

6 (a) Two parallel plate capacitors C_1 and C_2 are connected to a supply that has a potential difference (p.d.) V_S . The capacitors may be connected in series or in parallel.

The supply provides charge Q_S and the plates of the two capacitors acquire charges Q_1 and Q_2 respectively. The p.d.s across the plates of the capacitors are V_1 and V_2 respectively.

Complete Table 6.1 to indicate how Q_S , Q_1 and Q_2 relate to each other, and how V_S , V_1 and V_2 relate to each other, for series and parallel connections of the capacitors to the supply.

Table 6.1

	relationship between charges	relationship between p.d.s
series		
parallel		

[4]

(b) An isolated capacitor of capacitance $470\text{ }\mu\text{F}$ stores 19 mJ of energy.

(i) Calculate the p.d. across the capacitor.

p.d. =V [2]

(ii) Calculate the charge on the capacitor.

charge = C [2]

(iii) The capacitor is now connected in parallel with a capacitor of capacitance $180\text{ }\mu\text{F}$ that is initially uncharged.

Determine the total energy, in mJ, now stored in the two capacitors.

energy = mJ [3]

[Total: 11]

- 6 Fig. 6.1 shows part of a bridge rectifier circuit that can be used for rectification of an alternating input voltage V_{IN} .

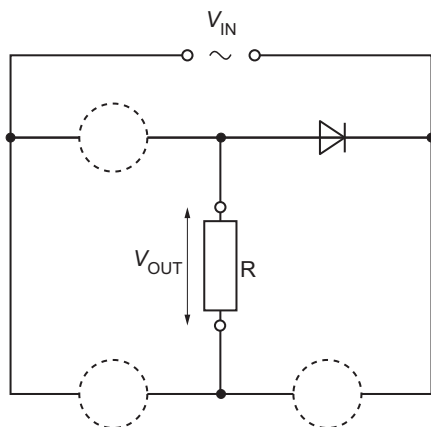


Fig. 6.1

The circuit contains four diodes, one of which is shown.
The rectified output voltage V_{OUT} is applied across load resistor R .

- (a) (i) State what is meant by rectification.
.....
..... [1]
- (ii) State the name of the type of rectification produced by a bridge rectifier circuit.
..... [1]
- (iii) Complete the circuit in Fig. 6.1 by drawing the three missing diodes inside the dashed circles.
[2]

- (b) The input voltage varies with time t according to the equation

$$V_{IN} = 34 \sin 18t$$

where V_{IN} is in V and t is in s.

- (i) Show that the period of the input voltage is 0.35 s.

[2]

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

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

- (iii) On Fig. 6.2, sketch the variation of V_{OUT} with t from $t = 0$ to $t = 0.35$ s.

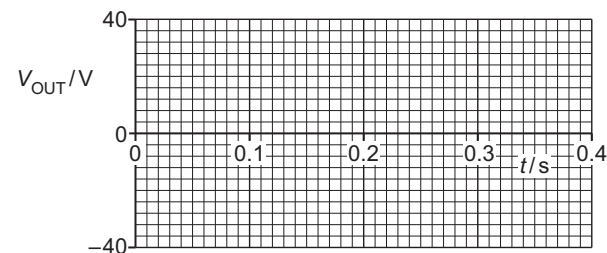


Fig. 6.2

[3]

(c) Resistor R has a resistance of $56\text{ k}\Omega$. A capacitor of capacitance $12\text{ }\mu\text{F}$ is connected into the circuit of Fig. 6.1 in order to smooth the output voltage.

(i) On Fig. 6.1, draw the capacitor correctly connected into the circuit. [1]

(ii) Calculate the time constant of the smoothing circuit.

time constant = s [2]

(iii) During each discharge cycle, the time for which the capacitor is discharging is 0.14 s .

Determine the minimum value of the smoothed output voltage.

minimum voltage = V [2]

[Total: 15]

7 Fig. 7.1 shows a circuit containing a capacitor of capacitance C and a resistor of resistance R .

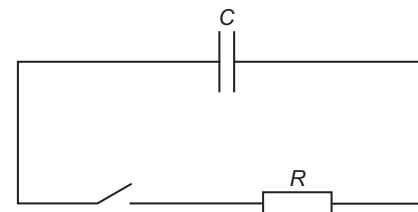


Fig. 7.1

Initially, the switch is open and the potential difference (p.d.) across the capacitor is 12 V .

The switch is closed at time $t = 0$ and the capacitor discharges through the resistor.

Fig. 7.2 shows the variation of the charge Q on the capacitor with the p.d. V_C across the capacitor as the capacitor discharges. Fig. 7.3 shows the variation of the current I in the resistor with the p.d. V_R across the resistor as the capacitor discharges.

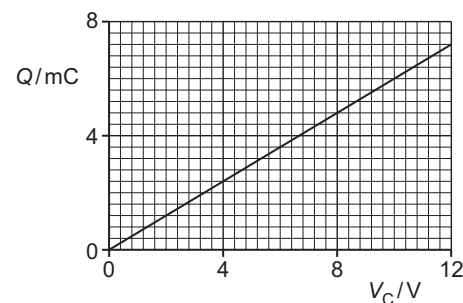


Fig. 7.2

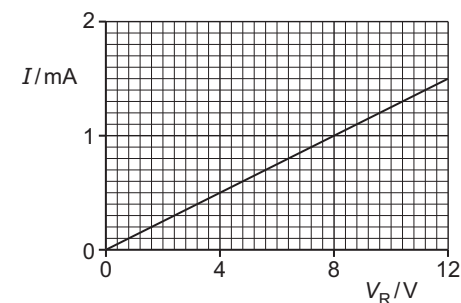


Fig. 7.3

(a) State the relationship between V_C and V_R .

..... [1]

(b) Determine:

(i) the capacitance C , in μF

$C =$ μF [2]

(ii) the resistance R , in $\text{k}\Omega$

$R = \dots\dots\dots \text{k}\Omega$ [2]

(iii) the time constant τ of the circuit.

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

(c) Use Fig. 7.2, Fig. 7.3 and your answer in (a) to explain why the variation of Q with t is exponential in nature.

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..... [3]

[Total: 10]