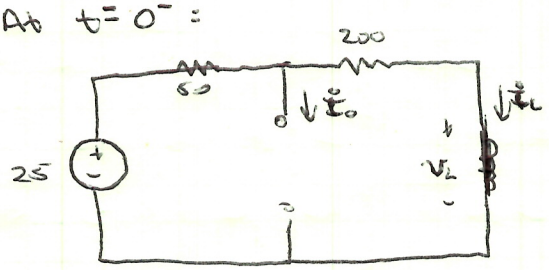
ENGR 2910 -
HOMEWORK & SOLUTIONS

(1) a) At $t = 0^-$:

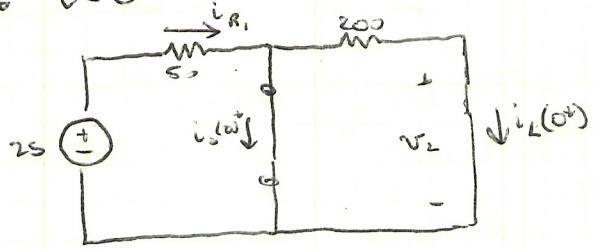



$i_o(0^-) = 0$ OPEN

$i_L(0^-) = \frac{V}{R_{EQ}} = \frac{25}{250} = 0.1\ A$

$v_L(0^-) = 0$ SHORT CIRCUIT

b) At $t = 0^+$:



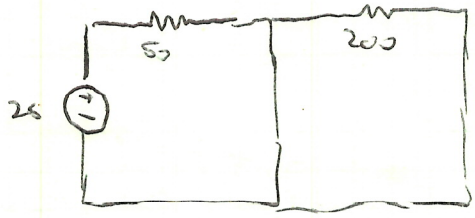

$i_L(0^+) = i_L(0^-) = 0.1\ A$

$i_{R_1} = \frac{25V}{50\Omega} = 0.5\ A$

$i_o(0^+) = i_{R_1} - i_L(0^+) = 0.4\ A$

$v_L(0^+) = -200\, i_L(0^+) = -20V$

c) At $t \to \infty$:




$v_L(\infty) = 0$

$i_L(\infty) = 0$

$i_o(\infty) = \frac{25}{50} = 500\ mA$

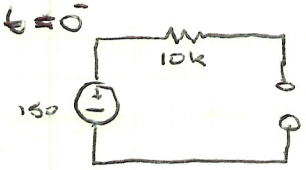
d) $\tau = \frac{L}{R} = \frac{0.05}{200} = 0.25\ mS$

$i_L(t) = 0 + (0.1 - 0)\, e^{-4000t} = 0.1\, e^{-4000t}\ A$

e) $i_o(t) = i_{R_1} - i_L(t) = 0.5 - 0.1\, e^{-4000t}\ A$

f) $v_L(t) = L\frac{di_L}{dt} = (0.05)(-4000)\, e^{-4000t} = -20\, e^{-4000t}\ V$

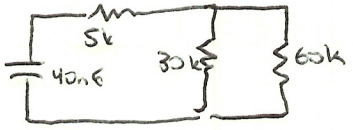
(2) a) $t \le 0^-$




$v(0^-) = 150V$

b) $w(0) = \frac{1}{2} C v(0)^2 = \frac{1}{2}(40 \times 10^{-9})(150)^2 = 450\ \mu J$

c) $t > 0$:



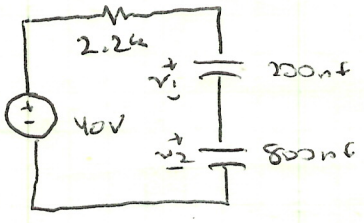

$R_{EQ} = 5k + 30k \| 60k = 5k + 20k = 25k\Omega$

$\tau = RC = (25k\Omega)(40nF) = 1mS$

d) $v(t) = v(0)\, e^{-\frac{t}{\tau}} = 150\, e^{-1000t}\ V \quad t \ge 0$

(3) $t = 0^-$

a)

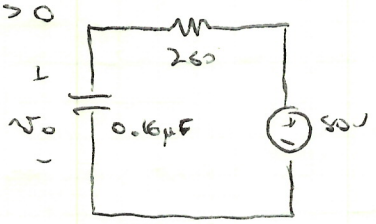



$v(0^-) = 40V$

$v_1(0^-) = \frac{80}{200+80} \cdot 40 = 32V$

$v_2(0^-) = \frac{20}{200+80} \cdot 40 = 8V$

$t > 0$




$v_o(0^-) = v_o(0^+) = 40V$

$v_o(\infty) = 80V$

$\tau = RC = (16\mu F)(25\Omega) = 40\mu s$

$v_o(t) = 80 + (40-80)e^{-25000t}$

$= 80 - 40e^{-25000t}$

b) $i_o(t) = -C\frac{dv_o}{dt} = -(0.16\mu F)(1{,}000{,}000)e^{-25000t}$

$= 0.16e^{-25000t}$ A

c) $v_1(t) = \frac{-1}{0.2\times10^{-6}}\int_0^t (+0.16)e^{-25000t}\,dt + 32V$

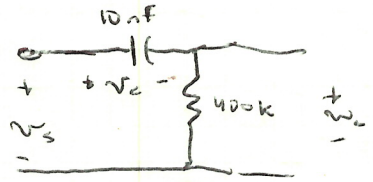
$= 64 - 32e^{-25000t}$ V

d) $v_2(t) = \frac{1}{0.8\times10^{-6}}\int_0^t (-0.16)e^{-25000t}\,dt + 8V$

$= 16 - 8e^{-25000t}$ V

e) $\omega_{trapped} = \frac{1}{2}(0.2\mu F)(64V)^2 + \frac{1}{2}(0.8\mu F)(16V)^2 = 512\mu J$

(4)




$0 \le t \le 1ms$

$v_c(0^-) = v_c(0^+) = 0V$

$v_c(\infty) = 50V$ is $V_s$ applied

$\tau = RC = (400k)(10n) = 4ms$

$v_c(t) = 50 - 50e^{-250t}$

$v_o(t) = 50 - (50 - 50e^{-250t}) = \boxed{50e^{-250t}\ V \quad 0 \le t \le 1ms}$

$1ms \le t < \infty$

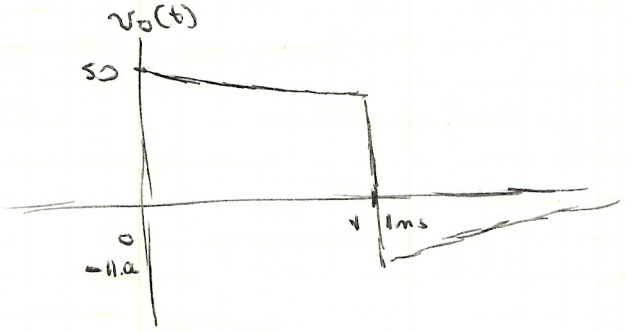
$v_c(1ms) = 50 - 50e^{-0.25} = 11.06V$

$v_c(\infty) = 0 \quad \tau = 4ms$

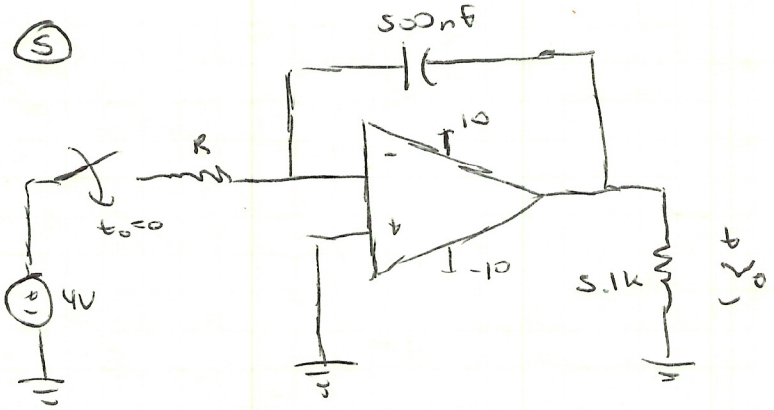
$v_c(t) = 11.06e^{-250(t-0.001)}$

$v_o = -v_c = \boxed{-11.06e^{-250(t-0.001)}\ V \quad t > 1ms}$

(b)




(5)




$$v_o = -\frac{1}{R(500\times10^{-9})}\int_0^t 4\,dt + 0$$

$$= \frac{-4t}{R(500\times10^{-9})}$$

At $t = 15mS$

$$v_o = -10 = \frac{-4(15\times10^{-3})}{R(500\times10^{-9})}$$

$$R = \frac{-4(15\times10^{-3})}{-10(500\times10^{-9})} = 12\,k\Omega$$