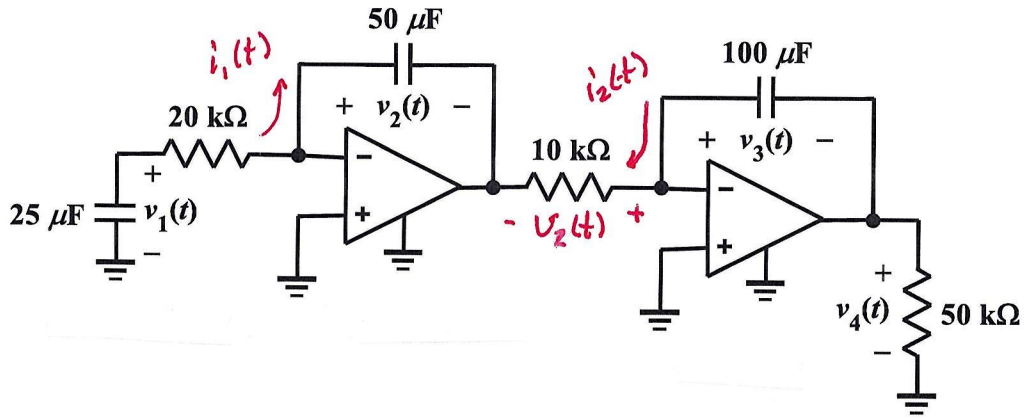
EE 2240

Homework Problem #068



The operational amplifiers are ideal. If $v_1(0) = 20\,\text{V}$, $v_2(0) = -10\,\text{V}$ and $v_3(0) = -5\,\text{V}$, determine $v_4(t)$ for $t \geq 0$.

$\tau = (20\text{k}\Omega)(25\,\mu\text{F}) = 0.5\,\text{s}$

$v_1(t) = 20e^{-2t}\ \text{V},\quad t \geq 0$

$i_1(t) = \dfrac{v_1(t)}{20\text{k}\Omega} = e^{-2t}\ \text{mA},\quad t \geq 0$

$v_2(t) = v_2(0) + \dfrac{1}{50\,\mu\text{F}} \int_0^t i_1(t)\,dt$

$= -10 + 20000\left[-\tfrac{1}{2}e^{-2t} \times 10^{-3}\right]_0^t$

$= -10 - 10\left[e^{-2t} - e^{0}\right] = -10e^{-2t}\ \text{V},\quad t \geq 0$

$i_2(t) = \dfrac{v_2(t)}{10\text{k}\Omega} = -e^{-2t}\ \text{mA},\quad t \geq 0$

$v_3(t) = v_3(0) - \dfrac{1}{100\,\mu\text{F}} \int_0^t i_2(t)\,dt$

$= -5 - 10000\left[\tfrac{1}{2}e^{-2t} \times 10^{-3}\right]_0^t$

$= -5 - 5\left[e^{-2t} - e^{0}\right] = -5e^{-2t}\ \text{V},\quad t \geq 0$

$v_4(t) = -v_3(t) = 5e^{-2t}\ \text{V},\quad t \geq 0$