Numericals

1. Two coils, A and B, are wound on the same ferromagnetic core. There are 300 turns on A and 2800 turns on B. A current of 4A through coil A produces a flux of 800μWb in the core. Calculate the self-inductances and mutual-inductance of the coils. If this current is reversed in 20ms, calculate the average emf induced in coils A and B. (Answer: 0.06H, 5.22H, 0.56H, 24V, 224V)

2. Two identical 1000 turn coils, X and Y lie in parallel plains such that 60% of magnetic flux produced by one links the other. A current of 5A in X produces a flux of 0.05mWb. If current in X changes from +5A to -5A in 0.01 second, what will be the magnitude of emf induced in Y. Also, calculate the self-inductance of each coil and mutual inductance between two coils. (Answer: 6V, 0.01H, 0.01H, 0.006H)

3. A coil of 1500 turns carrying a current of 5A produces a flux of 2.5mWb. If the current is reversed in 0.2 second, find the average value of emf induced in the coil. Also, find the self-inductance of the coil. (Answer: 37.5V, 0.75H)

4. The self - inductance of a coil of 500 turns is 0.25H. If 60% of the flux linked with the second coil of 10,000 turns, calculate the mutual inductance between the coils. Also find the emf induced in the second coil when current in the first coil changes at the rate of 100A/s. (Answer: 3H, -300V)

5. There are two coils having coefficient of coupling 0.8. The current in coil A is 3A and the total flux is 0.4mWb. The voltage induced in coil B is 85V when the current in coil A is reduced to zero in 3ms. The number of turns in coil A is 300. Determine L_1, L_2, M and N_2. (Answer: 0.04H, 0.282H, 85mH, 797)

$N_A = 300$; $N_B = 2800$; $I_A = 4A$; $\phi_A = 800 \mu Wb$;
Avg EMF = ? $t = 20 \times 10^{-3} s$

① $L_A = \frac{N_A \phi_A}{I_A}$

$L_A = \frac{300 \times 800 \times 10^{-6}}{4}$

$= \underline{0.06 H}$ //

$\frac{L_A}{L_B} = \frac{N_A^2}{N_B^2}$

$L_B = \frac{L_A N_B^2}{N_A^2}$

$L_B = \frac{0.06 \times (2800)^2}{(300)^2}$

$\underline{L_B = 5.226 H}$ //

$M_B = \frac{N_B \times k \times \phi_A}{I_B} = \frac{2800 \times 800 \times 10^{-6} \times 1}{4}$

$= \underline{0.56 H}$ //

Avg EMF :- $e_A = \frac{L_A dI_A}{dt} = \frac{0.06 \times (4 - (-4))}{20 \times 10^{-3}}$

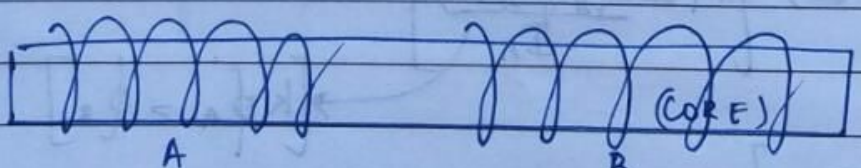
$= \frac{0.06 \times 8}{20 \times 10^{-3}}$

$= \underline{24 V}$ //

$e_B = \frac{L_B \cdot dI_B}{dt} = \frac{5.226 \times 8}{20 \times 10^{-3}} = \underline{2090.66 V}$

NOTE :-

⟹ Same ferromagnetic field :-



$\left[L_A = \frac{N_A^2}{S}\right]$ $\left[L_B = \frac{N_B^2}{S}\right]$ } (S - reluctance)

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(I) → ~~Rel~~ Reluctance (R)
(ϕ) → Reluctance (S)

→ Reluctance is defined as the opposition of the flow of flux in core.

(2) A coil of 1500 Turns carrying a current of 5A produces a $\phi_A = 2.5$ mWb. If the current is reversed in 0.2 seconds, find the average value of emf induced in coil. Also find the self-inductance of the coil.

$N = 1500$; $I = 5A$; $\phi = 2.5 mWb$; $t = 0.2s$.
$e_A = ?$; $L_A = ?$

$$\Rightarrow L_A = \frac{N_A \cdot \phi_A}{I_A} = \frac{1500 \times 2.5 \times 10^{-3}}{5} = \underline{0.75 H} //$$

$$\Rightarrow e_A = L_A \times \frac{d\phi I}{dt} = \frac{0.75 (\pm 10)}{0.2} = \frac{7.5}{0.2} = \underline{37.5 V} //$$

(2) ~~N=1000 identical~~ 1000 turn coils, X and Y be in parallel plains such that 60% of magnetic flux produced by one links the other. A current of 5A in X produces a flux of 0.05 mWb. If current changes from +5A to -5A in 0.01 s. What will be the magnitude of emf induced in Y. Also calculate the self-inductance of each coil and mutual inductance between 2 coils.

$N = 1000$; $I_x = 5A$; $\phi_x = 0.05 \times 10^{-3} Wb$; $dI = 10A$.
$dt = 0.01s$; $|e_y| = ?$; $L_x = ?$; $L_y = ?$ $M = ?$
$[k = 60\% \text{ of } \phi_x]$

$$L_x = \frac{N_x \phi_x}{I_x} = \frac{1000 \times 0.05 \times 10^{-3}}{5}$$

$$L_x = 0.01\,H$$

$$L_y = \frac{1000 \times 0.05 \times 10^{-3}}{5}$$

$$L_y = 0.01\,H$$

$$M = \frac{N_y \times k\phi_x}{I_x}$$

$$= 10,000 \times \frac{60}{100} \times \frac{0.05}{5}$$

$$= 0.2\,H \quad 0.006\,H \Rightarrow 6\,mH$$

$$e = \frac{M\,dI}{dt} = \frac{6 \times 10^{-3} \times 10}{0.01}$$

$$e = 6\,V$$

(4) The self-inductance of coil of 500 turns is 0.25 H & 60% of the flux linked with the second coil of 10,000 turns, calculate the mutual inductance b/n the coils. Also find the emf induced in the second coil when current in first coil changes at the rate of 100 A/s.

$N_A = 500$; $L_A = 0.25\,H$; $K = 60\% = 0.6$;

$N_B = 10,000$. $M = ?$

$e = ?$ $\frac{dI}{dt} = 100\,A/s$.

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$L_A = \frac{N_A \times \phi_A}{I_A} = \frac{500 \times \phi_A}{150}$ = 10 volt.

$\phi_A = \frac{0.25 \times 100}{500} = 0.05$

$M = \frac{N_B \times k\phi_A}{I_B} = \frac{10000 \times 0.6 \times 0.05}{100}$.

$M = N_B \times k\left(\frac{L_A}{N_A}\right)$

$M = 10,000 \times 0.6 \times \frac{0.25}{500}$

$M = 3H$

$e = M \cdot \frac{dI}{dt} = 3 \times 100 = -300V$ //

(5) There are 2 coils having coefficient of coupling 0.8. The current in coil A is 3 A and the total flux is 0.4 mWb. Voltage in coil B is 85 V when the current in coil A is reduced to zero in 3×10^{-3} s. The no. of turns in coil A is 300. Determine L_1, L_2, M and N_2.

$k = 0.8$; $I_A = 3A$; $\phi = 0.4 \times 10^{-3}$ Wb; $e_B = 85$ V.
$dI = 3$ $dt = 3 \times 10^{-3}$ s. $N_A = 300$ $k = \frac{M}{\sqrt{L_A L_B}}$
$L_1 = ?$; $L_2 = ?$; $M = ?$ $N_2 = ?$

$L_1 = \frac{N_1 \phi}{I_1} = \frac{300 \times 0.4 \times 10^{-3}}{3} = 0.04H$ //

$\frac{L_2}{N_2} = \frac{\phi}{I_1} = \frac{0.4 \times 10^{-3} \times 797}{3} = 0.2280H$.

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$$M = \frac{N_B \times k \times \phi_A}{I_A}$$

$$M = \frac{N_B \times 0.8 \times 0.4 \times 10^{-3}}{3}$$

$$85 = \frac{N_B \times 0.8 \times 0.4 \times 10^{-3}}{3}$$

$$N_B = \frac{85 \times 3 \times 10^{3} \times 10^{-3}}{0.8 \times 0.4}$$

$$N_B = 796.87$$

$$N_B = 797 \text{ //}$$

$$e = M \times \frac{d\Gamma}{\partial \Gamma}$$

$$M = \frac{85 \times 3 \times 10^{-3}}{3}$$

$$M = 85 \text{ mH}$$