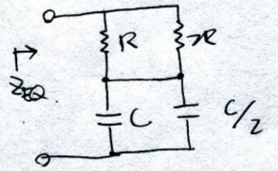
10.2



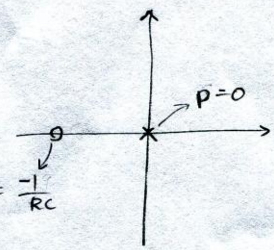
By observing the circuit: we have R & 2R in parallel
C & C/2 in parallel

$$R // 2R = \frac{2R^2}{R+2R} = \frac{2R}{3}$$

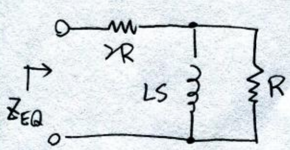
$$\frac{1}{CS} // \frac{2}{CS} = \frac{\frac{1}{CS} \cdot \frac{2}{CS}}{\frac{1}{CS} + \frac{2}{CS}} = \frac{2}{3CS}$$

$$Z_{EQ} = \frac{2R}{3} + \frac{2}{3CS} = \frac{2RCS+2}{3CS}$$

poles: $S = 0$. zeros: $S = \frac{-1}{RC}$

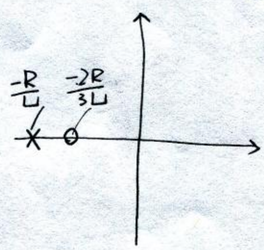


10.4



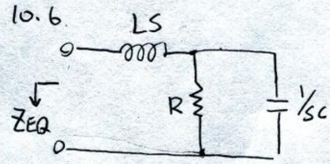
$$LS // R = \frac{LRS}{LS+R}$$

$$Z_{EQ} = 2R + \frac{LRS}{LS+R} = \frac{3LRS + 2R^2}{LS+R}$$



Poles: $S = \frac{-R}{L}$ zeros: $S = \frac{-2R}{3L}$

10.6



$$Z_{EQ} = LS + R // \frac{1}{SC}$$

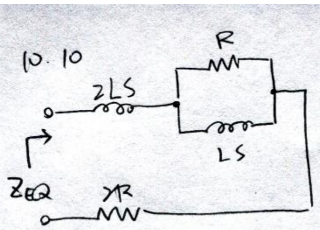
$$= LS + \frac{R}{RCS+1} = \frac{LRCS^2 + LS + R}{RCS+1} = \frac{10^{-3}S^2 + 2S + 10^3}{5\times10^{-4} S + 1}$$

Poles: $S = -\frac{1}{RC} = -2\times10^3$

Poles of Z_{EQ}: $S = -2\times10^3$

Zeros: $S = -1000, -1000$

10. 10



$$Z_{EQ} = 2LS + R /\!/ LS + 2R$$

$$= \frac{2L^2S^2 + 5LRS + 2R^2}{LS + R} = \frac{(LS+2R)(2LS+R)}{LS+R}$$

Poles @ $S = -\frac{R}{L}$

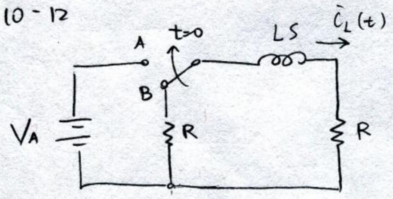
zeros @ $S = -\frac{2R}{L}$, & $\frac{-R}{2L}$

Select value to set $S = -\frac{R}{L} = -2000 \Rightarrow R = 2000\,L$.

we can choose $L = 1\,H$. & $R = 2\,k\Omega$

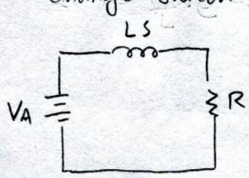
zeros of Z_{EQ} will be : -4000 & -1000 rad/s respectively

10-12



The switch has been in B for a long time $\Rightarrow i_L(0^-) = 0$

Change switch to A. circuit becomes :



$V_A(S) = \frac{V_A}{S}$

$Z = LS + R$

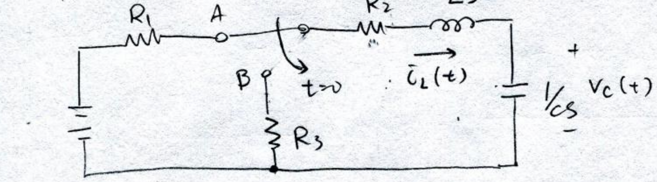
$$I_L(S) = \frac{V_A(S)}{LS+R} = \frac{V_A}{S \cdot (LS+R)} = \frac{A}{S} + \frac{B}{S + \frac{R}{L}}$$

$$A = I_L(S) \cdot S \Big|_{S=0} = \frac{V_A}{R}$$

$$B = I_L(S)\left(S + \frac{R}{L}\right)\Big|_{S=-\frac{R}{L}} = -\frac{V_A}{R}$$

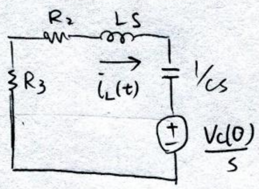
$$\Rightarrow i_L(t) = \frac{V_A}{R}\left(1 - e^{-\frac{R}{L}t}\right)u(t)$$

10.17



Switch @ A for a long time $\rightarrow$ $i_L(0) = 0$. $V_C(0) = V_A$

(a) Switch to B circuit become :



$$Z_{EQ} = R_2 + R_3 + LS + \frac{1}{CS} = \frac{LCS^2 + (R_2+R_3)CS + 1}{CS}$$

$$I_L(s) = -\frac{V_C(0)}{s} \Big/ Z_{EQ} = \frac{-V_A \cdot C}{LCS^2 + (R_2+R_3)CS + 1}$$

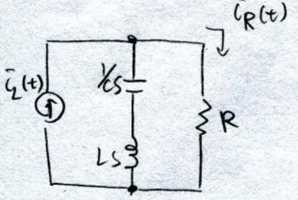
(c) For $R_1 = R_3 = 500\,\Omega$, $R_2 = 1\,K\Omega$, $L = 250\,mH$, $C = 4\,\mu F$. $V_A = 15V$

$$I_L(S) = \frac{-6\times10^{-5}}{10^{-6}S^2 + 6\times10^{-3}S + 1} = \frac{-60}{S^2 + 6\times10^{3}S + 10^{6}} = \frac{A}{S+5828.5} + \frac{B}{S+171.6}$$

solve the equation we have : $A = 10.61$ & $B = -10.61$

$$i_L(t) = 10.61\left[e^{-5828.5t} - e^{-171.6t}\right]u(t) \quad mA$$

10-19.



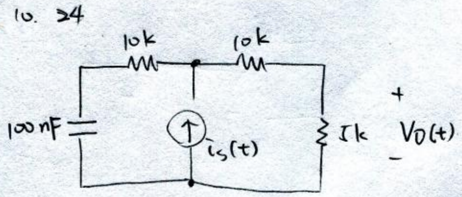
look for formula of current division

$$I_R(S) = I_L(S) \cdot \frac{1/R}{1/R + 1/(1/CS + LS)}$$

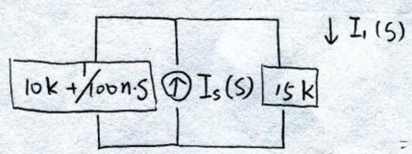
$$= I_L(S) \frac{1/R}{1/R + CS/(LCS^2+1)} = I_L(S) \cdot \frac{LCS^2+1}{LCS^2+RCS+1}$$

$$\frac{I_R(S)}{I_L(S)} = \frac{LCS^2+1}{LCS^2+RCS+1}$$

10. 24



⇓



$$I_1(S) = I_s(S) \cdot \frac{1/15k}{1/15k + 1/(10k + 1/100nS)} = I_s \cdot \frac{10^{-3}S+1}{2.5\times10^{-3}S+1}$$

$$= I_s(S) \cdot \frac{0.4S+400}{S+400}$$

$$= \frac{10^{-3}S+1}{(S+400)^2} = \frac{10^{-3}}{S+400} + \frac{0.6}{(S+400)^2}$$

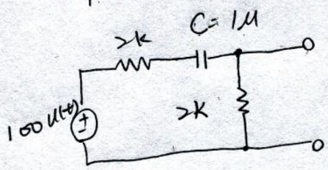
$i_s(t) = 2.5\, e^{-400t} \times 10^{-3}\, u(t)$

$$I_s(S) = \frac{2.5\times10^{-3}}{S+400}$$

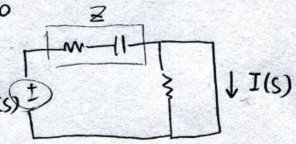
$$V_0(S) = I_1(S)\cdot 5k = \frac{5}{S+400} + \frac{3\times10^3}{(S+400)^2}$$

$$V_0(t) = [5\cdot e^{-400t} + 3\times10^3 \cdot t \cdot e^{-400t}] \cdot u(t)$$

10.27



Short circuit :

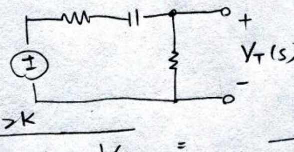


where $V_S(s) = \frac{100}{S}$

$Z = 2K + \frac{1}{1\mu S} = \frac{2\times10^{-3}S + 1}{10^{-6}S}$

$I_N(S) = \frac{V_S(S)}{Z} = \frac{100 \cdot 10^{-6} S}{S\ (2\times10^{-3} S + 1)} = \frac{0.05}{S+500}$

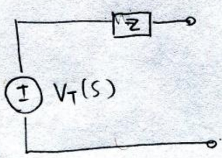
open circuit :



$V_T(S) = V_S \cdot \frac{2k}{2k + 2k + 1/_{1\mu S}} = \frac{50}{S+250}$

$Z = \frac{V_T(S)}{I_N(S)} = \frac{1000\ (S+500)}{S+250}$

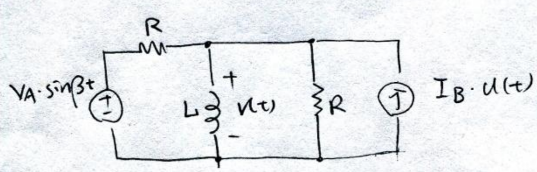
$\Rightarrow$ Thèvenin



where $V_T = \frac{50}{S+250}$

$Z = \frac{1000\ (S+500)}{S+250}$

10.28



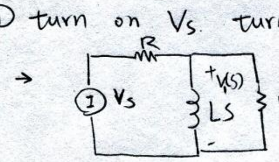
$V_S(S) = V_A \cdot \frac{\beta}{S^2+\beta^2}$

$I_S(S) = \frac{I_B}{S}$

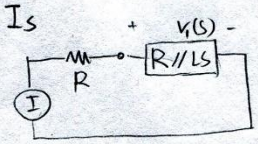
no initial energy using superposition

① turn on V_S turn off I_s

$\rightarrow$



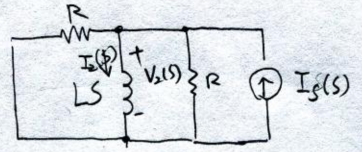
=



$V_1(S) = V_S \cdot \frac{R//LS}{R + R//LS}$

$= \frac{V_A\beta}{S^2+\beta^2} \cdot \frac{LS}{2LS + R}$

② turn on Is turn off Vs

$\Rightarrow$ 

$$I_2(S) = I_S \cdot \frac{1/LS}{1/LS + 1/R + 1/R}$$

$$= \frac{I_B}{S} \cdot \frac{R}{2LS + R}$$

$$V_2(S) = I_2(S) \cdot LS = \frac{I_B \cdot L \cdot R}{2LS + R}$$

Apply superposition ,

$$V(S) = V_1(S) + V_2(S)$$

$$= \frac{V_A \beta}{S^2 + \beta^2} \cdot \frac{LS}{2LS + R} + \frac{I_B LR}{2LS + R}$$

$$= \frac{I_B LRS^2 + V_A \beta L S + I_B LR \beta^2}{(2LS + R)(S^2 + \beta^2)}$$

forced poles : $S = \pm j\beta$

Natural pole : $S = -\frac{R}{2L}$