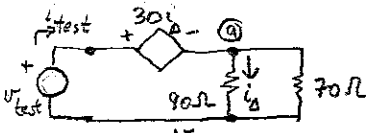
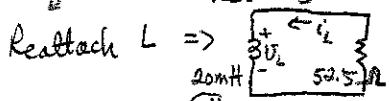
Nilsson + Riedel Ch. 7
11, 26, 36, 48, 55, 89

Engineering 11 – Electrical Circuit Analysis
Assignment Solutions

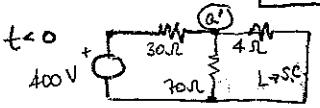
1. 7.11 a. Find $i_L(t)$ for $t \geq 0$. Find Thevenin equiv. of RHS using v_{test}, i_{test}.



$v_{test} - 30 i_\Delta - 90 i_\Delta = 0$
$90 i_\Delta = 70(i_{test} - i_\Delta)$ } $v_{test} = 120 i_\Delta = 120\left(\frac{70}{160}\right) i_{test}$ or $R_T = \frac{v_{test}}{i_{test}} = 52.5\,\Omega$

Reattach L => 

$\frac{di_L}{dt} + \frac{R}{L} i_L = 0 \Rightarrow s + \frac{52.5}{20(10^{-3})} = 0$ or $s = -2625$ so $i_L(t) = Ae^{-2625t}$

$t<0$ 

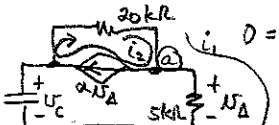
$V = \frac{280/74}{30 + 280/74}(400) = V_{a'}$

$I = \frac{70}{74}\left[\frac{400 - V_{a'}}{30}\right] = i_L(0^-) = 11.2\,A$

so $\boxed{i_L(t) = 11.2\,e^{-2625t}\ A;\ t \geq 0}$

b. $\boxed{v_L(t) = L\frac{di_L}{dt} = -588\,e^{-2625t}\ V;\ t \geq 0^+}$ c. $v_L = 120 i_\Delta \Rightarrow \boxed{i_\Delta = -4.9\,e^{-2625t}\ A;\ t \geq 0}$

2. 7.26 a. Find α for $\tau = 40$ ms. Use loop currents.



$0 = \frac{1}{C}\int i_1\,dt + 20k(i_1 - \alpha v_\Delta) + 5k i_1$ where $v_\Delta = 5k\,i_1 \Rightarrow$

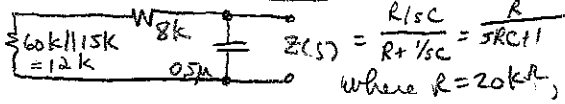
$\frac{1}{s(0.08\mu)} + (25k - 5k(20k)\alpha) = 0$

so $\boxed{\alpha = 2.5(10^{-4})\ A/V}$

b. Find v_Δ. For $t<0$, $v_c = -5(3.6) = -18\,V \Rightarrow$ for $t>0$, $v_c(t) = -18e^{-t/0.04}\ V;\ t \geq 0$

$\sum_a i = 0 = \frac{v_\Delta}{5k} + \frac{v_\Delta - v_c}{20k} + 25(10^{-4})v_\Delta = 0 \Rightarrow \boxed{v_\Delta = -v_c/10 = -1.8\,e^{-t/0.04}\ V,\ t \geq 0^+}$

4. 7.48 a. Find $v_o(t)$. For $t<0$, $v_o = 0$. For $t>0$



where $R = 20k\Omega$, $C = 0.5\mu F$.

$v_o = v_{oh} + v_{op} = Ae^{-t/RC} + v_{op}$; $v_{op} = 5(60\|15) = 60\,V$

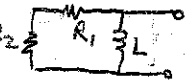
$\therefore \boxed{v_o = 60(1 - e^{-100t})\ V;\ t \geq 0}$ $\boxed{i_o = \frac{v_o + 8k\,i_c}{60k} = 1 - 0.6e^{-100t}\ mA;\ t \geq 0^+}$

b. Find $i_o(t)$. Use $i_c = C\,dv_c/dt = 3e^{-100t}$; $t \geq 0^+$

c. Find $\boxed{i_1(t) = i_o(t) + i_c(t) = 1 + 2.4e^{-100t}\ mA;\ t \geq 0^+}$ d. $\boxed{i_2(t) = \frac{v_o + 8k\,i_c}{15k} = 4 - 2.4e^{-100t}\ mA}$

e. Find $\boxed{i_1(0^+) = 1 + 2.4 = 3.4\ mA}$

3. 7.36 a. Find $v_o(t)$. $t<0$, $i_L = I_g$ $t \to \infty$, $v_o \to 0$



$Z(s) = \frac{sL(R_1+R_2)}{sL + R_1 + R_2}$ $sL + R_1 + R_2 = 0 \Rightarrow s = \frac{-(R_1+R_2)}{L}$

$t = 0^+$, $i_L = I_g$ & $v_o = -R_2 I_g$ so $\boxed{v_o = -R_2 I_g\,e^{-(R_1+R_2)t/L}\ V;\ t \geq 0^+}$

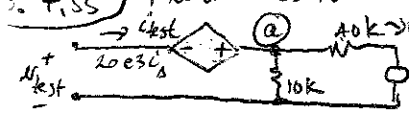
b. $\boxed{v_o = -150\,e^{-1250t}\ V;\ t \geq 0^+}$ c. $\boxed{\uparrow R_2 \Rightarrow \text{amplitude of } v_o \to \infty;\ \text{duration of } v_o \to 0}$

d. $v_{SW} = R_2 i_L$; $i_L = Be^{-(R_1+R_2)t/L}$ where $i_L(0) = I_g$, $i_{Lp} = \frac{R_2}{R_1+R_2} I_g \Rightarrow I_g = B + \frac{R_2}{R_1+R_2} I_g$

or $i_L = \frac{R_1 I_g}{R_1+R_2} e^{-(R_1+R_2)t/L} + \frac{R_2 I_g}{R_1+R_2} \Rightarrow \boxed{v_{SW} = \frac{1}{1 + R_1/R_2} I_g \left[R_1 + R_2\,e^{-(R_1+R_2)t/L}\right]\ V;\ t \geq 0^+}$

e. Same as for v_o.

7.55 Find $v_o(t)$. For $t<0$, $v_o = -3(15) = -45\,V$. For $t>0$, find Thev equiv of RHS w/o C, use v_{test}, i_{test}



$v_{test} = -20(10^3) i_\Delta + 8(10^3) i_{test}$; $i_\Delta = \frac{10}{50} i_{test}$

$\Rightarrow v_{test} = 4(10^3) i_{test} \Rightarrow R_T = 4k\Omega$

$V_a = \frac{10}{50}(25) = 15\,V$; $V_T = V_a - (20(10^3))(i_\Delta = -\frac{75}{50}) = 45\,V$

so $v_o(t) = Ae^{-t/RC} + v_{op}$; $v_{op} = 45\,V$ (C→o.c.); $v_o(0) = -45 = A + 45$ or $A = -90$

$\therefore \boxed{v_o(t) = 45 - 90\,e^{-4000t}\ V;\ t \geq 0}$

7.89 $v_- = v_+ = \frac{80}{80+20}(-45) = -36\,V$ $\sum i = \frac{14 - (-36)}{80k} + 2.5(10^{-6})\frac{d}{dt}(v_o - (-36)) \Rightarrow \frac{dv_o}{dt} = \frac{-50}{80k(2.5)(10^{-6})}$

$\therefore v_o(t) = \int_{-\infty}^{0} \frac{dv_o}{dt}dt + \int_0^t \frac{dv_o}{dt}dt = v_o(0) - 250t$; $v_o(0) = -36 + 56 = 20\,V \therefore v_o(t) = 20 - 250t\ V$

$v_o(t) = 0$ @ $\boxed{t = \frac{20}{250} = 0.08\ s}$