FACULTY OF INDUSTRIAL SCIENCES & TECHNOLOGY
MATERIAL TECHNOLOGY PROGRAMME

ELECTRICITY, MAGNETISM & OPTICS

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CH09: ELECTROMAGNETIC INDUCTION

1. The magnetic field between the poles of an electromagnet is uniform at any time, but its magnitude is increasing at the rate of 0.02 T/s. The area of the conducting loop in the field is 120 cm^2, and the total circuit resistance, including the meter, is 5 Ω.
   (i) Find the induced emf and the induced current in the circuit.
   (ii) If the loop is replaced by one made of an insulator, what effects does this have on the induced emf and the induced current?

2. A 500 loop circular wire coil with radius 4.00 cm is placed between the poles of a large electromagnet. The magnetic field is uniform and makes an angle of 60° with the plane of the coil, and decreases from 20 T to zero in 100 seconds. Calculate the magnitude and direction of the induced emf.

3. A coil 4.00 cm in radius, containing 500 turns, is placed in a uniform magnetic field that varies with time according to $B = (12.0\ \text{mT/s})\ t + (3.0 \times 10^{-5}\ \text{T/s}^4)\ t^4$. The coil is connected to a 600 Ω resistor, and its plane is perpendicular to the magnetic field. The resistance of the coil can be ignored.
   (i) Find the magnitude of the induced emf in the coil as a function of time.
   (ii) Determine the current in the resistor at time $t = 5.00$ s

4. Show that 1 H = 1 Wb/A and 1 H = 1 Ω·s.

5. A circular loop of wire with a radius of 15.0 cm and oriented in the horizontal *xy*-plane is located in a region of uniform magnetic field. A field of 1.5 T is directed along the positive *z*-direction, which is upward.
   (a) If the loop is removed from the field region in a time interval of 5.0 ms, find the average emf that will be induced in the wire loop during the extraction process.
   (b) If the coil is viewed looking down on it from above, is the induced current in the loop clockwise or counterclockwise?