(11) Magnetic Circuits

একটি magnet এর north ও south পোল থাকে তার চারপাশে একটি magnetic field তৈরী হয়, যে অনুযায়ী magnet এর strength বুঝা যায়, (N > S)

Magnetic field কে represent করার জন্য একটি চিত্র ব্যবহার করা হয় magnetic flux lines

একটি conductor এর মধ্যে দিয়ে current flow হলে তার মধ্যে সেই তারের চারপাশে চিত্র magnetic flux lines তৈরি হয়, Direction Right hand thumb rule

thumb → current direction

বাকি ৪টি আঙ্গুল → Circular Direction অনুযায়ী magnetic field তৈরি হবে,

তারের পরিমাণের মধ্যে দিয়ে current flow হলে এদের rule এর চিত্র

thumb এর direction = North

Flux Density: magnetic flux lines এর density

$$B = \frac{\Phi}{A}$$

B = teslas (T)
Φ = webers (Wb)
A = Area (m^2)

Permeability: যে easily material টি তার চারপাশে magnetic field তৈরি করতে পারে,

$\mu_0 = 4\pi \times 10^{-7} \frac{Wb}{Am}$ [permeability of free space]

Relative Permeability: Vaccume ~~এর~~ reference value ~~এ~~ ~~যেহেতু~~ ~~কতগুণ~~ ~~বেশি/কম~~ permeability ~~হচ্ছে~~ Relative permeability.

$$\mu_r = \frac{\mu}{\mu_0}$$

μ = material
μ_0 = vaccume

Reluctance: Resistance ~~এর~~ ~~মত~~ ~~এর~~ magnetic field ~~কে~~ ~~বাধা~~ ~~দেয়~~।

$$\mathcal{R} = \frac{l}{\mu A} \quad \text{compare to} \quad R = \rho \frac{l}{A}$$

rels. or At/Wb
↳ Ampares turns

Ohm's Law for Magnetic circuits

$$\text{Effect} = \frac{\text{cause}}{\text{opposition}} \quad \left.\begin{matrix} \\ \\ \end{matrix}\right\} \; I = V/R$$

$$\Phi = \frac{\mathcal{F}}{\mathcal{R}} \rightarrow \text{magnetomotive force (mmf)}$$

$\mathcal{F} = NI$ → ~~তারের~~ যত্ন ~~দিয়ে~~ current ~~প্রবাহের~~ flow ~~করে~~
↳ number of turns

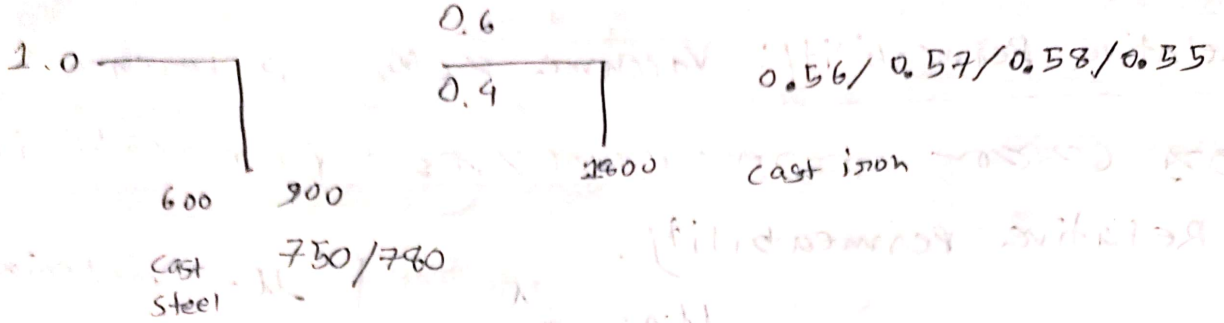
Magnetizing force: mmf ~~এর~~ ~~সাথের~~ ~~দৈর্ঘ্যের~~ ratio (Ampere-turns, At

$$H = \frac{\mathcal{F}}{l} \quad (At/m)$$

$$H = \frac{NI}{l} \quad [\mathcal{F} = NI \text{ ~~থেকে~~}]$$

$B = \mu H$ | B = Flux density, μ = permeability, H = magnetising force

BH graph ಅನ್ನು vary ಆಗುತ್ತೆ,



Ampere's Circuital Law: ಇಲ್ಲಿ closed magnetic circuit ಅನ್ನು

KVL. summation of
→ voltage rise = drop.

$$\Sigma \mathcal{F} = 0$$

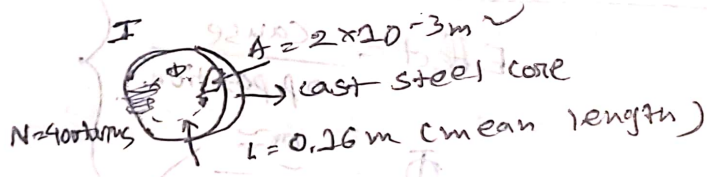
~~magnetic~~.
→ magnetomotive force

$$\mathcal{F} = HL, \quad \mathcal{F} = NI \quad [\text{ಅಂತರ}]$$
(At) (At)

$H = \frac{NI}{L}$

$\Rightarrow |\mathcal{F}| = NI = F$

Ex-11.3



a) Find the value of I required to develop a magnetic flux of $\Phi = 4 \times 10^{-4}$ Wb

b) Find μ and μ_r

Ans: a) flux density, $B = \frac{\Phi}{A} = \frac{4 \times 10^{-4}}{2 \times 10^{-3}}$

$= 2 \times 10^{-1} T = 0.2 T$

from BH curve,

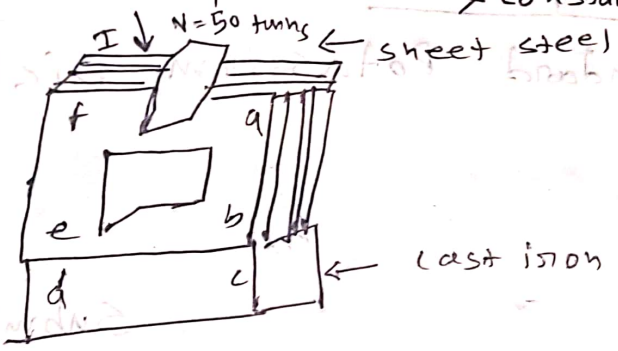
H_c (cast steel) = 170 At/m

$$I = \frac{Hl}{N} = \frac{170 \times 0.16}{400} = 68\,mA$$

b) $$\mu = \frac{B}{H} = \frac{0.2}{170} = 1.176 \times 10^{-3}\ Wb/A.m$$

$$\mu_r = \frac{\mu}{\mu_0} = \frac{1.176 \times 10^{-3}}{4\pi \times 10^{-7}} = 935.83$$ → constant

Ex-11.4



$l_{efab} = 304.8 \times 10^{-3}\ m$

$l_{bcde} = 127 \times 10^{-3}\ m$

Area = $6.452 \times 10^{-4}\ m^2$

$\Phi = 3.5 \times 10^{-4}\ Wb$

a) Determine current I required to establish the indicated flux in the core

Ans:

$$B = \frac{\Phi}{A} = \frac{3.5 \times 10^{-4}}{6.452 \times 10^{-4}} = 0.542\ T$$

from,

BH curve, $H \simeq 70$ At/m [sheet steel]

$H \simeq 1600$ At/m [cast iron]

$H_1 l_1 = 70 \times (304.8 \times 10^{-3}) = 21.34$ At

$H_2 l_2 = 1600 \times (127 \times 10^{-3}) = 203.2$ At

$NI = 224.54 (H_1 l_1 + H_2 l_2)$, $I = \frac{224.54}{50\ (turns)} = 9.49$ A

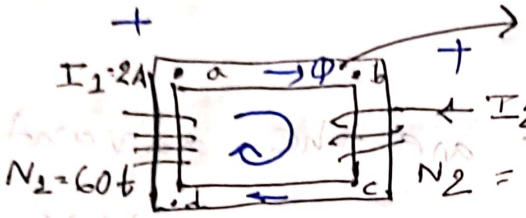
(11) Magnetic Circuits

$NI = Hl$

↓ rise usually → drop usually

Voltage source → resistance

Ex-11.5



$A = 0.15 \times 10^{-3} m^2$

$l_{abcda} = 0.16m$

Find I_2 if the resultant clockwise flusk is 1.5×10^{-5} Wb

[Electric Circuit Current = Magnetic circuit flusk]

Material এর কয়টি Hl এর কয়টি

কোথায় এর কয়টি NI এর কয়টি

$+ N_1 I_1$ (rise) $- N_2 I_2$ (drop) $= Hl$

$\therefore B = \frac{\Phi}{A}$

$= \frac{1.5 \times 10^{-5}}{0.15 \times 10^{-3}} = 0.1 T$ এখন থেকে H এর মান

সহজে করি।

Fig 11.24 (page- 416) H = 25 At/m

$+60 \times 2 - 30 \times I_2 = 25 \times 0.16$

$$I_2 = \frac{60 \times 2 - 25 \times 0.16}{30}$$

$= 3.86\ A$

Find μ/ permibiality of the material.

$B = \mu H$

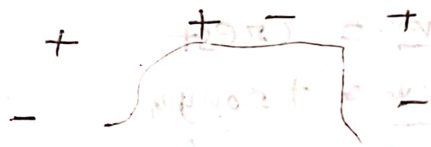
$\Rightarrow \mu = \frac{B}{H} = \frac{0.1}{25} = 4 \times 10^{-3}$ Wb/Am

$\mu_r = \frac{\mu}{\mu_0} = \frac{4 \times 10^{-3}}{4\pi \times 10^{-7}} = 3183.1$

sheet + cast হলে HL ছোট হবে

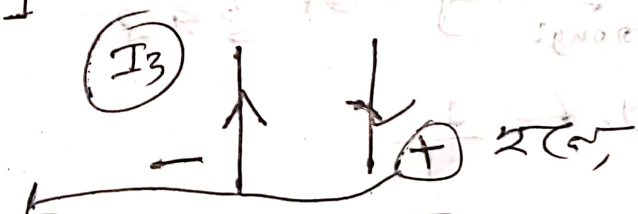
material গুলো কিছু কমেন্ট বেশি হলে

NI = 3, Hl = 1



Equation:

$+N_1I_1 - N_2I_2 - N_3I_3$ (For clockwise)



$N_1I_1 + N_3I_3 - N_2I_2$