# EE111 Spring 2022

## Homework 1

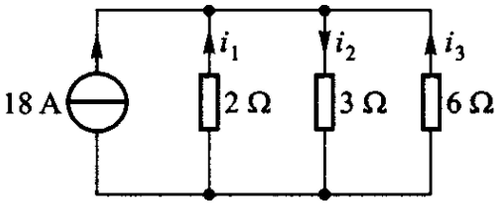
Due date: Feb. $28^{th}$, 2022, Monday
Turn in your homework in class

Rules:

- Work on your own. Discussion is permissible, but extremely similar submissions will be judged as plagiarism.
- Please show all intermediate steps: a correct solution without an explanation will get zero credit.
- Please submit on time. No late submission will be accepted.
- Please prepare your submission in English only. No Chinese submission will be accepted.

1. Find the value of $i_1$, $i_2$, $i_3$.

6'




Using the shunt formula with resistors in parallel, we can get:

$$i_1 = \frac{-\frac{1}{2\Omega}}{\frac{1}{2\Omega}+\frac{1}{3\Omega}+\frac{1}{6\Omega}} \times 18A = -9A \quad 2'$$

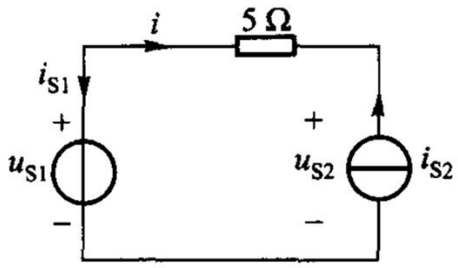
$$i_2 = \frac{\frac{1}{3\Omega}}{\frac{1}{2\Omega}+\frac{1}{3\Omega}+\frac{1}{6\Omega}} \times 18A = 6A \quad 2'$$

$$i_3 = \frac{-\frac{1}{6\Omega}}{\frac{1}{2\Omega}+\frac{1}{3\Omega}+\frac{1}{6\Omega}} \times 18A = -3A \quad 2'$$

Note the relationship between the desired current and the direction of the reference current.

2. Known that the voltage source is $u_{S1} = 10V$, and the current source is $i_{S2} = 3A$, find the power extracted from the voltage source and the current source.

8'




∵ $i_{S1} = i_{S2} = 3A$ 2'

The power extracted from the voltage source is:

$P_{S1} = -u_{S1} \times i_{S1} = -10V \times 3A = -30W$ 2'

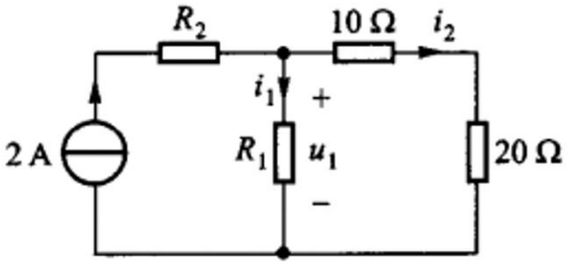
∵ $u_{S2} = u_{S1} + 5\Omega \times i_{S2} = 10V + 5\Omega \times 3A = 25V$ 2'

The power extracted from the current source is:

$P_{S2} = u_{S2} \times i_{S2} = 25 \times 3A = 75W$ 2'

3. Known that $u_1 = 30V$, find the value of the resistor $R_1$.

8'




The equation of KVL is:

$u_1 = 10\Omega \times i_2 + 20\Omega \times i_2 = 30V$ 2'

$\Rightarrow \quad i_2 = \frac{30V}{10\Omega + 20\Omega} = 1A$ 2'

Using KCL equation we can deduce:

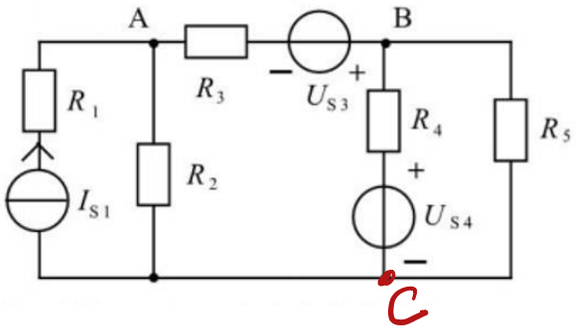
$i_1 = 2A - i_2 = 1A$ 2'

So $R_1 = \frac{u_1}{i_1} = \frac{30V}{1A} = 30\Omega$ 2'

The value of $R_2$ does not affect the calculation result.

4. Known that $U_{S3} = U_{S4} = 10V$, $I_{S1} = 10A$, $R_1 = R_2 = 5\Omega$, $R_3 = 4\Omega$, $R_4 = R_5 = 2\Omega$. Using nodal analysis, find $U_{AB}$.

12'



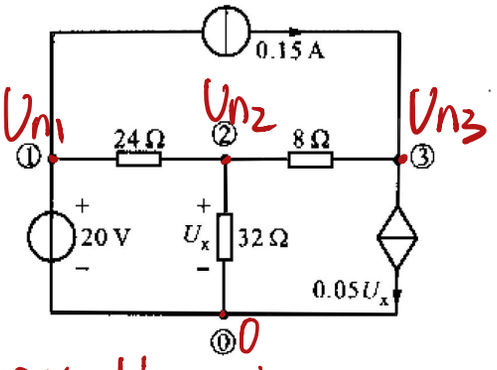

Suppose point C is the potential reference point.

$$\begin{cases} \left(\frac{1}{R_2} + \frac{1}{R_3}\right)V_A - \frac{1}{R_3}V_B = I_{S1} - \frac{U_{S3}}{R_3} & 4' \\ -\frac{1}{R_3}V_A + \left(\frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}\right)V_B = \frac{U_{S3}}{R_3} + \frac{U_{S4}}{R_4} & 4' \end{cases}$$

$$\Rightarrow \begin{cases} V_A = 22.5V \\ V_B = 10.5V \end{cases} \quad 4'$$

$$V_{AB} = V_A - V_B = 12V$$

5. Using nodal analysis, find the value of $U_X$. 14'



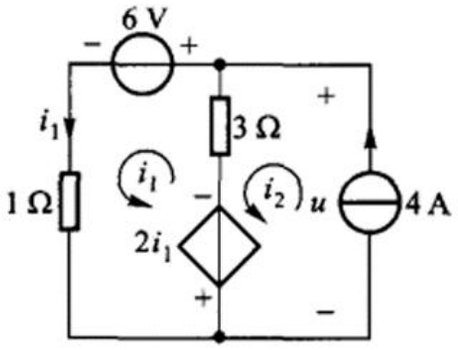

The node voltage equation is:

$$\begin{cases} U_{n2} = 20 & 2' \\ -\frac{1}{24}U_{n1} + \left(\frac{1}{24} + \frac{1}{32} + \frac{1}{8}\right)U_{n2} - \frac{1}{8}U_{n3} = 0 & 4' \\ -\frac{1}{8}U_{n2} + \frac{1}{8}U_{n3} = 0.15 - 0.05U_x & 4' \\ U_x = U_{n2} & 2' \end{cases}$$

$$\Rightarrow \begin{cases} 19U_{n2} - 12U_{n3} = 80 \\ -3U_{n2} + 5U_{n3} = 6 \end{cases}$$

$$\Rightarrow \quad \text{So} \quad U_x = U_{n2} = 8V \qquad 2'$$

6. Using mesh analysis, find the voltage u and the current $i_1$. 12'




The mesh equation is:

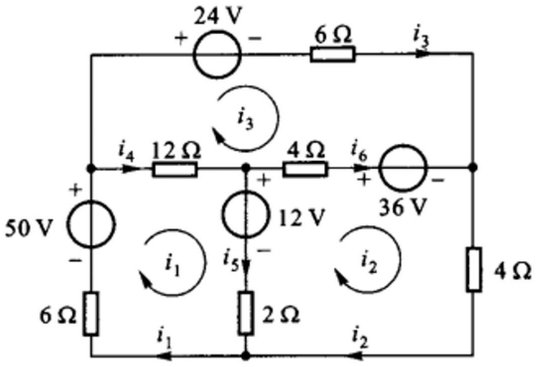
$$\begin{cases} (1\Omega+3\Omega)\times i_1-(3\Omega)\times i_2=-6V-(2\Omega)\times i_1 & 4' \\ i_2=4A & 4' \end{cases}$$

$$\Rightarrow \quad (6\Omega)\times i_1=-6V+12V$$

$$\Rightarrow \quad i_1=1A \ 2' \qquad u=6V+1\Omega\times 1A=7V \ 2'$$

7. Using mesh analysis, find $i_1,\ i_2,\ i_3,\ i_4,\ i_5,\ i_6$.

24'




The mesh equation is:

$$\begin{cases} (12\Omega+2\Omega+6\Omega)i_1-(2\Omega)i_2-(12\Omega)i_3=-12V+50V & 4' \\ -(2\Omega)i_1+(4\Omega+4\Omega+2\Omega)i_2-(4\Omega)i_3=-36V+12V & 4' \\ -(12\Omega)i_1-(4\Omega)i_2+(6\Omega+4\Omega+12\Omega)i_3=-24V+36V & 4' \end{cases}$$

$$\Rightarrow \begin{cases} 20i_1-2i_2-12i_3=38 \\ -2i_1+10i_2-4i_3=-24 \\ -12i_1-4i_2+22i_3=12 \end{cases}$$

$\Rightarrow$ $i_1=3A$ 2' $i_2=-1A$ 2' $i_3=2A$ 2'

Using KCL: $i_4=i_1-i_3=1A$ 2'

$i_5=i_1-i_2=4A$ 2'

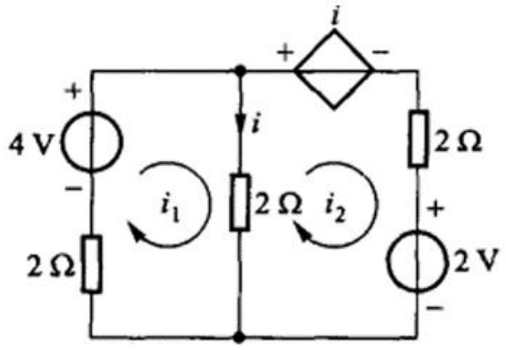
$i_6=i_2-i_3=-3A$ 2'

We can use KVL equation of the outer mesh to check the result.

$(6\Omega)\times 3A-50V+24V+(6\Omega)\times 2A+(4\Omega)\times(-1A)=0$

8. Using mesh analysis, find $i_1$, $i_2$.

16'




The mesh equation is:

$(2\Omega+2\Omega)\times i_1-(2\Omega)\times i_2=4V$ 4'

$-(2\Omega)\times i_1+(2\Omega+2\Omega)\times i_2=-2V-(1\Omega)\times i$ 4'

Supplementary equation: $i=i_1-i_2$ 4'

$$\Rightarrow \begin{cases} 4i_1-2i_2=4A \\ -i_1+3i_2=-2A \end{cases} \Rightarrow i_1=0.8A \quad i_2=-0.4A$$

2' 2'