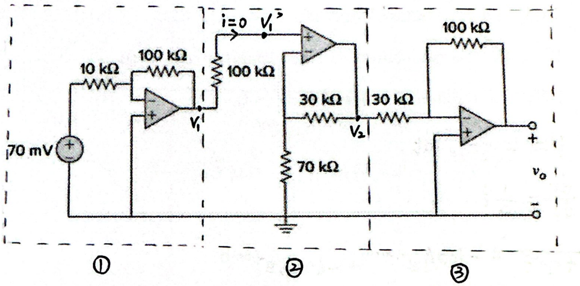
VE215 2025SU Assignment 1

JOINT INSTITUTE 交大密西根学院

Due Date: 23:59, June.12th, 2025
In order to get full marks, you shall write all the intermediate steps of calculation or proof, unless otherwise indicated.

Exercise 3.1 (20%) Find v_0 in the following op amp circuit.



① $V_1 = -\frac{R_f}{R_i} V_i = -\frac{100\times10^3}{10\times10^3} \times 70\times10^{-3} = -0.7V$

② $i=0$

$V_1' = V_1 = -0.7V$

$V_2 = (1+\frac{30\times10^3}{70\times10^3}) \times -0.7 = -1V$

③ $V_0 = -\frac{R_f'}{R_i} V_2 = -\frac{100}{30} \times -1 = \frac{10}{3}V \approx 3.33V$

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Exercise 3.2 (30%) A 4-mF capacitor has the terminal voltage

$$v(t) = \begin{cases} 50\,\mathrm{V}, & t \le 0 \\ Ae^{-100t} + Be^{-600t}\,\mathrm{V}, & t > 0 \end{cases}$$

If the capacitor has an initial current of 2A, find:

(a) (10%) the constants A and B,

(b) (10%) the energy stored in the capacitor at $t = 0$,

(c) (10%) the capacitor current for $t > 0$.

(a) $V(t) = \frac{1}{C}\int_0^t i\,dt$

$\frac{dv}{dt} = \frac{1}{C} i$

$\frac{2}{4\times10^{-3}} = -100Ae^{-100\cdot0} + -600Be^{-600\cdot0}$

$-1\cancel{00}A - 6\cancel{00}B = 5\cancel{00}$ ①

$A + B = 50$ ②

①② $\Rightarrow \begin{cases} A = 61 \\ B = -11 \end{cases}$

(b) $w = \frac{1}{2}Cv^2 = \frac{1}{2}\times4\times10^{-3}\times50^2 = 5\,\mathrm{J}$

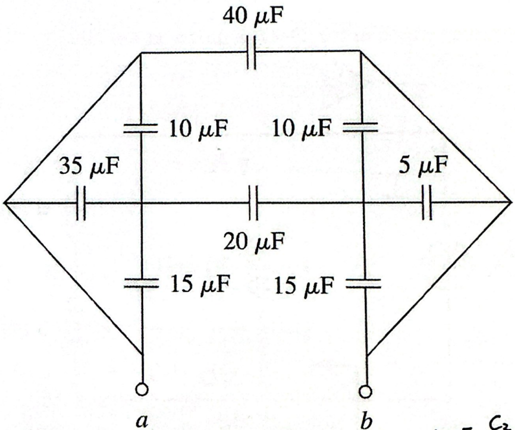
(c) $i = C\frac{dv}{dt}$

$= C\,(-100Ae^{-100t} - 600Be^{-600t})$

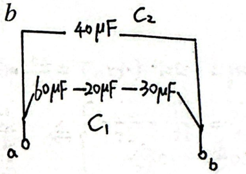
$= 4\times\cancel{10^{-3}}(-61\cancel{00}e^{-100t} + 66\cancel{00}e^{-600t})$

$= -24.4e^{-100t} + 26.4e^{-600t}$ A

Exercise 3.3(10%) Determine C_{eg} for the circuit.



$10\mu F \parallel 35\mu F \parallel 15\mu F = 60\mu F$
$10\mu F \parallel 5\mu F \parallel 15\mu F = 30\mu F$ $\longrightarrow$



$\frac{1}{C_1} = \frac{1}{60\mu F} + \frac{1}{20\mu F} + \frac{1}{30\mu F} \Rightarrow C_1 = 10\mu F$

$C_{eg} = C_1 + C_2 = 50\mu F$

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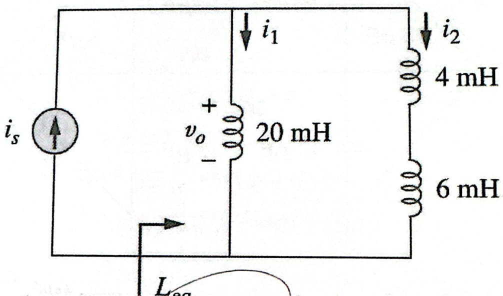
Exercise 3.4 (20%) Find:

(a) (10%) L_{eq}, $i_1(t)$, and $i_2(t)$ if $i_s = 3e^{-t}\,\text{mA}$,

(b) (5%) $v_o(t)$,

(c) (5%) energy stored in the 20-mH inductor at $t = 1\,\text{s}$.



(a) $L_{eq} = 20 \parallel (4+6) = \frac{20}{3}\,\text{mH} = 6.67\,\text{mH}$

$$\left.\begin{array}{l} \frac{di_s}{dt} = \frac{di_1}{dt} + \frac{di_2}{dt} \\ 20\frac{di_1}{dt} = 10\frac{di_2}{dt} \end{array}\right\} \Rightarrow \begin{array}{l} \frac{di_1}{dt} = \frac{10}{30}\frac{di_s}{dt} \\ \frac{di_2}{dt} = \frac{20}{30}\frac{di_s}{dt} \end{array}$$

$i_1 = \frac{1}{3} i_s = e^{-t}\,\text{mA}$

$i_2 = \frac{2}{3} i_s = 2e^{-t}\,\text{mA}$

(b) $V_0 = 20\times10^{-3}\frac{di_1}{dt} = 20\times10^{-3} \cdot -e^{-t}\times10^{-3}$

$= -2\times10^{-5}e^{-t}\ \text{V}$

(c) $w = \frac{1}{2}Li^2 = \frac{1}{2}\times20\times10^{-3}\times(e^{-1}\times10^{-3})^2 = 1.35\times10^{-9}\,\text{J}$

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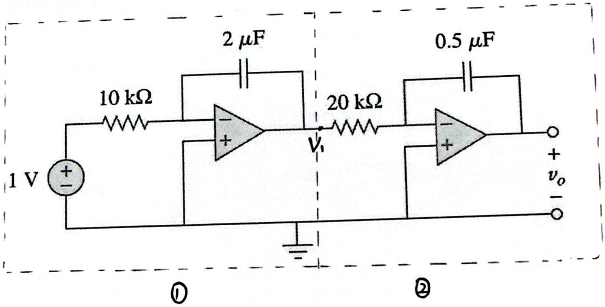
Exercise 3.5 (20%) At $t = 1.5ms$, calculate v_0, due to the cascaded integrators, Assume that the integrators are reset to $0V$ at $t = 0$.



① $V_1 = -\frac{1}{RC}\int_0^t 1\,dt + V_1(0)$

$= -\frac{1}{1\times10^4\times2\times10^{-6}}t + 0$

$= -50t$ (V)

② $V_0 = -\frac{1}{R'C'}\int_0^t -50t\,dt + V_0(0)$

$= -\frac{1}{2\times10^4\times0.5\times10^{-6}}(-25t^2) + 0$

$= 2500t^2$ (V)

$V_0(1.5ms) = 2500\times(1.5\times10^{-3})^2$

$= 5.625\times10^{-3}$ V