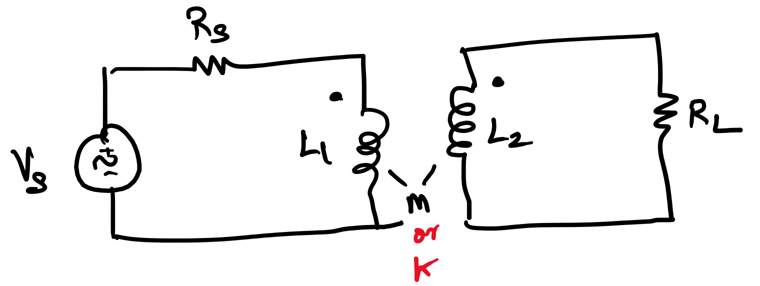
1

Review



- time domain

$M \rightarrow H$

$j\omega M$

- phasor domain

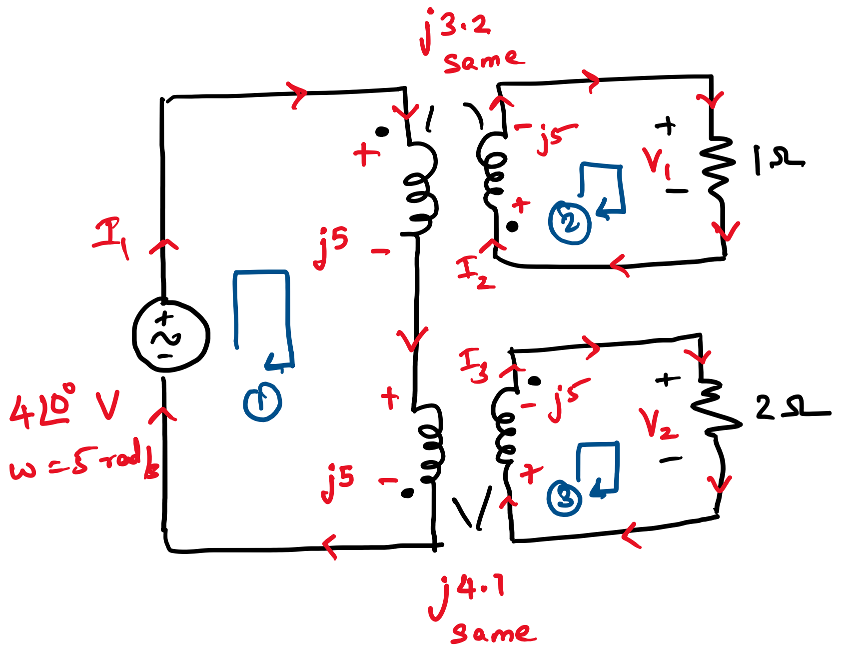
$M \rightarrow \Omega$

Coupling coefficient (K) (unit less)

$$M = K\sqrt{L_1 L_2}$$

$$0 < K < 1$$

$\rightarrow$



find $v_1(t)$, $v_2(t)$

$$\begin{array}{r} 0.64 \\ \times\ 5 \\ \hline 3.20 \end{array}$$

$$\begin{array}{r} 0.82 \\ 5 \\ \hline 4.10 \end{array}$$

Loop 1

$$+4\angle 0^\circ \underbrace{-j5 I_1 - j3.2 I_2} \underbrace{-j5 I_1 - j4.1 I_3} = 0$$

$$I_1(j10) + I_2(+j3.2) + I_3(j4.1) = 4 \quad \text{—— (1)}$$

Loop2

$$\underbrace{-j5 I_2 - j3.2 I_1} - I_2 \times 1 = 0$$

$$I_1(j3.2) + I_2(1 + j5) = 0 \quad \text{—— (2)}$$

Loop3

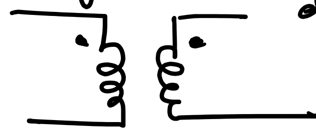
$$-j5 I_3 \underbrace{-j4.1 I_1} - I_3 \times 2 = 0$$

$$I_1(j4.1) + I_3(2 + j5) = 0 \quad \text{—— (3)}$$

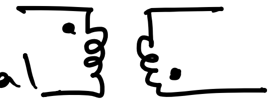
2

Transformer

Primary Secondary



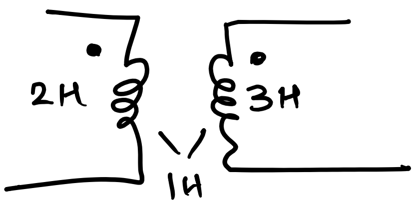
Linear | Ideal



Linear

Non magnetic core / weak coupling

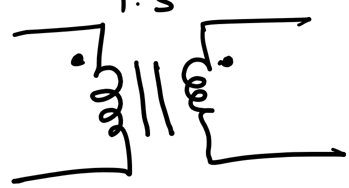
k low



Ideal

Magnetic core / strong coupling

k = 1

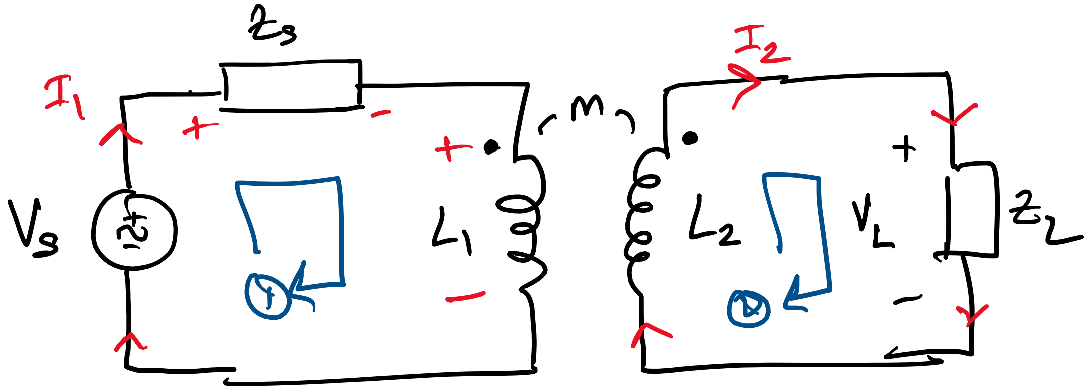


$L_1 \to \infty$

$L_2 \to \infty$

$M \to \infty$

Linear Transformer



M opposite

$$V_s = I_1 (Z_s + j\omega L_1) + I_2 (-j\omega M) \quad —— (1)$$

$$0 = I_1 (-j\omega M) + I_2 (j\omega L_2 + Z_L) \quad —— (2)$$

find $\frac{V_s}{I_1}$

$$\frac{(2)}{I_1} \Rightarrow 0 = -j\omega m + \frac{I_2}{I_1}(j\omega L_2 + Z_L)$$

$$\Rightarrow \frac{I_2}{I_1} = \frac{+j\omega m}{j\omega L_2 + Z_L} \quad \text{——— (3)}$$

$$\frac{(1)}{I_1} \Rightarrow \frac{V_s}{I_1} = (Z_s + j\omega L_1) + \frac{I_2}{I_1}(-j\omega m) \quad \text{——— (4)}$$

Sub (3) in (4)

$$\Rightarrow \frac{V_s}{I_1} = Z_s + j\omega L_1 + \frac{j\omega m}{j\omega L_2 + Z_2} \times -j\omega m$$

$$= Z_s + j\omega L_1 + \frac{\omega^2 m^2}{(j\omega L_2 + Z_L)} \times \frac{(Z_L - j\omega L_2)}{(Z_L - j\omega L_2)}$$

$$\Rightarrow \frac{V_s}{I_1} = Z_s + j\omega L_1 + \frac{Z_L \omega^2 m^2}{Z_L^2 + \omega^2 L_2^2} - \frac{j\omega^3 m^2 L_2}{Z_L^2 + \omega^2 L_2^2}$$

Assume $Z_s = R_s$, $Z_L = R_L$

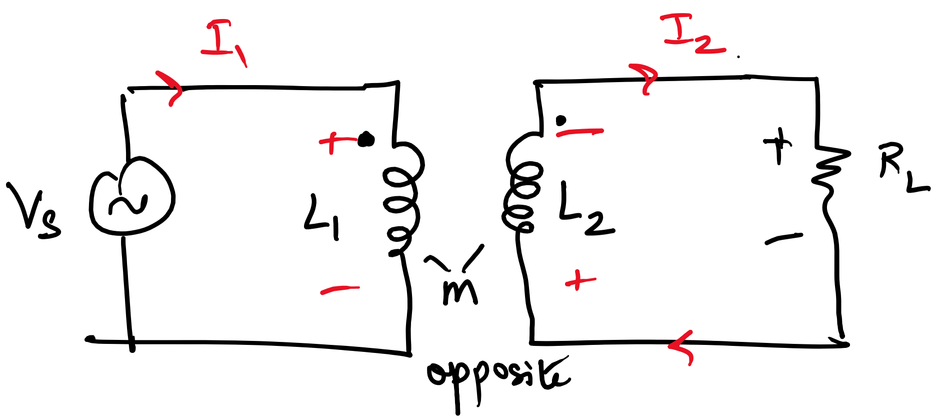
$$Z_{in} = \frac{V_s}{I_1} = \left(R_s + \frac{R_L \omega^2 m^2}{R_L^2 + \omega^2 L_2^2}\right) + j\left(\omega L_1 - \frac{\omega^3 m^2 L_2}{R_L^2 + \omega^2 L_2^2}\right)$$

Reflected impedance from secondary

What is $\frac{V_L}{I_2}$ — ?

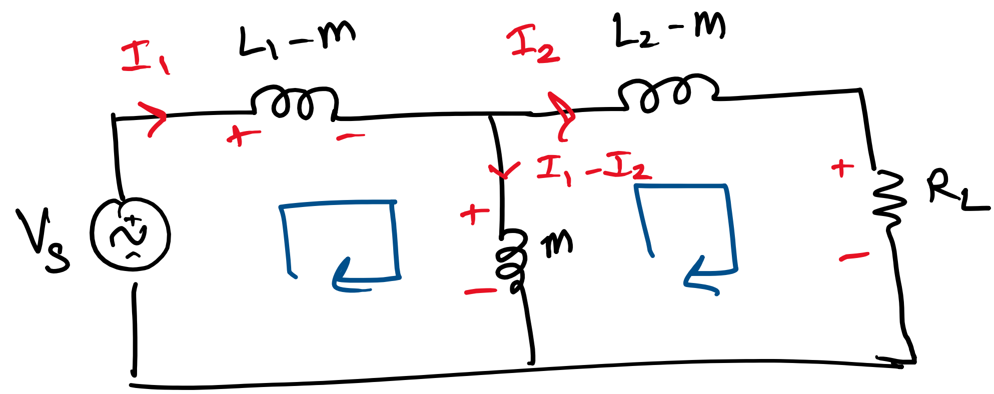
Please try this @ home

T equivalent circuit



$$V_s - j\omega L_1 I_1 + j\omega M I_2 = 0 \quad \text{—— (1)}$$

$$-j\omega L_2 I_2 + j\omega M I_1 - I_2 R_L = 0 \quad \text{—— (2)}$$



$$+V_s - j\omega (L_1 - M) I_1 - j\omega M (I_1 - I_2) = 0$$

$$\Rightarrow \quad V_s - j\omega L_1 I_1 + j\omega M I_2 = 0 \quad \text{—— (3)}$$

$$+j\omega M (I_1 - I_2) - j\omega (L_2 - M) I_2 - I_2 R_L = 0$$

$$j\omega M I_1 - j\omega L_2 I_2 - I_2 R_L = 0 \quad \text{— (4)}$$