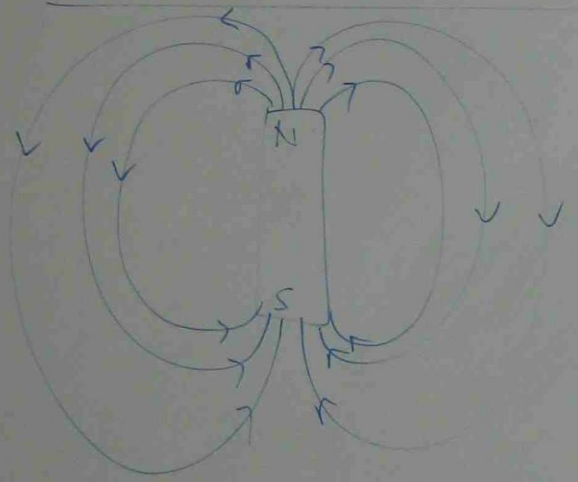
1001 MAGNETIC CIRCUITS

MAGNETISM

THE ABILITY TO ATTRACT IRON.

MAGNETIC FIELD of PERMANENT MAGNET



A MAGNET CONSISTS OF A NORTH AND SOUTH POLE WITH MAGNETIC LINES OF FLUX RADIATING FROM NORTH POLE AND RETURNING (OR) LOOPING BACK TO SOUTH POLE.

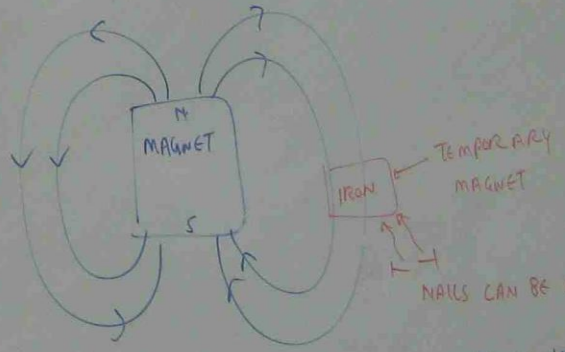
MAGNETIC AND NON MAGNETIC MATERIALS

STEEL – PERMENENT MAGNET

SOFT IRON – TEMPORARY MAGNET

WOOD | GLASS | RUBBER – NON MAGNETIC MATERIALS.

MAGNETIC INDUCTION



WHEN A PIECE OF SOFT IRON IS PLACED IN A MAGNETIC FIELD,

(1) LINES OF MAGNETIC FLUX PASS THROUGH A SOFT IRON

(2) MAGNETISM IS INDUCED.

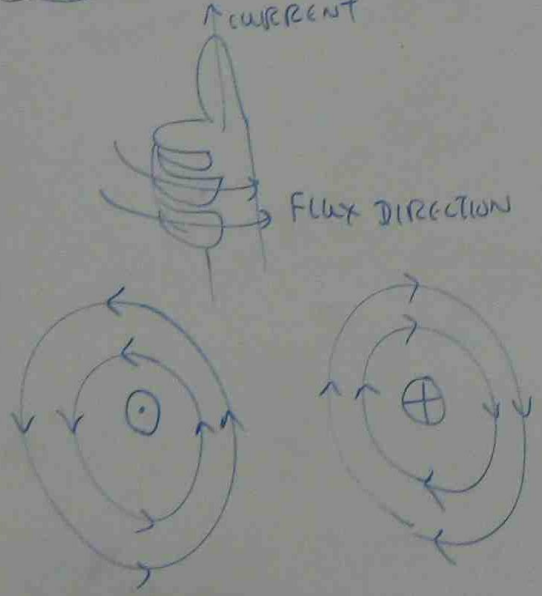
AFTER REMOVAL OF MAIN MAGNETIC FIELD, RESIDUAL MAGNETISM REMAIN.

MAGNETIC SHIELDING

THE PREFERENCE FOR MAGNETIC LINES OF FLUX TO PASS THROUGH THE SOFT IRON, RATHER THAN THROUGH AIR IS MADE USE OF SHIELDING OBJECTS AND EQUIPMENTS FROM MAGNETIC EFFECTS.

ELECTRO - MAGNETISM

CURRENT AND MAGNETIC FIELD

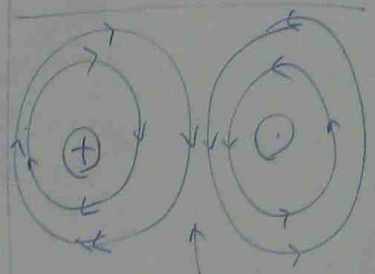


WHEN THE CURRENT IS FLOWING IN CONDUCTOR, THE MAGNETIC FLUXES ARE CIRCULATING AROUND IT.

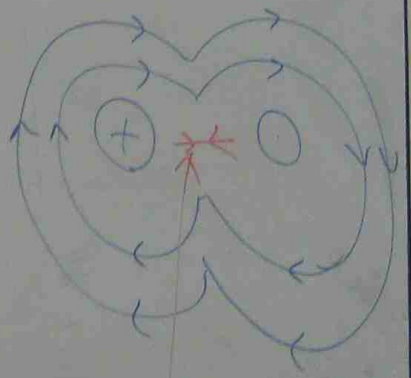
⊙ CURRENT FLOWING TOWARDS VIEWER

⊕ CURRENT FLOWING AWAY FROM VIEWER

THE MAGNETIC FIELD AROUND TWO CURRENT CARRYING CONDUCTORS

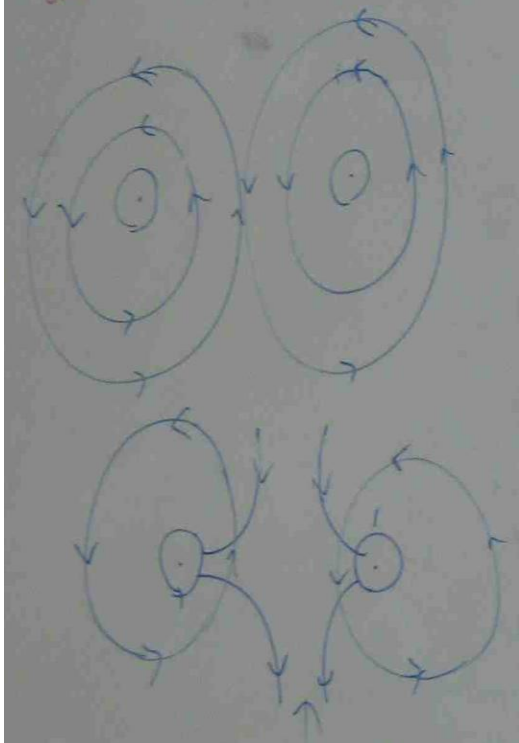


SAME DIRECTION - FLUX CAN BE COMBINED



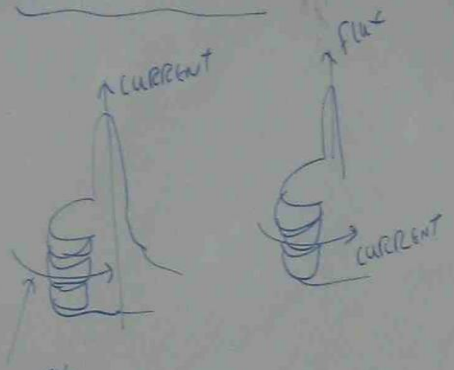
ATTRACTION

TWO MAGNETS WITH DIFFERENT POLARITY CAN ATTRACT EACH OTHER



REPULSION BETWEEN TWO SAME POLARITY POLES.

RIGHT HAND RULE



MAGNETIC FLUX

THE PRINCIPLE IS USED TO OPEN AND CLOSE VALVE TO CONTROL MATERIAL FLOW

MAGNETO MOTIVE FORCE

F_m = MAGNETOMOTIVE FORCE (Amp-Turn)

$$F_m = N I$$

N = NUMBER OF TURNS

I = CURRENT IN COIL

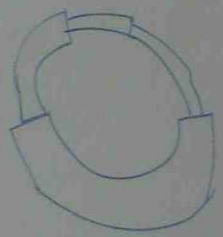
APPLICATION OF ELECTROMAGNET

SOLENOIDS

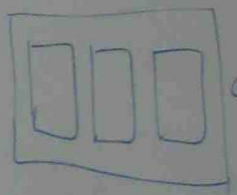
CONTACTORS

RELAYS

MAGNETIC CIRCUITS

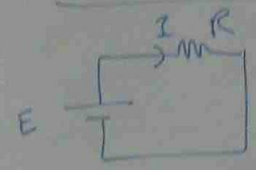


SERIES MAGNETIC CIRCUIT



← PARALLEL MAGNETIC CIRCUIT

ELECTRIC CIRCUIT



$$I = \frac{E}{R}$$

I = CURRENT E = VOLTAGE

R = RESISTANCE

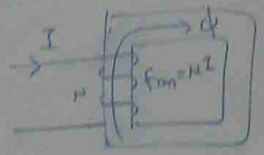
$$R = \frac{\rho L}{A}$$

ρ = RESISTIVITY

L = LENGTH

A = C.S.A

MAGNETIC CIRCUIT



$$\phi = \frac{F_m}{R_m}$$

ϕ = FLUX (wb)

F_m = MAGNETO MOTIVE FORCE (Amp Turn)

R_m = RELUCTANCE

$$R_m = \frac{l}{\mu_0 \mu_r A}$$

l = LENGTH

$\mu_0 \mu_r$ = PERMEABILITY

A = C.SA

MAGNETIZING FORCE

UNIT LENGTH of MAGNETIC PATH IS TERMED AS MAGNETIZING FORCE

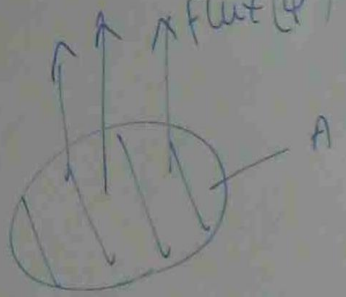
$$H = \frac{F_m}{l}$$

$$H = \frac{N \times I}{l}$$ Amp Turn/m

$\mu_0 = 4\pi \times 10^{-7}$

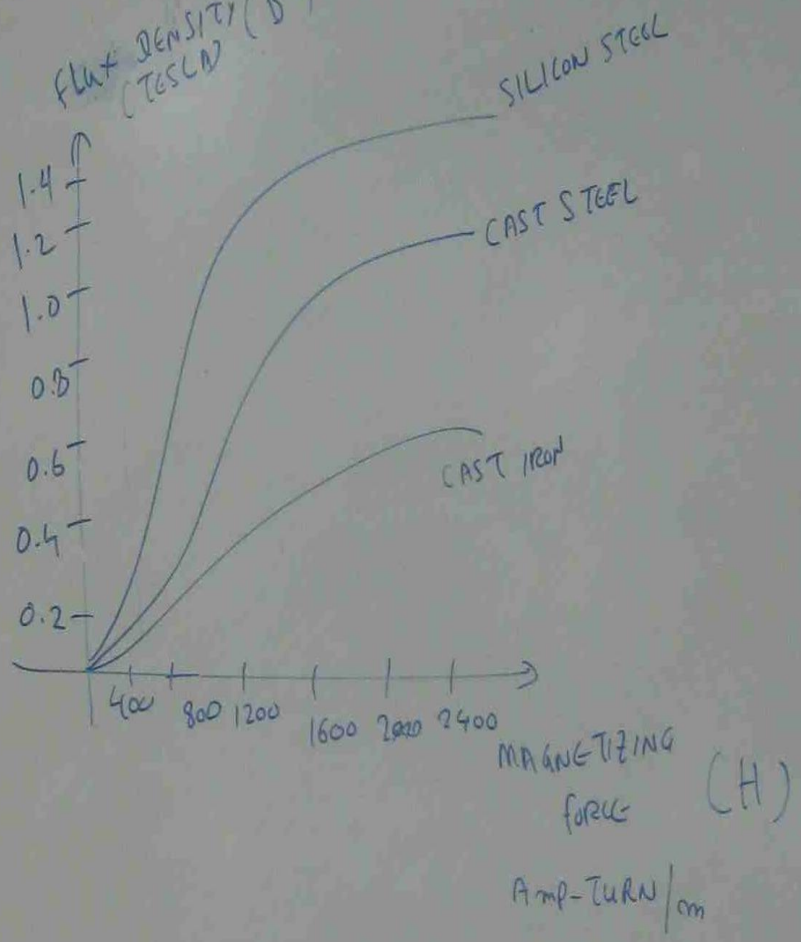
μ_r = RELATIVE PERMEABILITY

B-H - MAGNETIZING CURVE

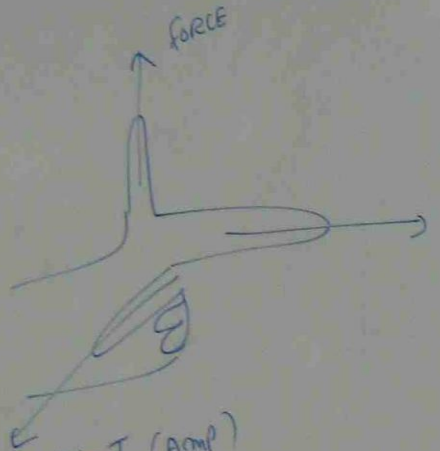


$$\text{Flux Density } (B) = \frac{\text{Flux}}{\text{AREA}}$$

$$B\ (\text{TESLA}) = \frac{\phi\ (\text{wb})}{A\ (m^2)}$$



FORCE ON CONDUCTOR



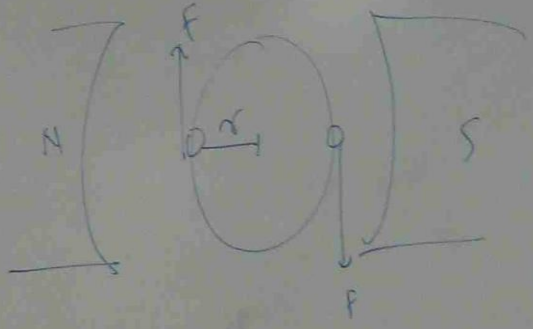
$$F = B\ I\ L$$

B = Flux Density (T)

I = Current (Amp)

L = Length (m)

F = Force (Newtons)



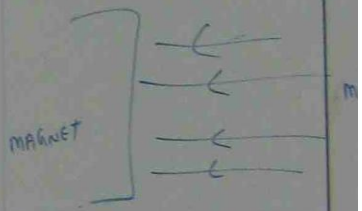
Torque = Force x Radius

$= F \times r$

$T = (B\ I\ L) \times r$

T = N-m

FORCE EXERTED BY MAGNET



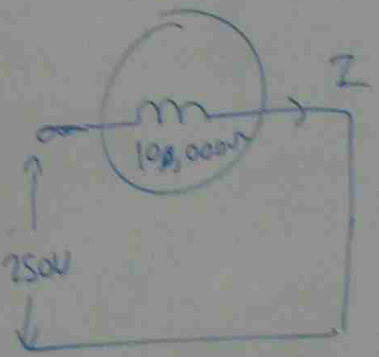
$$F = \frac{B^2 A}{2\mu_0}$$

B = Flux Density (T)

A = C.S.A (m^2)

$\mu_0 = 4\pi \times 10^{-7}$

Ph/ A 250 V VOLTMETER HAS RESISTANCE 100,000 Ω. IF METER COIL HAS 3000 TURNS CALCULATE THE MAGNETO MOTIVE FORCE OF THE COIL FOR FULL SCALE DEFLECTION.



$$I = \frac{V}{R} = \frac{250}{100,000} = 250 \times 10^{-5} \text{ Amp.}$$

$$f_m = N \times I = 3000 \times 250 \times 10^{-5} = 750000 \times 10^{-5} = 7.5 \text{ AMP-TURN}$$

Pb WHAT FLUX IS PRODUCED IN A MAGNETIC CIRCUIT WITH A RELUCTANCE of 30,000 Amp-Turn/wb WHEN ITS COIL OF 600 TURNS TAKES A CURRENT of 1.2Amp FROM THE SUPPLY.

$R_m = 30,000$ Amp Turn/wb

$N = 600$ TURNS

$I = 1.2$ Amp.

$\phi = ?$

$$\phi = \frac{F_m}{R_m} = \frac{N I}{30,000}$$

$$\phi = \frac{600 \times 1.2}{30,000}$$

$$= 0.024 \text{ wb}$$

Pb

A PLUNGER BRAKE ELECTRO MAGNET OPERATES AT A FLUX DENSITY of 1.2 TESLA. IF THE C.S.A of THE MAGNETIC CIRCUIT IS 0.04 Sq-m AND RELUCTANCE IS 12000 Amp-Turns/wb. WHAT CURRENT IS REQUIRED TO OPERATE THE MAGNET IF THE COIL HAS 1000 TURNS.

$B = 1.2$ T $A = 0.04 \text{ m}^2$ $R_m = 12000$ Amp-Turn/wb

$N = 1000$ $I = ?$

$$B = \frac{\phi}{A} \longrightarrow \phi = B \times A = 1.2 \times 0.04 = 0.048 \text{ wb}$$

$$\phi = \frac{F_m}{R_m}$$

$$0.048 = \frac{N \times I}{R_m}$$

$$0.048 = \frac{1000 \times I}{12000}$$

$$I = \frac{0.048 \times 12000}{1000}$$

$$= 0.576 \text{ Amp}.$$

Ph) THE CONDUCTOR OF A COIL CAN SAFELY CARRY A CURRENT OF 0.5 Amp AND WHEN WOUND INTO A COIL IS REQUIRED TO PRODUCE A FLUX of 0.06 wb IN A MAGNETIC CIRCUIT WHICH HAS A RELUCTANCE of 250,000 Amp-Turn/wb. CALCULATE THE NUMBER OF TURNS REQUIRED ON THE COIL.

$I = 0.5$ Amp $\quad \phi = 0.06$ wb, $\quad R_m = 250,000$ A-T/wb $\quad N = ?$

$$\phi = \frac{NI}{R_m}$$

$$0.06 = \frac{N \times 0.5}{250,000} \longrightarrow N = \frac{0.06 \times 250,000}{0.5} = 30,000 \text{ TURNS}$$

ph/ A 240V coil of 5000 turns provides a magnetizing force of 4000 Amp-turn/m, if the magnetic circuit is 200 mm long and has a C.S.A of 500 sq mm Find the resistance of the coil

$V = 240V$, $N = 5000$, $H = 4000$ Amp-turn/m

$L = 200\,mm = \frac{200}{1000} = 0.2\,m$

$A = 500 \times \left(10^{-3}\right)^2$

$= 500 \times 10^{-6}\ m^2$

$R = ?$

$NI = H.L$

$5000 \times I = 4000 \times 0.2$

$I = \frac{4000 \times 0.2}{5000} = 0.16$ Amp

$R = \frac{V}{I} = \frac{240}{0.16}$

$= 1500\Omega$

ph/ A core of $5000\ mm^2$ C.S.A has a resistance of 80,000 Amp Turn/wb and the coil on it has 100 turns and a maximum current carrying capacity of 4 Amp. Calculate the maximum flux density in the core.

$A = 5000\ mm^2 = 5000 \times \left(10^{-3}\right)^2 = 5000 \times 10^{-6}\ m^2$

$R_m = 80{,}000$ Amp-turn/wb $\quad N = 100, \quad I = 4, \quad B = ?$

$\phi = \frac{F_m}{R_m} = \frac{N \times I}{80{,}000} = \frac{100 \times 4}{80{,}000} = 0.005$ wb

$B = \frac{\phi}{A} = \frac{0.005}{5000 \times 10^{-6}} = \frac{0.005 \times 10^{6}}{5000} = 1$ Tesla.