An ideal iron-cored transformer is illustrated in Fig. 6.1.

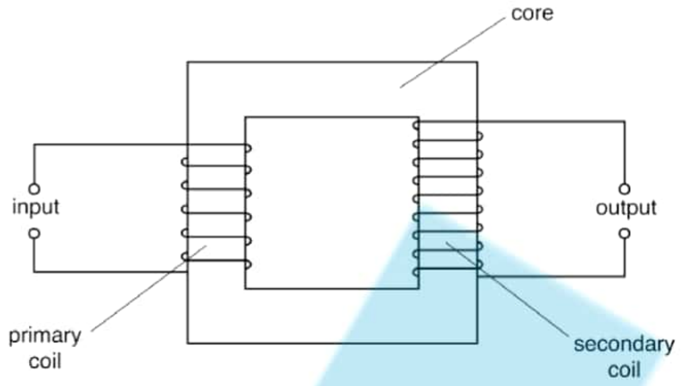

Fig. 6.1

(a) Explain why

(i) the supply to the primary coil must be alternating current, not direct current,

the flux linkage in the coil must be changing, so that the emf is induced in secondary. .... [2]

(ii) for constant input power, the output current must decrease if the output voltage increases.

P = IV, when P is constant and I decreases, V will increase .... [2]

(b) Fig. 6.2 shows the variation with time t of the current I_p in the primary coil. There is no current in the secondary coil.

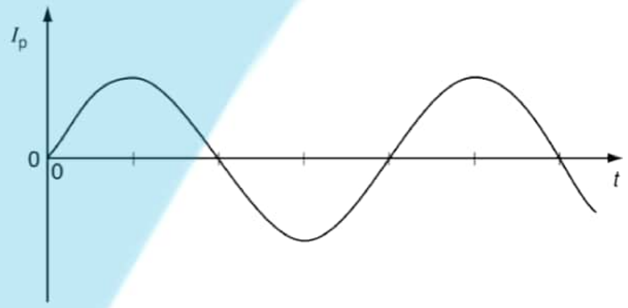

Fig. 6.2

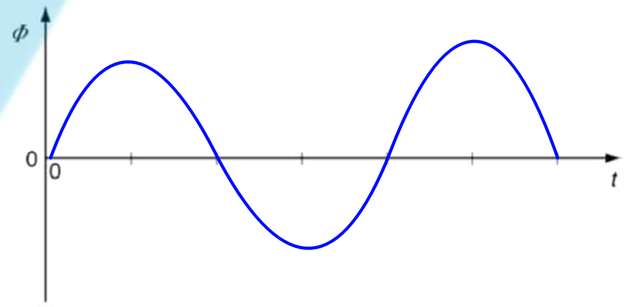

Fig. 6.3

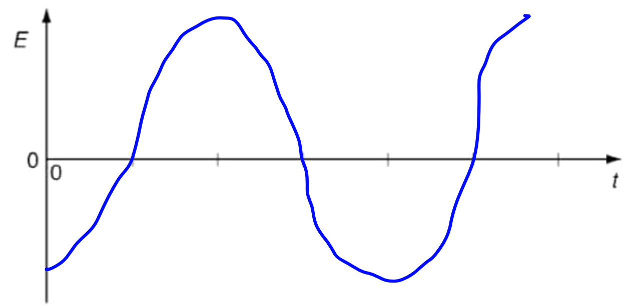

Fig. 6.4

(i) Complete Fig. 6.3 to show the variation with time t of the magnetic flux Φ in the core. [1]

(ii) Complete Fig. 6.4 to show the variation with time t of the e.m.f. E induced in the secondary coil. [2]

(iii) Hence state the phase difference between the current I_p in the primary coil and the e.m.f. E induced in the secondary coil.

phase difference = 90° [1]

An ideal transformer has 5000 turns on its primary coil. It is to be used to convert a mains supply of 230 V r.m.s. to an alternating voltage having a peak value of 9.0 V.

(a) Calculate the number of turns on the secondary coil.

$$\frac{N_p}{N_s} = \frac{V_p}{V_s} \qquad V_{rms} = \frac{9}{\sqrt{2}}$$

$$\frac{5000}{x} = \frac{230}{6.3639}$$

$$x = 138.34$$

number = 138 [3]

(b) The output from the transformer is to be full-wave rectified. Fig. 4.1 shows part of the rectifier circuit.

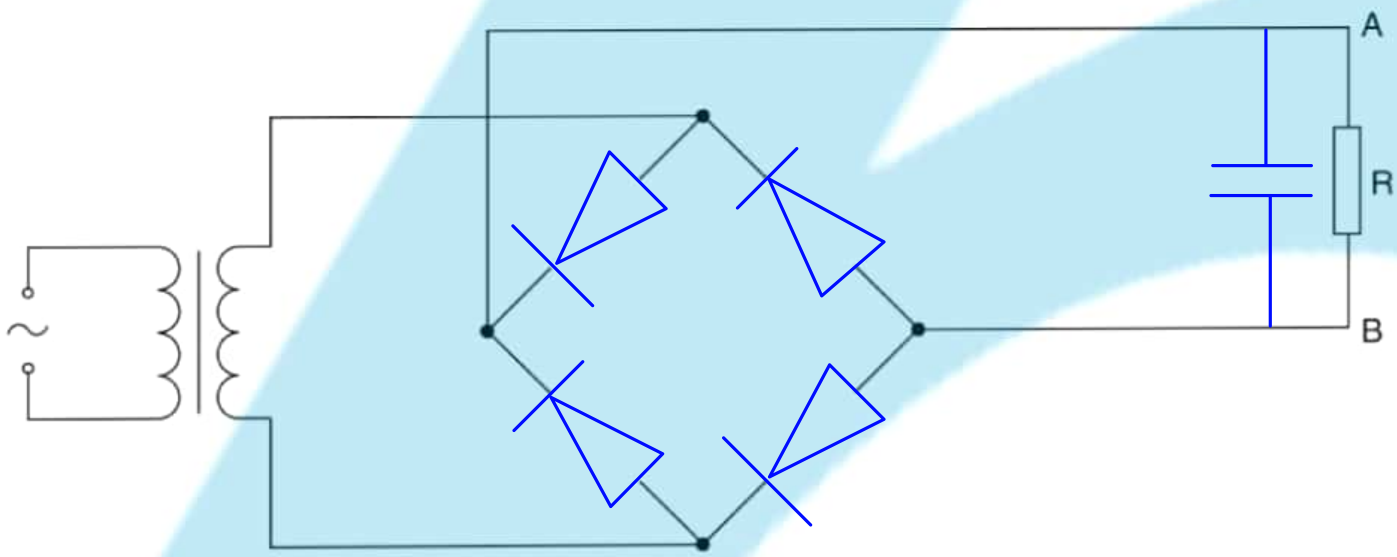

Fig. 4.1

On Fig. 4.1, draw

(i) diode symbols to complete the diagram of the rectifier such that terminal A of the resistor R is positive with respect to terminal B, [2]

(ii) the symbol for a capacitor connected to provide smoothing of the potential difference across the resistor R. [1]

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(c) Fig. 4.2 shows the variation with time t of the smoothed potential difference V across the resistor R.

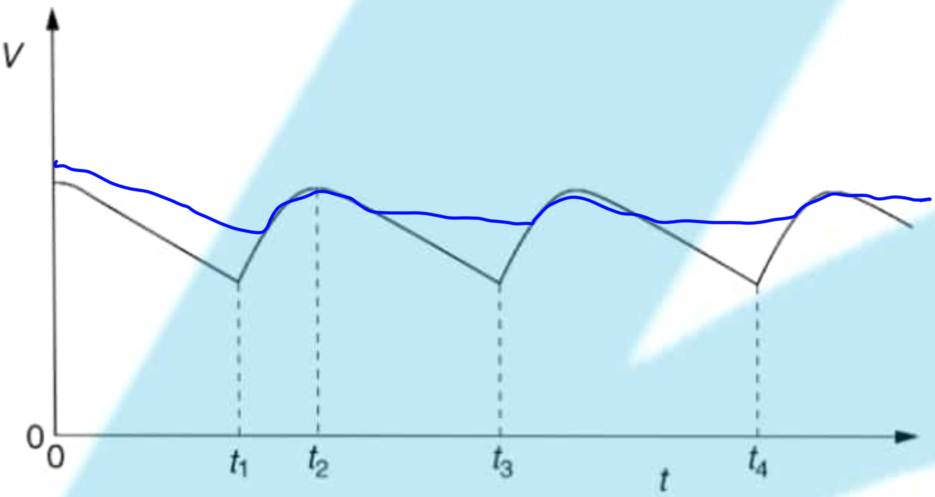

Fig. 4.2

(i) State the interval of time during which the capacitor is being charged from the transformer.

from time ...t_1... to time ...t_2... [1]

(ii) The resistance of the resistor R is doubled. On Fig. 4.2, sketch the variation with time t of the potential difference V across the resistor. [2]

A simple iron-cored transformer is illustrated in Fig. 6.1.

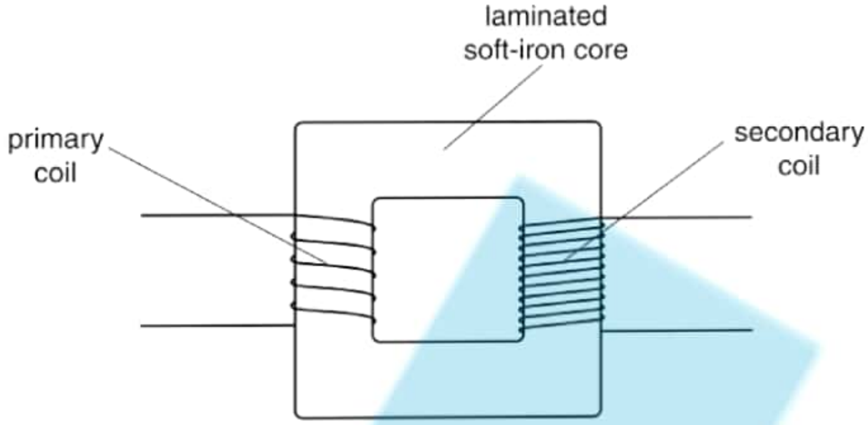

Fig. 6.1

(a) Suggest why the core is

(i) a continuous loop,

To improve the magnetic flux linkage

[1]

(ii) laminated.

To reduce heat loss due to eddy currents

[2]

(b) (i) State Faraday's law of electromagnetic induction.

The induced Emf is proportional to the rate of change of magnetic flux linkage

[2]

(ii) Use Faraday's law to explain the operation of the transformer.

The AC current in the primary give rise to the change in flux in the core this flux links with the secondary, and as the flux keeps changing, emf is induced in the secondary coil

[3]

(c) State two advantages of the use of alternating voltages for the transmission and use of electrical energy.

1. Can easily change the voltage

2. reduces power closs

[2]

The variation with time t of the output V of an alternating voltage supply of frequency 50 Hz is shown in Fig. 6.1.

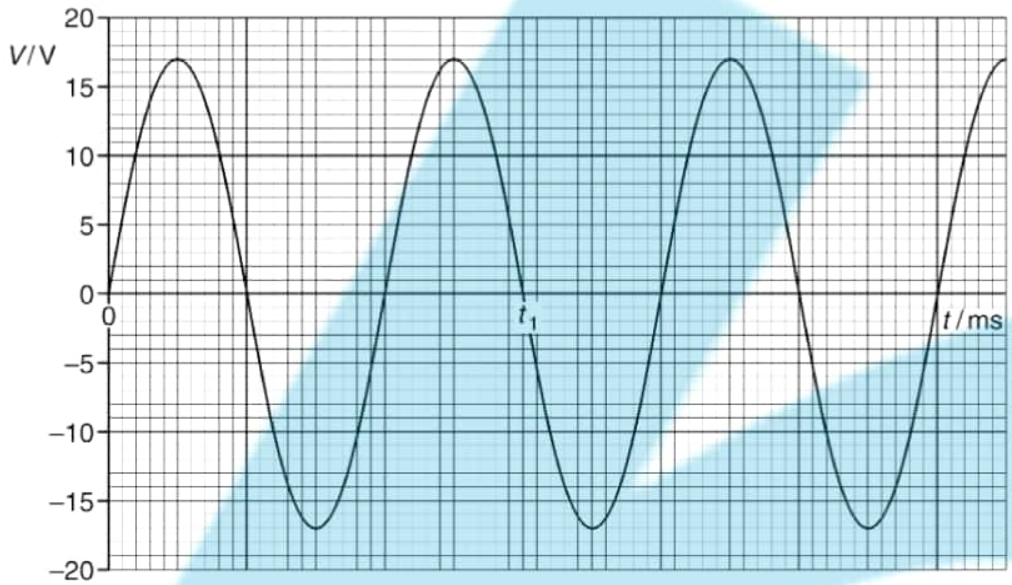

Fig. 6.1

(a) Use Fig. 6.1 to state

(i) the time t_1,

$f = \frac{1}{T} = \frac{1}{50} \times 1.5$

t_1 = ...0.03.... s [2]

(ii) the peak value V_0 of the voltage,

V_0 = ...17.... V [1]

(iii) the root-mean-square voltage V_{rms},

$\frac{17}{\sqrt{2}}$

V_{rms} = ...12.02.... V [1]

(iv) the mean voltage <V>.

<V> = ... V [1]

(b) The alternating supply is connected in series with a resistor of resistance 2.4 Ω. Calculate the mean power dissipated in the resistor.

$P = \frac{V_{rms}^2}{2.4} = \frac{12.02^2}{2.4} = 60.2$

power = ...60.... W [2]

A simple transformer is illustrated in Fig. 6.1.

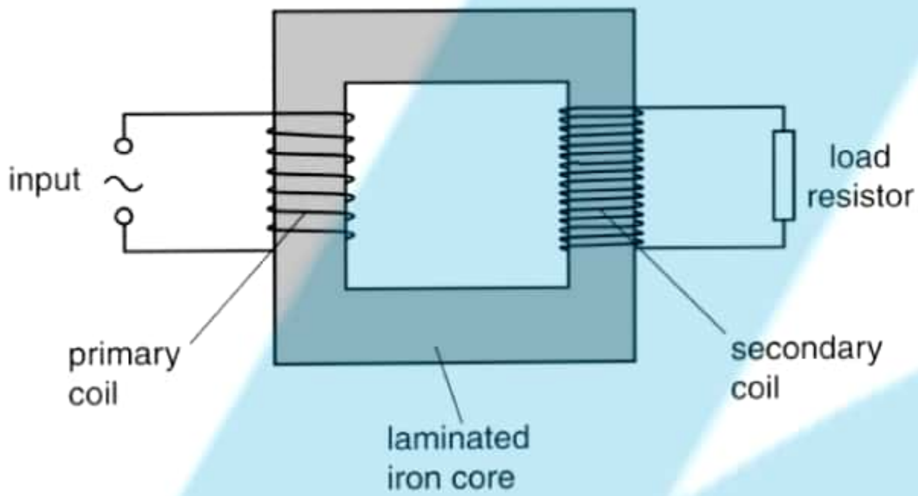

Fig. 6.1

(a) State

(i) why the iron core is laminated,

To reduce heat loss by eddy current

.... [2]

(ii) what is meant by an *ideal* transformer.

Input Power = output power

.... [1]

(b) An ideal transformer has 300 turns on the primary coil and 8100 turns on the secondary coil.
The root-mean-square input voltage to the primary coil is 9.0V.

Calculate the peak voltage across the load resistor connected to the secondary coil.

$$\frac{N_p}{N_s} = \frac{V_p}{V_s}$$

$V_s = 243$

$V_0 = 243 \times \sqrt{2} = 343.69$

$$\frac{300}{8100} = \frac{9}{V_{s\,rms}}$$

peak voltage = 340 V [2]