5(a) Fig. 5.1 shows a flat circular coil of $N = 500$ turns and radius $r = 0.12$ m.
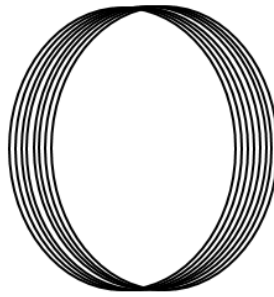

Fig. 5.1

A varying magnetic field is applied at right angles to the plane of the coil. Fig. 5.2 shows the variation with time t of this magnetic field of flux density B.
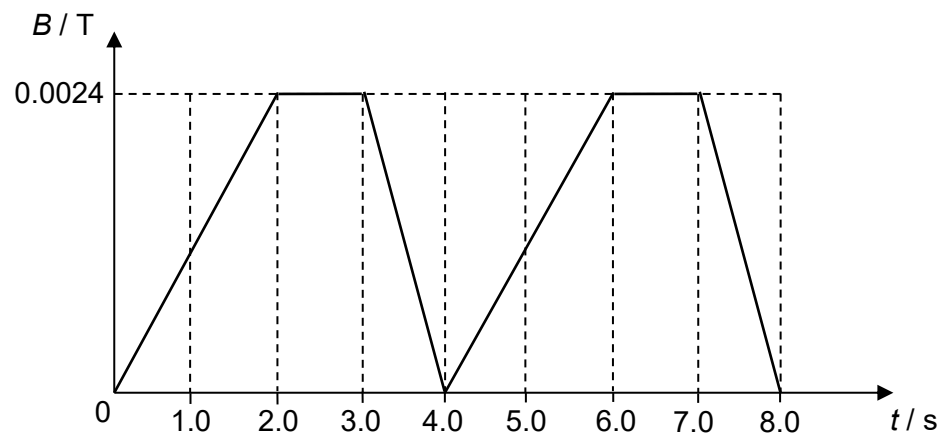

Fig. 5.2

(i) Calculate the magnitude of the maximum induced e.m.f. in the coil. [2]

(ii) On Fig. 5.3, sketch a graph to show the variation with time t of the induced e.m.f. E in the coil. [3]
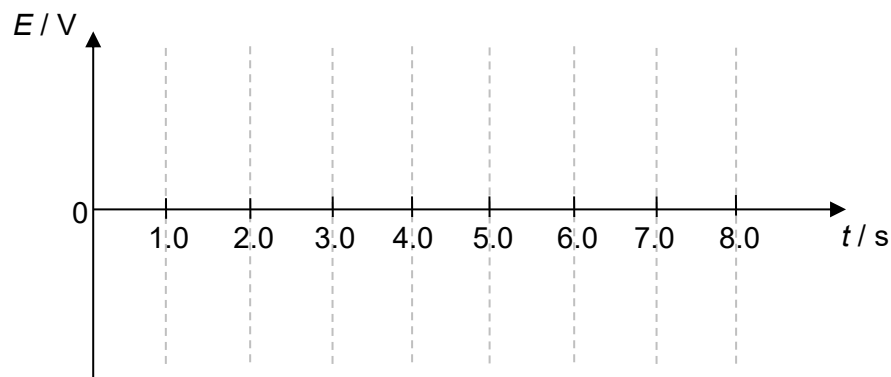
E / V

Fig. 5.3

(b)   The magnetic field in **(a)** is now removed and a sinusoidal alternating current supply is connected to the ends of the coil. A circular ring of area 0.025 m^2 and resistance 0.20 Ω is placed in the center of the coil as shown in Fig. 5.4.
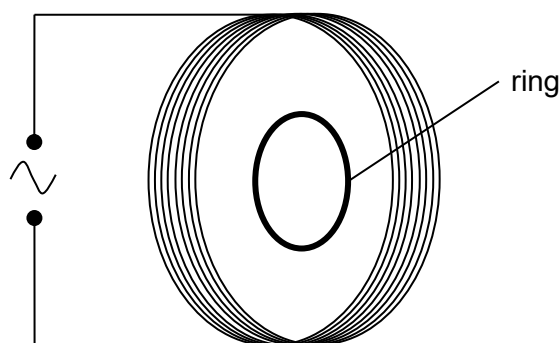

ring

Fig. 5.4

(i)   The sinusoidal alternating current is represented by the equation $I = I_0 \sin(\omega t)$, where I_0 is the peak current and ω is the angular frequency. Show that the maximum induced e.m.f. E_0 in the ring is given by the expression

$$E_o = (6.54 \times 10^{-5})I_0\, \omega$$ [3]

(ii)   The frequency of the supply is 50 Hz and the root-mean-square current in the coil is 3.5 A.

Determine the maximum induced current in the ring.   [2]

(iii)   Explain what the maximum induced current in the ring will be if it has two turns instead of one.   [2]

(c)   A simple induction cooker consists of a copper coil as shown in Fig. 5.5. When a steel cooking pot is placed on the cooker, the pot will heat up.
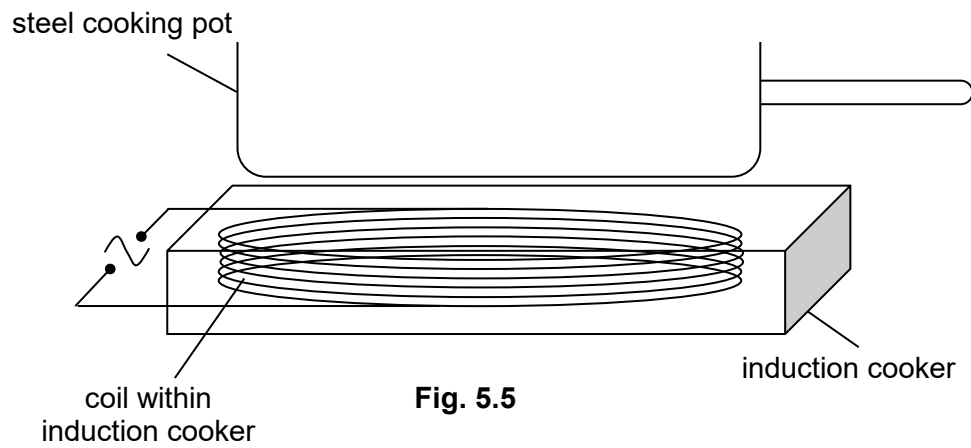
steel cooking pot

coil within
induction cooker

Fig. 5.5

induction cooker

Explain how the pot heats up. [3]