Ncert Ch-4

4.1) $n = 100$

$r = 8cm = 0.08\,m$

$I = 0.4A$

$(\mu_0 = 4\pi \times 10^{-7} T m A^{-1})$

$|B| = \frac{\mu_0}{4\pi} \times \frac{2\pi n I}{r} = \frac{\mu_0 \times 2 \times 100 \times 0.4}{4 \times 0.08}$

$= \frac{4\pi \times 10^{-7} \times 2 \times 100 \times 0.4}{4 \times 0.08} = 3.14 \times 10^{-4} T$

4.2) $I = 35A$

$r = 20cm = 0.2m$

$B = \frac{\mu_0 2I}{4\pi r}$

$= \frac{4\pi \times 10^{-7} \times 2 \times 35}{4\pi \times 0.2} = 3.5 \times 10^{-5} T$ (Ans)

4.6) $l = 3m = 0.03m$

$I = 10A$

$B = 0.27T$

$\theta = 90^\circ$

$\therefore F = BIl \sin\theta$

$= 0.27 \times 10 \times 0.03 \times \sin 90^\circ$

$= 8.1 \times 10^{-2} N$

4.7) $I_A = 8A$, $I_B = 5A$

$r = 4cm = 0.04m$, $l = 10cm = 0.1m$

$B = \frac{\mu_0 2 I_A I_B l}{4\pi r} = \frac{4\pi \times 10^{-7} \times 2 \times 8 \times 5 \times 0.1}{4\pi \times 0.04} = 2 \times 10^{-5} N$

4.8) $l = 0.8\,m$

$N = 5 \times 400 = 2000$

$D = 1.8\,cm = 0.018\,m$

$I = 8A$

$B = \frac{\mu_0 N I}{l} = \frac{4\pi \times 10^{-7} \times 2000 \times 8}{0.8} = 8\pi \times 10^{-3} = 2.512 \times 10^{-2} T$

4.11) $B = 6.5 \times 10^{-4}$ T

$v = 4.8 \times 10^{6}$ m/s

$e = 1.6 \times 10^{-19}$ C

$m = 9.1 \times 10^{-31}$ kg & $\theta = 90^\circ$

$F = evB\sin\theta$

& $F_e = \frac{mv^2}{r}$

$F_c = F$

$\Rightarrow \frac{mv^2}{r} = evB\sin 90^\circ \Rightarrow \frac{mv^2}{r} = evB$

$\Rightarrow r = \frac{mv}{Be} = \frac{9.1 \times 10^{-31} \times 4.8 \times 10^{6}}{6.5 \times 10^{-4} \times 1.6 \times 10^{-19}}$

$= 4.2 \times 10^{-2}$ m $= 4.2$ cm

4.12) $B = 6.5 \times 10^{-4}$ T

$e = 1.6 \times 10^{-19}$ C

$m_e = 9.1 \times 10^{-31}$ kg

$v = 4.8 \times 10^{6}$ m/s

$r = 4.2$ cm

$\omega = 2\pi\nu$

$v = r\omega$

$evB = \frac{mv^2}{r}$

$\Rightarrow eB = \frac{m}{r}(r\omega) = \frac{m}{r}(r 2\pi \nu)$

$\Rightarrow \nu = \frac{Be}{2\pi m}$

$= \frac{6.5 \times 10^{-4} \times 1.6 \times 10^{-19}}{2 \times 3.14 \times 9.1 \times 10^{-31}}$

$= 18.2 \times 10^{6}$ Hz

≈ 18 MHz

4.13) a) ~~no. of~~ $n = 30$

$r = 0.08$ m

$A = \pi r^2 = \pi (0.08)^2 = 0.0201\,m^2$

$I = 6$ A & $B = 1$ T $\theta = 60^\circ$

$\tau = nIBA\sin\theta = 30 \times 6 \times 1 \times 0.201 \times \sin 60°$
$= 3.133$ N m

b) It can be inferred from relation ($\tau = nIBA\sin\theta$) that τ is not dependent on shape. It depends on area of the coil. So there will no change in result if this condition is replaced by planar coil of same area.

4.14) $B_1 = \frac{\mu_0 n_1 I_1}{2r_1}$

$= \frac{4\pi \times 10^{-7} \times 20 \times 16}{2 \times 0.16} = 4\pi \times 10^{-4}$ T (eastwards)

$B_2 = \frac{\mu_0 n_2 I_2}{2r_2}$

$= \frac{4\pi \times 10^{-7} \times 25 \times 18}{2 \times 0.10} = 9\pi \times 10^{-4}$ T (westwards)

$B = B_2 - B_1$
$= 9\pi \times 10^{-4} - 4\pi \times 10^{-4}$
$= 5\pi \times 10^{-4}$ T $\approx 1.57 \times 10^{-3}$ T (towards west)

4.15) $B = \mu_0 nI$
$\Rightarrow nI = \frac{B}{\mu_0} = \frac{100 \times 10^{-4}}{4\pi \times 10^{-7}} = 7957.74$
≈ 8000 A/m

If the length of the coil is taken 50 cm, radius 4 cm no. of turns 400, current → 10 A, then these values are not unique for the given purpose.

4.16) $r_1 = 0.25$m & $r_2 = 0.26$ m
$N = 3500$, $I = 11$ A

a) Magnetic field outside toroid is zero. It is non zero inside it.

b) Magnetic field inside the core of a toroid is given by the relation;

$B = \frac{\mu_0 NI}{l} = \frac{4\pi \times 10^{-7} \times 3500 \times 11}{0.51\pi} \approx 3 \times 10^{-2}$ T

c) magnetic field in the empty space surrounded by toroid is zero.

4.18) a) The initial velocity of the particle is either parallel to magnetic field. Hence it travels along a st. path without suffering any deflection.

b) Yes, the final speed of the charged particle will be equal to its initial speed. This is because magnetic force can change the direction of velocity but not magnitude.

c) An electron travelling from W to E enters a chamber having a uniform electrostatic force field in the N-S direction. This moving electron can remain undeflected if the electric force acting on it is equal & opposite of magnetic field. Magnetic force is directed towards south. By fleming's left hand rule, magnetic force should be applied in a vertically downward direction.

4.19) $eV = \frac{1}{2} m v^2$

2) $v = \sqrt{\frac{2eV}{m}}$

a) Centripetal force $= \frac{mv^2}{r}$

$Bev = \frac{mv^2}{r}$

2) $r = \frac{mv}{Be}$

$= \frac{m}{Be}\left[\frac{2eV}{m}\right]^{1/2}$

$= \frac{9.1\times10^{-31}}{0.15\times1.6\times10^{-19}} \times \left(\frac{2\times1.6\times10^{-19}\times2\times10^3}{9.1\times10^{-31}}\right)^{1/2}$

$= 1\,mm$

b) $v_1 = v\sin\theta$

$\Rightarrow r_1 = \frac{mv_1}{Be} = \frac{m v \sin\theta}{Be}$

$= 0.5\times 10^{-3}\ m = 0.5\ mm$

4.20) $\frac{1}{2} mv^2 = eV$

$\Rightarrow \frac{e}{m} = \frac{v^2}{2V}$

$eE = evB$

$\Rightarrow v = \frac{E}{B}$

$\frac{e}{m} = \frac{1}{2} \frac{(E/B)^2}{V} = \frac{E^2}{2VB^2}$

$= \frac{(9\times 10^5)^2}{2\times 15000\times (0.75)^2} = 4.8\times 10^7\ C/kg$

This is not a unique answer.

4.24) a) $\bar{\tau} = I\bar{A}\times\bar{B}$

$= 12\times (50\times 10^{-4})\hat{i} \times 0.3\hat{k}$

$= -1.8\times 10^{-2}\hat{j}\ Nm$

Force on loop is zero as angle betwn A & B is 0.

b) ~~Same to (a)~~ $\tau = -1.8\times 10^{-2}\hat{j}\ Nm$

Force is zero.

c) $\tau = I\bar{A}\times\bar{B}$

$= -12(50\times 10^{-4})\hat{j}\times 0.3\hat{k}$

$= -1.8\times 10^{-2}\hat{i}\ Nm$

Force is zero

d) $|\tau| = IAB$

$= 12\times 50\times 10^{-4}\times 0.3$

$= 1.8\times 10^{-2}\ Nm$

Force is zero.

e) $\tau = I\bar{A}\times\bar{B}$

$= 0$ Force is zero

f) $\tau = I\bar{A} \times \bar{B}$

$= (50 \times 10^{-4} \times 12)\,\hat{k} \times 0.3\hat{k} = 0$

Force is zero.

case e → is in equilim stable equilibrium