Magnetism
lec/3

ز.شمت/2
م.حسن

Magnetic flux Φ_B

The magnetic flux (Φ_B) through a loop of wire with area A is defined by $\Phi_B = B \perp A = BA\cos\theta$

SI unit : Weber (Wb).

Ex : A conducting circular loop of radius 0.250 m is placed in the xy-plane in a uniform magnetic field of 0.360 Tesla that points in the positive z-direction as the normal to the place

Calculate :

(a) Magnetic Flux Φ_B through the loop

(b) If $\theta = 45^\circ$ calculate magnetic flux Φ_B

(c) What is the change in flux due to the rotation of the loop ?

Solution :

(a) $r = 0.250\ m$

$\theta = 0$

$\Phi_B = ?$

$A = \pi r^2 = \pi \times (0.250)^2 = 0.196\ m^2$

$\Phi_B = AB\cos\theta$

$= 0.196 \times 0.360 \times \cos 0$

$\Phi_B = 0.0706\ T.m^2 = 0.0706\ Wb$

(b) $\theta = 45^\circ$

$\Phi_B = ?$

$\Phi_B = AB\cos\theta$

$= 0.196 \times 0.36 \times \cos 45$

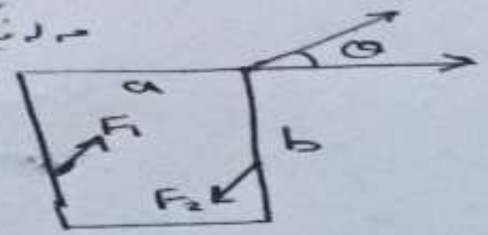
$= 0.0499\ T.m^2 = 0.0499\ Wb$

(c) $\Delta\Phi_B = 0.0499 - 0.0706$

$\Delta\Phi_B = -0.020\ Wb$

Torque on A current loop (پێچ) and electric

مەلاینک لاکیشە



$$F_1 = F_2 = BIb$$

$$\tau_{max} = BI\,ab$$

$$\tau_{max} = BIA \quad [A = ab]$$

$$\tau = BIA \sin\theta$$

$$\tau = BIAN \sin\theta$$

زنبری مگناتیسی

$$\mu = IAN \quad [\text{magnetic momentum}]$$

$$\tau = \mu B \sin\theta$$

$$\tau = BIAN\sin\theta = \mu B \sin\theta$$

B : [Magnetic field]

پێچ

N : is the number of Loop]

μ : is magnetic momentum

θ : The angle between $\vec{B}$ and $\vec{\mu}$

Ex: A circular wire loop of radius 1.00 m

$\theta = 30^\circ$, $I = 2$ Ampers , $N = 1$

$B = 0.500$ Tesla

Find:

(a) The magnetic momentum (μ) of the loop and the magnitude of the torque (τ).

(b) The same currents is carried by the rectangular 20m by 2m Find μ and τ.

$N = 3$

Solution

a) $A = \pi r^2 = \pi (1)^2 = 3.14\ m^2$

$\mu = IAN = 2 \times 3.14 \times 1$

$\mu = 6.28$ Amper . m^2

$\tau = \mu B \sin\theta = 6.28 \times 0.500$ Tesla $\times \sin 30$

$\tau = 1.57$. Tesla . Amper . m^2

درێژی بەرزی

(b) $A = L \times H = 2 \times 3 = 6\ m^2$

$\mu = IAN = 2 \times 6 \times 3$

$\mu = 36$ A . m^2

$\tau = \mu B \sin\theta = 36 \times 0.500 \times \sin 30$

$\tau = 9$ Tesla . Amp . m^2

Ampers law : The ampers law definition states that the line integral of amagnetic field intensity along aclosed path is equal to the current distribution passing through that loop.

$$B = \frac{\mu_0 I}{2\pi r} = \oint B \cdot dl = \mu_0 I$$

μ_0 = permeability of free space has the volue $\mu_0 = 4\pi \times 10^{-7}$ T.m/Amp

① Ampers law and along straingth wire

$$\sum B \Delta L = \mu_0 I$$

$$\sum B \Delta L = B \sum \Delta L = B(2\pi r) = \mu_0 I$$

$$B = \frac{\mu_0 I}{2\pi r}$$

Ex : A Long strainght wire carries a current of 5 Amp at one instant aproton 4mm from the wire travels at 1.5×10^{3} m/sec, parallel to the wire and the same direction as the current nd : (a) The magnitude and direction of the magnetic field created by the wire.

(b) The magnitude and direction on the magnetic force the wires magnetic field exerts on the proton.

Solution : (a)

$$B = \frac{\mu_o I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 5}{2\pi \times 4 \times 10^{-3}}$$

$$B = 2.5 \times 10^{-4} \text{ Tesla.}$$

(b) $F = qVB \sin\theta$

$$= 1.6 \times 10^{-19} \text{ coul} \times 1.5 \times 10^{3} \times 2.5 \times 10^{-4} \times \sin 90$$

$$F = 6 \times 10^{-20} \text{ Nt.}$$

(2) Magnetic Field of current loops and Solenoids

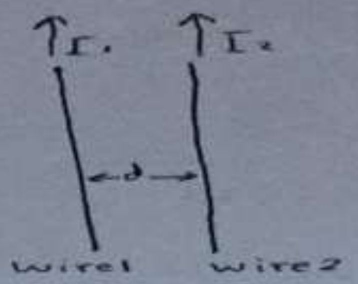
The magnetic field at the center of a coil of N circular Loops of radius R, each carrying current I is given by :

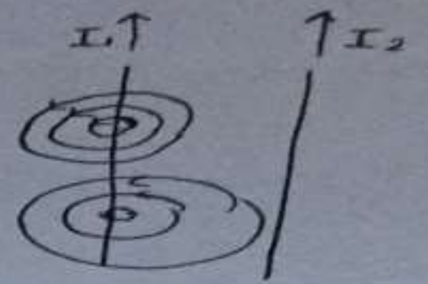
$$B = N \frac{\mu_o I}{2R}$$

wire per unit length where N/ℓ is the number of turns

Magnetic force between two parallel conductors

The magnetic field produced of the position of wire 2 due to the current in wire 1 is



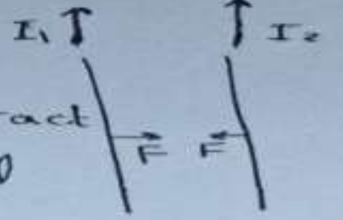


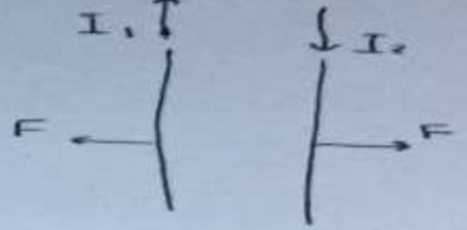
$$B_1 = \frac{\mu_0 I_1}{2\pi d}$$

The force this field exerts on a length l_2 of wire 2 is

$$F_2 = \frac{\mu_0 I_1 I_2}{2\pi d} l_2$$

- parallel currents attract
- antiparallel currents repel





Ex: Force between two current-carrying wires.

The Two wires of a 2 m long appiliance cord are 3 mm apart and carry a current of 8 Amp. Calculate the force one wire exerts on the other

$$F_2 = \frac{\mu_0 I_1 I_2}{2\pi d} l_2 = \frac{4\pi \times 10^{-7} \times (8 \times 8)}{2\pi \times 3 \times 10^{-3}} \times 2 = 85 \times 10^{-4} \text{ Nt}$$

$$B_2 = \frac{\mu_0 I_2}{2\pi d}$$

$$F_1 = B_2 I_1 \ell$$

$$F_1 = \left(\frac{\mu_0 I_2}{2\pi d}\right) I_1 \ell = \frac{\mu_0 I_1 I_2}{2\pi d} \ell$$

$$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$$