YILDIZ TECHNICAL UNIVERSITY

Name, Surname :
Number :
Course Code : BLM1612
Course Name : CIRCUIT THEORY
Exam : ☐ Quiz ⊗ Midterm ☐ Final
Date : 15.12.2016

Please make sure to write your name and student number on each paper that you have used

Question Number	1	2	3	4	5	6	7	8	Total
Mark									

Note: Exam duration is 120 minutes only and max 2 papers can be used.

QUESTIONS

1. A stereo system draws 1.8 A at 120 V. The audio output power is 50 W.
   a. How much power is lost in the form of heat in the system?
   b. What is the efficiency of the system?
2. Determine R_1 for the circuit in Fig. 1

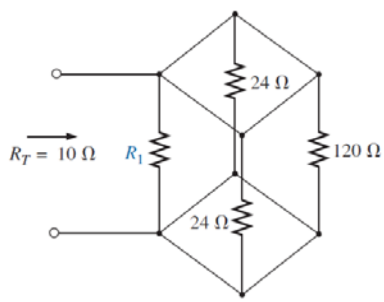


Fig. 1

3. The voltage across a 1 F capacitor is shown on the waveform of Fig. 2. Compute and sketch the current for the time interval $0 < t < 12$ s.

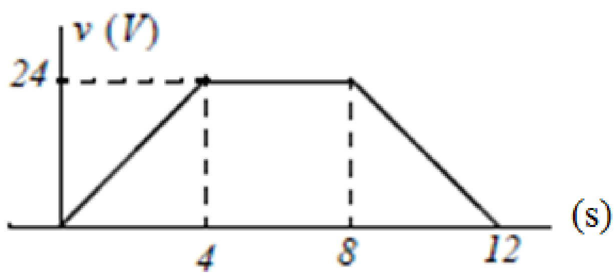


Fig. 2

4. Reduce the circuit in Fig. 3 to the fewest number of components.

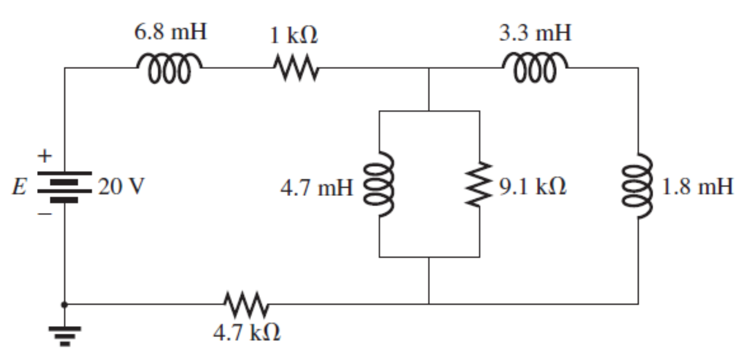


Fig. 3

5. In the circuit of Fig. 4, calculate the phasor voltage $\boldsymbol{V_{OUT2}}$. ($\boldsymbol{V_{IN}}$= -j5 V)

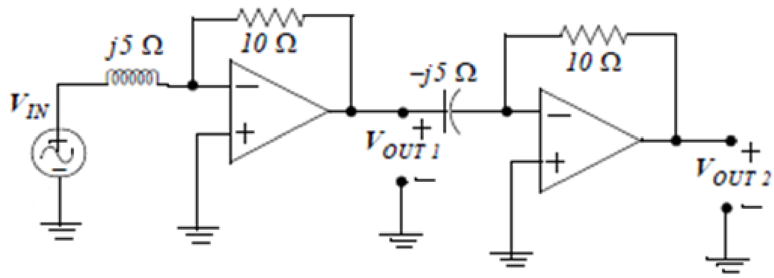


Fig. 4

6. Write loop equations to compute $i_c(t)$ for the circuit of Fig. 5 given that $v_s(t) = 12\sin(100t - 45^0)$ V.

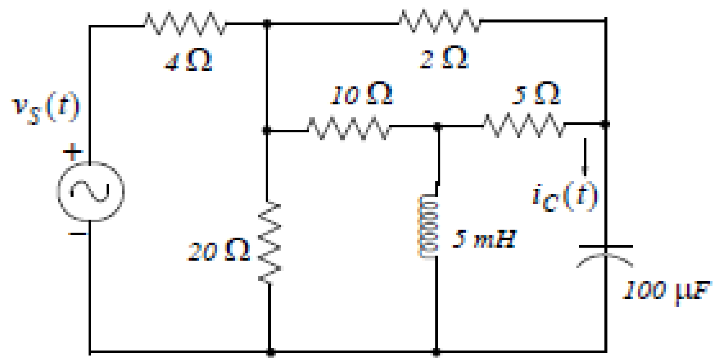


Figure 5

7. The circuit is given in Fig. 6. Find power dissipated in R_5= 36 kΩ using Thevenin equivalent of the circuit

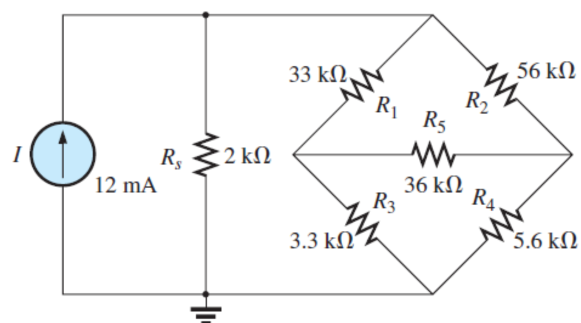


Fig. 6

8. In the circuit of Fig. 7, Switch S_1 has been closed for a long time while Switch S_2 has been open for a long time. Switch S_1 opens and Switch S_2 closes at t=0. In how many second after t=0 has the
   a. Voltage *v(t)* has reached half of its initial value?
   b. Energy stored in C has reached ¾ of its initial value

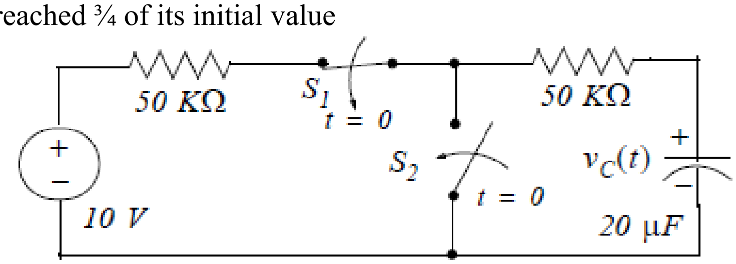


Fig. 7

ANSWERS

1. a) $P_{in} = V \cdot I = 120 \times 1{,}8 = 216 \text{ W}.$

$P_{in} = P_{loss} + P_{out}$

$166 = P_{loss} + 50 \Rightarrow P_{loss} = 216 - 50 = 166 \text{ W}.$

b.) $\eta\% = \dfrac{P_{out} \times 100}{P_{in}} = \dfrac{50 \times 100}{216} = 0{,}2315 \times 100 = \underline{\underline{23{,}15\ \%}}$

2. $R_T = R_1 \parallel 24 \parallel 24 \parallel 120$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{24} + \frac{1}{24} + \frac{1}{120}$$

$$\frac{1}{10} = \frac{1}{R_1} + 0{,}0416 + 0{,}0416 + 0{,}00833$$

$$\frac{1}{R_1} = 0{,}1 - 0{,}09167 = 0{,}00833 \text{ S}$$

$$R_1 = 120\ \Omega$$

3. $i_c = C \cdot \dfrac{dv_c}{dt} = C \cdot \text{slope}$

FOR $0 < t < 4$ s.

$$\text{slope} = \frac{24 - 0}{4} = 6 \text{ V/s}$$

$$i_c = C \cdot \text{slope}\Big|_0^4 = 1 \times 6 = 6 \text{ A}.$$

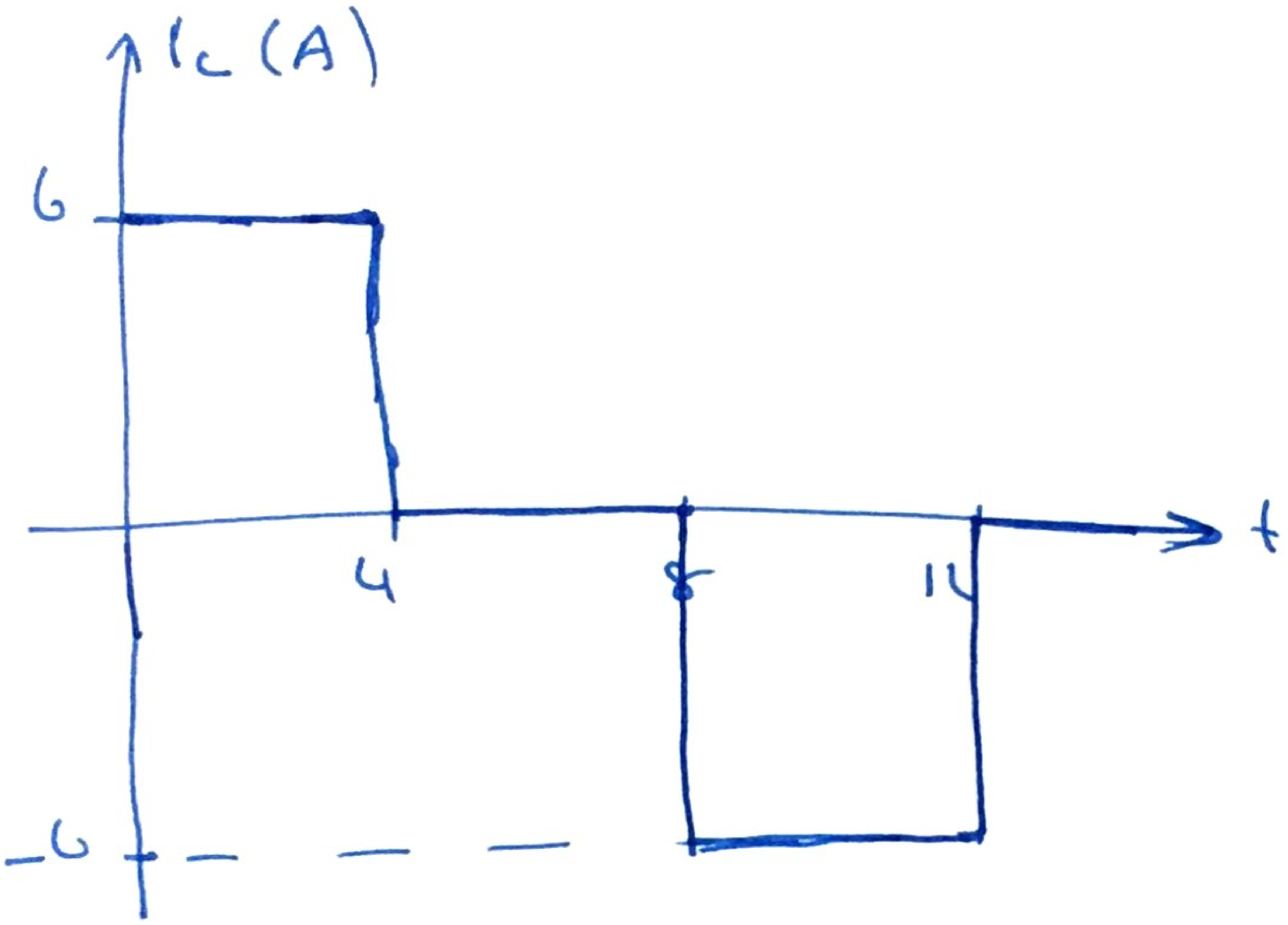
for $4 < t < 8$ s

$$\text{slope} = 0 \Rightarrow i_c = C \cdot \text{slope}\Big|_4^8 = 1 \times 0 = 0 \text{ V}$$

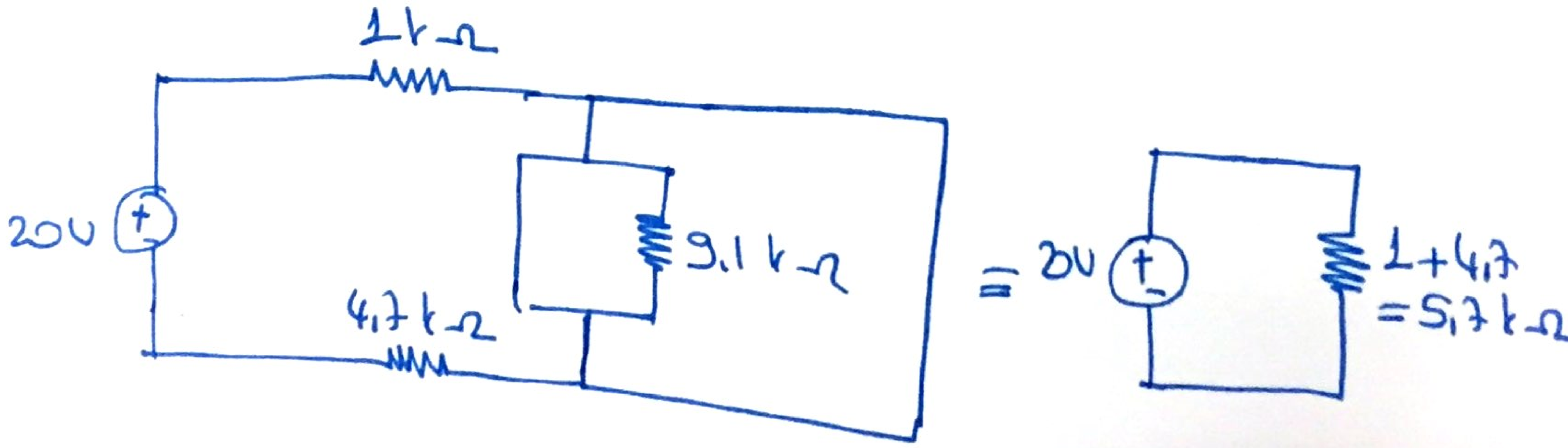
for $8 < t < 12$

$$\text{slope} = \frac{0 - 24}{12 - 8} = -6 \ V/s$$

$$i_c = C \cdot \text{slope}\Big|_8^{12} = 1 \times (-6) = -6 \ V.$$



(4) Under DC condition inductance behaves as if short circuit then the circuit becomes.



(5) $V_{out1} = -\frac{10}{j5} \times (-j5) = 10 \ V$

$V_{out2} = \frac{-10}{-j5} \times 10 = -j2 \times 10 = -j20$

$= 20 \angle -90^\circ$

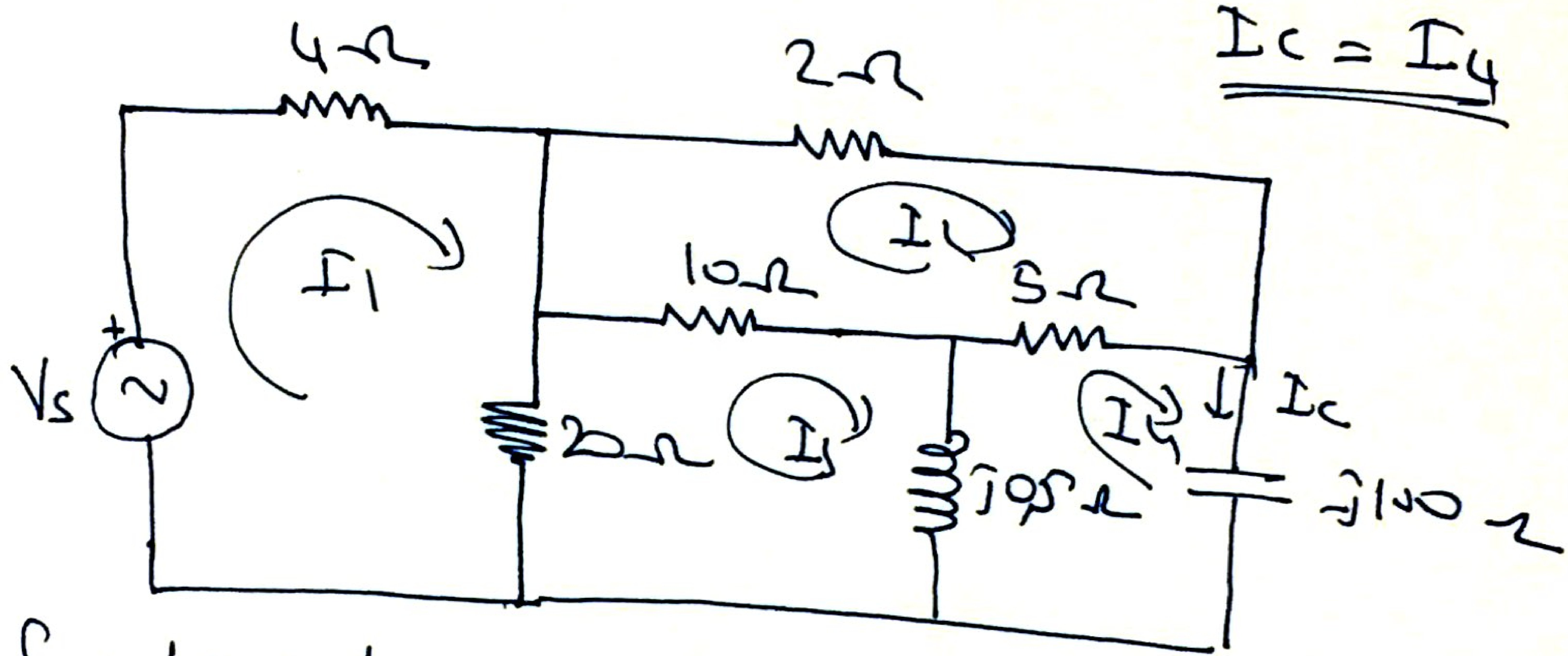
(6) $v_s(t) = 12\sin(100t - 45^\circ) = 12\cos(100t - 45^\circ - 90^\circ)$

$= 12\cos(100t - 135^\circ)$

$V_s = 12\angle{-135^\circ}$

$X_L = j\omega L = j\,100 \times 5 \times 10^{-3} = j0.5\ \Omega$

$X_C = \frac{1}{j\omega C} = \frac{1}{j\,100 \times 100 \times 10^{-6}} = -j100\ \Omega$



for Loop 1

$-V_s + 4I_1 + 20(I_1 - I_3) = 0$

* $24I_1 - 20I_3 = 12\angle{-135^\circ}$

for Loop 2

$2I_2 + 10(I_2 - I_3) + 5(I_2 - I_4) = 0$

* $17I_2 - 10I_3 - 5I_4 = 0$

for Loop 3

$20(I_3 - I_1) + 10(I_3 - I_2) + j0.5(I_3 - I_4) = 0$

* $(30 + j0.5)I_3 - 20I_1 - 10I_2 - j0.5I_4 = 0$ *

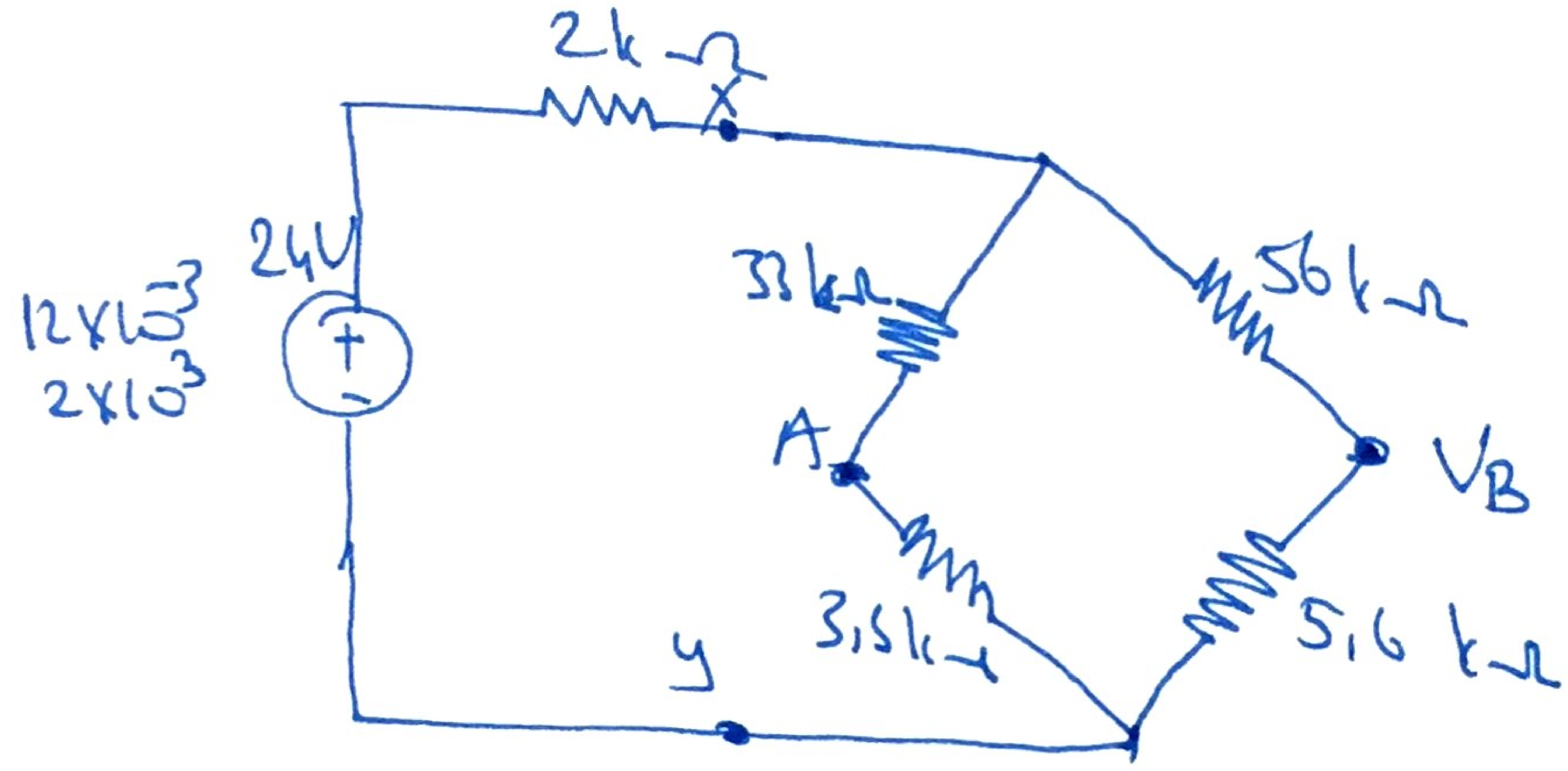
For Loop 4.

$$j0{,}5(I_4 - I_3) + 5(I_4 - I_2) - j100 I_4 = 0$$

$$(5 - j99{,}5) I_4 - j0{,}5 I_3 - 5 I_2 = 0$$

$$\begin{bmatrix} 24 & 0 & -20 & 0 \\ 0 & 17 & -10 & -5 \\ -20 & -10 & 30+j0{,}5 & -j0{,}5 \\ 0 & -5 & -j0{,}5 & 5-j99{,}5 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \end{bmatrix} = \begin{bmatrix} 12\angle -135^\circ \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

7



$$R_{eq} = \frac{36{,}3 \times 61{,}6}{36{,}3 + 61{,}6} = 22{,}84 \text{ k}\Omega$$

$$V_{xy} = \frac{22{,}84}{22{,}84+2} \times 24 = 20{,}42 \text{ V.}$$

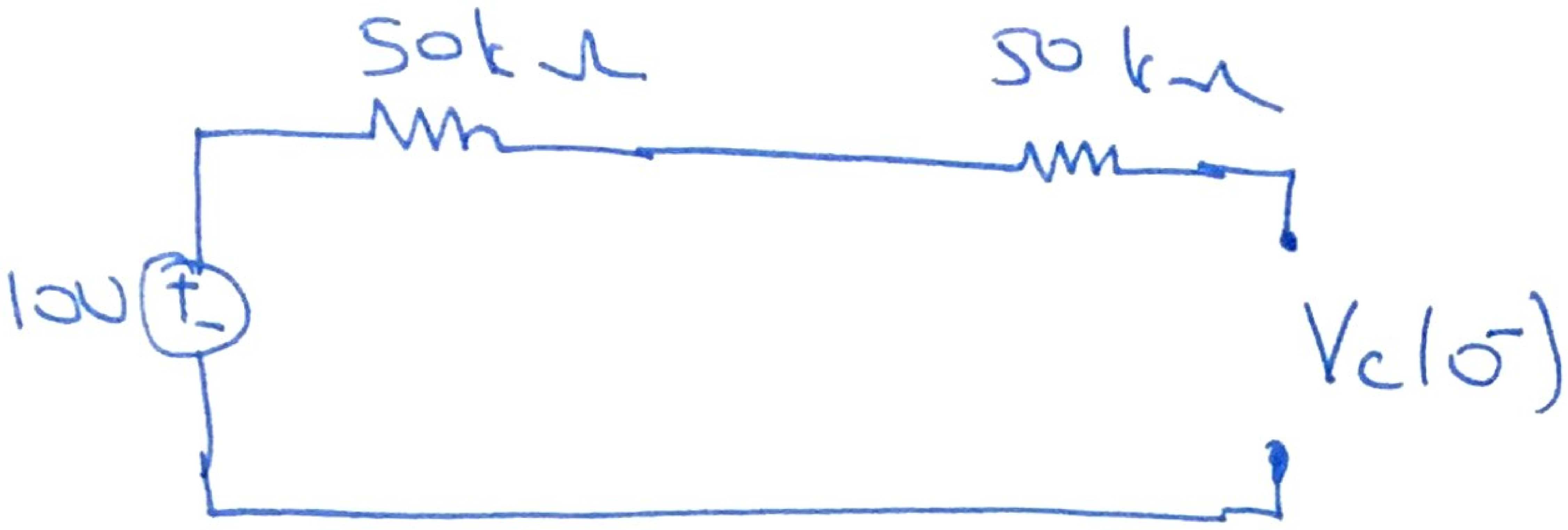
$$V_A = \frac{3{,}3}{36{,}3} \times 20{,}42 = 1{,}86 \text{ V}$$

$$V_B = \frac{5{,}6}{61{,}6} \times 20{,}42 = 1{,}86 \text{ V}$$

$V_{TH} = 0\text{V}$

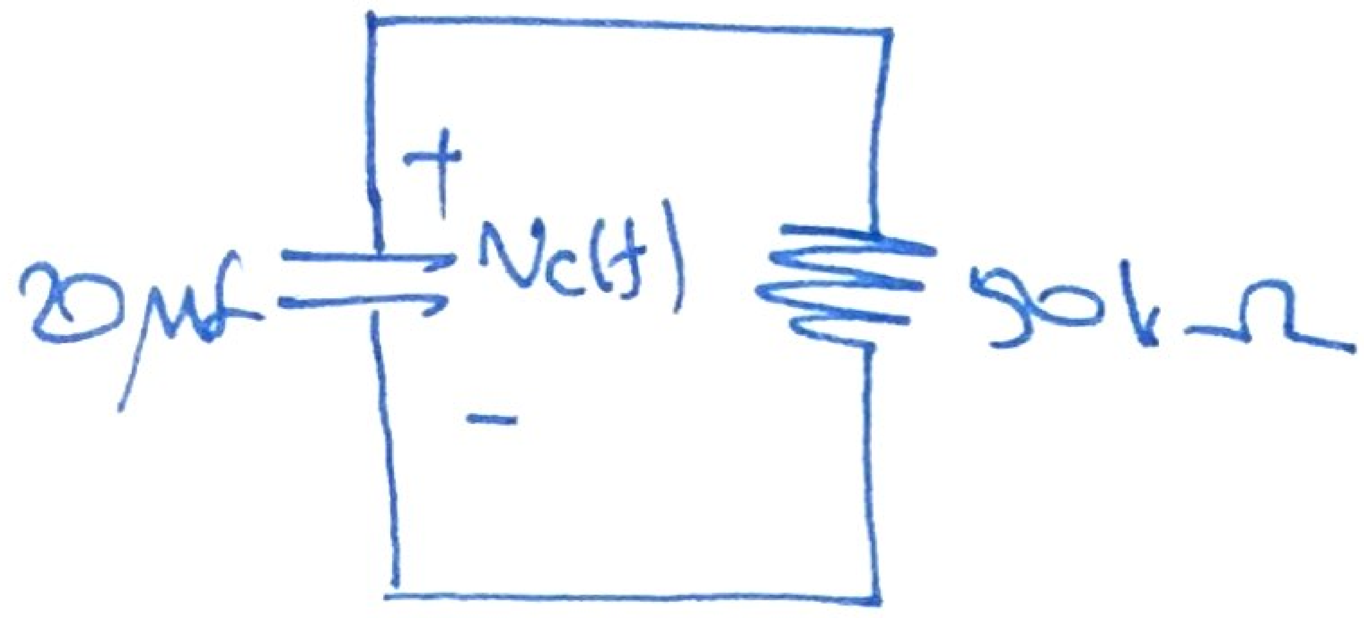
then $P_{R5} = \underline{0 \text{ Watt}}$

8.) At $t = 0^-$ S1 is closed S2 is open



$V_c(0^-) = 10$ V.

At $t = 0^+$



$$v_c(t) = V_0 e^{-t/RC}$$

$$\frac{1}{RC} = \frac{1}{50\times10^{3} \times 20\times10^{-6}}$$

$$\frac{1}{RC} = \frac{1}{1000\times10^{3}\times10^{-6}} = 1$$

$$v_c(t) = 10 e^{-t}$$

a.) $5 = 10 e^{-t} \Rightarrow \ln\left(\frac{5}{10}\right) = -t$

$t = -\ln(0,5) = 0,693 \text{ s} = \underline{\underline{693 \text{ ms}}}$

b.) $W(0) = \frac{1}{2} \cdot 20\times10^{-6} \times 10^{2} = 2 \; \underline{\underline{\text{mJ}}}$

$$\frac{3}{4} W(0) = \frac{1}{2} C \, v_c(t)^2$$

$$\frac{3}{4} = e^{-2t} \Rightarrow t = -\ln\left(\frac{3}{4}\right) = 0,144 \text{ s}$$

$$= \underline{\underline{144 \text{ ms}}}$$