EE 40 MIDTERM I SOLUTIONS : SPRING 2001

① a) $v_c(t=0) = 0V = v_c(t=0^+) \Rightarrow i(t=0^+) = \dfrac{10V - 0V}{50\Omega + 50\Omega + 10\Omega} = 0.5A$

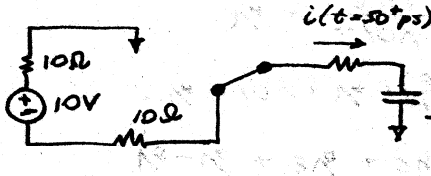
b) $v_c(t) = A + Be^{-t/\tau}$ $\quad \tau = RC = [20\Omega][1pF] = 20ps$

$t = 0^+ \Rightarrow v_c(0^+) = A + B = 0V$
$t \to \infty \Rightarrow v_c(\infty) = A = 10V$
$\Big\} A = 10V,\ B = -10V.$

$v_c(t) = 10V\left[1 - e^{-t/20ps}\right]$, $t \in (0, 50ps) \Rightarrow v_c(50ps) = 10V\left[1 - e^{-50/20}\right] = 9.2V$

$\therefore q = Cv_c = 1pF \cdot 9.2V = 9.2\,pC$

c) At $t = 50^+ ps$, circuit is



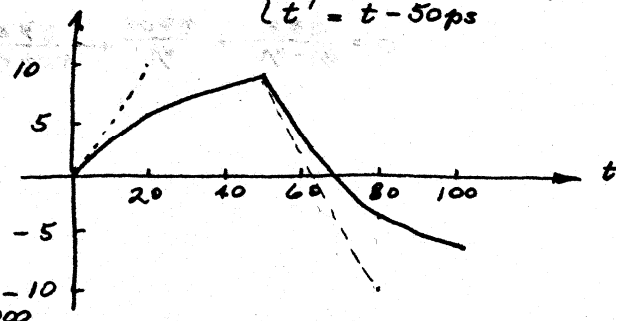
$i(t = 50^+ps) = \dfrac{-10 - 9.2\ V}{30\Omega}$

$= -0.64A$

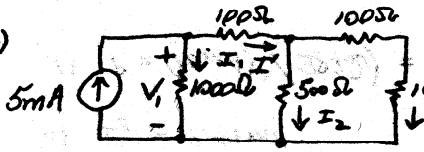
d)

Solution for $v_c(t)$ $[t > 50ps]$ is $v_c(t') = A' + B'e^{-t'/\tau'}$ $\quad \begin{cases} \tau' = R'C = 80\Omega \cdot 1pF \\ t' = t - 50ps \end{cases}$

$v_c(t = 50ps) = 9.2V = A' + B'$
$v_c(t \to \infty) = -10V = A'$
$\Big\} B' = +19.2V$



② a)



$V_1 = I_1(1k\Omega)$
$V_1 = (5mA)R_{eq}$.

$R_{eq} = \{[(100 + 1000) \| 500] + 100\Omega\} \| (1000\Omega) = 444 \| 1000$
$= 307\Omega \Rightarrow I_1 = \dfrac{V_1}{1k\Omega} = \dfrac{(5mA)(R_{eq})}{1k\Omega} = 1.54mA.$

b) Find I_2 using a current divider:

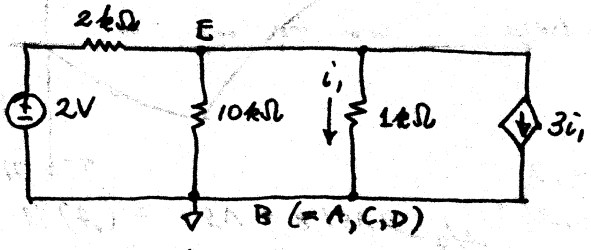
$I' = 5mA - 1.54mA = 3.46mA.$

$I_2 = I'\left[\dfrac{1100\Omega}{500 + 1100}\right] = 2.38mA.$

c) $I_3 = I' - I_2 = 3.46 - 2.38 = 1.08mA.$

d) $P = I^2R_{eq} = (5mA)^2(307\Omega) = 7.7mW$

③ a)



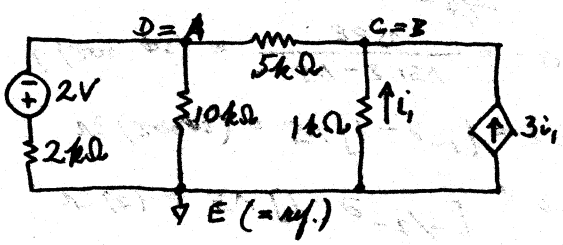
b) KCL @ node E: $\dfrac{i_1}{10}$, i_1, i_1

$\dfrac{V_E - 2V}{2k\Omega} + \dfrac{V_E}{10k\Omega} + \dfrac{V_E}{1k\Omega} + 3\left[\dfrac{V_E}{1k\Omega}\right] =$

$i_1\left[\frac{1}{2} + \frac{1}{10} + 1 + 3\right] = \dfrac{2V}{2k\Omega} = 1mA$

$i_1 = \dfrac{1mA}{4.6} = 217\mu A.$

c)



d) KCL @ node A: $\dfrac{V_A + 2V}{2k\Omega} + \dfrac{V_A}{10k\Omega} + \dfrac{V_A - V_B}{5k\Omega} =$

KCL @ node B: $\dfrac{V_B - V_A}{5k\Omega} + \dfrac{V_B}{1k\Omega} - 3\left(\dfrac{-V_B}{1k\Omega}\right) =$ ($\dfrac{V_B}{1k\Omega} = -i_1$)

$\therefore V_B - V_A + 5V_B + 15V_B = 0.$

$V_B = V_A/21 \Rightarrow 5V_A + 10V + V_A + 2V_A =$

$V_A = \dfrac{-10V}{3.0} = -1.26V$

VARIANT EXAM

B. Lane
2/27/01

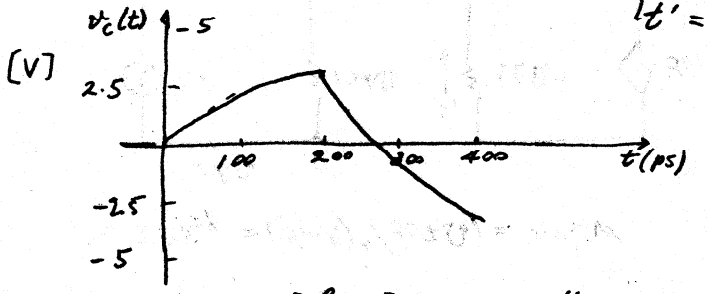
① a) $i(0^+) = \frac{5V}{40\Omega} = 0.125A$

b) $v_c(t) = 5V\left[1 - e^{-t/\tau}\right]$; $\tau = 40\Omega \cdot 5pF = 200ps$.

$v_c(200ps) = 5V\left[1 - e^{-1}\right] = 3.15V \Rightarrow q = (5pF)(3.15V) = 15.75pC$

c) $i(200^+ ps) = \frac{-5V - 3.15V}{30\Omega} = -0.27A$.

d) $v_c(t') = -5V + 8.15V\, e^{-t'/\tau'}$; $\begin{cases} \tau' = 30\Omega \cdot 5pF = 150ps. \\ t' = t - 200ps. \end{cases}$



② a) $I_1 = 10mA\left[\frac{R_{eq}}{500\Omega}\right]$; $R_{eq} = ((1000 \| 750) + 250) \| 500) = 287\Omega$

$= 5.76mA$

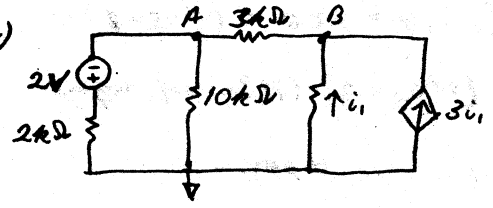
b) $I_2 = (10 - 5.76)\left[\frac{750}{1750}\right] = 1.82mA$

c) $I_3 = 2.42mA$

d) $P = (10mA)^2(287\Omega) = 28.7mW$.

③ a) same, b) same

c)



d) $\frac{V_A + 2V}{2k\Omega} + \frac{V_A}{10k\Omega} + \frac{V_A - V_B}{3k\Omega} = 0$.

$\frac{V_B - V_A}{3k\Omega} + \frac{V_B}{1k\Omega} + \frac{3V_B}{1k\Omega} = 0$.

$V_B - V_A + 3V_B + 9V_B = 0 \Rightarrow V_B = \frac{V_A}{13}$

$5V_A + 10V + V_A + \left(\frac{10}{3}\right)V_A - \left(\frac{10}{3}\right)\left(\frac{1}{13}\right)V_A = 0$.

$V_A = \frac{-10V}{9.07} = -1.1V$.