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RECITATION #10

1. Let the mutual inductance be M.

EMF induced = 22 kV = 22000 V

I_1 = 7.0 A

I_2 = 0 A

Time taken = 2.5 ms

EMF induced = M × $\frac{\text{change in current}}{\text{time taken}}$

$$22000 = M \times \frac{7.0}{2.5 \times 10^{-3}}$$

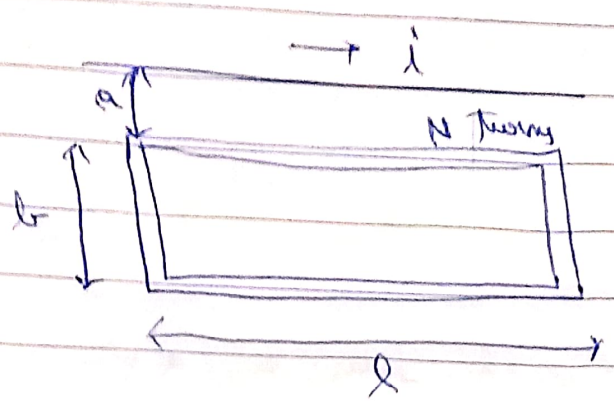
$$M = \frac{22000 \times 2.5 \times 10^{-3}}{7.0}$$

$$= \frac{22000 \times 25}{70 \times 10^3}$$

$$= \frac{2200 \times 25}{7 \times 10 \times 10^3}$$

$$= \frac{22 \times 2.5}{7} = 7.857 \text{ H}$$

2. Ans:



Here :- $N = 140$, $l = 35\text{ cm} = 0.35\text{ m}$, $a = 2.0\text{ cm}$, $b = 9.0\text{ cm}$

$$\therefore \frac{b}{a} = \frac{9.0}{2.0}$$

$$\Rightarrow 1 + \frac{b}{a} = 1 + \frac{9.0}{2.0}$$

$$= \frac{11.0}{2.0}$$

Also, $\mu_0 = 4\pi \times 10^{-7}$ SI units

The flux is :- $\phi = \int_a^{a+b} B\, l\, dy \rightarrow (1)$

$$= \int_a^{a+b} \left(\frac{\mu_0 i}{2\pi y}\right) l\, dy$$

$$= \frac{\mu_0 i l}{2\pi} \int_a^{a+b} \frac{1}{y}\, dy$$

$$= \frac{\mu_0 i l}{2\pi} [\ln x]_a^{a+b}$$

$$= \frac{\mu_0 i l}{2\pi} [\ln(a+b) - \ln a]$$

$$\therefore \phi = \frac{\mu_0 i l}{2\pi} \ln\left(1 + \frac{b}{a}\right) \quad \text{—— (2)}$$

But, mutual inductance is $M = \frac{N\phi}{i}$

$$\therefore M = \frac{N \mu_0 l}{2\pi} \ln\left(1 + \frac{b}{a}\right) \quad \text{—— (3)}$$

$$= \frac{140 \times 4\pi \times 10^{-7} \times 0.35}{2\pi} \times \ln\left(\frac{11}{2}\right)$$

$$= 192.7 \times 10^{-7} \text{ Henry}$$

OR

$$M \simeq 19.3 \, \mu H \quad [\because \mu = 10^{-6}]$$