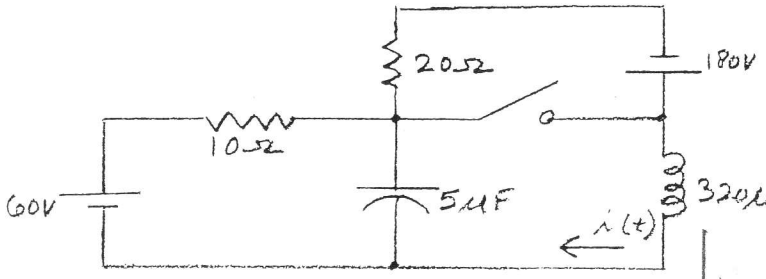
ECE 252
100 Points

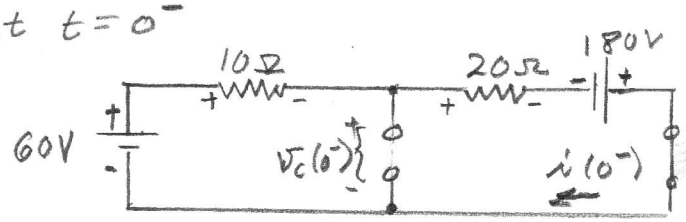
Introduction to Electrical Engineering
Show your work.

Quiz 9P
Practice Solution



Find i(t) for t ≥ 0+ . The switch is closed at t = 0.

at $t = 0^-$



KVL: $-60 + 10i(0^-) + 20i(0^-) - 180 = 0$

$30i(0^-) = 240$

$i(0^-) = 240/30 = \underline{8A}$

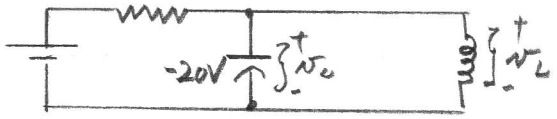
KVL: $-60 + 10(8) + v_c(0^-) = 0$

$v_c(0^-) = 60 - 80 = \underline{-20V}$

---

at $t = 0^+$ $\quad i(0+) = i(0^-) = \underline{8A}$

$v_c(0^+) = v_c(0^-) = \underline{-20V}$



KVL: $v_L(0+) - v_c(0+) = 0$

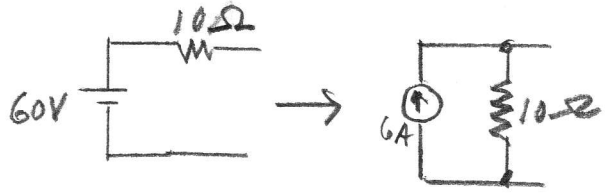
$v_c(0+) = v_L(0+) = -20$

$v_L = L\frac{di}{dt}$

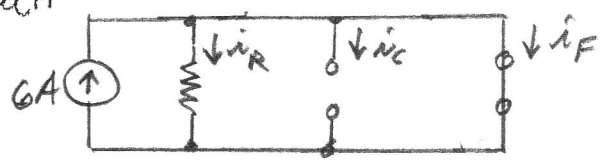
$i'(0) = v_L/L = -20/320\times10^{-6}$

$i'(0) = \underline{-62,500\ A/s}$

Source Transformation



at $t = \infty$;

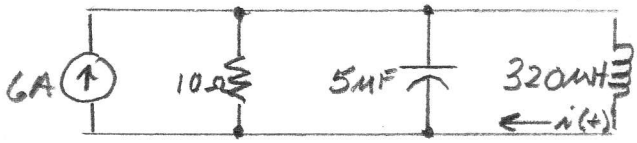


$i_R = V/R = 0$, $i_c = 0$

KCL: $-6 + i_R + i_c + i_F = 0$

$i_F = \underline{6A}$

General circuit for t > 0



$\alpha = \frac{1}{2RC} = \frac{1}{2(10)(5\times10^{-6})} = \underline{10,000\ rad/s}$

$\omega_0 = \sqrt{\frac{1}{LC}} = \sqrt{1/(320\times10^{-6})(5\times10^{-6})}$

$= 25,000\ rad/s$

$\omega_0 > \alpha$, ∴ underdamped

$i(t) = i_F + B_1 e^{-\alpha t}\cos\omega_d t + B_2 e^{-\alpha t}\sin\omega_d t$

$i(0) = 8 = 6 + B_1 \rightarrow B_1 = 2$

$i'(t) = -\alpha B_1 e^{-\alpha t}\cos\omega_d t - \omega_d B_1 e^{-\alpha t}\sin\omega_d t$

$-\alpha B_2 e^{-\alpha t}\sin\omega_d t + \omega_d B_2 e^{-\alpha t}\cos\omega_d t$

$i'(0) = -62,500 = -\alpha B_1 + \omega_d B_2$

$\omega_d = \sqrt{\omega_0^2 - \alpha^2} = 22,913\ rad/s$

$-62,500 = -(10,000)(2) + (22,913)(B_2)$

$B_2 = (20,000 - 62,500)/22,913 = -1.85$

$i(t) = 6 + 2e^{-10000t}\cos 22913t$

$\quad - 1.85e^{-10000t}\sin 22913t\ A$