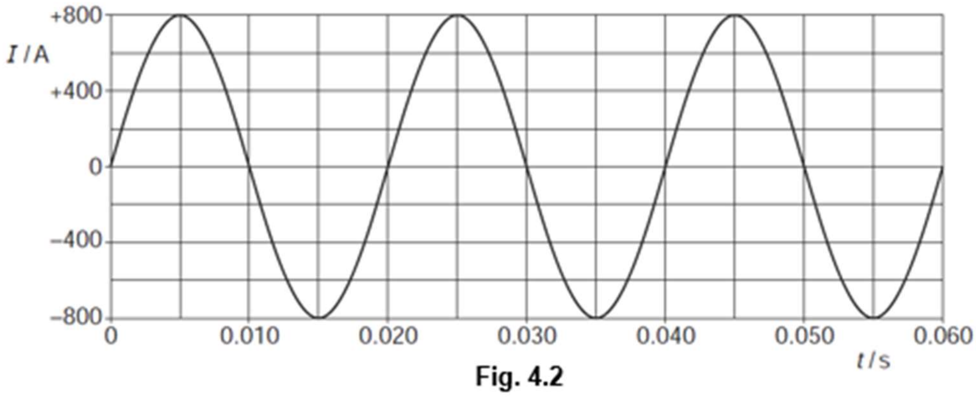

Fig. 4.2

(a) Determine the power delivered by the transmission line at

(i) t = 0.015 s,

power = ... W [1]

(ii) t = 0.030 s.

power = W [1]

9 **(b)** Using information from Fig. 4.1 and Fig. 4.2, sketch a graph on the axes of Fig. 4.3 to show the variation with time t of the power P delivered by the transmission line. Indicate the value of the maximum power on Fig. 4.3.

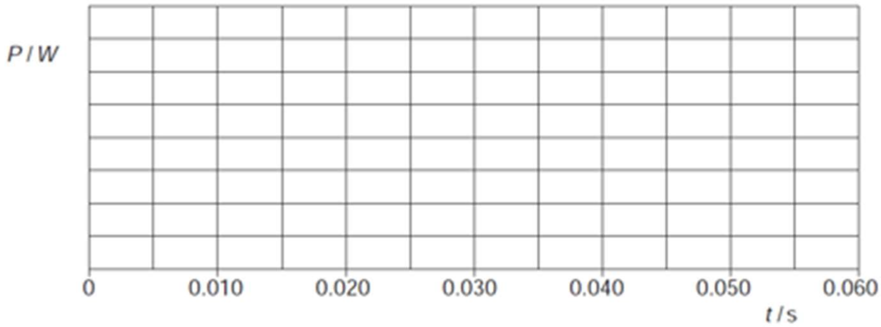

Fig. 4.3 [2]

(c) It is suggested that this transmission line is also used in a high voltage direct current (HVDC) transmission system delivering a current of 800 A at a constant voltage of 350 kV.

Show, with some workings, that the average power delivered by the HVDC transmission line would be greater than that delivered by the line when transmitting the a.c..

....

.... [2]

(d) The a.c. transmission line passes through an ideal transformer of step-down ratio 20:1. Explain the change, if any, to the peak value of the current of the a.c..
You may show your workings in the spaces below.

....

.... [2]

[Total: 8]