TUTORIAL QUESTIONS ELECTROMAGNETIC INDUCTION

Question 1

An aircraft wing can be considered as straight conductor of length 30 m. If the aircraft flies at a steady velocity of 100 ms^{-1} through a magnetic field of strength 2.0×10^{-7} T acting vertically downwards, calcualte the magnitude of the emf induced between its wing tips.

Question 2

A circular coil of 20 turns of radius 10 cm in situated with its plane perpendicular to a magnetic field of strength 0.5 T. Calculate the emf indcued if the coil is rotated through 90° in a time 50 ms.

Question 3

A flat, square coil of 250 turns, each of area 1.6×10^{-3} m^2, is connected to a galvanometer and placed with its plane perpendicular to magnetic field of flux density 0.35 T. If this flux density is reduced to zero in 0.050 s, and the total resistance of the coil and galvanometer is 100 Ω, calculate:

a.) the emf induced in the coil

b.) the induced current

Question 4

A closed wire loop has an electrical resistance of 4.0×10^{-3} Ω and is in the shape of an equilateral triangle of side 4.0 cm. The loop is situated in a uniform magnetic field of flux density 0.4 T acting in a direction perpendicular to the plane of the coil. If the wire loop is rotated through 90° to a new position in which its plane is parallel to the field in a time of 5.0×10^{-3} s, calculate:

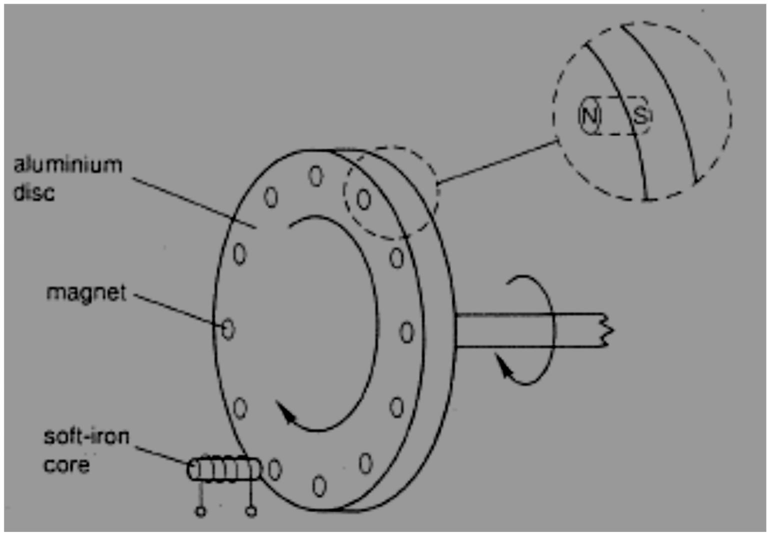
a.) the emf induced

b.) the current in the loop

c.) the energy dissipated by the current

Question 5

A revolving aluminium disc has small magnets equally spaced around its rim as shown in figure below. The magnets are all aligned in the same direction with the north poles on the same side of the disc.



A coil, wound on a soft-iron core, is fixed so that the north poles of the magnets pass close by the end of the coil without touching it. The terminals of the coil are connected to a detector which monitors the emf induced in the coil.

a.) Draw a sketch graph to show the possible variation with time of the emf induced in the coil as one magnet passes the coil.

b.) Explain, on the basis of the laws of electromagnetic induction, the shape of your graph.

c.) The disc in (b) has N magents attached to its rim and each magnet produces a signal in the output of the detector as it passes under the coil. IF the time between corresponding points in successive signals is T, show that the rotational speed R of the disc, measured in revolutions per unit time, is given by the expression $R = 1/NT$

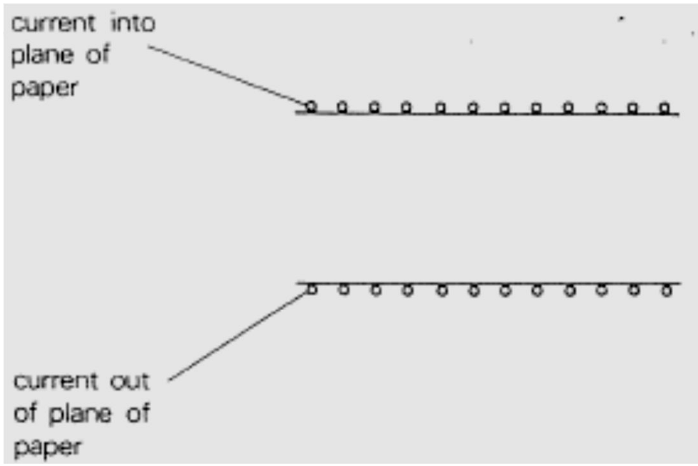
d.) A similar device to that in (b) is used in a make of car. The two front wheels are monitored in order to detect differences in their rotational speeds. The disc attached to each wheel has 60 magnets and, at one particular instant, both wheels are rotating at 15.0 revolutions per second.

i.) Calculate the time T between signals at this speed.

ii.) The speed of one wheel suddenly changes so that the values of T differ by 10 % for the two wheels. What are the possible rotational speeds of this wheel?

Question 6

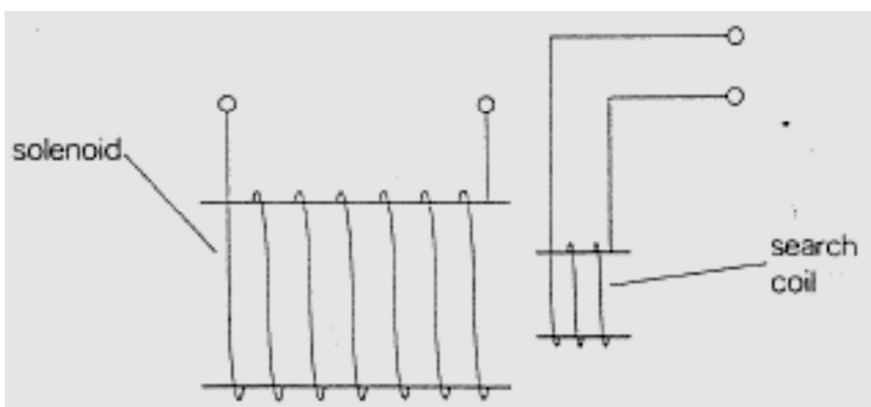
Figure below shows a cross-section through a solenoid.



Sketch on the figure above, the pattern of the magnetic flux which would be obtained, when a direct current passes around the solenoid. Mark on your sketch the direction of the magnetic flux due to the current in the solenoid.

Question 7

A current-carrying solenoid is placed near to a search coil as shown below.



The variation with time t of the current I in the solenoid is shown.

Fig 7.1

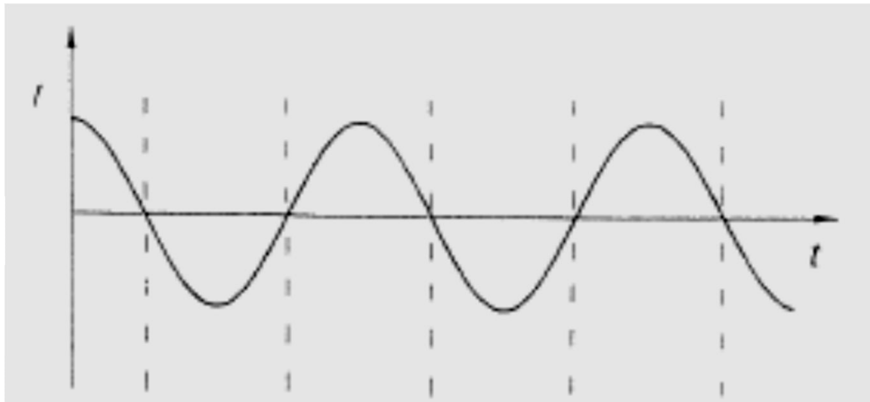


Fig 7.2

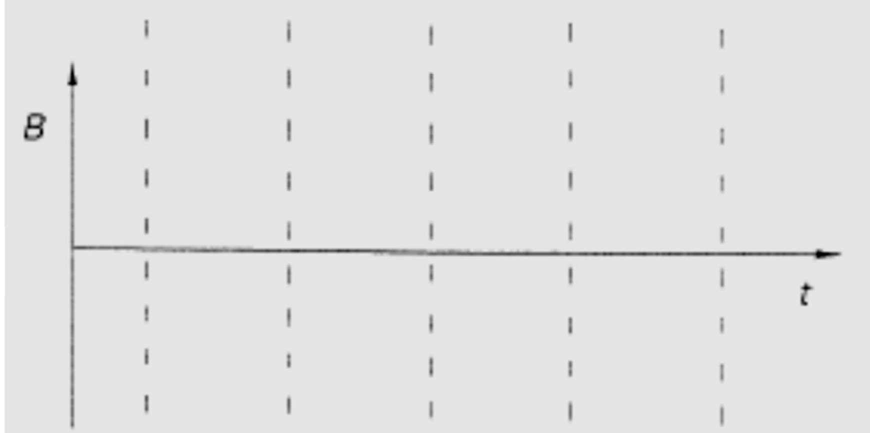
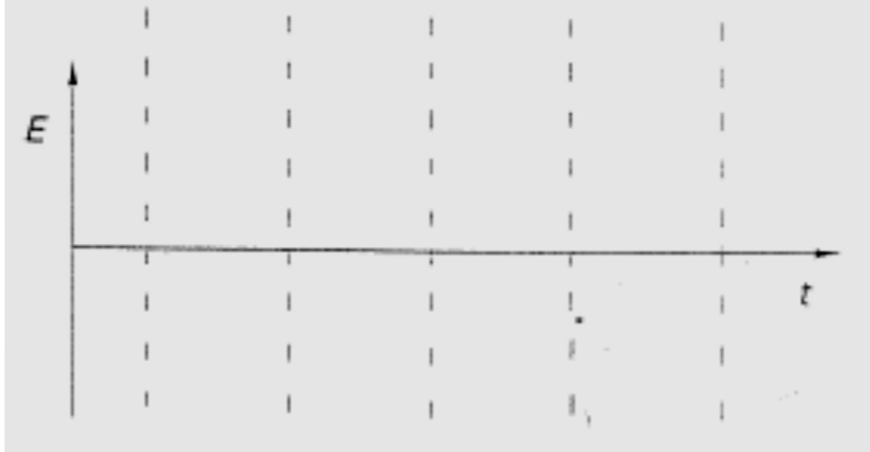


Fig 7.3



a.) Sketch on Fig 7.2 the variation with time, t of the magnetic flux density B in the solenoid.

b.) Sketch on Fig 7.3 the variation with time, t of the emf induced in the search coil.

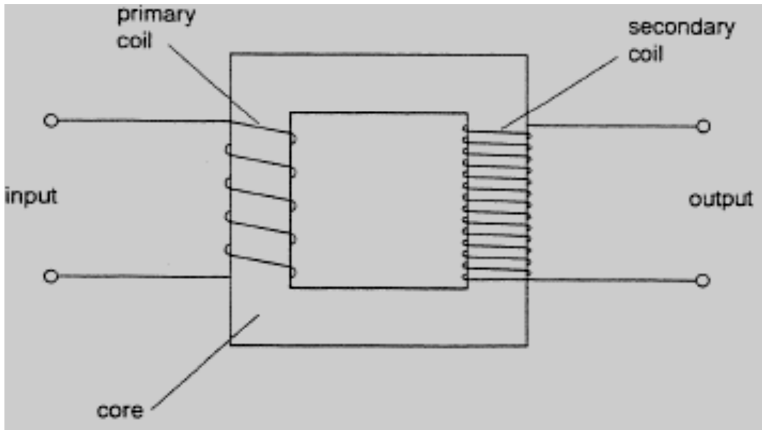
c.) Based on the experiment above, briefly describe and explain the effect on the amplitude and frequency of E if, separately

i.) a ferrous core is slowly introduced into the solenoid

ii.) the frequency of the current in the solenoid is increased, whilst maintaining the same amplitude

Question 8

A simple iron-cored transformer is illustrated in figure below.



a.) State Faraday's Law of electromagnetic induction.

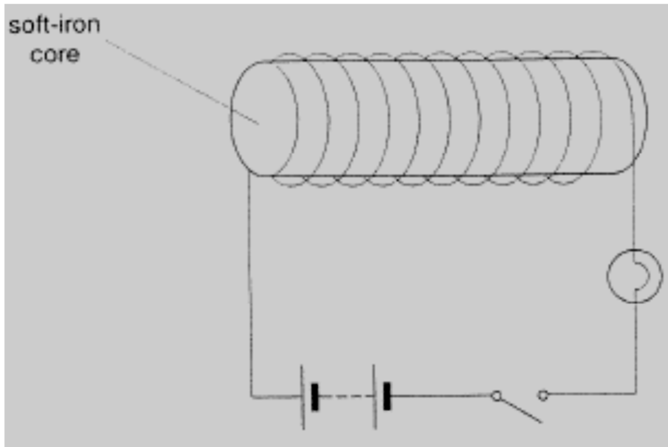
b.) Use Faraday's Law to explain why a transformer will operate for an alternating input voltage but not for a direct voltage.

c.) State Lenz's Law.

d.) Use the laws of electromagnetic induction to suggest why the input voltage and the output emf have the same frequency.

Question 9

A coil consisting of many turns of insulated metal wire wrapped around a soft-iron core is connected in series with a battery, a switch and a lamp.



a.) State what happens to the magnitude of the magnetic flux in the coil as the current increases from zero when the switch is closed.

b.) Hence explain why an emf is induced in the coil as the current increases.

c.) Explain why there is a noticeable delay before the lamp lights up after the switch is closed.

d.) State and explain what will happen to the length of the delay if the soft-iron core is replaced by one make of wood.