Summary of Chapter 20 – Induced Voltage and Inductance

Please read Chapter 20 carefully, and make sure that you understand the summary points below.

►The magnetic flux, Φ, through a planar surface is defined as

$$\Phi = BA\cos\theta$$

where *B* is the strength of the uniform magnetic field, *A* is the cross-sectional area of the surface, and θ is the angle between **B** and the direction perpendicular to the plane.

►**Faraday's law of induction** states that the instantaneous emf induced in a circuit equals the rate of change of magnetic flux through the circuit:

$$\text{emf} = -\frac{\Delta\Phi}{\Delta t}$$

where Φ is the flux through the surface enclosed by the circuit.

►**Lenz's law** states that the polarity of the induced emf is such that it produces a current whose magnetic field opposes the change in magnetic flux through the circuit.

►If a conducting bar of length C moves through a magnetic field with a speed, v, so that **B** is perpendicular to the bar, the emf induced in the bar, often called a motional emf, is

$$\text{emf} = BLv$$

►When a coil of wire with N turns, each of area A, rotates with constant angular speed ω in a uniform magnetic field **B,** the emf induced in the coil is

$$\text{emf} = NAB\omega\sin\omega t$$

►When the current in a coil changes with time, an emf is induced in the coil according to Faraday's law. This self-induced emf is defined by the expression

$$\text{emf} = -L\frac{\Delta I}{\Delta t}$$

where *L* is the inductance of the coil. The SI unit for inductance is the henry; 1 H=1Vs/A.

►The inductance of a coil can be found from the expression

$$L = \frac{N\Phi}{I}$$

where *N* is the number of turns on the coil, *I* is the current in the coil, and Φ is the magnetic flux through the coil produced by that current.

►**RL circuit**. If a resistor and inductor are connected in series to a battery and a switch is closed at t = 0, the current in the circuit does not rise instantly to its maximum value. After one time constant, τ = L/R, the current in the circuit is 63% of its final value, emf/R.

►The **energy stored** in the magnetic field of an inductor carrying current *I* is

$$U_L = \frac{1}{2}LI^2$$