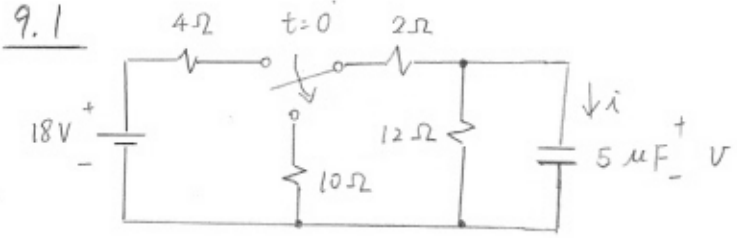
9.1



$v(0^+) = [12/(4+2+12)] \times 18 = 12\ V$

$R_{eq} = (10+2) \parallel 12 = 6\ \Omega$

$\tau = 6 \cdot 5\mu = 30\ \mu s$

$v(t) = 12e^{-t/\tau}\ V$,

$i(t) = -v(t)/R_{eq} = -2e^{-t/\tau}\ A$

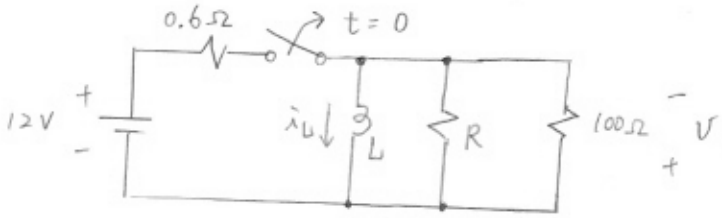
9.5

$i_L(0^+) = 12/0.6 = 20\ A$

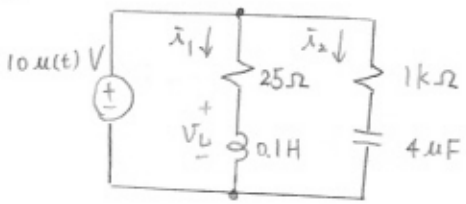
$v(0^+) = R_{eq} \times 20 = 1000\ V$

$R_{eq} = 50\ \Omega \Rightarrow R = 100\ \Omega$

$L = R_{eq} \cdot \tau = 1\ mH$



9.7



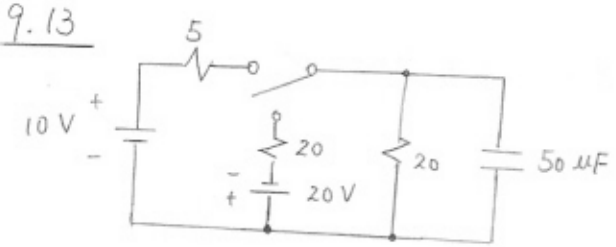
$v_c(0^+) = v_c(0^-) = 0$, $v_c(\infty) = 10\ V$

$v_c(t) = 10(1 - e^{-t/R_2C})$, $R_2C = 4\ ms$

$i_1(0^+) = i_1(0^-) = 0$, $v_L(0^+) = 10\ V$, $v_L(\infty) = 0$

$v_L(t) = 10e^{-R_1t/L}$, $L/R_1 = 4\ ms$

9.13



(a) $V_0 = \frac{20}{25} \cdot 10 = 8\ V$,

$V_{ss} = \frac{20}{40}(-20) = -10\ V$, $R_{eq} = 20 \parallel 20 = 10\ k\Omega$

$\tau = 0.5\ s$

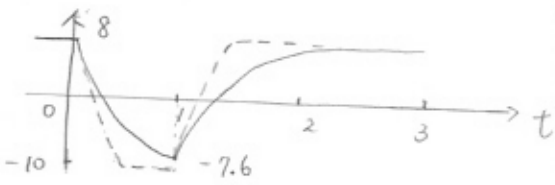
$v(t) = -10 + 18e^{-2t}$, $0 < t < 1$

$v(t) = 0 \Rightarrow e^{-2t} = 10/18$, $t = 0.5 \ln 1.8 = 0.294\ s$

(b) $V_0 = v(1^-) = -10 + 18e^{-2} = -7.6\ V$, $V_{ss} = 8\ V$

$R_{eq} = 5 \parallel 20 = 4\ k\Omega$, $\tau = 0.2\ s$

$v(t) = 8 - 15.6e^{-5(t-1)}$, $t > 1$

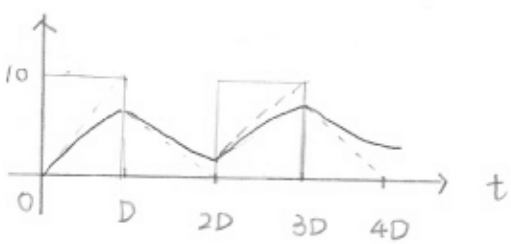


9.16

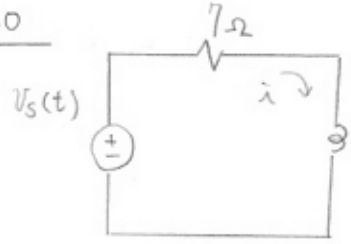
$V_c(D) = 10(1 - e^{-\frac{D}{0.5D}}) = 8.65\ V$

$V_c(2D) = V_c(D)\, e^{-\frac{(2D-D)}{0.5D}} = 1.17\ V$

$V_c(3D) = 10 + [V(2D) - 10]\, e^{-\frac{(3D-2D)}{0.5D}} = 8.81\ V$



9.20



$t<0$, $\underline{I} = 50/(7+j24) = 2\angle -73.7°$

$i(0^+) = i(0^-) = 2\cos(-73.7°) = 0.561$

$v(0^+) = v_s(0^+) - 7\cdot i(0^+) = -3.93$

$t>0$, $\underline{I} = 50\angle 90°/(7+j24) = 2\angle 16.3°$,

$\underline{V} = j24\,\underline{I} = 48\angle 106.3°$

$i_F = 2\cos(24t+16.3°)$, $i_F(0^+) = 1.92$

$v_F = 48\cos(24t+106.3°)$, $v_F(0^+) = -13.47$

$i(0^+) - i_F(0^+) = -1.36$, $v(0^+) - v_F(0^+) = 9.54$

$\tau = L/R = 1/7$

$i(t) = 2\cos(24t+16.3°) - 1.36e^{-7t}$ A

$v(t) = 48\cos(24t+106.3°) + 9.54e^{-7t}$ V

9.21

$t<0$, $\underline{I} = 30/(12+j9) = 2\angle -36.9°$

$i(0^+) = i(0^-) = 2\cos(-36.9°) = 1.6$, $v(0^+) = v_s(0^+) - 12i(0^+) = 10.8$

$t>0$, $\underline{I} = 30/(12+j16) = 1.5\angle -53.1°$, $\underline{V} = j16\,\underline{I} = 24\angle 36.9°$

$i_F = 1.5\cos(16t-53.1°)$, $i_F(0^+) = 0.9$

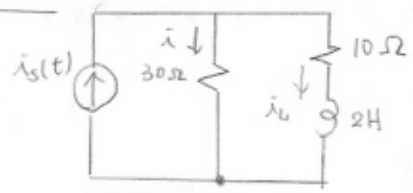
$v_F = 24\cos(16t+36.9°)$, $v_F(0^+) = 19.2$

$i(0^+) - i_F(0^+) = 0.7$, $v(0^+) - v_F(0^+) = -8.4$, $\tau = L/R = 1/12$

$i(t) = 1.5\cos(16t-53.1°) + 0.7e^{-12t}$ A

$v(t) = 24\cos(16t+36.9°) - 8.4e^{-12t}$ V

9.24



$i_L(0^+) = i_L(0^-) = \frac{30}{30+10}\times 4 = 3$ A,

$i_s(0^+) = 4$, $i(0^+) = i_s(0^+) - i_L(0^+) = 1$

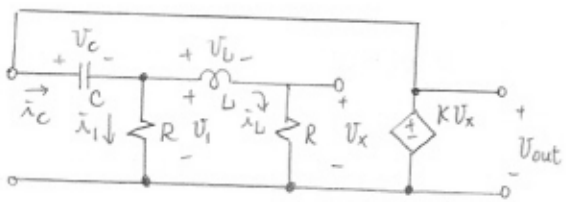
$Z_L = j20$, $\underline{I} = (10+j20)\times 4/(40+j20) = 2\angle 36.9°$

$i_F = 2\cos(10t+36.9°)$, $i_F(0^+) = 1.6$, $i(0^+) - i_F(0^+) = -0.6$

$R_{eq} = 10+30 = 40$, $\tau = 2/40 = 1/20$

$i(t) = 2\cos(10t+36.9°) - 0.6e^{-20t}$ A

9.30



$v_x = Ri_L$, $v_1 = Kv_x - v_C$, $i_1 = v_1/R$

$i_C = Cv_C' = i_1 + i_L = (K+1)i_L - v_C/R$

$v_L = Li_L' = v_1 - v_x = (K-1)Ri_L - v_C$

$\therefore \frac{v_C'}{10} = 4i_L - v_C/2 \Rightarrow i_L = \frac{v_C'}{40} + \frac{v_C}{8}$ — (1)

$2i_L' = 4i_L - v_C \Rightarrow v_C = 4i_L - 2i_L'$ — (2)

from (1), (2)

$i_L'' + 3i_L' + 10i_L = 0$, $\therefore v_C'' + 3v_C' + 10v = 0$

$v_1 = 3v_x - v_C = 6i_L - v_C$

$(6i_L'' - v_C'') + 3(6i_L' - v_C') + 10(6i_L - v_C) = 0 \Rightarrow v_1'' + 3v_1' + 10v_1 = 0$

9.41 from (9-19) $v_c'' + \frac{R}{L} v_c' + \frac{1}{LC} v_c = \frac{1}{LC} v_s$

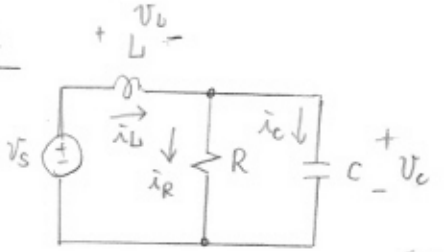
$\alpha = R/2L$, $\omega_0^2 = 1/LC \Rightarrow \alpha^2 = \omega_0^2 \Rightarrow R^2 = 4L/C$

$Q_{ser} = \left(\frac{L}{C}\right)^{1/2} R = \left(\frac{L}{C}\right)^{1/2} / \left(\frac{4L}{C}\right)^{1/2} = \frac{1}{2}$

9.44 let $x = A_4 t e^{-\alpha t} \Rightarrow \frac{dx}{dt} = A_4 e^{-\alpha t} + A_4 t(-\alpha) e^{-\alpha t} = (1 - \alpha t) A_4 e^{-\alpha t}$

$\frac{dx}{dt} = 0 \Rightarrow t = 1/\alpha$, $x_{max} = A_4 (1/\alpha) e^{-\alpha/\alpha} = A_4/\alpha e$

9.46



$P_1, P_2 = -5 \pm \sqrt{(25 - 16)} = -2, -8$

$v_L(0^+) = v_s(0^+) - v_c(0^+) = 0$

$i_L'(0^+) = v_L(0^+)/L = 0$

$\begin{bmatrix} 1 & 1 \\ -2 & -8 \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \end{bmatrix} = \begin{bmatrix} 3 - 0 \\ 0 \end{bmatrix} \Rightarrow A_1 = 4, A_2 = -1$

$i_L(t) = 4e^{-2t} - e^{-8t}$

9.52 $\alpha^2 = \omega_0^2 \Rightarrow P_1 = P_2 = -5$, $i_L(0^+) = i_L(0^-) = 0$, $v_c(0^+) = v_c(0^-) = 0$

$v_L(0^+) = 20 - v_c(0^+) = 20$, $i_L'(0^+) = v_L(0^+)/L = 10$, $I_{ss} = 20/R = 4$

$A_3 = 0 - 4 = -4$, $A_4 = 10 + 5(-4) = -10$

$i_L(t) = 4 - 4e^{-5t} - 10te^{-5t}$

9.60 $\alpha^2 = \omega_0^2 \Rightarrow P_1 = P_2 = -5$, $I_{ss} = 30/5 = 6$

$i_L(0^+) = i_L(0^-) = -10/R = -2$, $v_c(0^+) = v_c(0^-) = -10$

$v_L(0^+) = 30 - v_c(0^+) = 40$, $i_L'(0^+) = v_L(0^+)/L = 20$

$A_3 = -2 - 6 = -8$, $A_4 = 20 + 5(-8) = -20$

$i_L(t) = 6 - 8e^{-5t} - 20te^{-5t}$