Topic 23 Electromagnetic induction

Summary

- Magnetic flux is the product of flux density and area normal to the flux.
- The direction of the induced current in a conductor moving through a magnetic field is given by Fleming's right-hand rule. That is, if the first two fingers and thumb of the right hand are held at right angles to each other, the first finger in the direction of the magnetic field and the thumb in the direction of motion, then the second finger gives the direction of the induced e.m.f. or current.
- Faraday's law of electromagnetic induction states that the e.m.f. induced is proportional to the rate of change of magnetic flux linkage.
- Lenz's law states that the direction of the induced e.m.f. is such as to cause effects to oppose the change producing it.
- Faraday's law of electromagnetic induction and Lenz's law may be summarised using the equation $E = -\mathrm{d}(N\Phi)/\mathrm{d}t$ where E is the e.m.f. induced by a rate of change of flux linkage of $\mathrm{d}(N\Phi)/\mathrm{d}t$. The sign indicates the relative direction of the e.m.f. and the change in flux linkage.

Definitions and formulae

- Magnetic flux is the product of the magnetic flux density and the area normal to the direction of the lines of magnetic flux.
- Unit of magnetic flux is the weber (Wb). One weber is equal to one tesla metre squared (T m^2).
- Magnetic flux $\phi = BA \cos \theta$
- Magnetic flux linkage $N\Phi$ = (number of turns × magnetic flux)
- Faraday's law: The induced electromotive force is proportional to the rate of change of magnetic flux linkage.
- Lenz's law: the direction of the induced e.m.f. is such as to cause effects to oppose the change producing it.
- Induced e.m.f. $= -\Delta N\Phi/\Delta t = -N\Delta\varphi/\Delta t$ (rate of change of magnetic flux linkage)