

Q1.

- 5 (a) Explain, in terms of heating effect, what is meant by the *root-mean-square (r.m.s.) value* of an alternating current.

.....
.....
..... [2]

- (b) State the relation between the peak current I_0 and the r.m.s. current I_{rms} of a sinusoidally-varying current.

..... [1]

- (c) The value of a direct current and the peak value of a sinusoidal alternating current are equal.

- (i) Determine the ratio

$$\frac{\text{power dissipation in a resistor of resistance } R \text{ by the direct current}}{\text{power dissipation in the resistor of resistance } R \text{ by the alternating current}}$$

ratio = [2]

- (ii) State one advantage and one disadvantage of the use of alternating rather than direct current in the home.

advantage

.....

disadvantage

..... [2]

(d) A current I varies with time t as shown in Fig. 5.1.

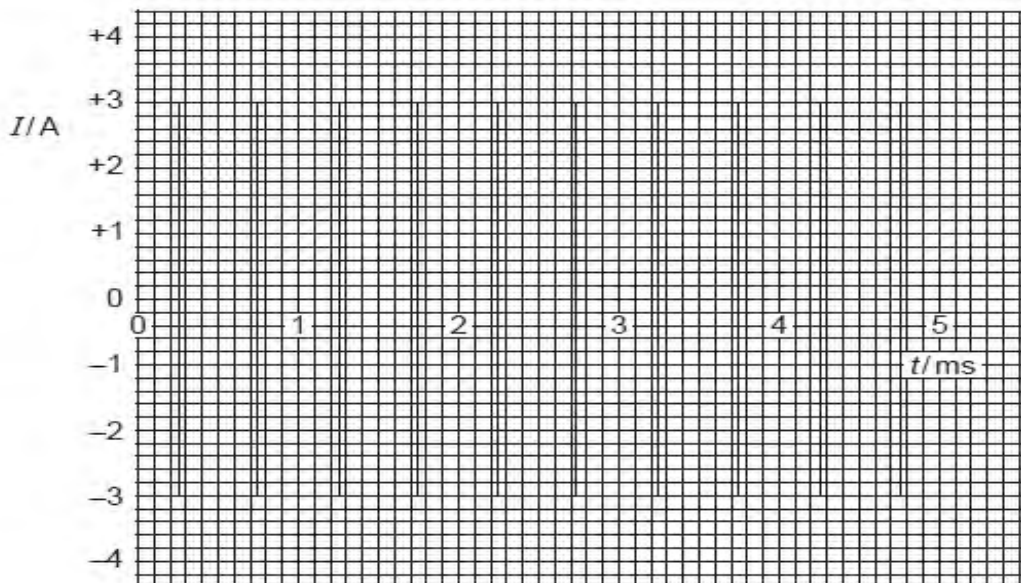


Fig. 5.1

For this varying current, state

(i) the peak value,

peak value = A [1]

(ii) the r.m.s. value.

r.m.s. value = A [1]

Q2.

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

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

number = [3]

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

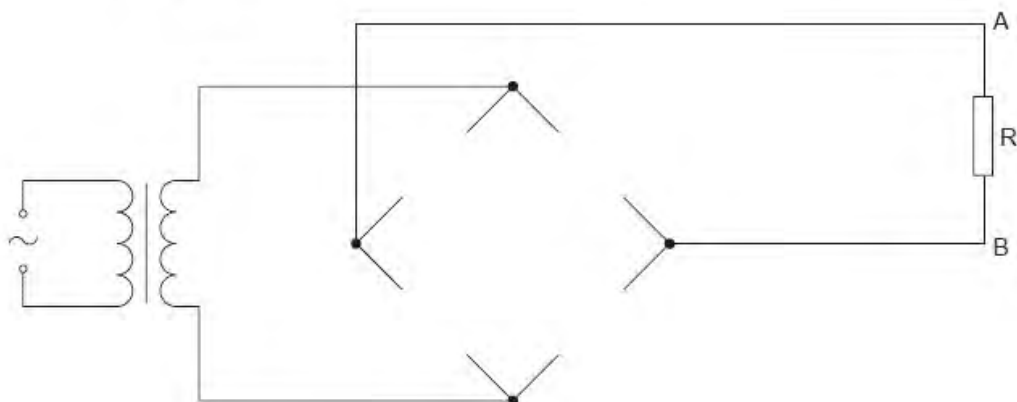


Fig. 4.1

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]

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

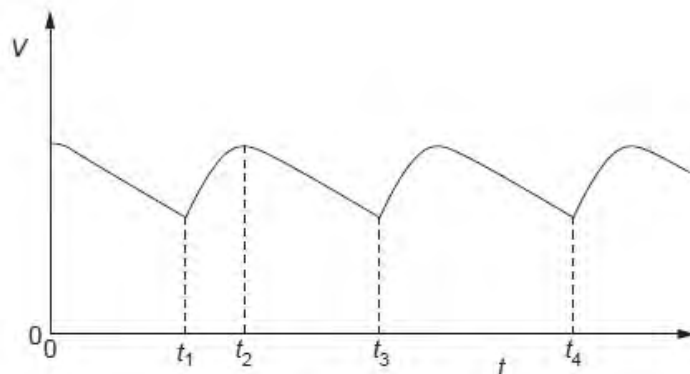


Fig. 4.2

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

U₂

Q3.

- 6 A student is asked to design a circuit by which a direct voltage of peak value 9.0V is obtained from a 240V alternating supply. The student uses a transformer that may be considered to be ideal and a bridge rectifier incorporating four ideal diodes. The partially completed circuit diagram is shown in Fig. 6.1.

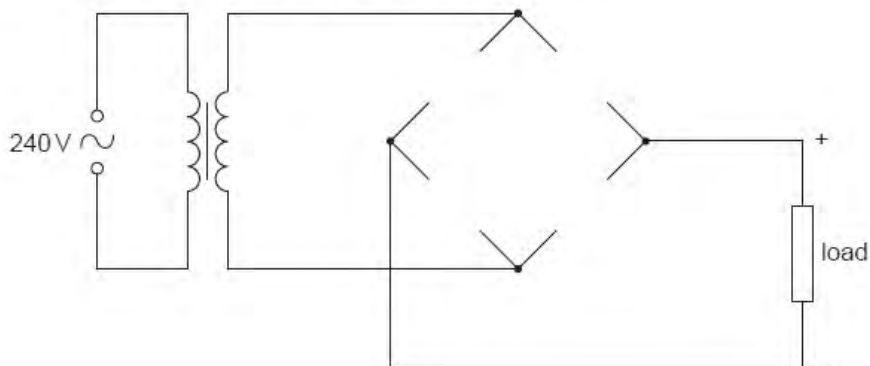


Fig. 6.1

- (a) On Fig. 6.1, draw symbols for the four diodes so as to produce the polarity across the load as shown on the diagram. [2]

- (b) Calculate the ratio

$$\frac{\text{number of turns on the secondary coil}}{\text{number of turns on the primary coil}}$$

ratio = [3]

Q4.

- 7 (a) Explain what is meant by the *root-mean-square* (r.m.s.) value of an alternating voltage.

.....

 [2]

- (b) An alternating voltage V is represented by the equation

$$V = 220 \sin(120\pi t),$$

where V is measured in volts and t is in seconds.

For this alternating voltage, determine

- (i) the peak voltage,

peak voltage = V [1]

- (ii) the r.m.s. voltage,

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

- (iii) the frequency.

frequency = Hz [1]

- (c) The alternating voltage in (b) is applied across a resistor such that the mean power output from the resistor is 1.5 kW.

Calculate the resistance of the resistor.

resistance = Ω [2]

Q5.

6 A transformer is illustrated in Fig. 6.1.

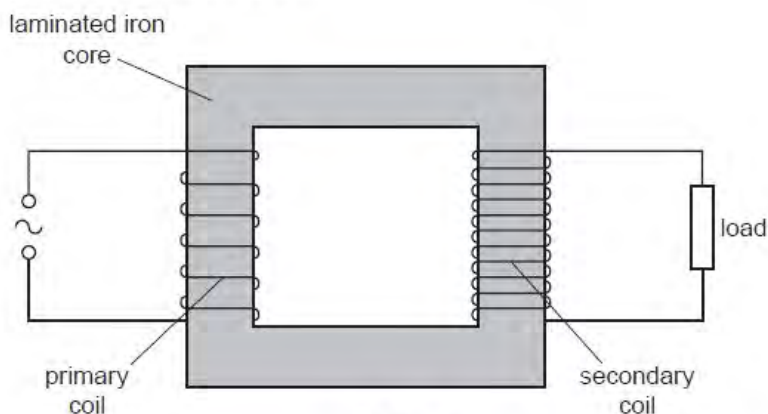


Fig. 6.1

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(a) (i) Explain why the coils are wound on a core made of iron.

.....
 [1]

(ii) Suggest why thermal energy is generated in the core.

.....

 [2]

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

.....

 [2]

(ii) Use Faraday's law to explain why the potential difference across the load and the e.m.f. of the supply are not in phase.

.....

 [2]

(c) Electrical energy is usually transmitted using alternating current. Suggest why the transmission is achieved using

F
Exar
L

(i) high voltages,

.....
.....
..... [2]

(ii) alternating current.

.....
..... [1]

Q6.

6 An alternating current supply is connected in series with a resistor R, as shown in Fig. 6.1.

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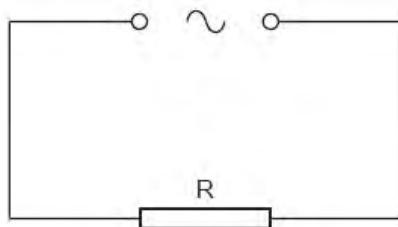


Fig. 6.1

The variation with time t (measured in seconds) of the current I (measured in amps) in the resistor is given by the expression

$$I = 9.9 \sin(380t).$$

(a) For the current in the resistor R, determine

(i) the frequency,

frequency = Hz [2]

(ii) the r.m.s. current.

r.m.s. current = A [2]

(b) To prevent over-heating, the mean power dissipated in resistor R must not exceed 400W.
Calculate the minimum resistance of R.

For
Examin
Use

resistance = Ω [2]

Q7.

- 6 A sinusoidal alternating voltage supply is connected to a bridge rectifier consisting of four ideal diodes. The output of the rectifier is connected to a resistor R and a capacitor C as shown in Fig. 6.1.

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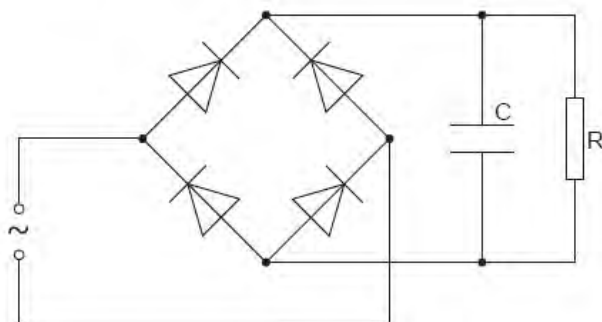
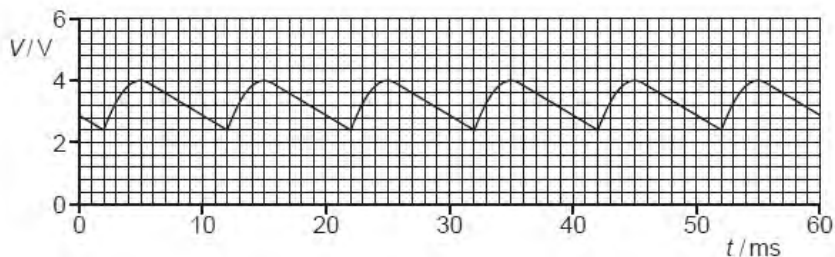


Fig. 6.1

The function of C is to provide some smoothing to the potential difference across R . The variation with time t of the potential difference V across the resistor R is shown in Fig. 6.2.



- (a) Use Fig. 6.2 to determine, for the alternating supply,

- (i) the peak voltage,

peak voltage = V [1]

- (ii) the root-mean-square (r.m.s.) voltage,

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

(iii) the frequency. Show your working.

Ex

frequency = Hz [2]

(b) The capacitor C has capacitance $5.0\ \mu\text{F}$.
For a single discharge of the capacitor through the resistor R, use Fig. 6.2 to

(i) determine the change in potential difference,

change = V [1]

(ii) determine the change in charge on each plate of the capacitor,

change = C [2]

(iii) show that the average current in the resistor is $1.1 \times 10^{-3}\text{A}$.

[2]

- (c) Use Fig. 6.2 and the value of the current given in (b)(iii) to estimate the resistance of resistor R.

Ex

resistance = Ω [2]

Q8.

- 6 A simple transformer is illustrated in Fig. 6.1.

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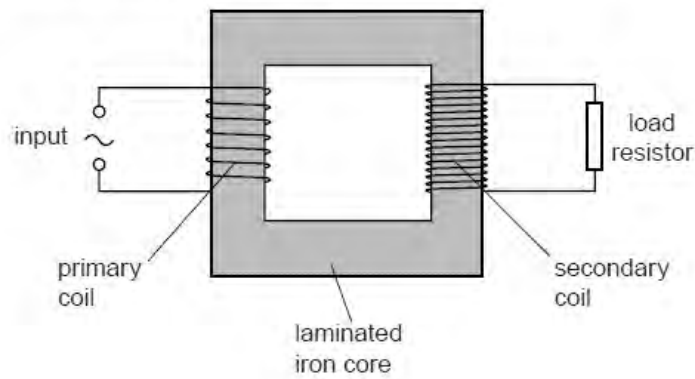


Fig. 6.1

- (a) State

- (i) why the iron core is laminated,

.....
.....
..... [2]

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

.....
..... [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.

peak voltage = V [2]

Q9.

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

.....
.....
..... [2]

(b) The output of an ideal transformer is connected to a bridge rectifier, as shown in Fig. 6.1.

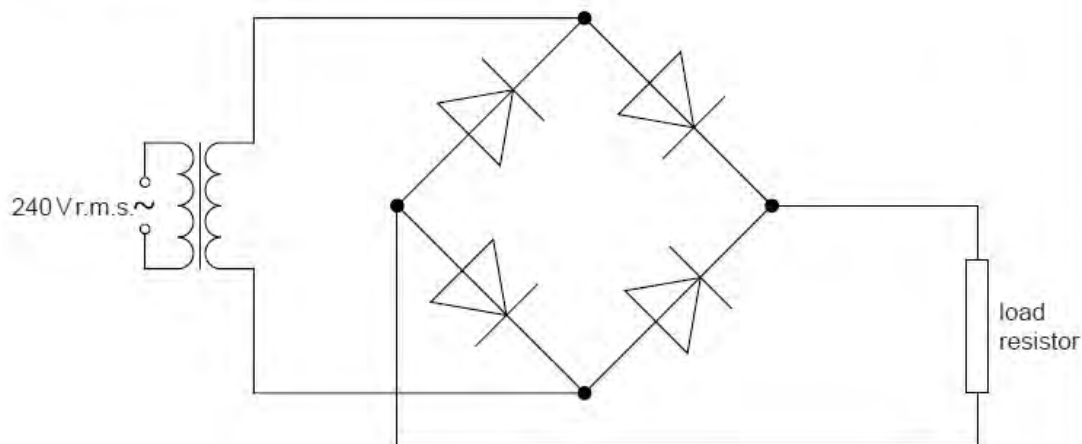


Fig. 6.1

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Use

The input to the transformer is 240 V r.m.s. and the **maximum** potential difference across the load resistor is 9.0 V.

(i) On Fig. 6.1, mark with the letter P the positive output from the rectifier. [1]

(ii) Calculate the ratio

$$\frac{\text{number of turns on primary coil}}{\text{number of turns on secondary coil}}$$

ratio = [3]

(c) The variation with time t of the potential difference V across the load resistor in (b) is shown in Fig. 6.2.

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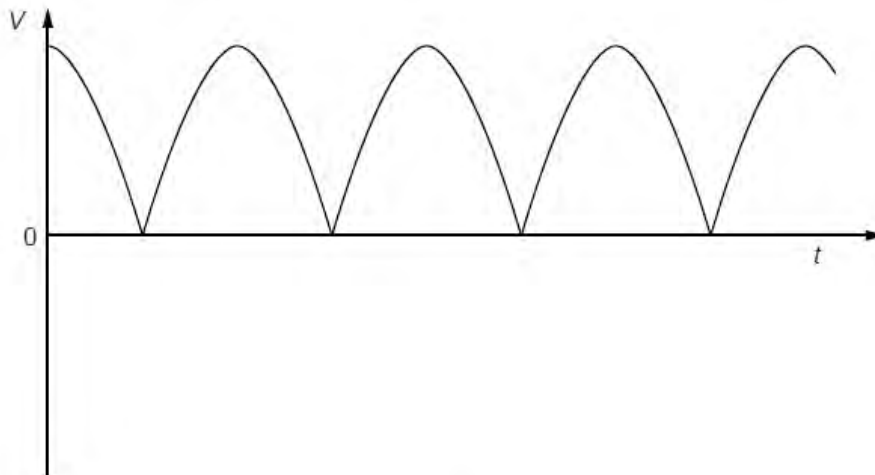


Fig. 6.2

A capacitor is now connected in parallel with the load resistor to produce some smoothing.

- (i) Explain what is meant by *smoothing*.

.....
 [1]

- (ii) On Fig. 6.2, draw the variation with time t of the smoothed output potential difference. [2]

Q10.

- 4 The rectified output of a sinusoidal signal generator is connected across a resistor R of resistance $1.5\text{ k}\Omega$, as shown in Fig. 4.1.



Fig. 4.1

The variation with time t of the potential difference V across R is shown in Fig. 4.2.

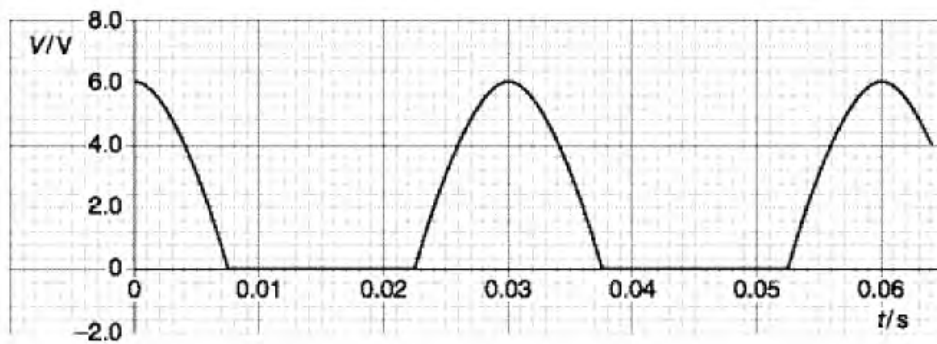


Fig. 4.2

- (a) State how the rectification shown in Fig. 4.2 may be achieved.

.....
 [2]

- (b) A capacitor is now connected in parallel with the resistor **R**. The resulting variation with time t of the potential difference V across **R** is shown in Fig. 4.3.

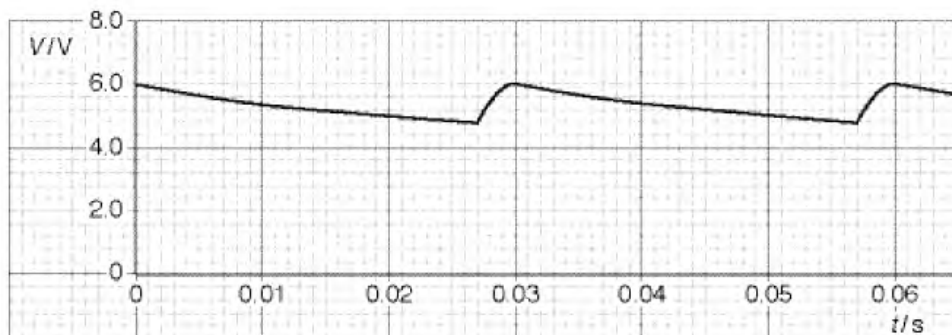


Fig. 4.3

- (i) Using Fig. 4.3, determine
1. the mean potential difference across the resistor **R**,

potential difference = V

2. the mean current in the resistor,

mean current = A

3. the time in each cycle during which the capacitor discharges through the resistor.

time = s
[4]

(ii) Using your answers in (i), calculate

1. the charge passing through the resistor during one discharge of the capacitor,

charge = C

2. the capacitance of the capacitor.

capacitance = F
[4]

(c) A second capacitor is now connected in parallel with the resistor **R** and the first capacitor. On Fig. 4.3, draw a line to show the variation with time t of the potential difference V across the resistor. [1]

Q11.

- 6 An alternating supply of frequency 50 Hz and having an output of 6.0 V r.m.s. is to be rectified so as to provide direct current for a resistor R. The circuit of Fig. 6.1 is used.

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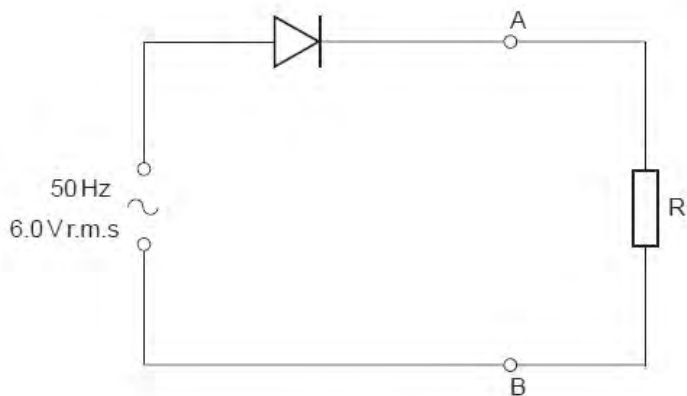


Fig. 6.1

The diode is ideal. The Y-plates of a cathode-ray oscilloscope (c.r.o.) are connected between points A and B.

- (a) (i) Calculate the maximum potential difference across the diode during one cycle.

potential difference = V [2]

- (ii) State the potential difference across R when the diode has maximum potential difference across it. Give a reason for your answer.

.....
 [1]

- (b) The Y-plate sensitivity of the c.r.o. is set at 2.0 V cm^{-1} and the time-base at 5.0 ms cm^{-1} .

On Fig. 6.2, draw the waveform that is seen on the screen of the c.r.o.

[3]

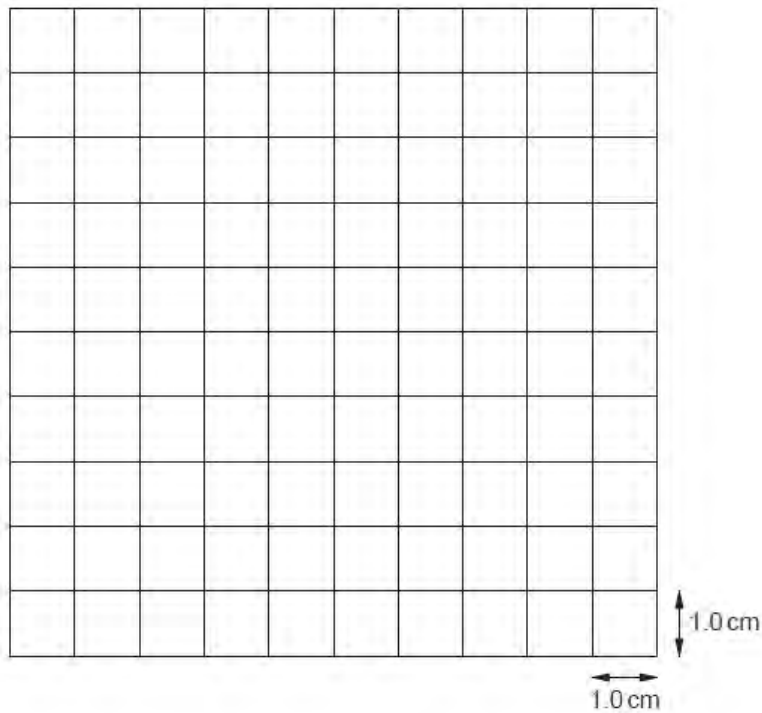


Fig. 6.2

- (c) A capacitor of capacitance $180 \mu\text{F}$ is connected into the circuit to provide smoothing of the potential difference across the resistor R.

(i) On Fig. 6.1, show the position of the capacitor in the circuit.

[1]

(ii) Calculate the energy stored in the fully-charged capacitor.

energy = J [3]

- (iii) During discharge, the potential difference across the capacitor falls to $0.43 V_0$, where V_0 is the maximum potential difference across the capacitor.

Calculate the fraction of the total energy that remains in the capacitor after the discharge.

fraction = [2]

Q12.

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

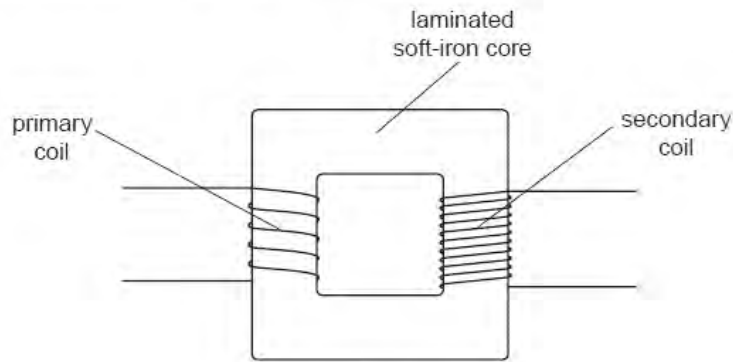


Fig. 6.1

- (a) Suggest why the core is

- (i) a continuous loop,

.....
..... [1]

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(ii) laminated.

.....
.....
..... [2]

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

.....
.....
..... [2]

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

.....
.....
.....
..... [3]

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

1.
.....
2.
..... [2]

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Us

Q13.

7 A sinusoidal alternating voltage is to be rectified.

(a) Suggest one advantage of full-wave rectification as compared with half-wave rectification.

.....
..... [1]

(b) The rectification is produced using the circuit of Fig. 7.1.

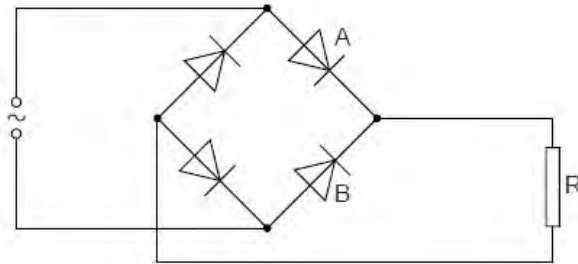


Fig. 7.1

All the diodes may be considered to be ideal.

The variation with time t of the alternating voltage applied to the circuit is shown in Fig. 7.2 and in Fig. 7.3.

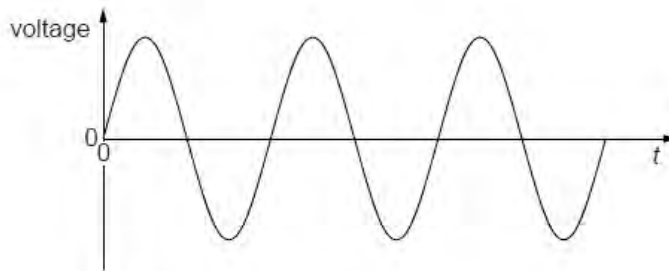


Fig. 7.2

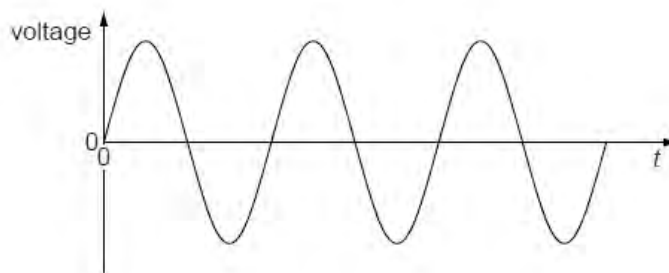


Fig. 7.3

- (i) On the axes of Fig. 7.2, draw a graph to show the variation with time t of the potential difference across diode A. [1]
- (ii) On the axes of Fig. 7.3, draw a graph to show the variation with time t of the potential difference across diode B. [1]
- (c) (i) On Fig. 7.1, draw the symbol for a capacitor, connected into the circuit so as to provide smoothing. [1]
- (ii) Fig. 7.4 shows the variation with time t of the smoothed potential difference across the resistor R in Fig. 7.1.

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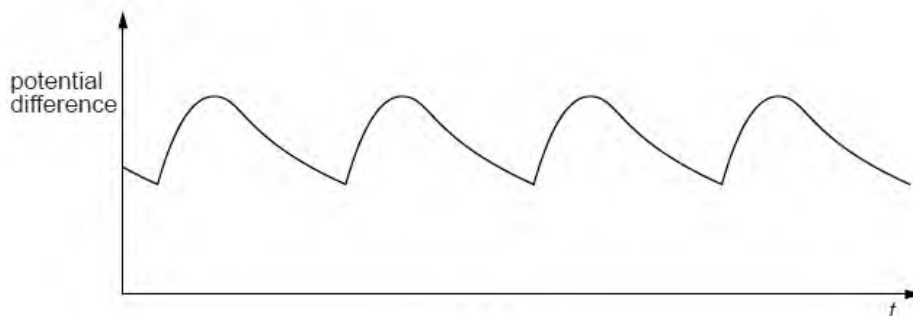


Fig. 7.4

1. State how the amount of smoothing may be increased.

.....
..... [1]

2. On Fig. 7.4, draw the variation with time t of the potential difference across resistor R for increased smoothing. [2]

Q14.

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

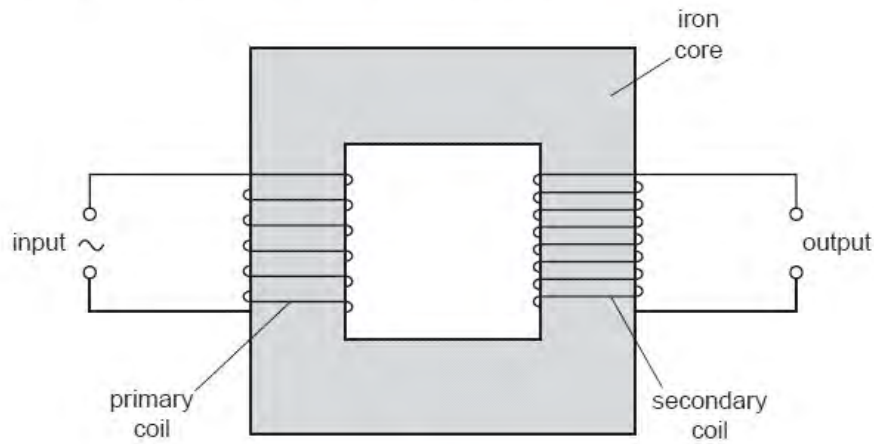


Fig. 6.1

(a) (i) State why the primary and secondary coils are wound on a core made of iron.

.....
.....
..... [1]

(ii) Suggest why thermal energy is generated in the core when the transformer is in use.

.....
.....
.....
..... [3]

Exa
L

- (b) The root-mean-square (r.m.s.) voltage and current in the primary coil are V_P and I_P respectively.
The r.m.s. voltage and current in the secondary coil are V_S and I_S respectively.

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Use

- (i) Explain, by reference to direct current, what is meant by the *root-mean-square* value of an alternating current.

.....
.....
..... [2]

- (ii) Show that, for an ideal transformer,

$$\frac{V_S}{V_P} = \frac{I_P}{I_S}$$

[2]

Q15.

- 6 The variation with time t of the current I in a resistor is shown in Fig. 6.1.

For
Examin
Use

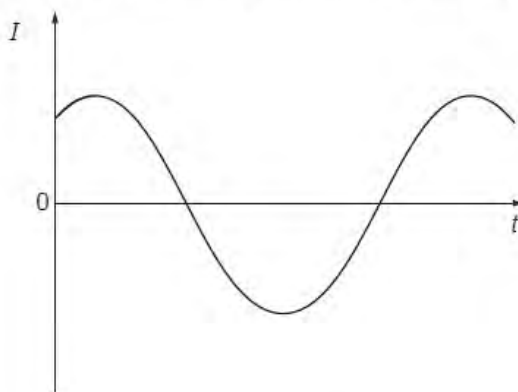


Fig. 6.1

The variation of the current with time is sinusoidal.

- (a) Explain why, although the current is not in one direction only, power is converted in the resistor.

.....

 [2]

- (b) Using the relation between root-mean-square (r.m.s.) current and peak current, deduce the value of the ratio

$$\frac{\text{average power converted in the resistor}}{\text{maximum power converted in the resistor}}$$

ratio = [3]

Q16.

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

For
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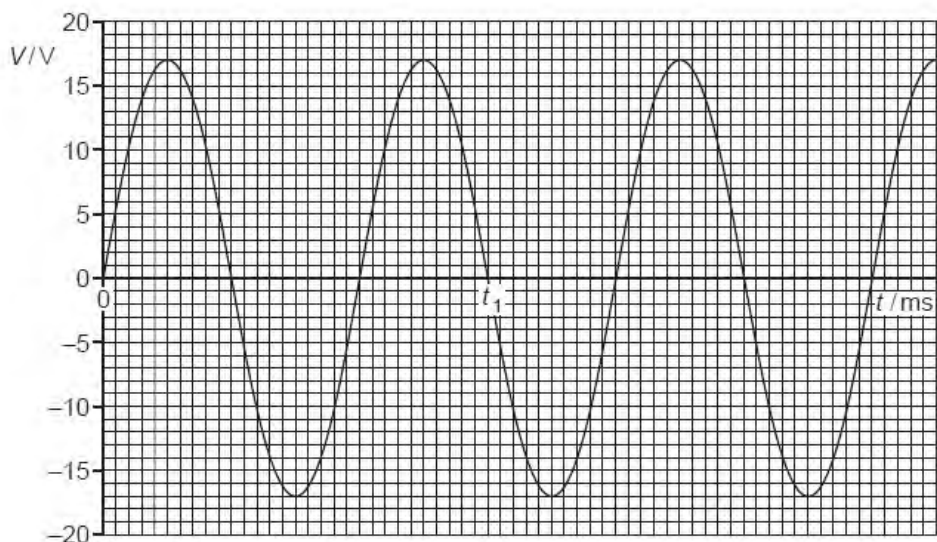


Fig. 6.1

- (a) Use Fig. 6.1 to state

- (i) the time t_1 ,

$$t_1 = \dots\dots\dots \text{ s [2]}$$

- (ii) the peak value V_0 of the voltage,

$$V_0 = \dots\dots\dots \text{ V [1]}$$

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

$$V_{\text{rms}} = \dots\dots\dots \text{ V [1]}$$

- (iv) the mean voltage $\langle V \rangle$.

$$\langle V \rangle = \dots\dots\dots \text{ V [1]}$$

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

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power = W [2]

Q17.

- 5 The components for a bridge rectifier are shown in Fig. 5.1.

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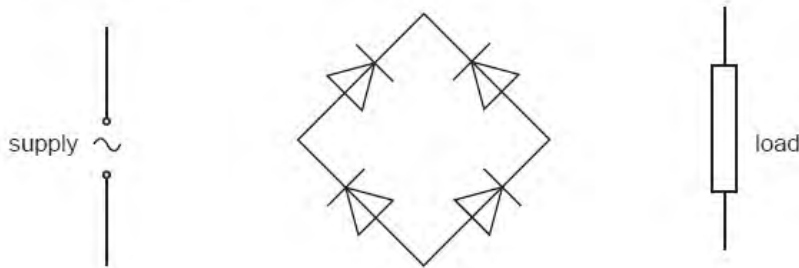


Fig. 5.1

- (a) Complete the circuit of Fig. 5.1 by showing the connections of the supply and of the load to the diodes. [2]
- (b) Suggest one advantage of the use of a bridge rectifier, rather than a single diode, for the rectification of alternating current.

..... [1]

- (c) State

- (i) what is meant by *smoothing*,

..... [1]

- (ii) the effect of the value of the capacitance of the smoothing capacitor in relation to smoothing.

.....

.....

..... [2]

Q18.

- 6 A bridge rectifier consists of four ideal diodes A, B, C and D, connected as shown in Fig. 6.1.

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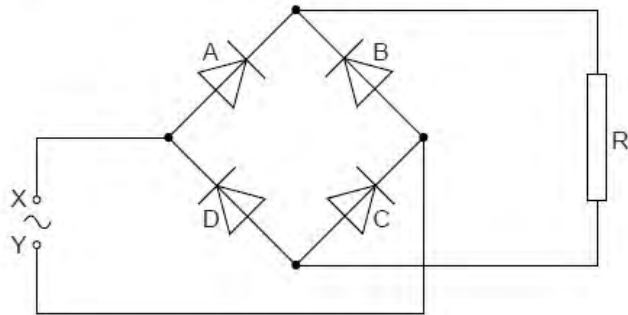


Fig. 6.1

An alternating supply is applied between the terminals X and Y.

- (a) (i) On Fig. 6.1, label the positive (+) connection to the load resistor R. [1]

- (ii) State which diodes are conducting when terminal Y of the supply is positive.

diode and diode [1]

(b) The variation with time t of the potential difference V across the load resistor R is shown in Fig. 6.2.

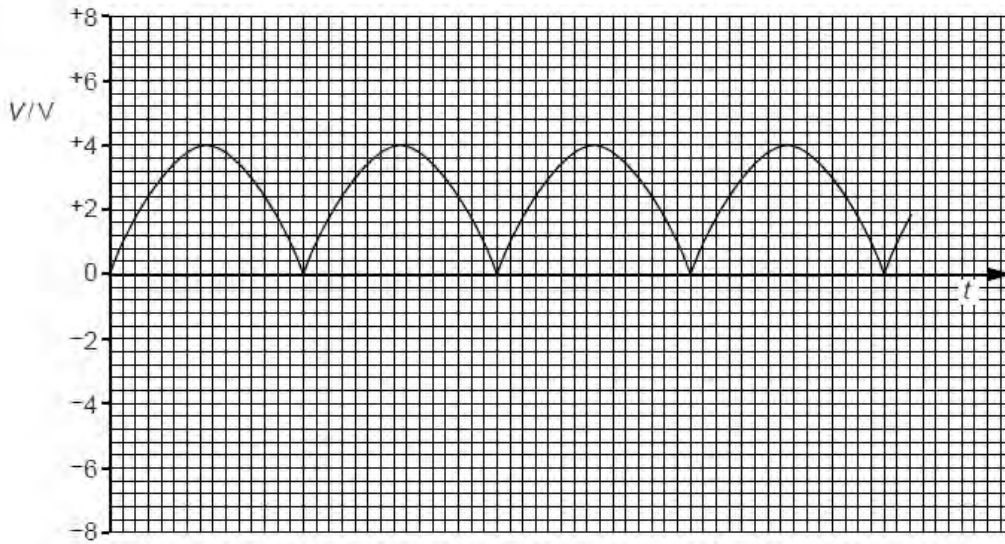


Fig. 6.2

The load resistor R has resistance $2700\ \Omega$.

(i) Use Fig. 6.2 to determine the mean power dissipated in the resistor R .

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power = W [3]

(ii) On Fig. 6.1, draw the symbol for a capacitor, connected so as to increase the mean power dissipated in the resistor R . [1]

(c) The capacitor in (b)(ii) is now removed from the circuit.
The diode A in Fig. 6.1 stops functioning, so that it now has infinite resistance.

On Fig. 6.2, draw the variation with time t of the new potential difference across the resistor R . [2]

Q19.

7 (a) The mean value of an alternating current is zero.

Explain

(i) why an alternating current gives rise to a heating effect in a resistor,

.....
.....
..... [2]

(ii) by reference to heating effect, what is meant by the root-mean-square (r.m.s.) value of an alternating current.

.....
.....
.....
..... [2]

(b) A simple iron-cored transformer is illustrated in Fig. 7.1.

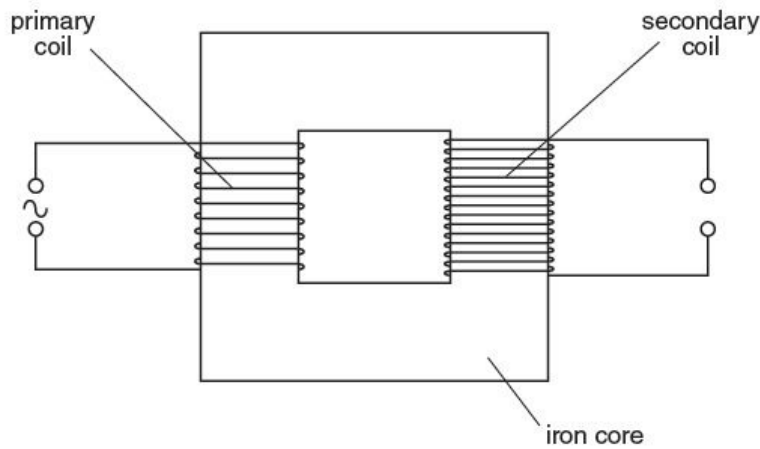


Fig. 7.1

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

.....
.....
..... [2]

- (ii) Use Faraday's law to explain why the current in the primary coil is not in phase with the e.m.f. induced in the secondary coil.

.....

.....

.....

.....

..... [3]

