11 INDUCED E.M.F.

Dynamically induced e.m.f.

If a conductor is moved in a magnetic field in such a way as to cut across the lines of force of the field, an e.m.f. will be induced. If the conductor lies in the plane of the field or if it is moved along the lines of force, then no e.m.f. will be induced. Figure 11.1 shows two important cases. In figure 11.1a the conductor moves at right-angles to the field. If the field strength is \( B \), the conductor length \( l \), and velocity \( v \), all in SI units, then the induced e.m.f. is

\[ E = Blv \text{ volts} \]

If the direction of motion is at an angle \( \theta \) to the direction of the field, as in figure 11.1b, then

\[ E = Blv \sin \theta \text{ volts} \]

The direction of the induced e.m.f. is given by a right-hand rule similar to the left-hand rule used before. It is illustrated in figure 11.2, the directions of pointing being...
Applying this rule to the case of figure 11.1 we see that the induced e.m.f. acts towards us.

The law governing the magnitude of the induced e.m.f. was discovered by Faraday; it is as follows: when an e.m.f. is induced in a circuit by a change in the number of lines of force through the circuit, the magnitude of the e.m.f. is proportional to the rate of change of that number. In figure 11.3 the crosses indicate the lines of force of a field acting at right-angles to the paper. A conductor of length \( l \) moves with velocity \( v \) from left to right. In one second it sweeps out the shaded area, the number of lines cut therefore being \( Blv \). But as these are cut in one second, \( Blv \) is also the rate of cutting. Also if the conductor is part of a closed circuit \( Blv \) is also the rate at which the lines of force thread or 'link' the circuit.

**Example 11.1.** A small motor has two poles. The active length of each conductor on the armature is 8 cm and the diameter of the circle in which the conductors rotate 8.5 cm. The average field strength in the air-gap is 0.45 T, and the armature speed is 2000 rev/min.