Nilsson + Riedel Ch 5 49, 52 Ch 6 32, 33, 50 Ch 7 3, 4

Engineering 11: Electrical Circuit Analysis Assignment Solutions

2005 LAM

(3. 6.32) $i_o = 5e^{-2000t}(2\cos 4000t + \sin 4000t)$ A ; $t \geq 0^+$. Find $v_1(t)$, $v_2(t)$ @ $t = 0^+$.

$v_R = 40\, i_o \Rightarrow v_R(0^+) = 400$ V ; $v_L = 0.01 \frac{di_o}{dt} \Rightarrow v_L(0^+) = 0.01(4000) + 0.01(-2000)(2) = 0$

$v_C = v_1$ @ $t = 0^+ \Rightarrow v_1 = v_C = v_R = 400$ V $\Rightarrow$ $v_1 = 400$ V, $v_2 = 0$ @ $t = 0^+$

(4. 6.33) $i_o = 1.5e^{-16000t} - 0.5e^{-4000t}$ $v_C(0) = -50$ V. Find $v_o(t \geq 0)$. ($i_C = -i_o = -i_L$)

$v_C = \frac{1}{C}\int i_C\, dt = -\frac{1}{.625(10^{-6})}\int_0^t (1.5e^{-16000t} - 0.5e^{-4000t})\,dt + v_C(0) = 150e^{-16000t} - 200e^{-4000t} - 50$ V

$v_L = L\frac{di_L}{dt} = 0.025(-16000(1.5)e^{-16000t} - 0.5(-4000)e^{-4000t}) = -600e^{-16000t} + 50e^{-4000t}$ V

$v_o = v_C - v_L = 750e^{-16000t} - 250e^{-4000t}$ V ; $t > 0$

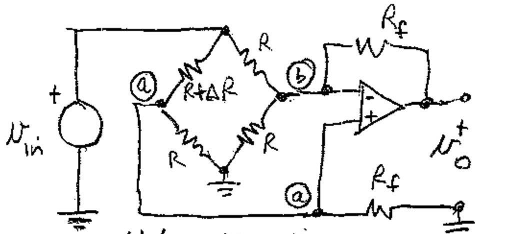
(5. 6.50) For all $v_C(0^-) = 0$, Find change in voltage if person touches lamp

w/o finger, $v(t) = \frac{10}{20} v_s(t)$ for $10\,pF$ caps.

w/ finger & C_p = cap of person, $C = \frac{100(10)}{100+10}\,pF = 9.09\,pF$; $C_{11} = C + C_p = 19.09\,pF$

so $v(t) = \frac{10}{29.09} v_s = .34\, v_s$ $\Rightarrow$ $\Delta v(t) = 0.5 v_s - 0.34 v_s = 0.16 v_s$

(1. 5.49) a. Show: for $\Delta R << R$, $v_o \simeq \frac{R_f}{R^2}\frac{(R+R_f)}{(R+2R_f)}(-\Delta R)\, v_{in}$.



$\sum_a i = \frac{v_{in} - v_a}{R + \Delta R} - \frac{v_a}{R} - \frac{v_a}{R_f} = 0$

$\sum_b i = \frac{v_{in} - v_a}{R} - \frac{v_a}{R} + \frac{v_o - v_a}{R_f} = 0$

Solve simultaneously $\Rightarrow$ $v_o = \frac{-R_f(\Delta R)(R+R_f)\, v_{in}}{R[R(R+\Delta R) + R_f(R+\Delta R) + RR_f]}$

or $v_o \cong \frac{-R_f(\Delta R)(R+R_f)}{R^2(R+2R_f)} v_{in}$ ✓

Note: $v_a = v_b$

b. If $R_f = 470\,k\Omega$, $R = 10\,k\Omega$, $\Delta R = 95\,\Omega$, $v_{in} = 15$ V, find $v_o = -3.38$V (use ✓ed answer from a)

c. Find actual v_o. (use ( )) $\Rightarrow$ $v_o = -3.37$

(2. 5.52) Repeat 5.49 if the variable resistor $R + \Delta R$ becomes $R - \Delta R$.

a. Find v_o if $\Delta R << R$. Using prev. results from 5.49, $\longrightarrow$ $v_o = \frac{R_f(\Delta R)(R+R_f)}{R[R(R+\Delta R) + R_f(R+\Delta R) + RR_f]} v_{in}$

b. % error in v_o as a function of $R, R_f, \& \Delta R$?

Approx $\propto R[R(R-\Delta R) + R_f(R-\Delta R)] + RR_f$; Actual $\propto R^2(R+2R_f)$

$\text{Error} = \frac{R(R-\Delta R) + R_f(R-\Delta R) + RR_f - R^2(R+2R_f)}{R^2(R+2R_f)} = \frac{-\Delta R(R+R_f)}{R(R+2R_f)} = \text{Error}$

c. If $R - \Delta R = 9.810\,k\Omega$, w/ same values of R, R_f, & v_{in}. Find approx v_o. If $R - \Delta R = 9.81\,k$,

Then $v_o \approx 6.77$V d. Error for $9.81\,k\Omega$ is -0.96% $\Delta R = R - 9.81\,k = 0.19\,k\Omega$

(7. 7.4) $v(t) = 400e^{-5t}$ V $t \geq 0^+$; $i(t) = 10e^{-5t}$ A

a. Find $R = \frac{v(0)}{i(0)} = 40\,\Omega$

b. Find $\tau = 1/5$ s $= 200$ mS

c. Find $L = R\tau = 40(200\,m) = 8$ H

d. Find $w(0) = \frac{1}{2}Li^2(0) = \frac{1}{2}(8)(100) = 400$ J

e. Find time to dissipate 80% of initial stored energy. (20% left)

$\frac{1}{2}8(100e^{-10t}) = 0.2(400) \Rightarrow t = 160.9$ mS

6. 7.3 S closes @ $t=0$

a. $i(0^-) = 0$

b. $i_L(0^-) = \frac{120}{120+60}\left(\frac{12}{10+(120\|60)}\right)$; $(120\|60) = 40 \Rightarrow i_L(0^-) = \frac{120(12)}{180(10+40)} = 160\,mA$

c. $i_o(0^+) = \frac{120}{160}\left(\frac{12}{10+(120\|60)}\right) - i_L(0^+)$; $i_L(0^+) = i_L(0^-) \Rightarrow i_o(0^+) = 65\,mA$

d. $i_L(0^+) = i_L(0^-) = 160\,mA$

e. $i_o(\infty) = \frac{120}{160}\left(\frac{12}{10+30}\right) = 225\,mA$

f. $i_L(\infty) = 0$

g. $i_L = i_{Lp} + i_{Lh} = 0 + Ae^{-Rt/L}$; $i_L(0) = A = 160\,mA$; $\frac{R}{L} = 200 \Rightarrow i_L = 160e^{-200t}\,mA$ $t \geq 0$

h. $v_L(0^-) = 0$

i. $v_L(0^+) = -v_R(0^+)$ (since RL now shorted) or $v_L(0^+) = -20(i_L(0^+)) = -3.2\,V$

j. $v_L(\infty) = 0$

k. $v_L(t) = v_{Lp} + v_{Lh} = 0 + Ae^{-200t}$; $v_L(0^+) = A = -3.2$ so $v_L(t) = -3.2e^{-200t}\,V$; $t \geq 0^+$

l. $i_o = (225 - 160e^{-200t})\,mA$; $t \geq 0^+$