7 A square coil of side 5.0 cm and 50 turns is placed horizontally midway between the poles of a magnet as shown in Fig. 7.1.

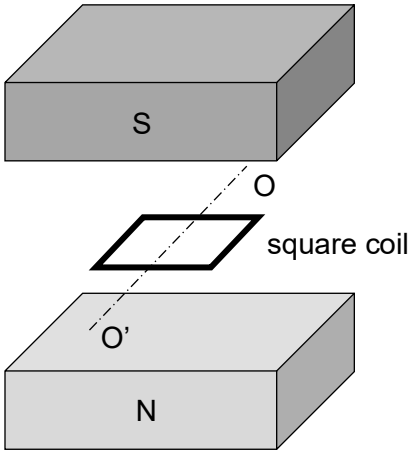

Fig. 7.1

The magnetic flux density due to the magnet in the area of the coil may be regarded as uniform and acts in a vertical direction with a magnitude of 0.12 T.

(a) Calculate the magnetic flux through the area of the coil.

magnetic flux = ... Wb [1]

(b) The coil can be displaced by any angle θ about its axis OO' as shown in Fig. 7.2.

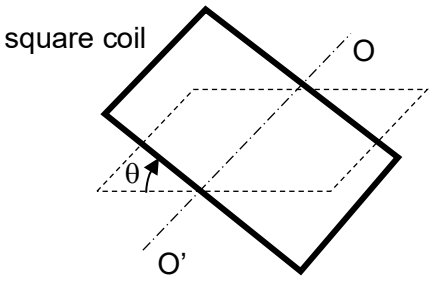

Fig. 7.2

Calculate the magnetic flux linkage in the coil when $\theta = 30°$.

magnetic flux linkage = ... Wb-turns [2]

(c) The coil is rotated about OO' with a constant angular frequency. With reference to Faraday's law of electromagnetic induction,

(i) explain why a current is present in the coil,

.....

.....

.....

.....[2]

(ii) state and explain the value(s) of θ within one rotation of the coil at which the current in the coil is the greatest.

.....

.....

.....

.....[2]

(d) Fig. 7.3 shows the current induced in the coil when it is rotating with a period of 50 ms.

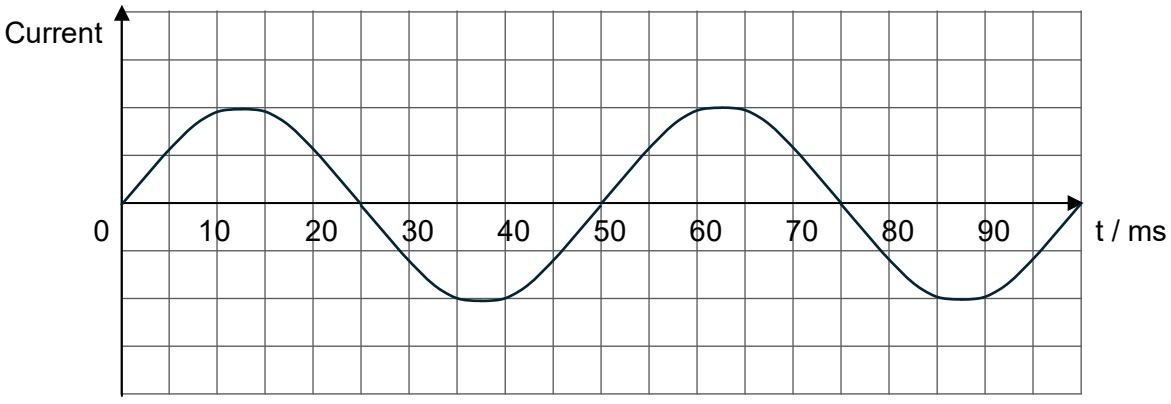

Fig. 7.3

(i) Without further calculations, draw another graph on Fig. 7.3 to show the current in the coil when the period of rotation is decreased to 30 ms. [1]

(ii) Determine the ratio of

$$\frac{\text{mean power required to rotate the coil with a period of 30 ms}}{\text{mean power required to rotate the coil with a period of 50 ms}}.$$

ratio = ... [2]

[Total: 10]