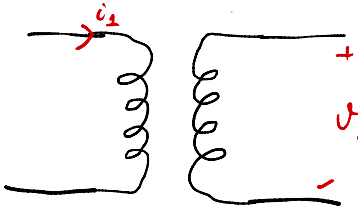
Transformer



→ Linear : Comm
→ Ideal : power

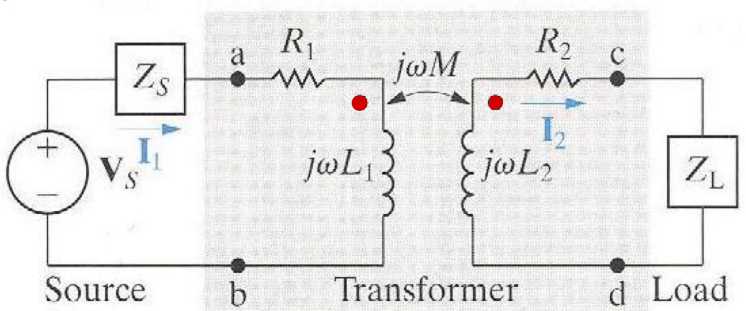
$$v_2 = M\frac{dI_1}{dt} \rightarrow j\omega M\bar{I}_1$$

primary winding / coil

Secondary winding / coil

Use to match impedance → Max power transform

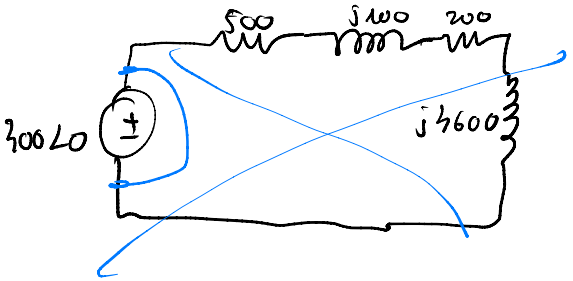
Linear Transformer :

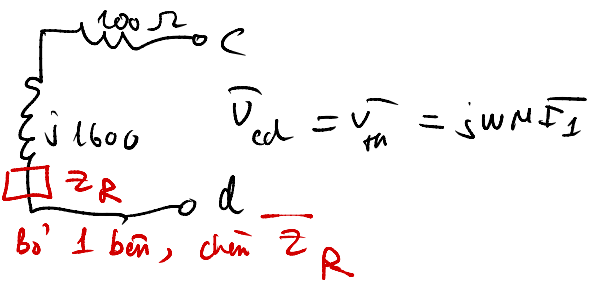


$$\bar{Z}_{ab} = \frac{\bar{V}_{Ab}}{\bar{I}_1} = \frac{\bar{V}_S - \bar{I}_1\bar{Z}_S}{\bar{I}_1}$$

$$\bar{Z}_{Ab} = R_1 + j\omega L_1 + Z_R$$

$$Z_R = \frac{\omega^2 M^2}{R_2 + j\omega L_2 + Z_L} = \frac{\omega^2 M^2}{|Z_{22}|^2} Z_{22}$$





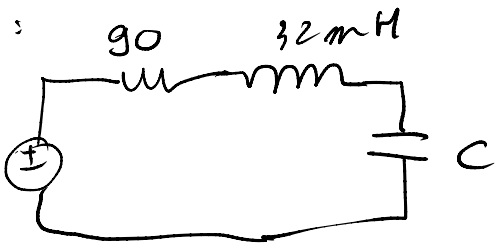
$$\bar{I}_1 = \frac{400\angle 0}{500 + j100 + 200 + j1600}$$

$$\bar{Z}_{th} = \bar{Z}_{cd} = 100 + j1600 + \frac{(\omega M)^2}{|Z_{11}|^2}\bar{Z}_{11}$$

$$\bar{Z}_{11} = 500 + 200 + j100 + j1600 = 700 + j3700$$

Ideal Transformer:

Question 1:



Find C to obtain $I = |\bar{I}|\angle -105^\circ$

$$|I| = \frac{12\angle -60^\circ}{|\bar{z}|\angle \theta_z} \Rightarrow |I|\angle -60^\circ - \theta_z$$

a) $-60^\circ - \theta_z = -105^\circ \Rightarrow \theta_z = 45^\circ$

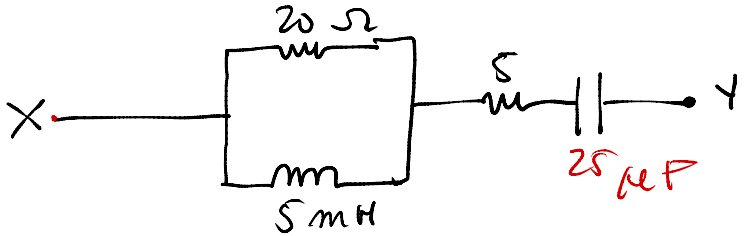
$$z = 90 + jwL + \frac{1}{jwC} = 90 + j\left(wL - \frac{1}{wC}\right)$$

$$\Rightarrow \theta_z = \tan^{-1}\left(\frac{wL - \frac{1}{wC}}{90}\right)$$

$$\Rightarrow \tan^{-1}(45^\circ) = 1 = \frac{wL - \frac{1}{wC}}{90} \Rightarrow C = 2.86\,\mu F$$

b) $$|I| = \frac{12}{\sqrt{90^2 + \left(wL - \frac{1}{wC}\right)^2}} = 0.982\,(A)$$

Question 2:



a) $w = 2000$ rad/s, compute $\overline{Z}_{XY}$

b) At what finite f does the impedance of $\overline{Z}_{XY}$ becomes purely positive?

c) $\overline{Z}_{XY} = ?$ if w found in b

a) $Z_x = \frac{20 \times j10}{20 + j10} = 4 + j8$

$Z_t = 5 - j20$

$Z_{XY} = 9 - j12$

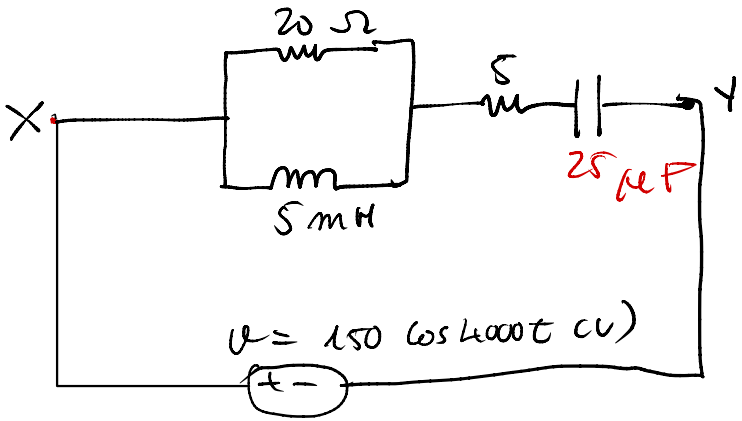
b) $\frac{20 \times jwL}{20 + jwL} \times \frac{20 - jwL}{20 - jwL} + 5 - \frac{1}{wC}$

$\ldots = \frac{20w^2L^2}{400 + w^2L^2} + \frac{j400wL}{400 + w^2L^2} + 5 - j\frac{10^6}{25w}$

$= 0$

c)

$10 + 5 = 15$

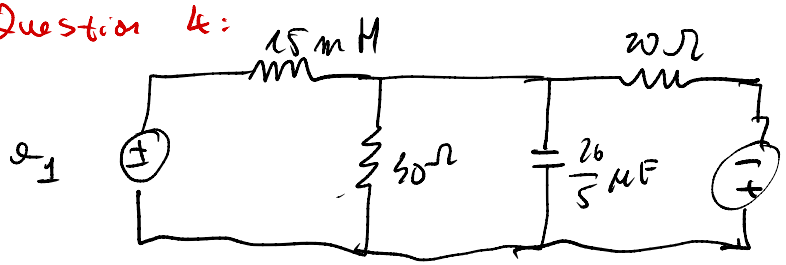


what is the mat amplitude of the current in the 5 mH inductor

$$\bar{I}_{max} = \frac{150\angle 0}{15} = 10\ A$$

$$\bar{I}_L = \frac{10 \times 10}{20 + j\omega L} = 7.07\angle -45^\circ$$

Question 4:



$v_1 = 240 \cos(40000t + 53.13^\circ)$

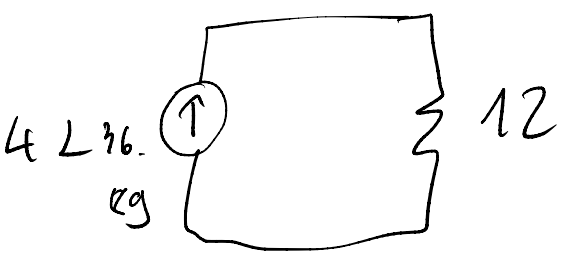
$v_2 = 96 \sin 40000t = 96\angle -90^\circ$

$Z_L = j60 \rightarrow I_1 = \frac{240\angle 53.13^\circ}{j60} = 3.2 - j2.4$

$Z_C = -j60$

$\Rightarrow I_2 = \frac{96\angle -90}{20} = -j4.8$

$I_1 - I_2 = 3.2 + j2.4$



$V_0 = 48\angle 36.87$