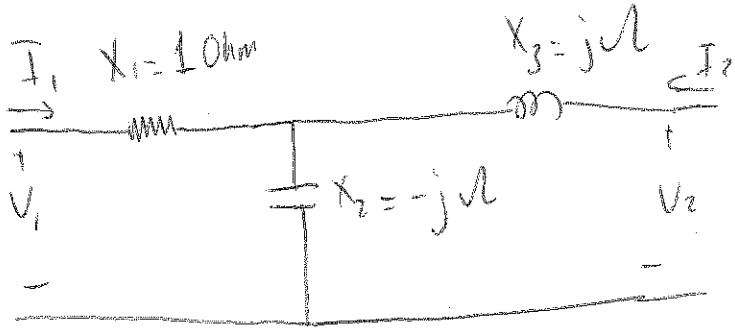
ECE 232 Final 2013-2014 Spring

Q-1-



$V_1 = X_1 I_1 + X_2 (I_1 + I_2)$

$V_1 = (X_1 + X_2) I_1 + X_2 I_2$

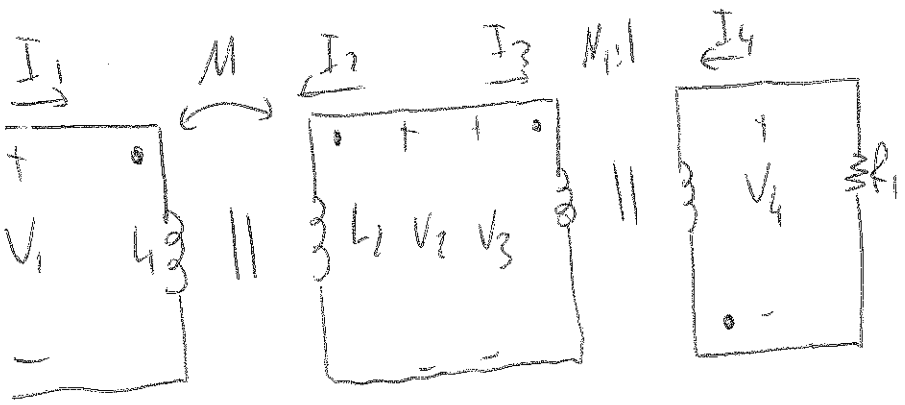
$V_2 = X_3 I_2 + X_2 (I_1 + I_2)$

$V_2 = X_2 I_1 + (X_2 + X_3) I_2$

$V_1 = (1 - j) I_1 - j I_2$ $\quad V_2 = -j I_1 + 0 I_2$

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 1-j & -j \\ -j & 0 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

Q-2



$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} sL_1 & sM \\ sM & sL_2 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$V_3 = N_1 V_4$

$I_3 = \frac{1}{N_1} I_4$

(2) $V_4 = -R_1 I_4$

(2) $V_2 = V_3$

(1) $I_2 = -I_3$

$V_4 = -R_1 I_4 \longrightarrow \frac{V_3}{-N_1} = -R_1 N_1 I_3 \qquad V_3 = N_1^2 R_1 I_3$ //

Q1 (b) (c)

$V_3 = V_2 = N_1^2 R_1 I_3 = -N_1^2 R_1 I_2$ //

$V_2 = sMI_1 + sL_2 I_2 \longrightarrow -N_1^2 R_1 I_2 = sMI_1 + sL_2 I_2$

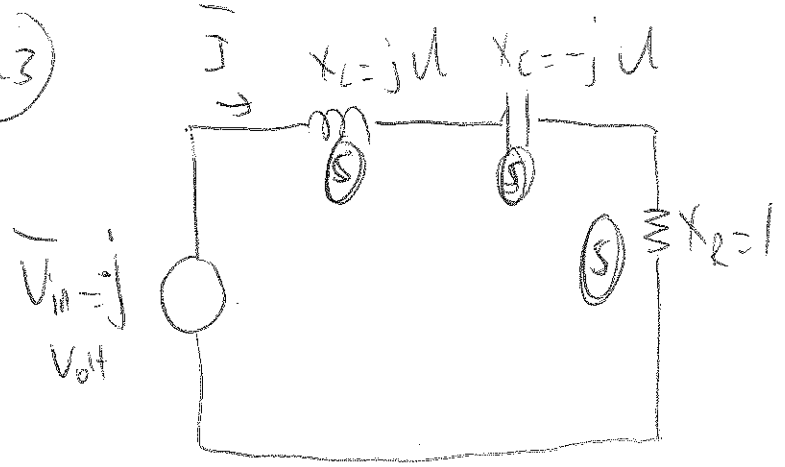
$0 = (N_1^2 R_1 + sL_2) I_2 + sMI_1 \qquad I_2 = \frac{-sM}{N_1^2 R_1 + sL_2} I_1$ //

$V_1 = sL_1 I_1 + sMI_2 \qquad V_1 = \left[sL_1 - \frac{s^2 M^2}{N_1^2 R_1 + sL_2} \right] I_1$

$Z_{in} = \frac{V_1}{I_1} = sL_1 - \frac{s^2 M^2}{N_1^2 R_1 + sL_2}$

(4)

Q-3

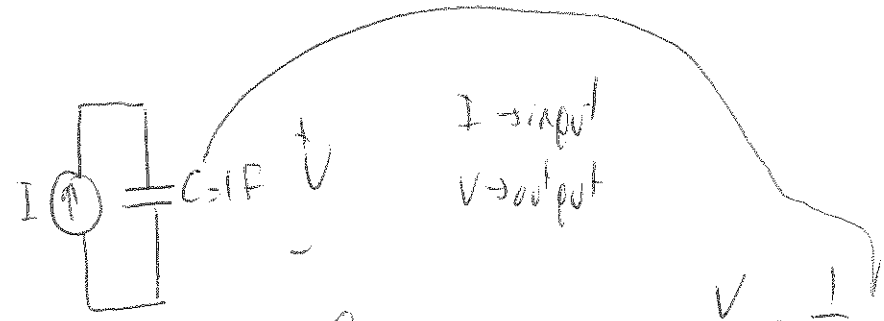


$\sin(\omega t) \xrightarrow{\text{Phasor}} e^{-j90^\circ} = -j$ (1)

$$\bar{I} = \frac{\bar{V}_{in}}{X_L + X_C + X_R} = \frac{-j}{j^1 - j^1 + 1} = -j \text{ Amper}$$ (1)

$$P_{X_R} = \frac{1}{2}\bar{I}\bar{I}^* R = \frac{1}{2} \cdot -j \times j \times 1 = \frac{1}{2} \text{ Watt}$$ (5)

Q-4



(5) (a) $C\frac{dV}{dt} = I \xrightarrow{\mathcal{L}} CsV = I \Rightarrow \frac{V}{I} = \frac{1}{sC} = \frac{1}{s} = H(s)$

(5) (b) $h(t) = \mathcal{L}^{-1}\left\{\frac{1}{s}\right\} = u(t)$ (unit step function)

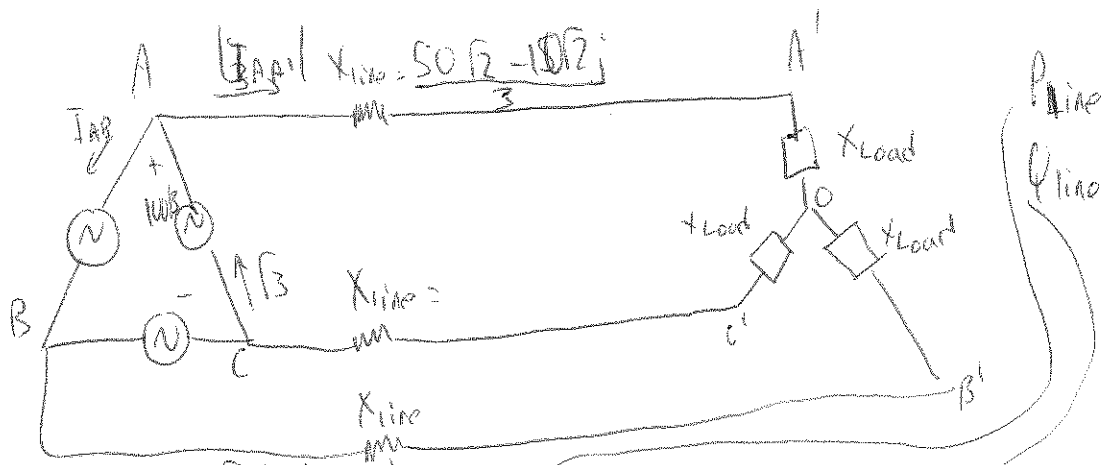
(10) (c) if $I(t) = u(t)$ $\quad V(t) = \int_{-\infty}^{t} I(\tau)\, h(t-\tau)\, d\tau$

$$V(t) = \int_{-\infty}^{t} u(\tau)\, u(t-\tau)\, d\tau = \int_{0}^{t} 1 \cdot 1\, d\tau = \tau \Big|_0^t = t$$

$$V(t) = \begin{cases} 0 & , t<0 \\ t & , t>0 \end{cases} \Rightarrow V(t) = r(t) \text{ Volt}$$

ramp function

Q5)



$P_{line} = 3 \times |I_{AA'}|^2 \times Re\{X_{line}\}$

$Q_{line} = 3 \times |I_{AA'}|^2 \times Im\{X_{line}\}$ (3)

(a) $|V_{AB}| = 100\sqrt{3}$ Volt (rms)

$Q_{source} = 450\Omega$ VAR

$P_{source} = 450\Omega$ Watt

$S_{source} = \sqrt{P_{source}^2 + Q_{source}^2}$

$|S_{source}| = 900$ VA

$P_{line} = 3 \times 3^2 \times \frac{50\Omega}{3}$ Watt

$= 450\Omega^2$ Watt

$Q_{line} = 3 \times 3^2 \times \frac{(-10\Omega)}{3}$

$= -90\Omega^2$ VAR

$P_{Load} = P_{source} - P_{line}$

$= 0$ Watt

$Q_{Load} = Q_{source} - Q_{line}$

$= 450\Omega - (-90\Omega)$

$= 540\Omega$ VAR

$|S_{Load}| = \sqrt{P_{Load}^2 + Q_{Load}^2}$

$= 540\Omega$ VA (3)

$|S_{source}| = |V_{AB}| |I_{AB}| = 900 = 3 \times 100\sqrt{3} \times |I_{AB}|$

$|I_{AB}| = \sqrt{3}$ Ampere (rms) (3)

$|I_{AA'}| = \sqrt{3}|I_{AB}| = 3$ Ampere (rms) (3)

$|S_{Load}| = \sqrt{3}|V_{A'B'}||I_{AA'}|$

$540\Omega = \sqrt{3}|V_{A'B'}| 3$ (3)

$|V_{A'B'}| = \frac{180\Omega}{\sqrt{3}}$ Volt (rms)

$|V_{A'O}| = \frac{|V_{A'B'}|}{\sqrt{3}} = 60\sqrt{3}$ Volt (rms)

(b) $|X_{Load}| = \frac{|V_{A'O}|}{|I_{AA'}|} = \frac{60\Omega}{3} = 20\Omega$ (3)

(c) $S_{Load} = P_{Load} + jQ_{Load} = -j540\Omega$ VA (1)

Since $Q_{Load} < 0$ the load x is capacitive