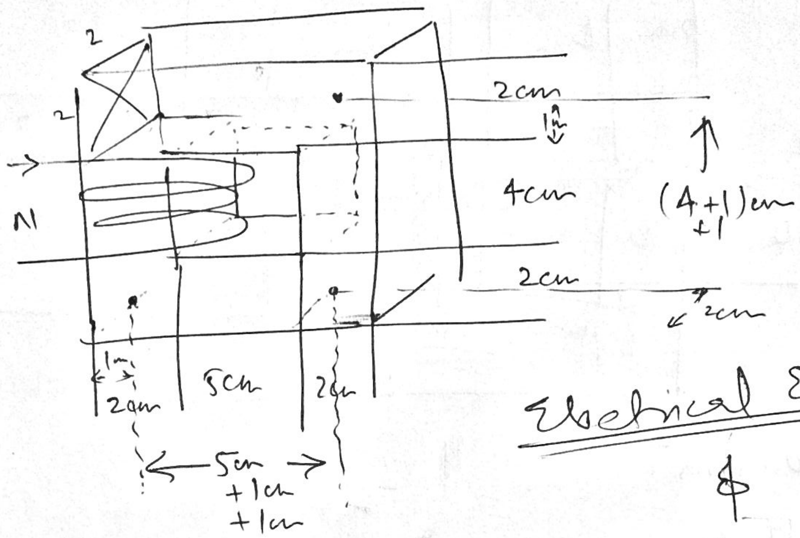
$\phi = ?$

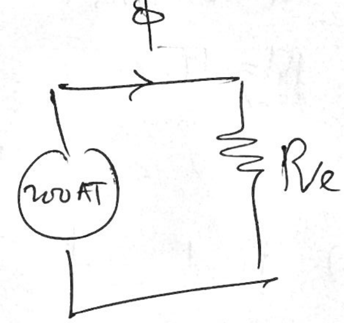
$4\,Am = i$

$\mu_r = 1500$

$N = 50$



Electrical Equivalent



Total length = 7cm + 7cm + 6cm + 6cm

$l_e = 26\,cm = 26 \times 10^{-2}\,m$

effective area = $0.02 \times 0.02 = 4 \times 10^{-4}\,m$

$$R_e = \frac{1}{\mu_0 \mu_r} \times \frac{l_e}{A_e}$$

$$R_e = \frac{1}{1500 \times 4\pi \times 10^{-7}} \times \frac{26 \times 10^{-2}}{4 \times 10^{-4}}$$

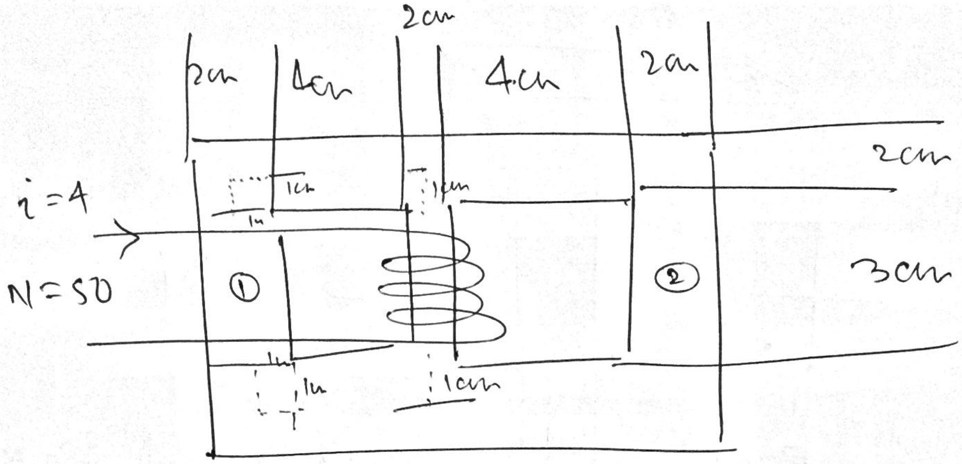
$$= 0.000344 \times 10^{-2+4+7}\ AT/wb$$

$$R_e = 344 \times 10^{3}\ AT/wb$$

$$\phi = \frac{Ni}{R_e}$$

$$= \frac{4\,\text{ampere} \times 50\,\text{turns}}{344 \times 10^{+3}\ AT/wb}$$

$$\phi = 0.58 \times 10^{-3}\ wb$$



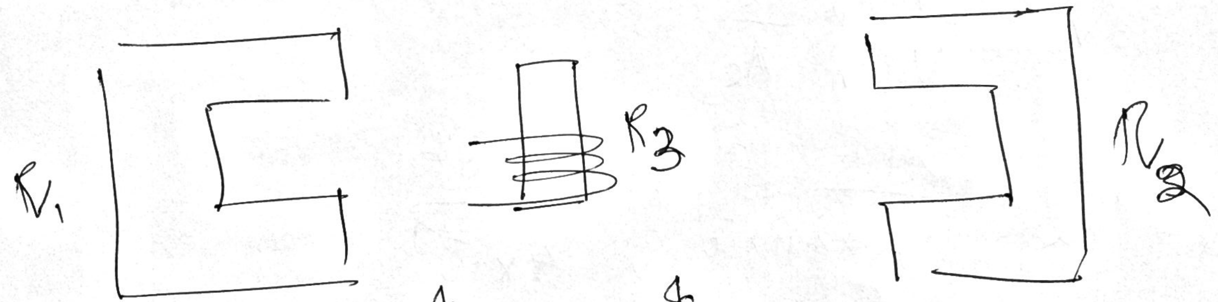
$A_e = 0.25\,m^2$

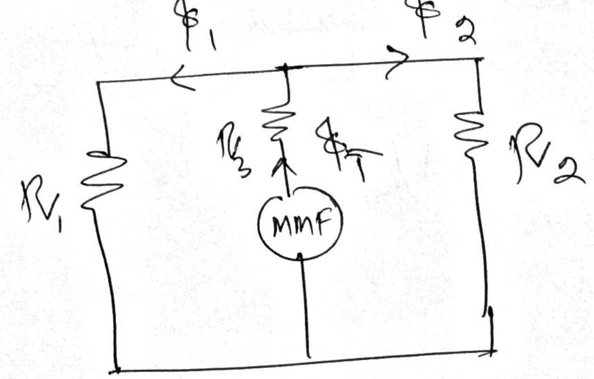
$\mu_r = 1700$

a) Draw equivalent circuit in electrical components.

b) Find Φ in arm 2

find Magnetization intensity H in arm 2





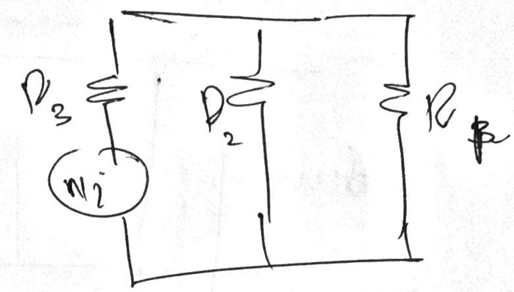
l_{e1} = 1cm + 4cm + 1cm + 3cm + 1cm + 1cm + 4cm + 1cm
= 16cm = l_{e2}

l_{e3} = 3cm + 1cm + 1cm = 5cm

$$R_1 = \frac{1}{\mu_0 \mu_r} \frac{l_{e1}}{A_e} = x$$

$$R_2 = \frac{1}{\mu_0 \mu_r} \frac{l_{e2}}{A_e} = y$$

$$R_3 = \frac{1}{\mu_0 \mu_r} \frac{l_{e3}}{A_e} = z$$



$$R_{total} = R_3 + R_1 \,//\, R_2$$

$$= z + \frac{xy}{x+y}$$

$$R_{total} = w \;\left(AT/wb\right)$$

$$\phi_{total} = \frac{Ni}{R_{total}} = \frac{200}{w}$$

$$\phi_2 = \phi_{total} * \frac{R_1}{R_1 + R_2}$$ } current divident rule

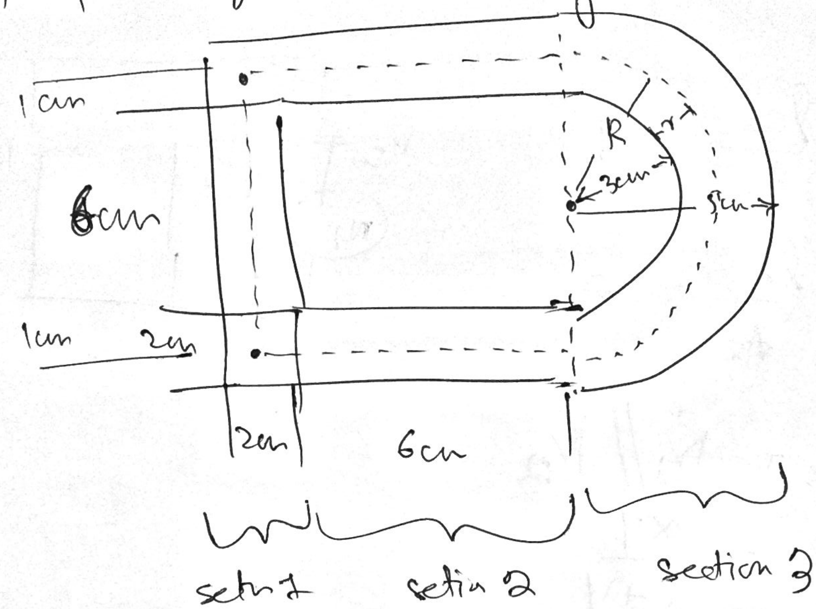
$$\phi_2 = v \;(wb)$$

$$\phi_2 = B_2 A_2$$

$$\phi_2 = \mu_0 \mu_r H_2 A_2 \quad \because A_2 = A_e$$

$$H_2 = \frac{\phi_2}{\mu_0 \mu_r A_e} \;\left(A/m\right)$$

Find R of magnetic circuit given



$A_e = 0.25 m^2$

$\mu_r = 1600$

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

$A_{e1} = 0.25 m^2$

$l_{e1} = 1cm + 6cm + 1cm = 8cm = 8 \times 10^{-2} m$

$$R_1 = \frac{1}{1600 \times 4\pi \times 10^{-7} \left(\frac{H}{m}\right)} * \frac{8 \times 10^{-2} m}{0.25 m^2} = x \, (AT/wb)$$

$A_{e2} = 0.25 m^2$

$l_{e2} = (1cm + 6cm) \times 2 = 14cm = 14 \times 10^{-2} m$

$$R_2 = \frac{1}{1600 \times 4\pi \times 10^{-7}} \times \frac{14 \times 10^{-2}}{0.25 m^2} = y \, (AT/wb)$$

$A_{e3} = 0.25 m^2$

$$r = \frac{5cm - 3cm}{2} = \frac{2cm}{2cm} = 1cm$$

$R = 3cm + 1cm = 4cm$

$$l_{e3} = \frac{2\pi R}{2} = \pi(R) \text{ : Half circle } = 12.56 \, cm = 12.5 \times 10^{-2} m$$

$$R_3 = \frac{1}{1600 \times 4\pi \times 10^{-7}} \times \frac{12.5 \times 10^{-2}}{0.25 m^2} = z \, (AT/wb)$$

$$R = R_1 + R_2 + R_3$$

Trasformers

(1)

$V_{in} = 200\ V$

$V_{out} = 400\ V$

$I_{in} = 300\ A$

$I_{out} = ?$

$\frac{N_1}{N_2} = ?$

$V_1 I_1 = V_o I_o$

$200 \times 300 = 400 \times I_O$

$\frac{300}{2} = I_o$

$$\boxed{I_O = 150 A}$$

$\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{V_i}{V_o} = \frac{200}{400} = \frac{1}{2}$

$$\boxed{\frac{N_1}{N_2} = \frac{1}{2}}$$

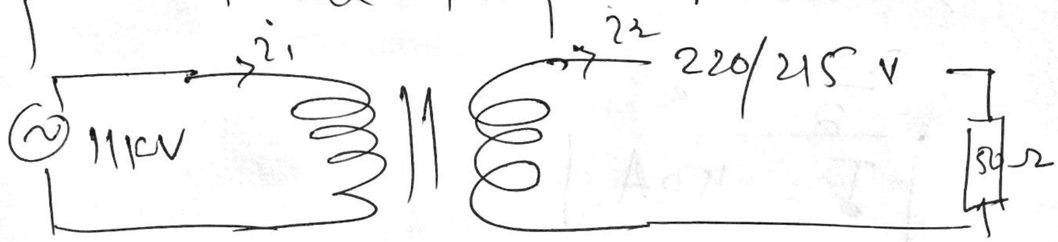
(2) find efficieny of trasformer for $V_{out} = V_{in}$ and $I_{out} = 0.99 I_{in}$

$\eta = \frac{\text{output power}}{\text{input power}} = \frac{0.99 I_{in} \times V_{in}}{I_{in} V_{in}}$

$\eta = 0.99$

$\eta\% = 99\%$

(3) A load of 50 Ω is connected to a transformer due to which the voltage is reduced from no load voltage of 220V at the output to 215 V at the output for a constant input voltage 11000 volts. Find the voltage regulation and the power taken by the load as well as the loss of power inside transformer.



Solution

$$\% \text{ regulation} = \frac{V_{no\,load} - V_{full\text{-}load}}{V_{full\text{-}load}} \times 100\%$$

$$= \frac{220V - 215V}{215V} = \frac{500}{215}\ \%$$

$$\% Reg = 2.32\%$$

$$I_{out_{lossy}} = \frac{215V}{50\,\Omega} = 4.3\,A$$

$$I_{out_{no\,loss}} = \frac{220\,V}{50\,\Omega} = 4.4\,A$$

$$\Delta I_{out} = 0.1\,A$$

(6)

Turn ratio $= \frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{11K\ V}{220\ V} = 50$

V_{in} for 215V $= 215 * 50 = 10750$ Volts

$\Delta V_{in} = 11000 - 10750 = +250$ V

$\Delta I_{in} = \frac{0.1}{50} = 0.002$ A

$P_{loss_{in}} = \Delta V_{in} * \Delta I_{in}$

$= 0.002 \times 250$

$P_{in\ loss} = 0.5$ watt ✓

$P_{out} = \Delta V_{out} \Delta I_{out}$

$= 5 * 0.1$

$P_{out} = 0.5$ watt ✓

Total $I_{in} = \Delta I_{in} + I_{in}$

Total $P_{in} = P_{out} + P_{loss} = P_{out_{lossless}}$ ②

$= (4.3)^2 \times 50 + (0.1)^2 \times 50$

$= (4.3 + 0.1)^2 \times 50$

$= (4.4)^2 \times 50 = I_{total}^2 \times R$

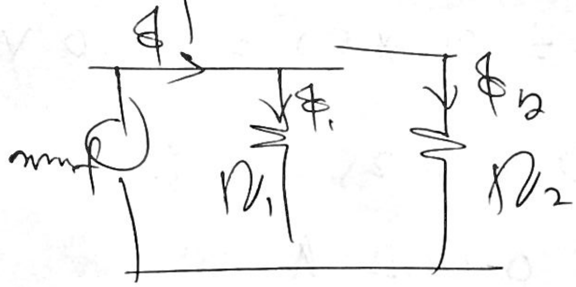
$P_{total} = 968$ watt

$\eta = \frac{P_{out}}{P_{in_{total}}} = \frac{968 - 0.5}{968}$

$\eta = 0.99948$

$\eta\% = 99.948\%$

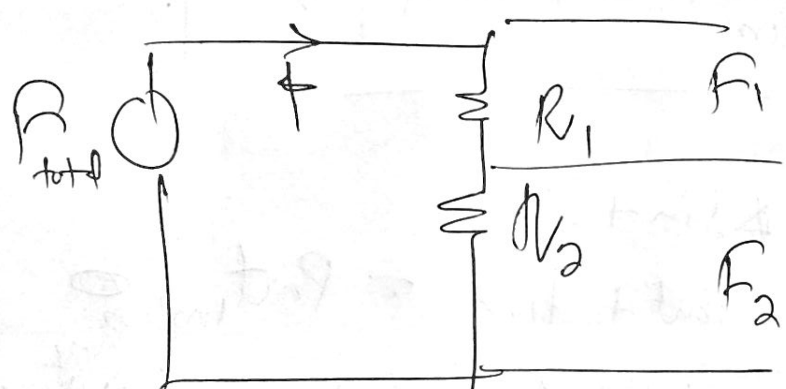
Flux division in parallel



$\phi = \phi_1 + \phi_2$

$$\phi_{(2)} = \phi * \frac{R_{(1)}}{R_1 + R_2} \quad (2-1), \qquad \phi_{(1)} = \phi \frac{R_{(2)}}{R_1 + R_2} \quad (1-2)$$

mmf division in series.



$$F_2 = \phi R_2 \quad , \quad F_1 = \phi R_1$$

$$F_{(2)} = F_{total} * \frac{R_{(2)}}{R_1 + R_2} \quad (2-2) \qquad F_1 = F_1 + F_2$$

$$F_{(1)} = F_{total} * \frac{R_{(1)}}{R_1 + R_2} \quad (1-1)$$