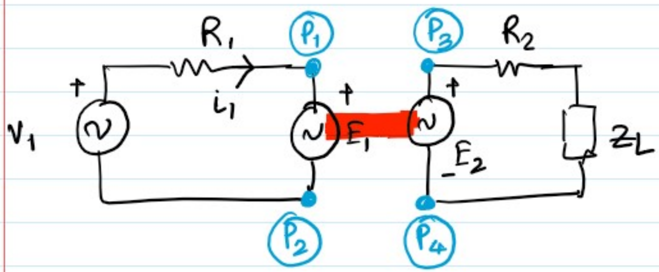
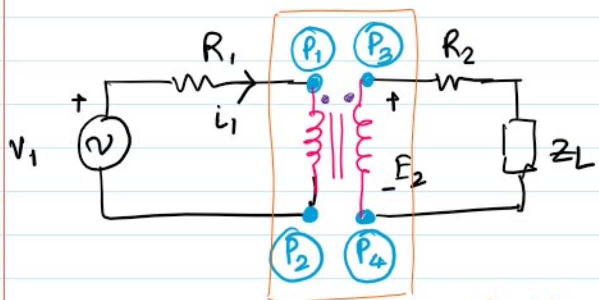
Lecture 22

Thursday, June 17, 2021 10:55 AM





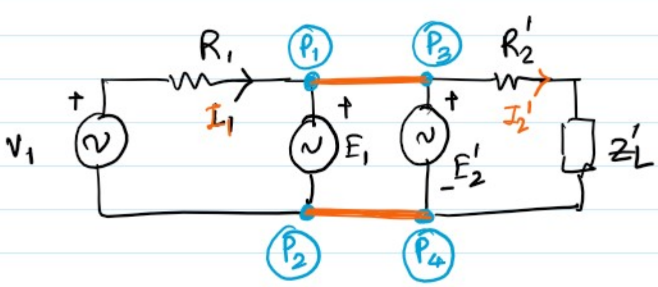
↳ ideal transformer circuit symbol

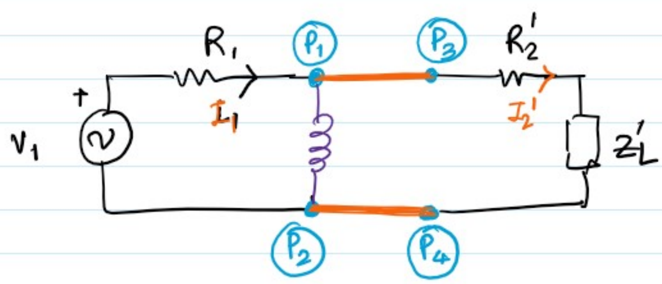
flux linked $\quad N_1\Phi_1 = \lambda_1 = N_1\Phi_{lk-1} + \underline{N_1\Phi_{12(NL)}}$

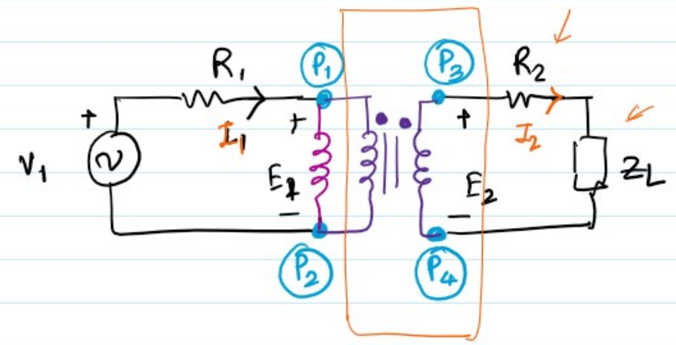
$$N_2\Phi_2 = \lambda_2 = \underline{N_2\Phi_{12(NL)}} - N_2\Phi_{lk-2}$$

$$\frac{d\lambda_1}{dt} = e_{lk-1} + e^{(1)}_{mutual} = e_1$$

$$\frac{d\lambda_2}{dt} = e^{(2)}_{mutual} - e_{lk-2} = e_2$$

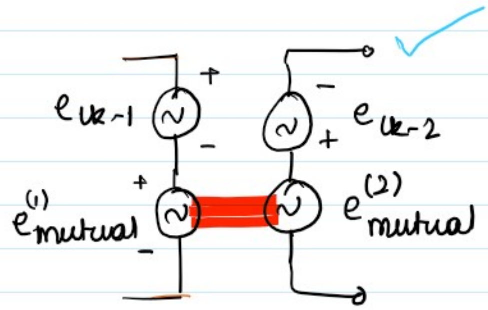




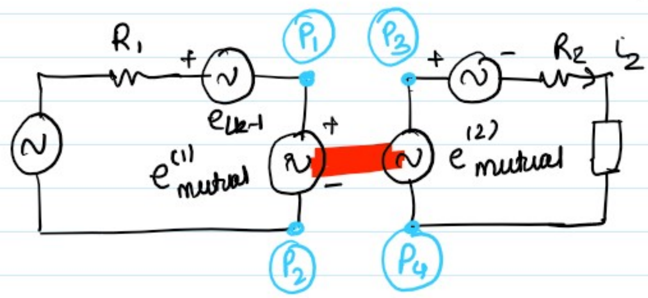


Refer it the primary side

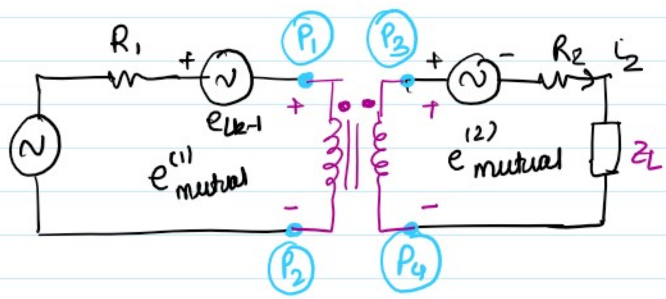
$\left(\frac{N_1}{N_2}\right)^2 \rightarrow$ impedances are referred with this

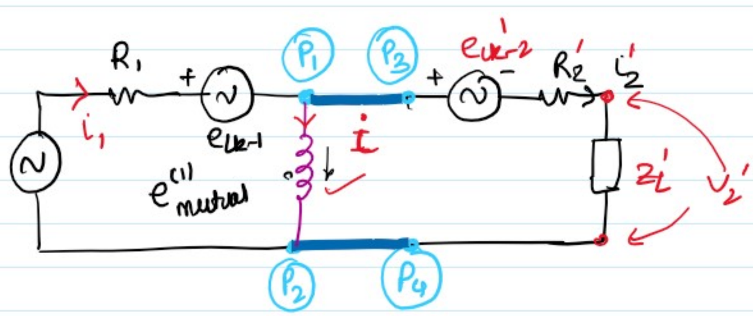


$e^{(1)}_{mutual}$ & $e^{(2)}_{mutual}$ are related by magnetic circuit



$v_{P_1-P_2} = v_{P_3-P_4}$





$$\boxed{\begin{aligned} i_1 &= i + i_2' \longrightarrow i_1 \\ I_1 &= I + I_2' \end{aligned}}$$

$$i_1 = i + i_2$$

$$\boxed{I_1 = I + I_2'}$$

$$e^{(1)}_{mutual} = L_M \frac{di}{dt} \qquad e_{lk-1} = L_{lk} \frac{di_1}{dt} \qquad e_{lk-2} = L_{lk-2} \frac{di_2'}{dt}$$

$$\lambda = N\phi = Li$$

$$e = \frac{d\lambda}{dt} = N\frac{d\phi}{dt} = L\frac{di}{dt}$$

$$\lambda_1 = \underline{\underline{N_1}} (\phi_{lk-1} + \phi_m) \;||$$

$$\lambda_1 = N_1 \phi_{lk_1} + N_1 \phi_m = L_{lk-1} i_1 + \underline{\underline{L_M}} \, i$$

magnetizing inductance

$$i = i_1 - i_2' \;///$$

$$N_1 i = \phi_m R \qquad \frac{l}{\mu A}$$

$$\phi_m = \frac{\mu N_1 A}{l} i \qquad \lambda_m = N_1 \phi_m = \frac{\mu N_1^2 A}{l} i$$

$$\boxed{L_M = \frac{\mu N_1^2 A}{l}}$$

flux linked λ_1 is due to coil-1 itself

$$\lambda_1 = N_1 \phi_{11} + \cancel{N_1 \phi_{21}}$$ zero (cancel)

$$\lambda_1 = N_1 \phi_{\underline{\underline{11}}} = N_1 (\phi_{lk-1} + \phi_{12}) = N_1 (\phi_{lk-1} + \phi_m)$$

$$\lambda_1 = L_{11} i_1 + \cancel{M i_2}$$

$$\lambda_1 = L_{11} i_1$$

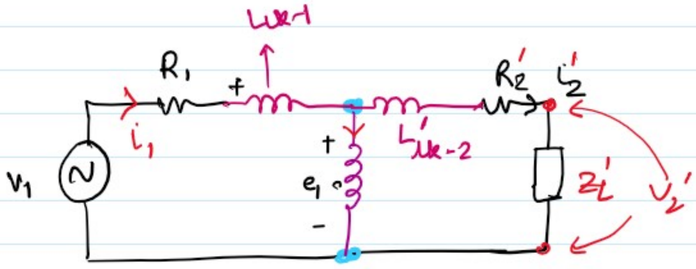
$$L_{lk-1} + L_M = L_{11}$$

$$\boxed{L_{lk-1} = L_{11} - L_M}$$

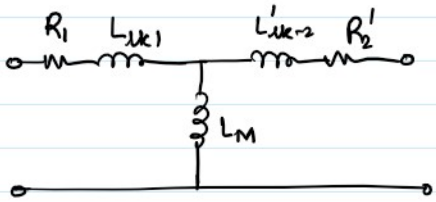
Self inductance, leakage inductance & magnetizing inductance

$$L_M = \frac{\mu N_1^2 A}{l} = \frac{N_1}{N_2} \cdot \underbrace{\frac{\mu N_1 N_2 A}{l}}_{\text{mutual inductance } (M)}$$

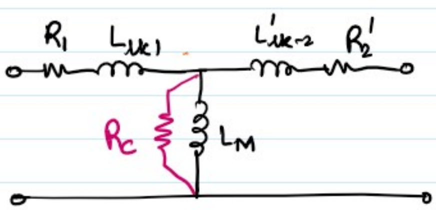
$$\boxed{L_M = \frac{N_1}{N_2} \cdot M}$$



$$e^{(1)}_{mutual} \equiv e_1$$

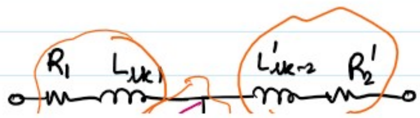


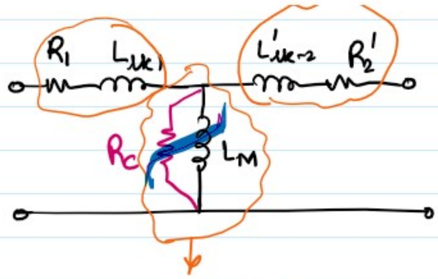
EQUIVALENT CIRCUIT OF TRANSFORMER



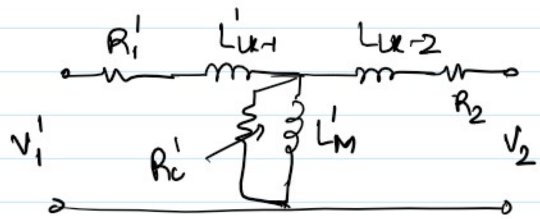
why the losses in the core are shown to be in parallel → Refer to the excitation current & losses

Hysteresis and eddy current losses → these are dependent on frequency and voltage applied





leakage inductances are linear that is because the leakage flux produced in air. when we say flux is in air, what we mean is majority of flux path is air



Equivalent circuit drawn by referring the primary side to the secondary side

$$V'_1 = \frac{N_2 V_1}{N_1} \qquad I'_1 = \frac{N_1 I_1}{N_2}$$

11000/415V

↓

$$Z'_1 = \frac{Z_1}{(N_1/N_2)^2}$$

Equivalent circuit of induction machine is similar to that of the XFMR

leakage inductance, magnetizing inductance, resistance (R_1 & R_2) can be easily established by conducting tests in laboratories.

1. open circuit / No load test
2. short circuit test