Home Assignment 4

IE1206 Embedded Electronics

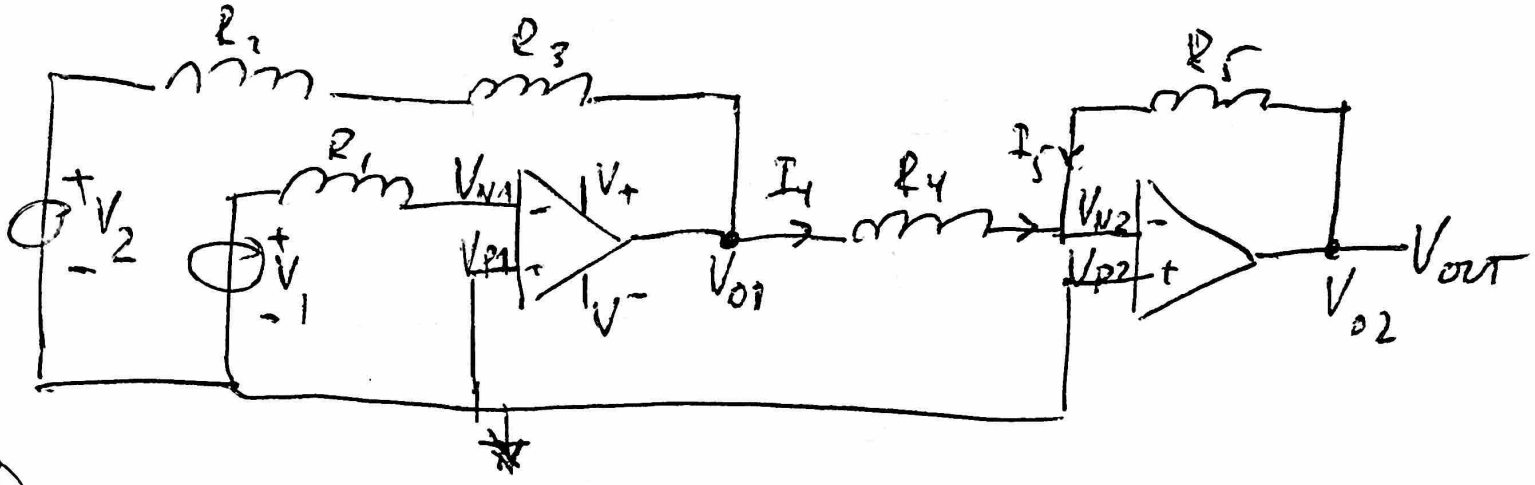
Emil Ståhl

PROBLEM 2

$V_1 = 2\ V$

$V_2 = 3\ V$

$R_1 - R_5 = 2000\ k\Omega$



(A)

$$V_o - \left(-\frac{V_1}{R_1} - \frac{V_2}{R_2}\right) \cdot R_3 = 0$$

KCL: V_{N2} $\quad I_4 + I_5 = 0 \Rightarrow I_4 = \frac{V_{O1} - V_{N2}}{R_4} = \left(-\frac{V_1}{R_1} - \frac{V_2}{R_2}\right)\frac{R_3}{R_4}$

$$I_5 = \frac{V_{O2} - V_{N_2}}{R_5} = \frac{V_{O2} - 0}{R_5} = \frac{V_{O2}}{R_5}$$

$$\frac{V_{O2}}{R_5} + \left(-\frac{V_1}{R_1} - \frac{V_2}{R_2}\right)\frac{R_3}{R_4} = 0 \Rightarrow V_{O2} = \left(\frac{V_1}{R_1} + \frac{V_2}{R_2}\right)\frac{R_3 \cdot R_5}{R_4}$$

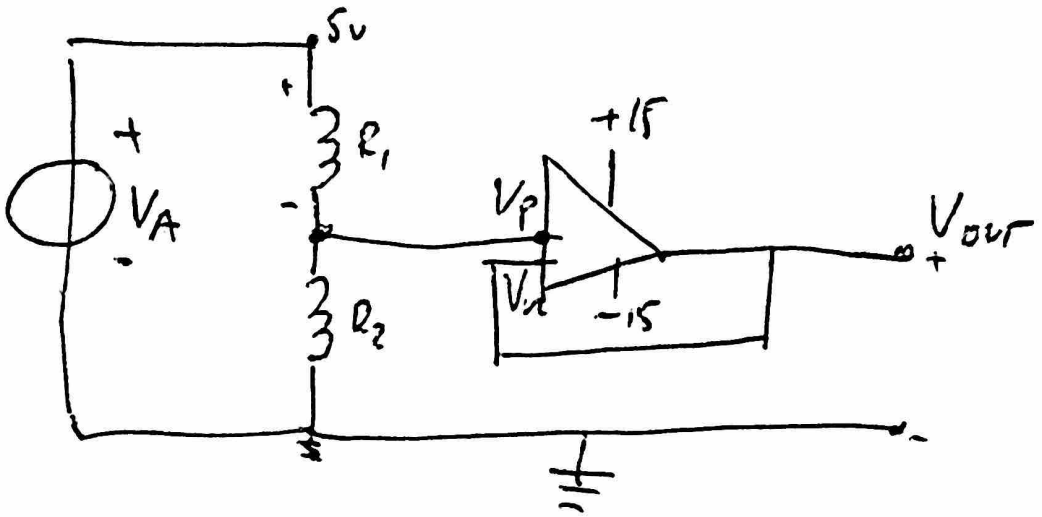
$$V_{OUT} = \left(\frac{V_1}{R_1} + \frac{V_2}{R_2}\right) \cdot \frac{R_3 \cdot R_5}{R_4}$$

(B)

$$V_{OUT} = \left(\frac{2}{2000} + \frac{3}{2000}\right) \cdot \frac{2000 \cdot 2000}{2000}$$

$$V_{OUT} = 5\ V$$

PROBLEM 3



$R_1 = 10000\ \Omega$

$R_2 = 10000\ \Omega$

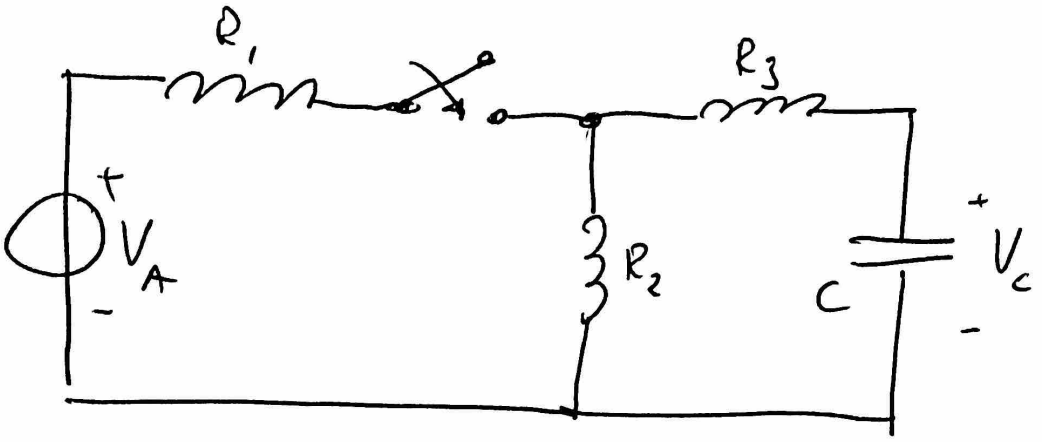
$V_A = 5\ V$

(A) $V_n = V_p$

$$V_p = V_A \cdot \frac{R_1}{R_1 + R_2} \Rightarrow 5 \cdot \frac{10000}{20000} = 2.5\ V$$

$$V_{OUT} = V_n \Rightarrow V_{OUT} = 2.5\ V$$

PROBLEM 4

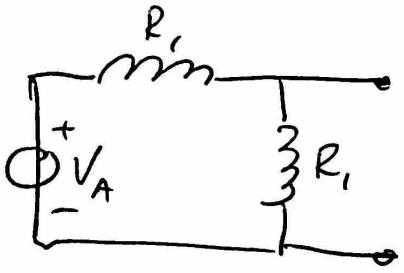


$V_A = 6\ V$

$R_1 - R_2 = 10\,000\ \Omega$

$R_3 = 5000\ \Omega$

$C = 100\ nF$



$$R = \frac{R_2 \cdot R_3}{R_2 + R_3} \Rightarrow \frac{10\,000 \cdot 5000}{10000+5000} = 3333\ \Omega$$

$$V_c(\infty) = V_A \cdot \frac{R}{R+R_1} \Rightarrow 6 \cdot \frac{3333}{10000+3333} = 1,5\ V$$

$$V_c(0) = 0$$

$$R_{TH} = R + R_1 \Rightarrow 3333 + 10000 = 13333\ \Omega$$

$$\tau = R_{TH} \cdot C \Rightarrow 13333 \cdot 0,0000001 = 0,0013333\ s = 1,3\ ms$$

$$V_c(t=0,002) = 1,5 + (0-1,5) \cdot e^{-\frac{0,002}{0,0013333}}$$

$$V_c(t=0,002) = 1,16\ V$$

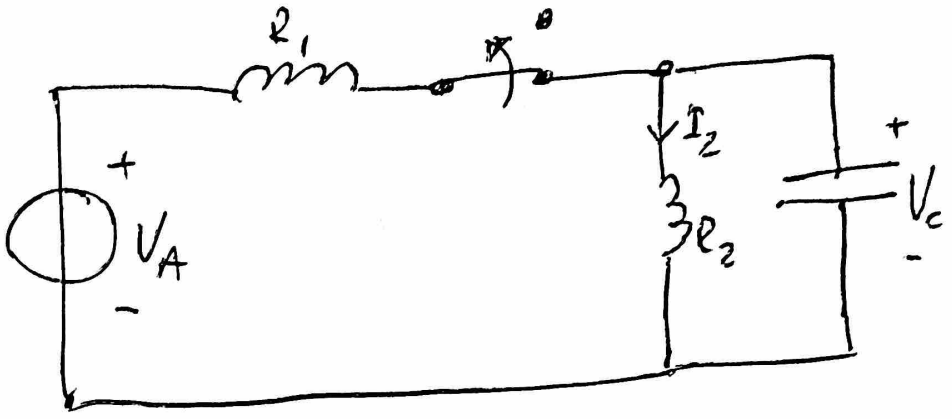
PROBLEM 5

$V_A = 5\,V$

$R_1 = 1000\,\Omega$

$R_2 = 4000\,\Omega$

$C = 2{,}5\,nF$



(A) $V_c(0) = V_A \cdot \frac{R_2}{R_1 + R_2} \Rightarrow 5 \cdot \frac{4000}{5000} = 4\,V$

$V_c(\infty) = 0$

$I_2(t=0) = \frac{V_c}{R_2} \Rightarrow \frac{4}{4000} = 0{,}001 = 1\,mA$

$P_c(0) = I_2 \cdot V_c \Rightarrow 0{,}001 \cdot 4 = 0{,}004 = 4\,mW$

(B) $R_{TH} = \frac{R_1 \cdot R_2}{R_1 + R_2} \Rightarrow \frac{1000 \cdot 4000}{1000 + 4000} = 800\,\Omega$

$\tau = R_{TH} \cdot C \Rightarrow 800 \cdot 0{,}0000000025 = 0{,}000002 = 2\,\mu s$

$V_c(t) = V_c(\infty) + (V_c(0) - V_c(\infty)) \cdot e^{-\frac{t}{\tau}}$

$V_c(t=10\mu s) = 0 + (4 - 0) \cdot e^{-\frac{0{,}00001}{0{,}000002}} = 0{,}027 = 27\,mV$

$I_2(t=10\mu s) = \frac{0{,}027}{4000} = 0{,}00000675 = 6{,}7\,\mu A$

$P_c(10\mu s) = I_2 \cdot V_c \Rightarrow 0{,}0000067 \cdot 0{,}027 = 0{,}00000018$

$P_c = 0{,}18\,\mu W$