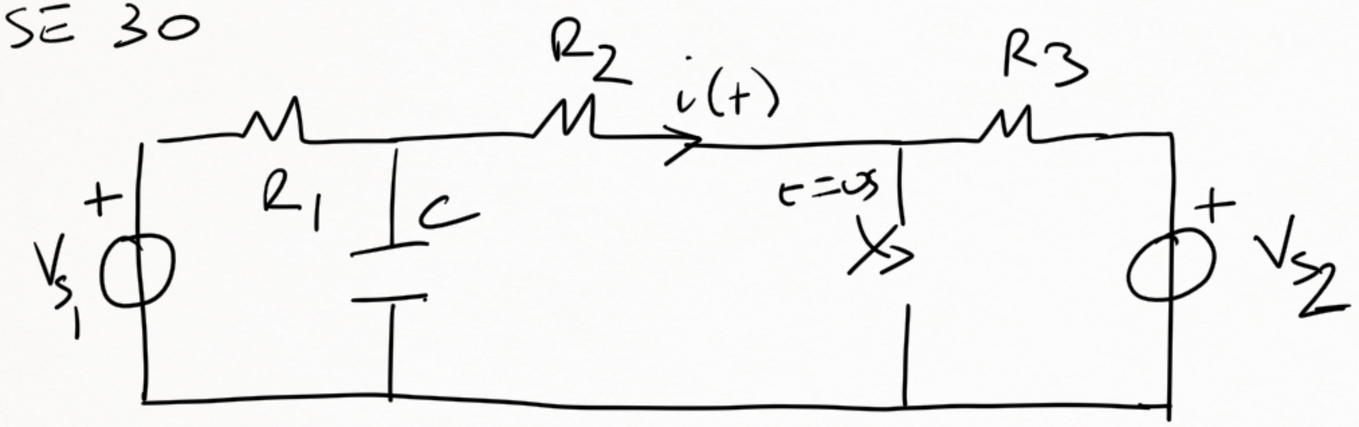
ESE 30



$V_{s_1} = 36\,V$

$V_{s_2} = 12\,V$

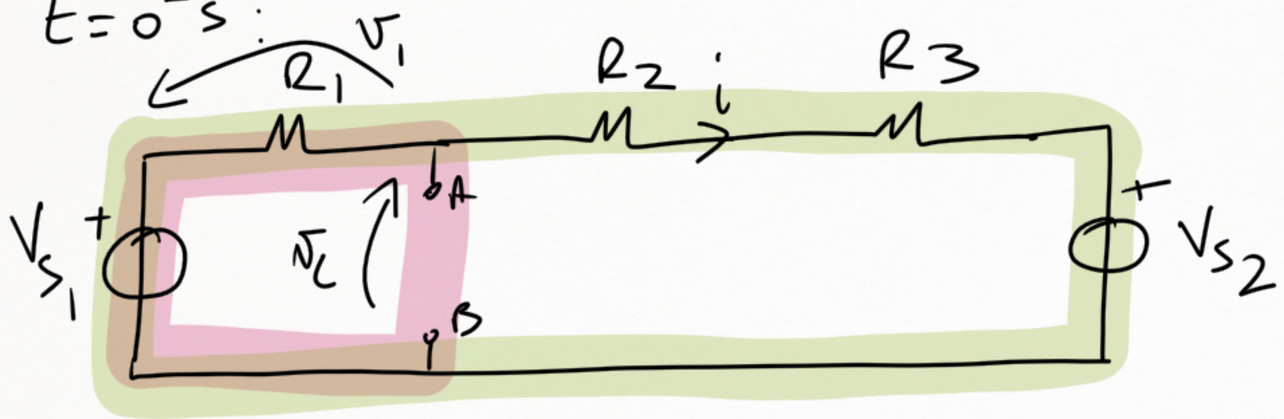
$R_1 = 2\,K\Omega$

$R_2 = 6\,K\Omega$

$R_3 = 4\,K\Omega$

$C = 100\,\mu F$

$i(t) = ?$

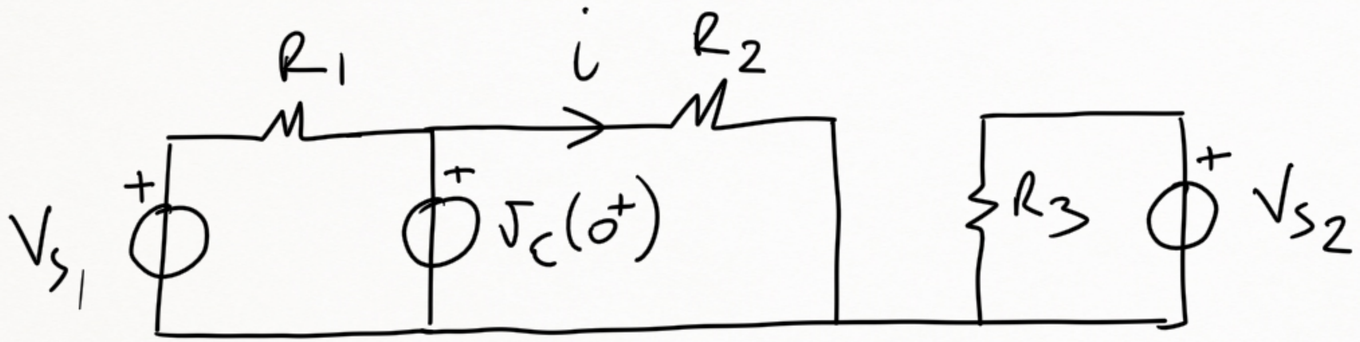


$$i(0^-) = \frac{V_{s_1} - V_{s_2}}{R_1 + R_2 + R_3} = 2\,mA$$

$$V_{s_1} = V_1 + V_c(0^-) \Rightarrow V_c(0^-) = V_{s_1} - V_1$$

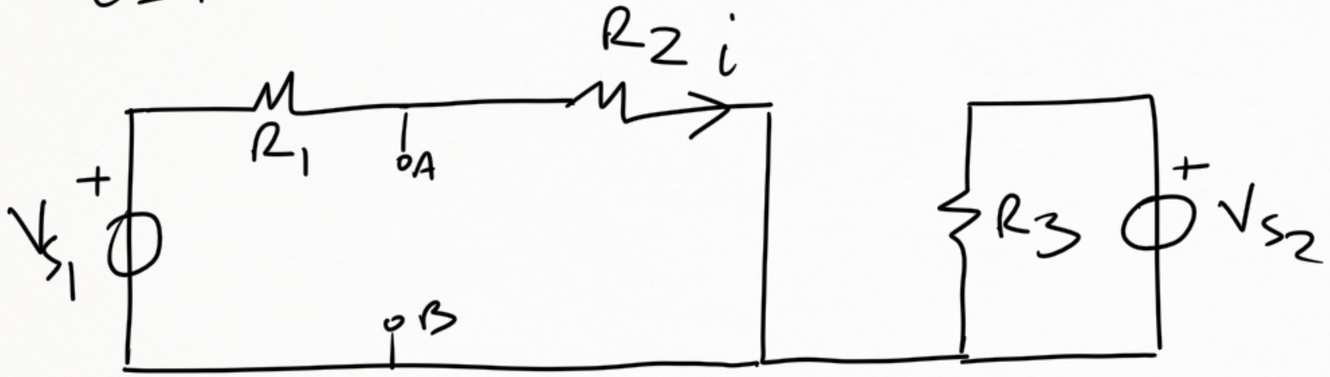
$$v_C(0^-) = V_{S_1} - i(0^-)\,R_1 = 32V = v_C(0^+)$$

$t = 0^+ s$:



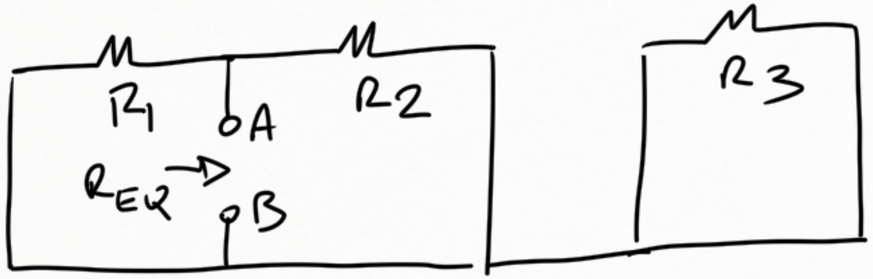
$$i(0^+) = \frac{v_C(0^+)}{R_2} = \frac{16}{3}\ mA$$

$t = +\infty$:



$$i(+\infty) = \frac{V_{S_1}}{R_1 + R_2} = \frac{3}{2}\ mA$$

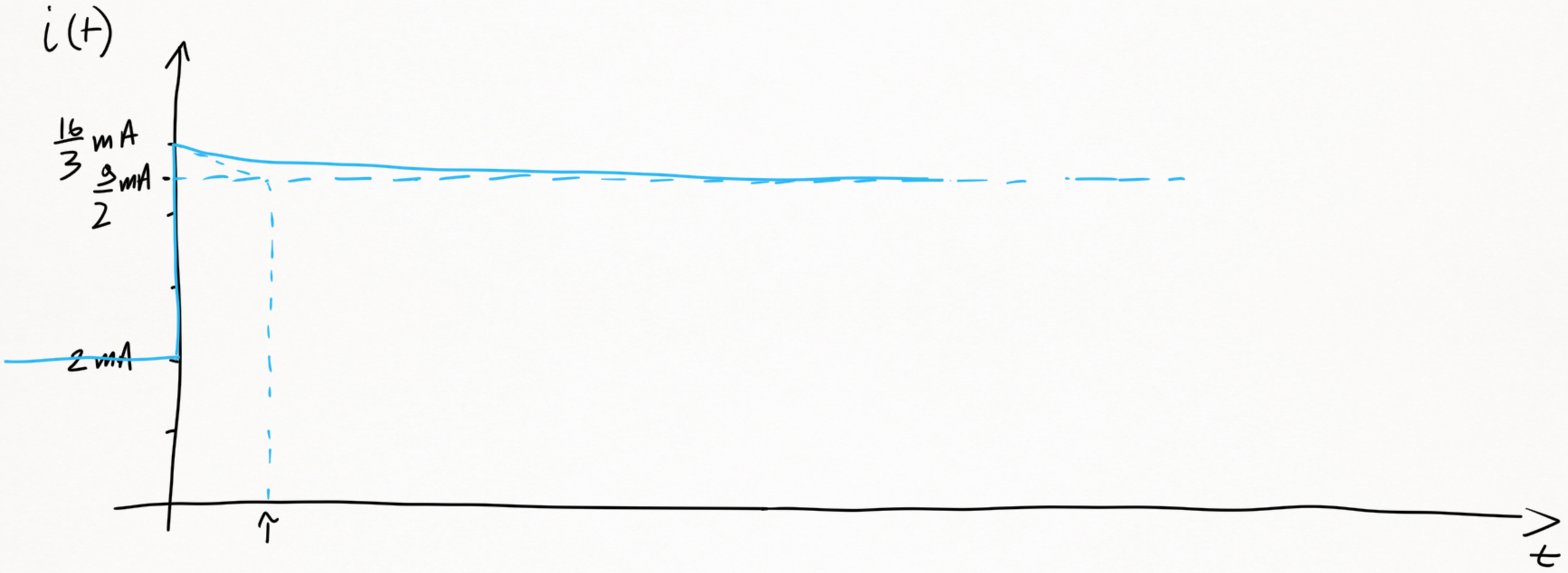
$\uparrow$:



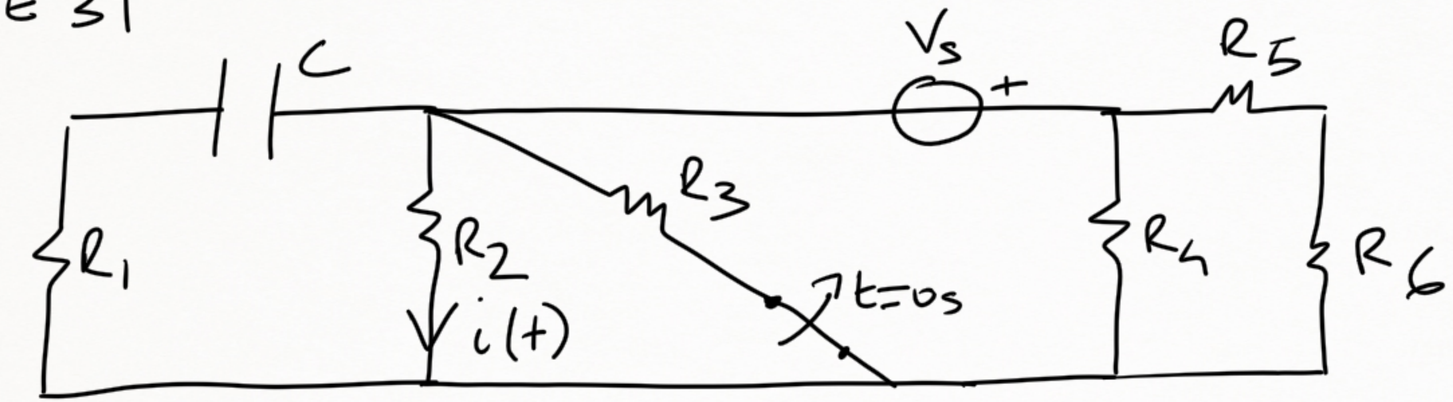
$$R_{EQ} = R_1 // R_2 = \frac{3}{2}\ k\Omega$$

$$\uparrow = C R_{EQ} = 150\ ms$$

$$i(t) = [i(0^+) - i(+\infty)]\, e^{-t/\tau} + i(+\infty) = \frac{5}{6} e^{-t/\tau} + \frac{9}{2} \quad mA$$



ESE 31



$V_s = 10V$

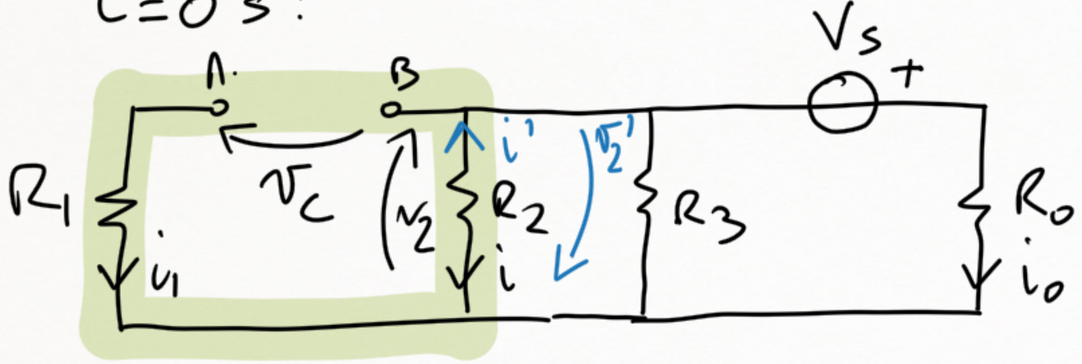
$R_1 = R_5 = R_6 = 5\,\Omega$

$R_2 = R_3 = R_4 = 10\,\Omega$

$C = 10\,\mu F$

$i(t) = ?$

$t = 0^- s$:



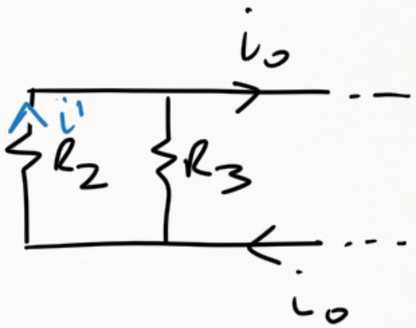
$$i_0 = \frac{V_s}{R_0 + R_2 /\!/ R_3} = 1\,A$$

$R_0 = R_4 /\!/ (R_5 + R_6) = 5\,\Omega$

$i_1(0^-) = 0\,A$

$R_2 /\!/ R_3 = 5\,\Omega$

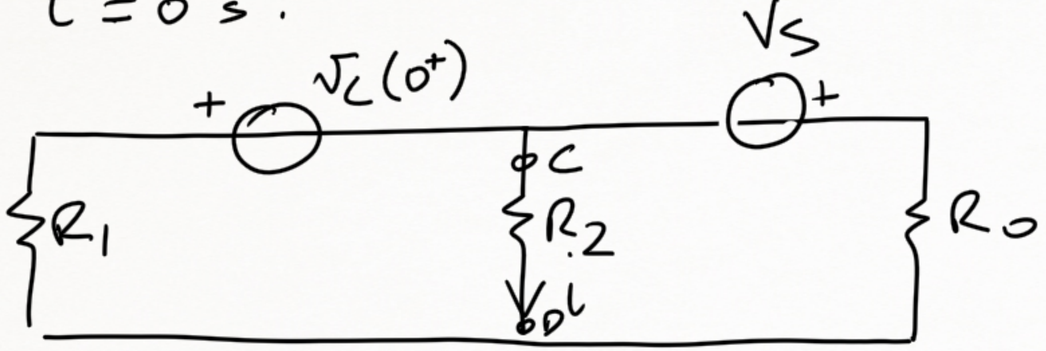
$$i'(0^-) = i_0(0^-) \cdot \frac{R_3}{R_2 + R_3} = i_0(0^-) \quad \frac{G_2}{G_2 + G_3} = \frac{1}{2} A$$

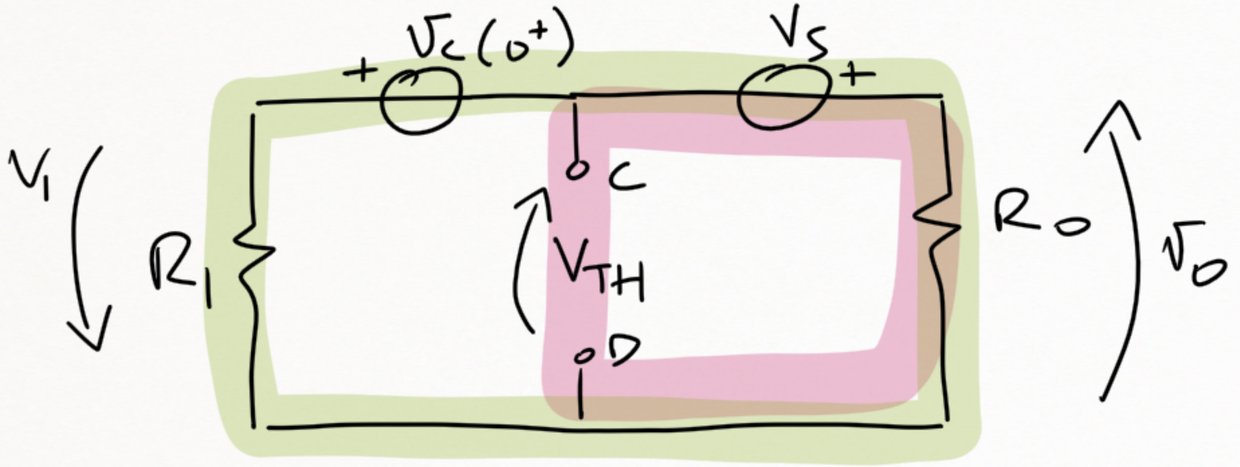


$$i(0^-) = -i'(0^-) = -\frac{1}{2} A$$

$$v_C(0^-) = v_2' = -v_2 = -i(0^-) R_2 = 5V = v_C(0^+)$$

$t = 0^+ s$:

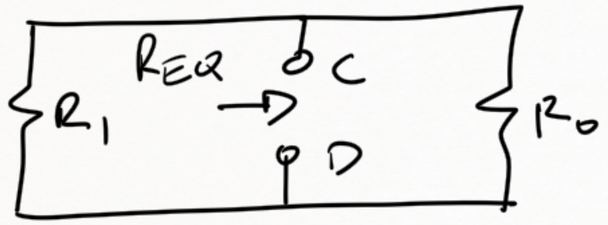




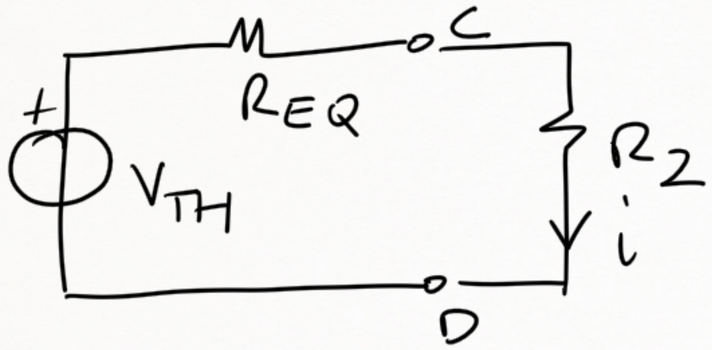
$$v_c(0^+) + v_1 + v_0 = V_S$$

$$v_0 = \left(V_S - v_c(0^+)\right) \frac{R_0}{R_1 + R_0} = \frac{5}{2}\,V$$

$$V_S + V_{TH} = v_0 \Rightarrow V_{TH} = v_0 - V_S = -\frac{15}{2}\,V$$

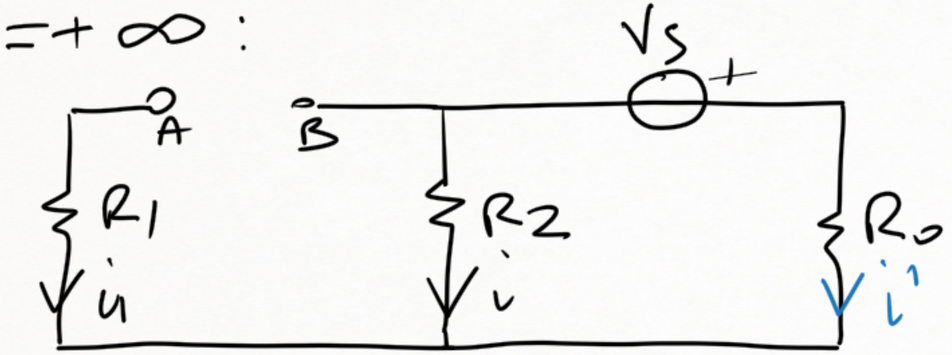


$$R_{EQ} = R_1 /\!/ R_0 = \frac{5}{2}\,\Omega$$



$$i(0^+) = \frac{V_{TH}}{R_{EQ} + R_2} = -\frac{3}{5}\ A$$

$t = +\infty$:

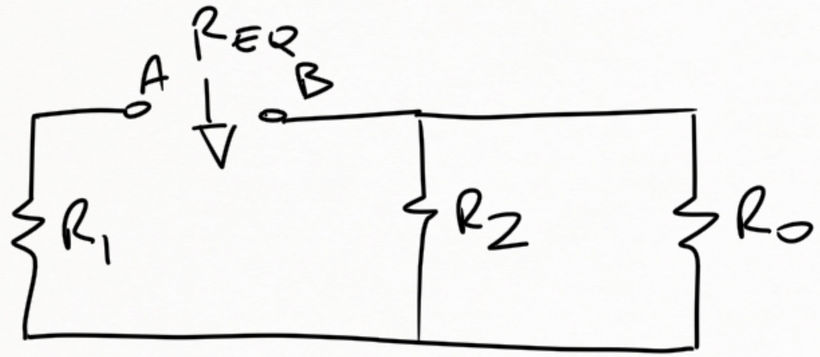


$$i_1 = 0\ A$$

$$i' = \frac{V_S}{R_2 + R_0} = \frac{2}{3}\ A$$

$$i(+\infty) = -i' = -\frac{2}{3}\ A$$

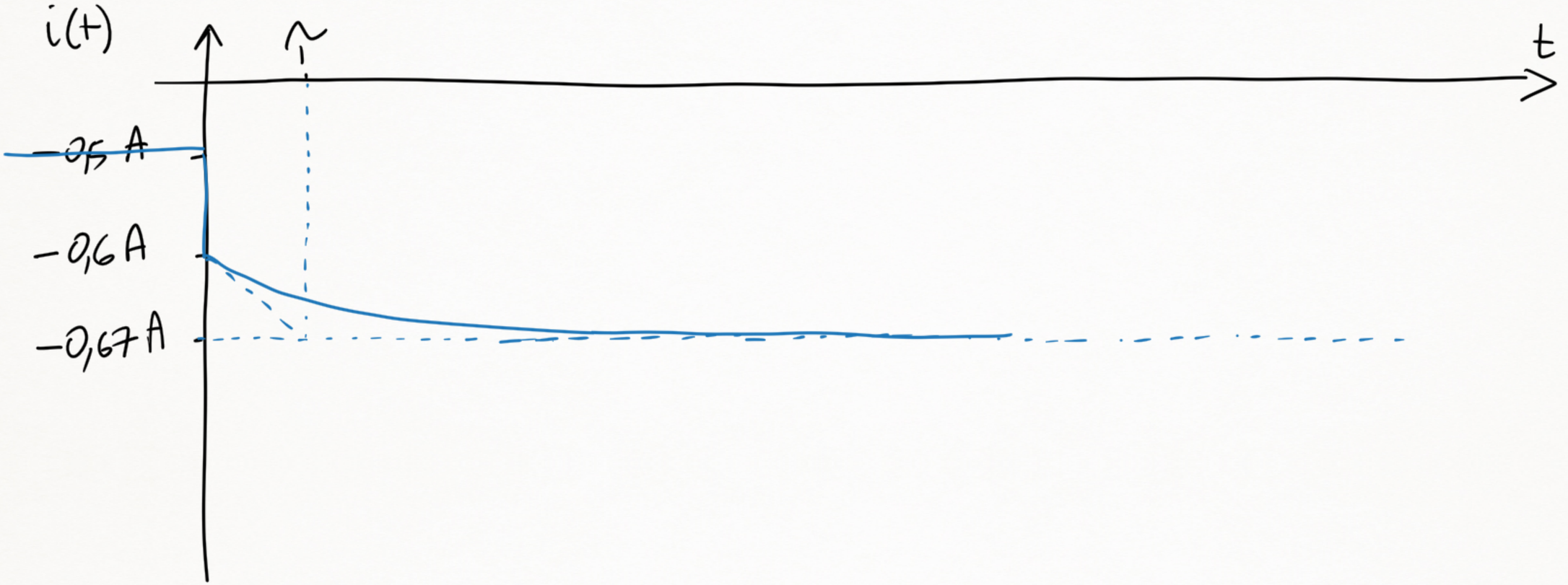
τ:



$$R_{EQ} = R_1 + R_2 // R_0 = 8{,}33\ \Omega$$

$$\tau = C R_{EQ} = 83{,}3\ \mu s$$

$$i(t) = [\, i(0^+) - i(+\infty)]\, e^{-t/\tau} + i(+\infty) \simeq 0{,}07\, e^{-t/\tau} - \frac{2}{3}\ A$$


i(t)
t
τ
−0,5 A
−0,6 A
−0,67 A

REGIME SINUSOIDALE

TEMPO

$$x(t) = A \cos(\omega t + \varphi) \quad \Rightarrow$$

$$y(t) = \mathrm{Re}\left\{ |\bar{Y}| e^{j\varphi_Y} e^{j\omega t} \right\} = \quad \Leftarrow$$

$$= |\bar{Y}| \cos(\omega t + \varphi_Y)$$

FASORI

$$\bar{X} = A e^{j\varphi} = A(\cos\varphi + j \sin\varphi) =$$

$$= a + jb$$

$$\bar{Y} = c + jd$$

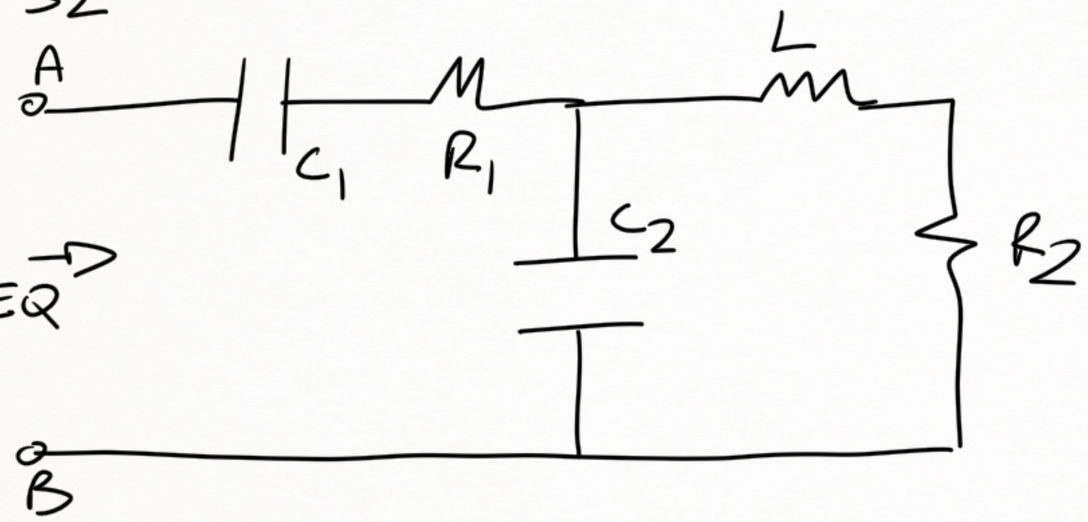
$$|\bar{Y}| = \sqrt{c^2 + d^2}$$

$$\varphi_Y = \mathrm{atan2}(d, c)$$

$$e^{j\frac{\pi}{2}} = j \; ; \; e^{j\pi} = -1 \; ; \; e^{j\frac{\pi}{4}} = \frac{\sqrt{2}}{2} + j\frac{\sqrt{2}}{2} \; ; \; e^{j\frac{\pi}{6}} = \frac{\sqrt{3}}{2} + j\frac{1}{2} \; ; \; e^{j\frac{\pi}{3}} = \frac{1}{2} + j\frac{\sqrt{3}}{2}$$

$$\cos\left(\alpha - \frac{\pi}{2}\right) = \sin\alpha \; ; \; \sin\left(\alpha + \frac{\pi}{2}\right) = \cos\alpha$$

ESE 32



$C_1 = 2\,mF$

$R_1 = 20\,\Omega$

$C_2 = 4\,mF$

$L = 2\,H$

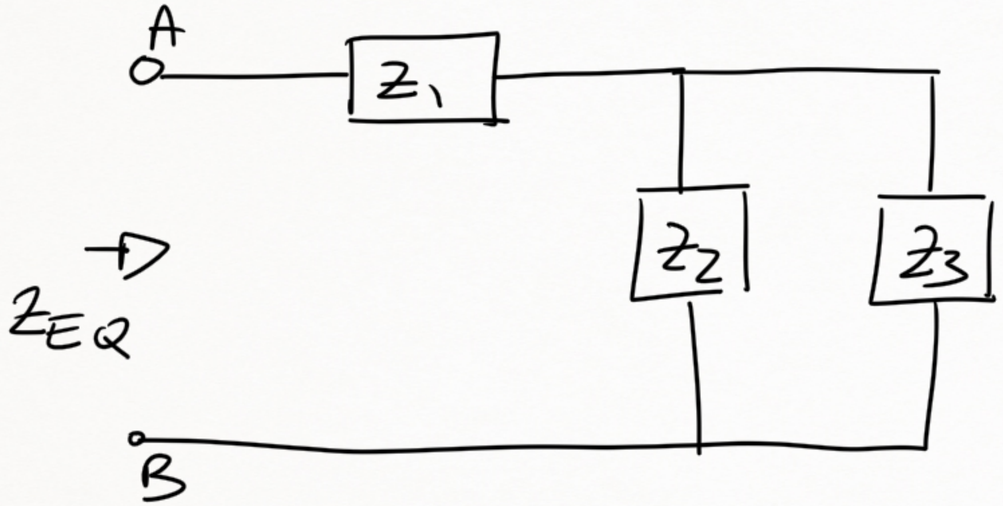
$R_2 = 50\,\Omega$

$\omega = 10\,\frac{rad}{s}$

$$X_{C_1} = -\frac{1}{\omega C_1} = -50\,\Omega \Rightarrow Z_{C_1} = jX_{C_1}$$

$$X_{C_2} = -\frac{1}{\omega C_2} = -25\,\Omega \Rightarrow Z_{C_2} = jX_{C_2}$$

$$X_L = \omega L = 20\,\Omega$$



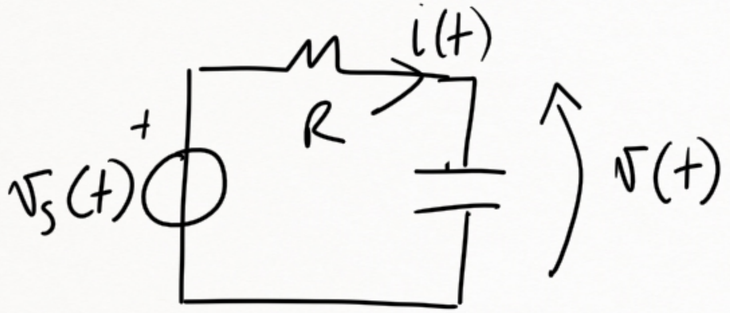
$$Z_1 = R_1 + jX_{C_1} = (20 - j50)\,\Omega$$

$$Z_2 = jX_{C_2}$$

$$Z_3 = R_2 + jX_L = (50 + j20)\,\Omega$$

$$Z_{EQ} = Z_1 + Z_2 /\!/ Z_3 = Z_1 + \frac{Z_2 Z_3}{Z_2 + Z_3} \simeq (32{,}37 + j73{,}76)\,\Omega$$

ESE 33



$$v_s(t) = 10 \cos(4t)\ V = A\cos(\omega t + \varphi)$$

$R = 5\,\Omega$ $\quad A = 10\,V$

$C = 0{,}1\,F$ $\quad \omega = 4\ \frac{rad}{s} \Rightarrow \bar{V}_s = Ae^{j\varphi} = 10\,V$

$i(t) = ?$ $\quad \varphi = 0\ rad$

$v(t) = ?$

$$X_C = -\frac{1}{\omega C} = -2{,}5\,\Omega$$

$$\bar{I} = \frac{\bar{V}_s}{R + jX_C} = (1{,}6 + j\,0{,}8)\,A = |\bar{I}|\,e^{j\varphi_I}$$

$$|\bar{I}| = 1{,}789\,A$$

$$\varphi_I = tg^{-1}\left(\frac{0{,}8}{1{,}6}\right) = 0{,}46\ rad$$

$$i(t) = Re\{|\bar{I}| e^{j\varphi_I} e^{j\omega t}\} = 1{,}789 \cos(\omega t + 0{,}46)\ A$$

$$\bar{V} = \bar{I}\, jX_C = e^{j\frac{\pi}{2}} |\bar{I}| e^{j\varphi_I} \left(-\frac{1}{\omega C}\right) = \frac{|\bar{I}|}{\omega C} e^{j\left(\frac{\pi}{2} - \pi + \varphi_I\right)} = |\bar{V}| e^{j\varphi_V}$$

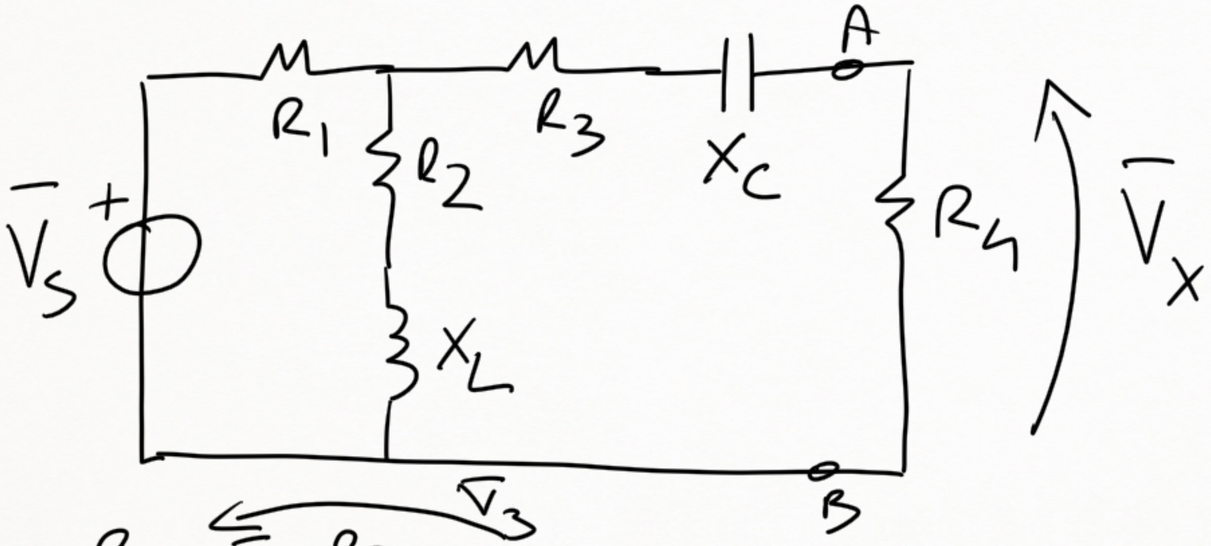
$$|\bar{V}| = \frac{|\bar{I}|}{\omega C} = 4{,}472\ V$$

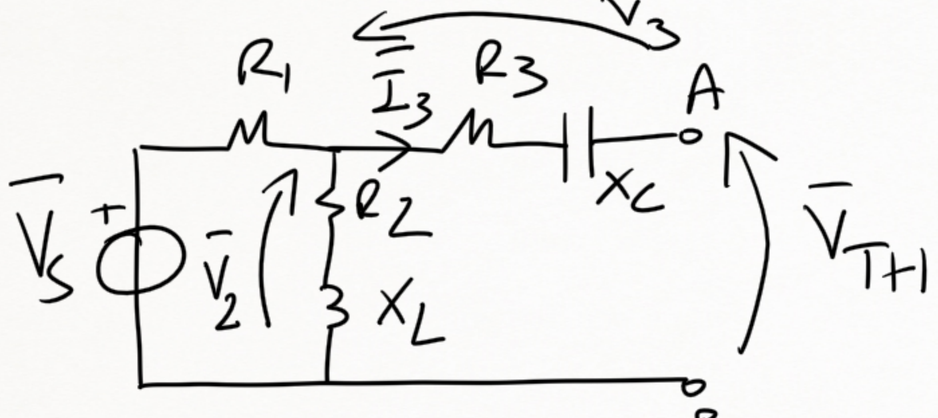
$$\varphi_V = \varphi_I - \frac{\pi}{2}$$

$$v(t) = Re\{|\bar{V}| e^{j\varphi_V} e^{j\omega t}\} = |\bar{V}| \cos\left(\omega t + \varphi_I - \frac{\pi}{2}\right) =$$

$$= 4{,}472 \sin(4t + 0{,}46)\ V$$

ESE 34





$\bar{V}_S = -j20\,V$

$R_1 = 5\,\Omega$

$R_2 = 3\,\Omega$

$R_3 = 4\,\Omega$

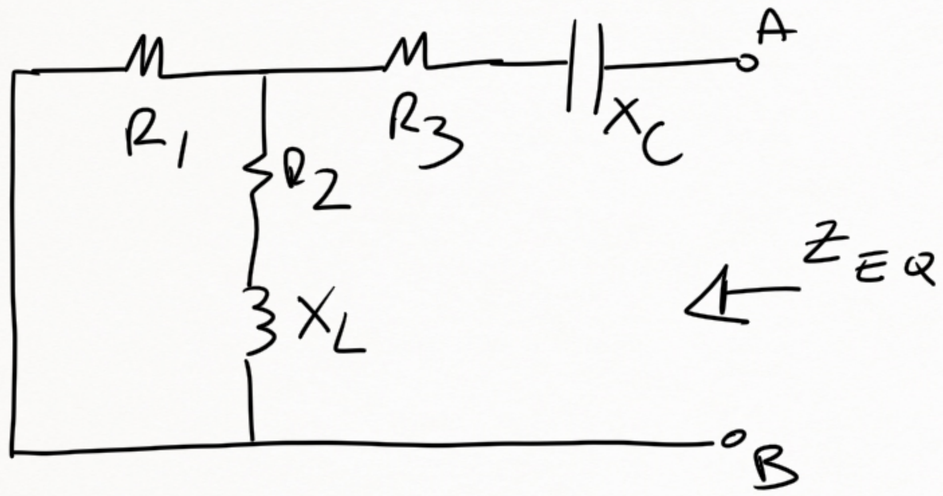
$R_4 = 10\,\Omega$

$X_L = 4\,\Omega$

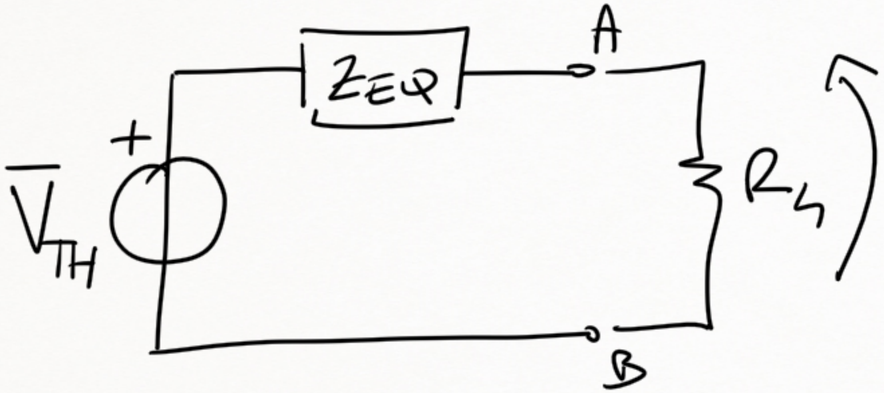
$X_C = -13\,\Omega$

$\bar{V}_X = ?$

$\left.\begin{array}{l}\bar{I}_3 = 0A \\ \bar{V}_3 = 0\,V\end{array}\right\} \Rightarrow \bar{V}_2 = \bar{V}_3 + \bar{V}_{TH} \Rightarrow \bar{V}_{TH} = \bar{V}_2 = \bar{V}_S \dfrac{R_2 + jX_L}{R_1 + R_2 + jX_L} = (5 - j8)\,V$

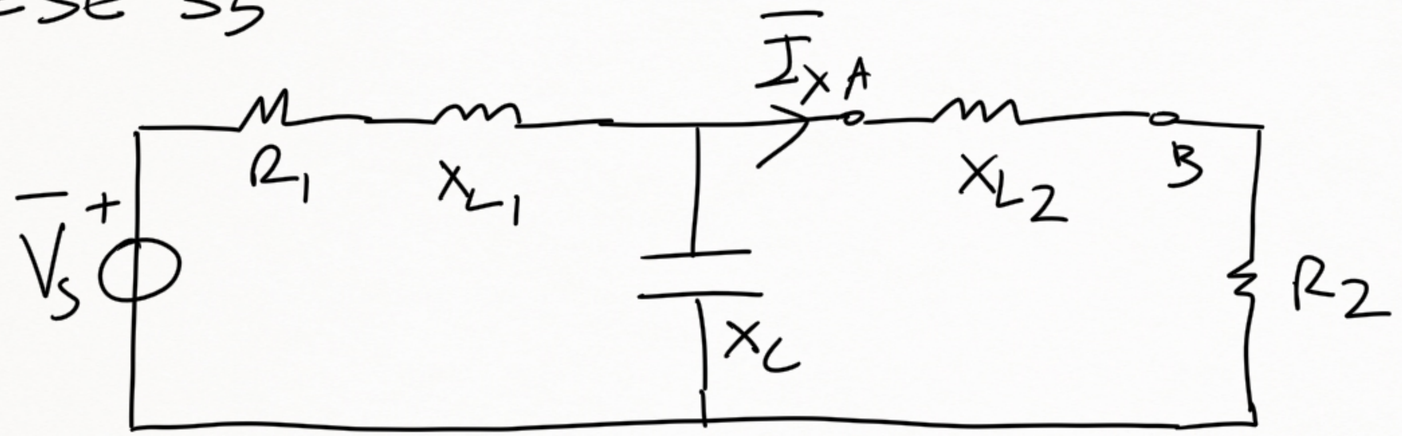


$$\bar{Z}_{EQ} = R_3 + jX_C + R_1 // (R_2 + jX_L) = (6{,}5 - j\,11{,}75)\,\Omega$$



$$\bar{V}_X = \bar{V}_{TH} \frac{R_L}{\bar{Z}_{EQ} + R_L} \simeq (4{,}874 - j\,2{,}54)\ V$$

ESE 35



$\bar{V}_S = 30 e^{j\frac{\pi}{9}}$ V

$R_1 = 6\,\Omega$

$R_2 = 10\,\Omega$

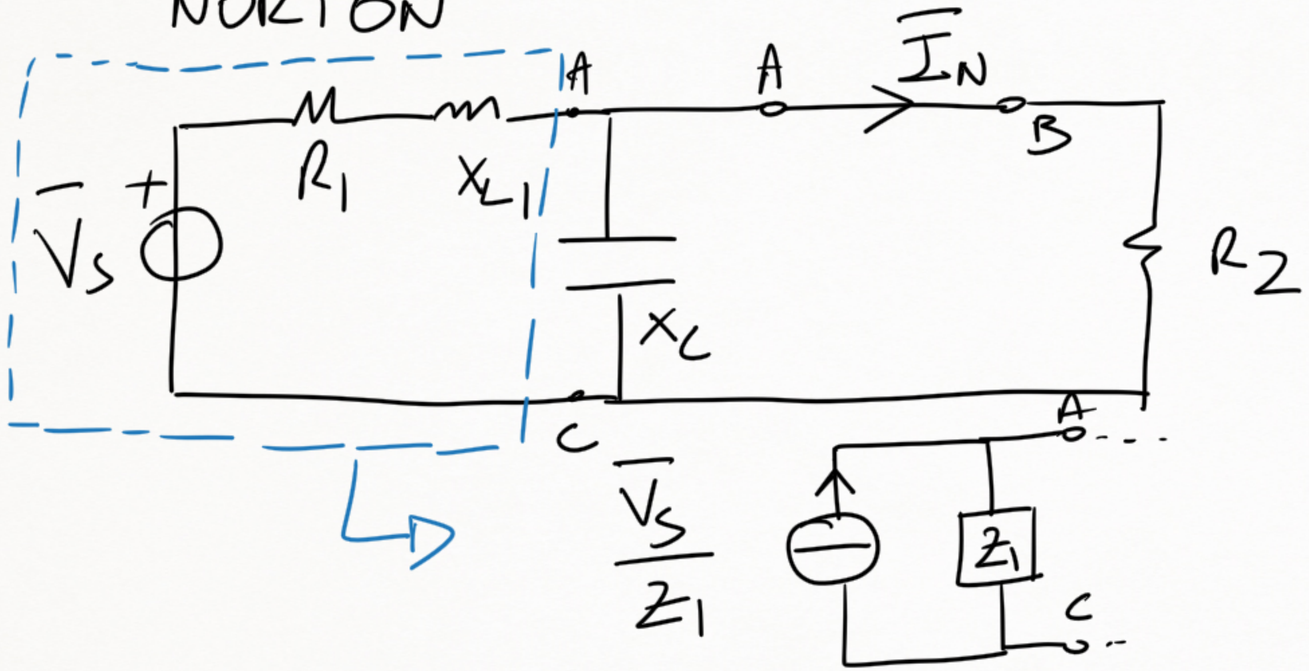
$X_{L_1} = 2\,\Omega$

$X_{L_2} = 1\,\Omega$

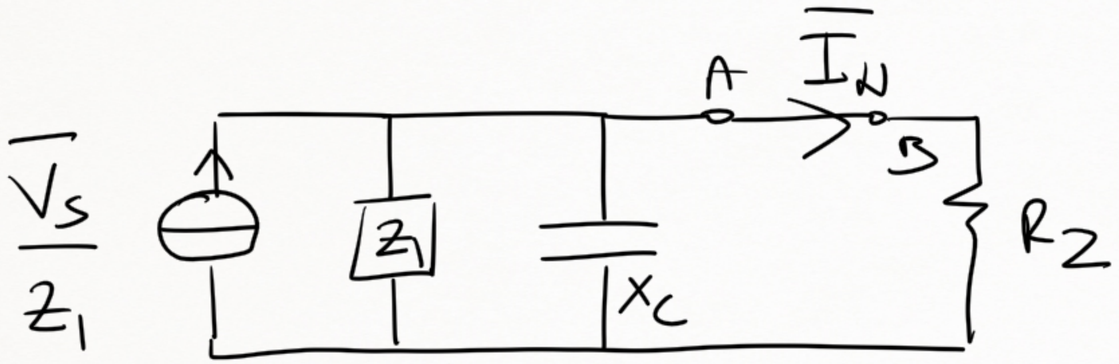
$X_C = -4\,\Omega$

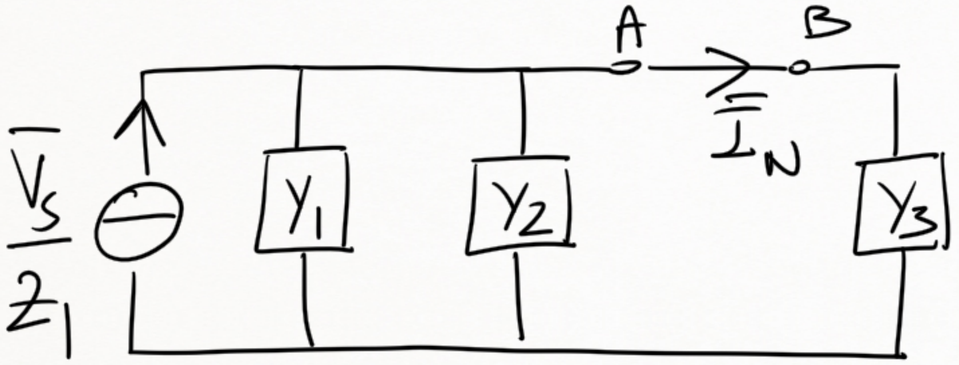
$\bar{I}_x = ?$

NORTON



$Z_1 = R_1 + jX_{L_1} = (6 + j2)\,\Omega$



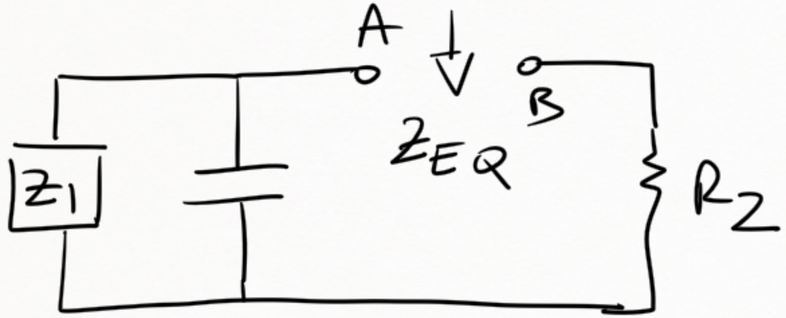


$$Y_1 = \frac{1}{Z_1} = (0{,}15 - j\,0{,}05)\,S$$

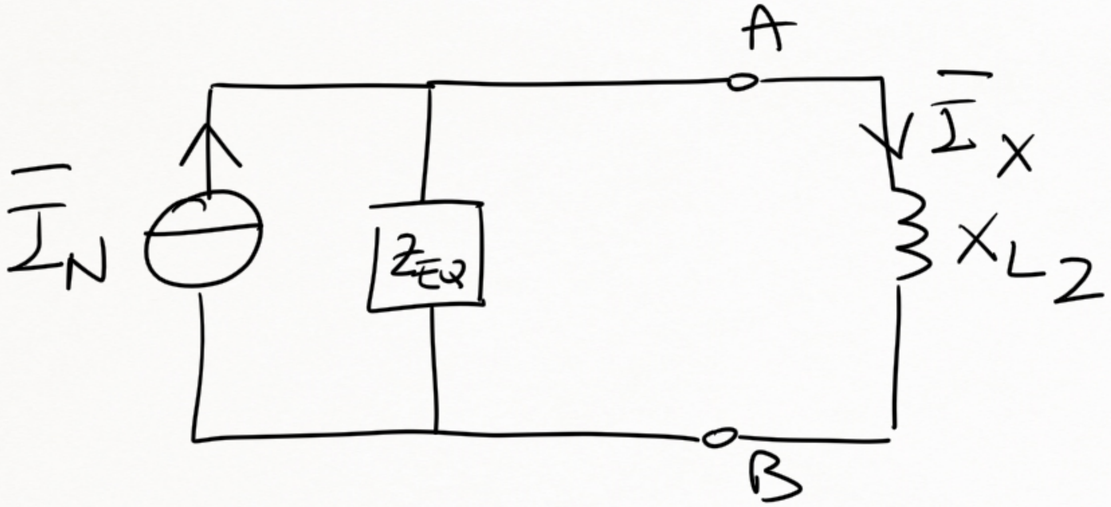
$$Y_2 = \frac{1}{jX_C} = j\,0{,}25\,S$$

$$Y_3 = \frac{1}{R_2} = 0{,}1\,S$$

$$\bar{I}_N = \frac{\bar{V}_S}{Z_1} \cdot \frac{Y_3}{Y_1 + Y_2 + Y_3} = (1{,}182 - j\,0{,}934)\,A$$



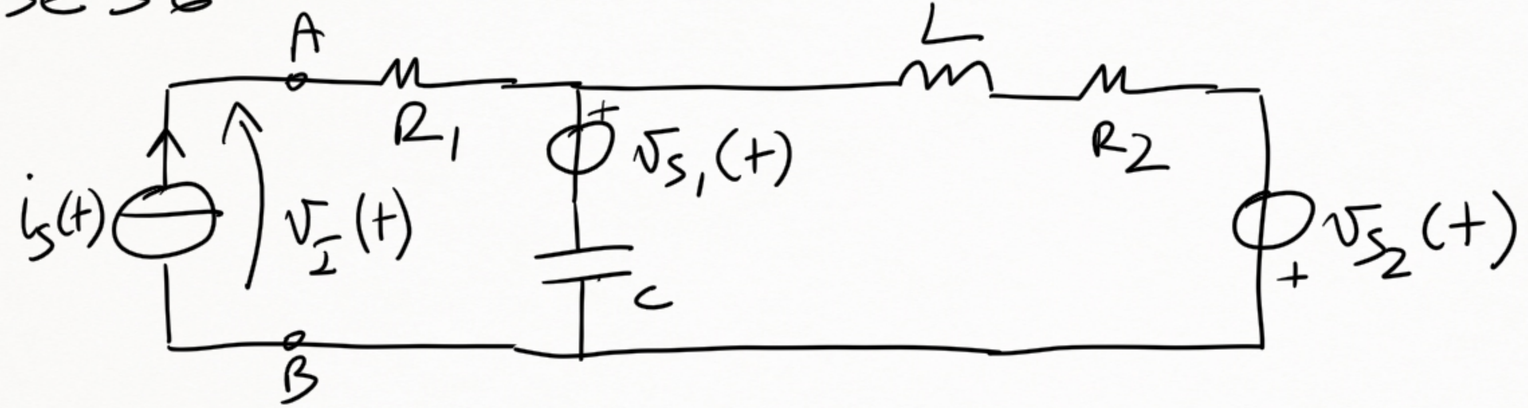
$$Z_{EQ} = R_2 + jX_C // Z_1 = (12,4 - j3,2)\,\Omega$$



$$\bar{I}_X = \bar{I}_N \frac{Z_{EQ}}{Z_{EQ} + jX_{L_2}} =$$

$$= \bar{I}_N \frac{1/jX_{L_2}}{\frac{1}{jX_{L_2}} + \frac{1}{Z_{EQ}}} \simeq (1,128 - j)\,A$$

ESE36



$R_1 = 5\Omega$

$R_2 = 10\Omega$

$L = 20\,mH$

$C = 100\mu F$

$v_I(t) = ?$

$$v_{s_1}(t) = 100\sqrt{2}\,\sin(500t)\,V$$

$$v_{s_2}(t) = 300\sqrt{2}\,\cos(500t)\,V$$

$$i_s(t) = 10\sqrt{2}\,\sin\left(500t - \frac{\pi}{4}\right)A$$

$$\omega = 500\ \frac{rad}{s} \Rightarrow X_C = -\frac{1}{\omega C} = -20\Omega\ ;\ X_L = \omega L = 10\Omega$$

$$v_{s_1}(t) = 100\sqrt{2}\,\sin(500t) = 100\sqrt{2}\,\cos\left(500t - \frac{\pi}{2}\right)\,V$$

$$A_V = 100\sqrt{2}\,V$$

$$\varphi_{V_1} = -\frac{\pi}{2}$$

$$\bar{V}_{s_1} = 100\sqrt{2}\,e^{-j\frac{\pi}{2}} = -j\,100\sqrt{2}\,V$$

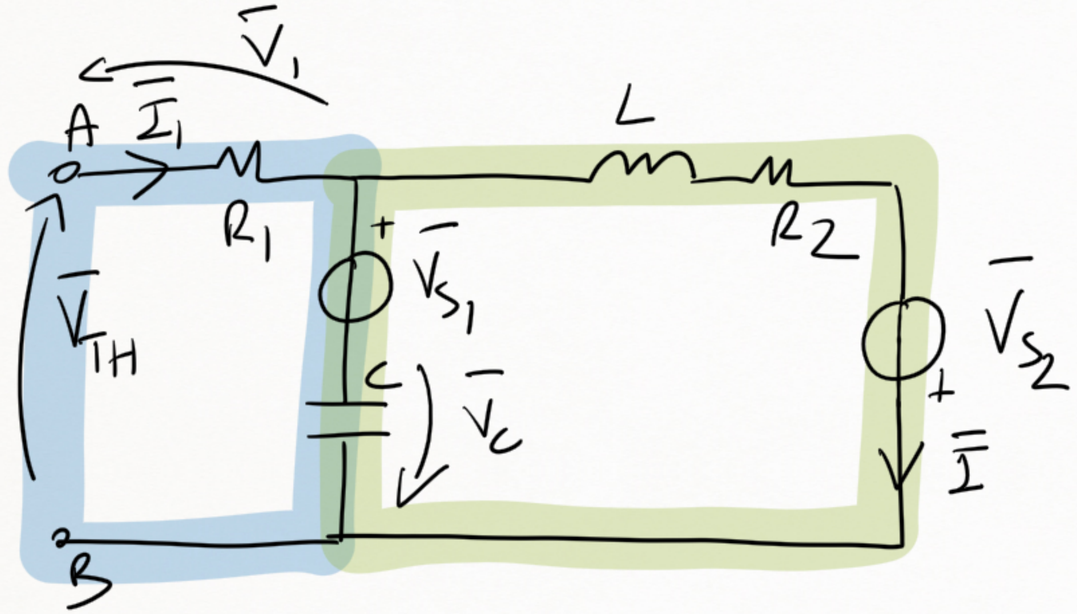
$$v_{s_2}(t) = 300\sqrt{2}\,\cos(500t)\,V \Rightarrow \bar{V}_{s_2} = 300\sqrt{2}\,V$$

$$i_s(t) = 10\sqrt{2}\,\sin\left(500t - \frac{\pi}{4}\right) = 10\sqrt{2}\,\cos\left(500t - \frac{\pi}{4} - \frac{\pi}{2}\right)\,A$$

$$A_I = 10\sqrt{2}\,A$$

$$\varphi_I = -\left(\frac{\pi}{4} + \frac{\pi}{2}\right) = -\frac{3}{4}\pi$$

$$\Rightarrow \bar{I}_S = 10\sqrt{2}\, e^{-j\frac{3}{4}\pi} = 10\sqrt{2}\left(-\frac{\sqrt{2}}{2} - j\frac{\sqrt{2}}{2}\right) = (-10 - j10)\,A$$



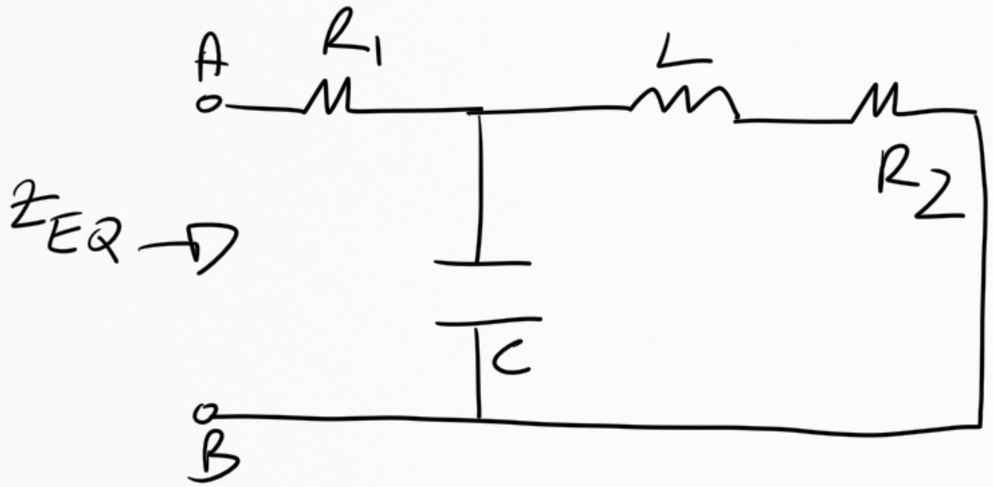
$$\bar{I}_1 = 0\,A \Rightarrow \bar{V}_I = 0\,V$$

$$\bar{V}_{S_2} + \bar{V}_{S_1} = \bar{I}\left(jX_L + R_2 + jX_C\right)$$

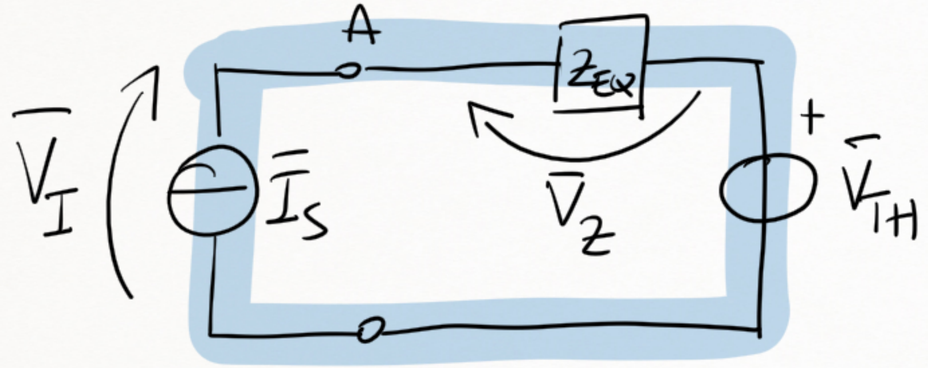
$$\bar{I} = \frac{\bar{V}_{S_1} + \bar{V}_{S_2}}{R_2 + j(X_C + X_L)} = (20 + j10)\,A$$

$$\bar{V}_C + \bar{V}_{TH} = \bar{V}_{S_1} + \bar{V}_1 \Rightarrow \bar{V}_{TH} = \bar{V}_{S_1} - \bar{V}_C = \bar{V}_{S_1} - \bar{I}\,jX_C =$$

$$= (-200\sqrt{2} + j300\sqrt{2})\,V$$



$$Z_{EQ} = R_1 + jX_C // (R_2 + jX_L) = 25\ \Omega$$



$$\bar{V}_I = \bar{V}_{TH} + \bar{V}_Z = \bar{V}_{TH} + \bar{I}_S Z_{EQ} =$$

$$= (-532 + j174)\,V = 560\, e^{j2,825}\,V$$

$$v_I(t) = Re\left\{560 e^{j2,825} e^{jwt}\right\} =$$

$$= 560 \cos(500t + 2,825)\, V$$