[redacted]

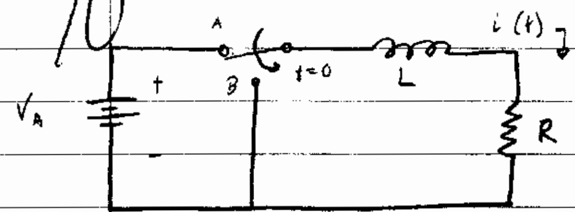
ECE 301 HW # B2

Ch. 10 (11, 17, 23, 25, 26)

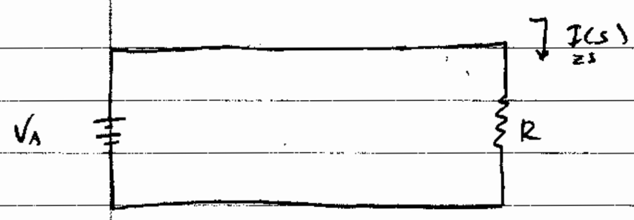
10/10

11 The switch in Figure P10-11 has been in position A for a long time and is moved to position B at $t=0$. Transform the circuit into the s domain and solve for $I_L(s)$ and $i_L(t)$ in symbolic form.

10

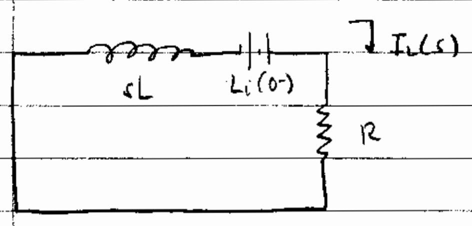


initial conditions



$$I_{zs}(s) = \frac{V_A}{R} = Li(0^-)$$

$t>0$



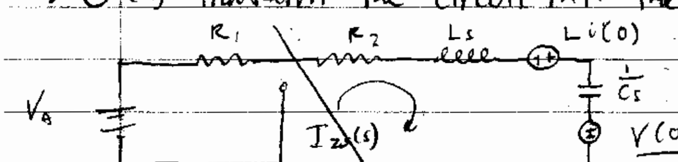
$$I_{zi}(s) = \frac{L\,i_L(0^-)}{sL+R} = \frac{V_A/R}{s+R/L}$$

$$I_L(s) = \frac{V_A/R}{s+R/L}$$

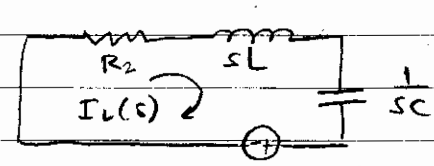
$$i_L(t) = \left[\frac{V_A}{R} e^{-(R/L)t}\right] u(t)$$

17 The switch in Figure P10-17 has been in position A for a long time and is moved to position B at $t=0$

10 (a) Transform the circuit into the s domain and solve for $I_L(s)$ in symbolic form.



$t>0$



$$\cancel{I_{zs}(s) = \frac{V_A}{R_1+R_2+Ls+\frac{1}{Cs}}}$$

$$I_{zi}(s) = \frac{-\frac{V_C(0^-)}{s}}{R_2+sL+\frac{1}{sC}} = \frac{-V_A}{s(sL+R_2+1/sC)} = -V_A/(s^2L+sR_2+1/C)$$

$$\frac{V_C(0^-)}{s}$$

$V_C(0^-) = V_A$

$\times \frac{C}{C}$

$$\boxed{I_L(s) = \frac{-V_A C}{s^2LC+sCR_2+1}}$$

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(b) Find $i_L(t)$ for $R_1 = R_2 = 500\Omega$, $L = 250\,mH$, $C = 4\mu F$ and $V_A = 15V$

$$I_L(s) = \frac{-V_A C}{LCs^2 + R_2 C s + 1} = \frac{-V_A/L}{s^2 + \frac{R_2}{L}s + \frac{1}{LC}}$$

$$I_L(s) = \frac{-60}{s^2 + 2k\,s + 1000k}$$

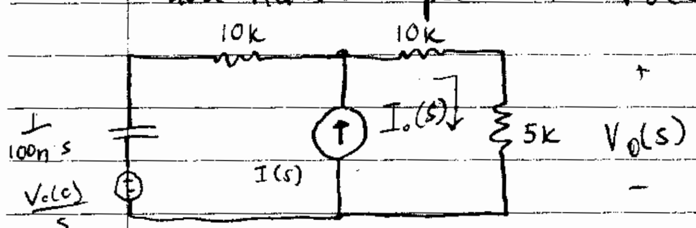
$$\frac{1}{(s+\alpha)^2}$$

$$I_L(s) = \frac{-60}{(s+1000)^2}$$

$$\boxed{i_L(t) = -\left[60\,t\,e^{-1000t}\right]u(t)\ A}$$

23 There is no energy stored in the capacitor at $t=0$. Transform the circuit into the s domain and use current division to find $v_o(t)$ when the input is $i_s(t) = 2.5e^{-100t}u(t)$ mA. Identify the forced and natural poles in $V_o(s)$

10



$$I_s(s) = \frac{2.5}{s+100}$$

$$\frac{10k + \frac{10000k}{s}}{25k + \frac{10000k}{s}} \cdot \frac{2.5}{s+100} = \frac{25ks + 25000k}{25k\,s^2 + 12500s + 1{,}000{,}000k}$$

$$= \frac{s+1000}{s^2 + 500 + 40000} = \frac{s+1000}{(s+400)(s+100)}$$

$$I_o(s) = \frac{k_1}{s+400} + \frac{k_2}{s+100} \qquad k_1 = -2 \qquad k_2 = 3$$

$p_1 = -400$

$p_2 = -100$

$$I_o(s) = \left[-2e^{-400t} + 3e^{-100t}\right]u(t)\ mA$$

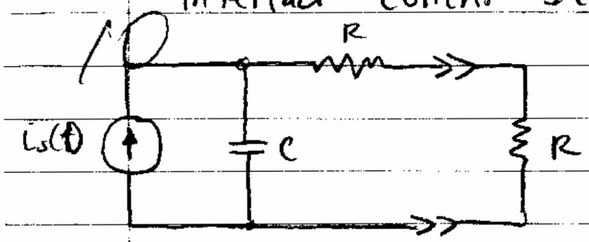
$V_o(s) = I_o(s)\,5K$

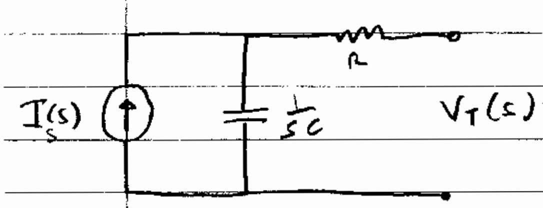
$$\boxed{V_o(s) = \left[-10e^{-400t} + 15e^{-100t}\right]u(t)\ V}$$

I passive sign from source

$p_1 = -400$ natural pole $p_2 = -100$ forced pole

25 The circuit is in the zero state. Use a Thevenin equivalent to find the s-domain relationship between the input $I_s(s)$ and the interface current $I(s)$

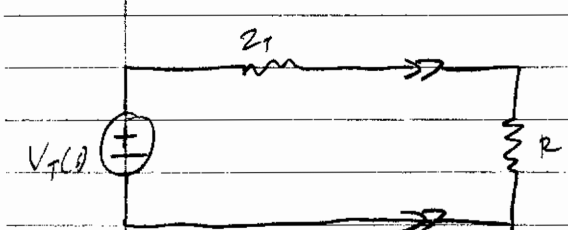




$$V_T(s) = I_s(s) \cdot \frac{1}{sC}$$

$$I_{sc} = \frac{\frac{1}{sC}}{R+\frac{1}{sC}} I_s(s) = \frac{I_s(s)}{sCR+1}$$

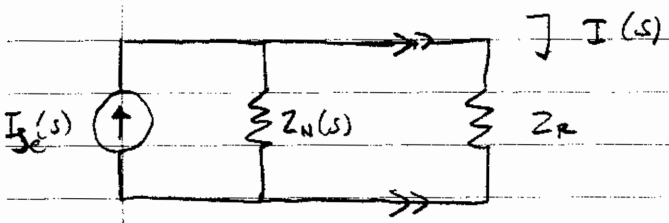
$$Z_T = \frac{V_T(s)}{I_{sc}(s)} = \frac{I(s)/sC}{\frac{I(s)}{sCR+1}} = \frac{sCR+1}{sC}$$



$$I(s) = \frac{V_T(s)}{Z_T+R} = \frac{\frac{I_s(s)}{sC}}{\frac{sCR+1}{sC}+R} = \frac{\frac{I_s(s)}{sC}}{\frac{2sCR+1}{sC}} = \frac{I_s(s)}{\cancel{sC}} \cdot \frac{\cancel{sC}}{2sCR+1}$$

$$\boxed{I(s) = \frac{1}{2sCR+1} I_s(s)}$$

26 Repeat Problem 25 using a Norton equivalent circuit.



$$I_{sc}(s) = \frac{I_s(s)}{sCR+1}$$

10

$$Z_N = \frac{sCR+1}{sC}$$

$$I(s) = \frac{Z_N(s)}{Z_R + Z_N(s)} \; I_{sc}(s)$$

$$I(s) = \left[\frac{\frac{sCR+1}{sC}}{\frac{sCR+1}{sC} + R} * \frac{I_s(s)}{sCR+1} \right]$$

$$= \frac{sCR+1/sC}{\frac{2sCR+1}{sC}} * \frac{I_s(s)}{sCR+1}$$

$$= \frac{\cancel{sCR+1}}{\cancel{sC}} \; \frac{sC}{2sCR+1} \; \frac{I_s(s)}{\cancel{sCR+1}}$$

$$\boxed{I(s) = \frac{1}{2sCR+1} \; I_s(s)}$$