EE1-Fall2022 HW1 Solution

Digital Image Processing (International University - VNU-HCM)

Name:

ID :

PRINCIPLES OF EE1

<u>Homework #1</u> - Solution

Submission deadline: ……….

IMPORTANT: You should hand in a copy of your report that contains a full and detailed description of all the work done on the homework. Marks will be deducted if there are sign of violation of regulation and late submission (20% for each day). <u>*You should print out this document and write down your solution directly on it.*</u>

Tip: You should draw a bounding box for your final answer. Ex: Y = ABC + AC = $\boxed{AC}$

Problem 1: **(20 marks)** Calculate the equivalent resistance R_{ab} in the circuits

a/

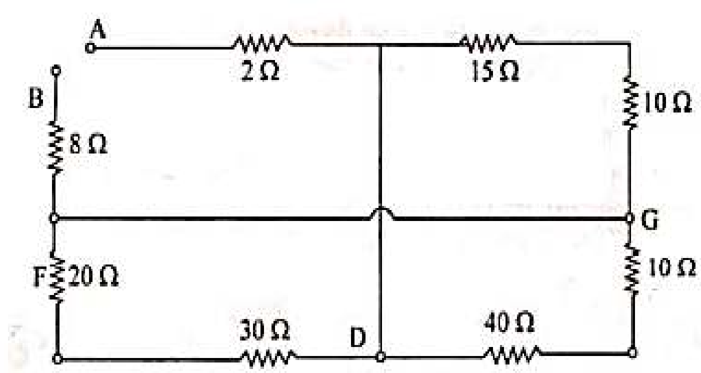


Figure 1.1

b/

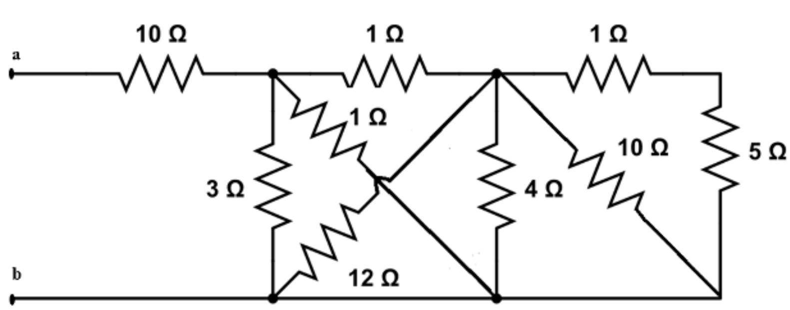
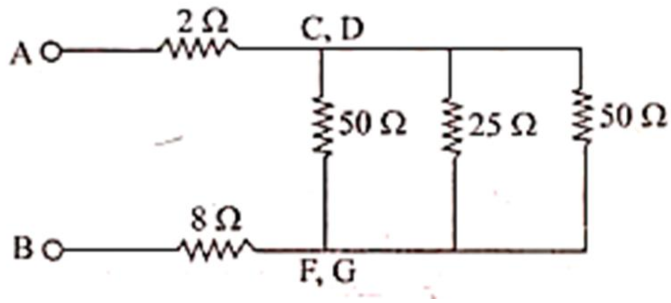


Figure 1.2

Solution

a/

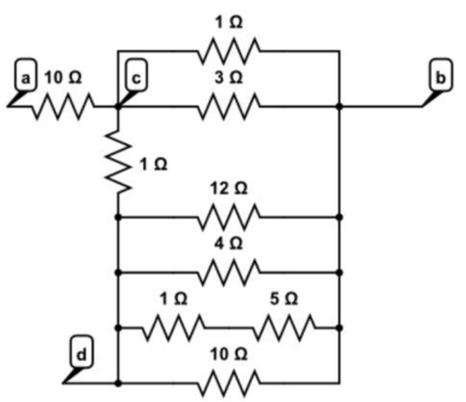
In Figure 1.1, redraw the circuit as below

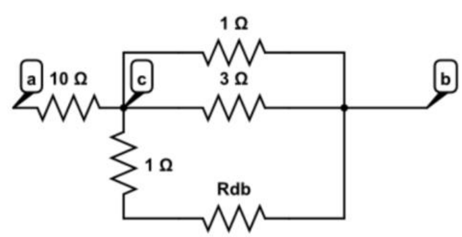


$$\boldsymbol{R_{AB} = 2 + \frac{1}{\frac{1}{50} + \frac{1}{25} + \frac{1}{50}} + 8 = 22.5\ \Omega}$$

b/

In Figure 1.2





$$\frac{1}{R_{db}} = \frac{1}{12} + \frac{1}{4} + \frac{1}{1+5} + \frac{1}{10} = 0.6\ \Omega$$

$$R_{db} = 5/3\ \Omega$$

$$\frac{1}{R_{cb}} = 1 + \frac{1}{3} + \frac{1}{1+5/3} = 1.703\ \Omega$$

$$R_{cb} = 0.58\ \Omega$$

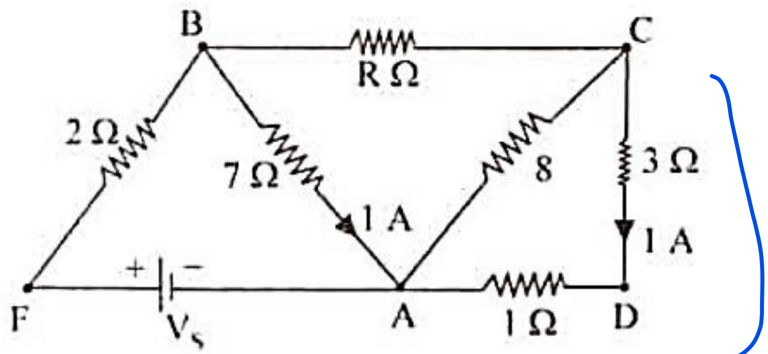
$$\boldsymbol{R_{ab} = 10 + 0.58 = 10.58\ \Omega}$$

Problem 2: (15 marks)

Apply Kirchoff's Laws to find:

a/ The values of R

b/ V_s



4V

Figure 2

Solution

a/

$V_{CA} = 1(3+1) = 4V$

$I_{CA} = \frac{4}{8} = 0.5\ A$

Apply KCL at node C

$$I_{CB} = -(I_{CA} + I_{CD}) = -(0.5+1) = -1.5\ A$$

Apply KVL for loop BCA

$$V_{BC} = -V_{CA} - V_{AB} = -4 - (-7 \times 1) = 3\ V$$

⇨ $\boldsymbol{R = \frac{V_{BC}}{I_{CB}} = 2\ \Omega}$

b/

Apply KCL at node B

$$I_{FB} = I_{BA} + I_{BC} = 1 + 1.5 = 2.5\ A$$

⇨ $V_{FB} = 2 \times 2.5 = 5\ V$

⇨ $\boldsymbol{V_S = V_{FA} = V_{BA} + V_{FB} = 7 + 5 = 12\ V}$

Problem 3: (15 marks)

Using voltage divider to find the values of R_1, R_2, R_3 and R_4 if the source current is 16 mA in the Figure 3.

100 − 36 − 12 − 20

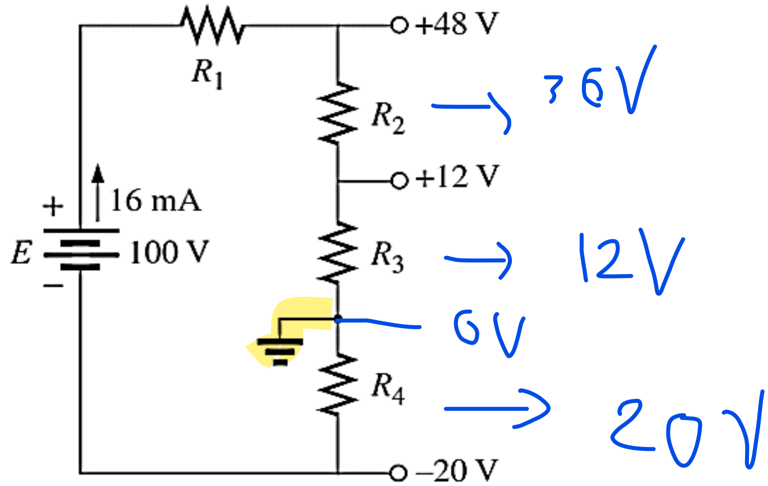


Figure 3

Solution

$$V_{R_2} = 48\text{ V} - 12\text{ V} = 36\text{ V}$$

$$R_2 = \frac{V_{R_2}}{I} = \frac{36\text{ V}}{16\text{ mA}} = \mathbf{2.25\ k\Omega}$$

$$V_{R_3} = 12\text{ V} - 0\text{ V} = 12\text{ V}$$

$$R_3 = \frac{V_{R_3}}{I} = \frac{12\text{ V}}{16\text{ mA}} = \mathbf{0.75\ k\Omega}$$

$$V_{R_4} = 20\text{ V}$$

$$R_4 = \frac{V_{R_4}}{I} = \frac{20\text{ V}}{16\text{ mA}} = \mathbf{1.25\ k\Omega}$$

$$V_{R_1} = E - V_{R_2} - V_{R_3} - V_{R_4}$$

$$= 100\text{ V} - 36\text{ V} - 12\text{ V} - 20\text{ V} = 32\text{ V}$$

$$R_1 = \frac{V_{R_1}}{I} = \frac{32\text{ V}}{16\text{ mA}} = \mathbf{2\ k\Omega}$$

Problem 4: (20 marks)

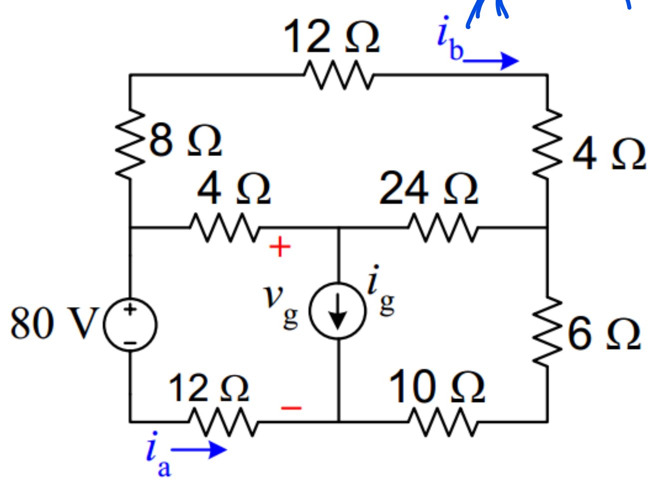
In Figure 4, we get the circuit with the currents $i_a = 4A$ and $i_b = 2A$.

a/ Find i_g

b/ Determine the power dissipated in each resistor

c/ Find v_g

2A

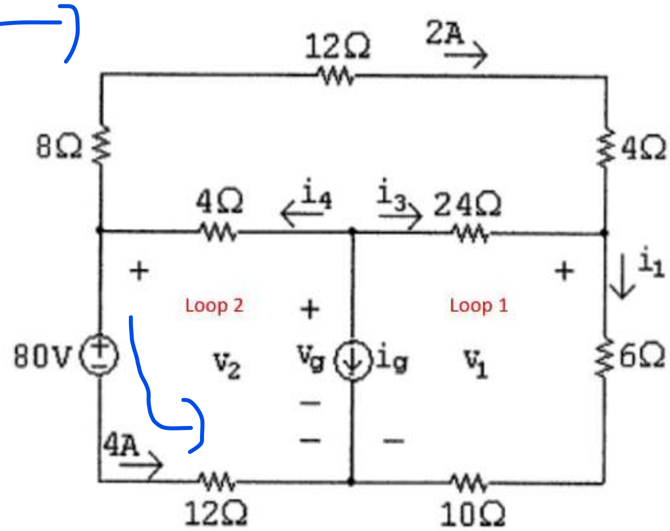


4A

Figure 4

Solution

a/



$I =$

$\boxed{U = I R}$

Apply KVL, we have:

For loop 2: $v_2 = 80 + 4 \times 12 = 128\ V$

For loop the loop that goes all the way around the outside:

$$-v_2 + (8 + 12 + 4) \times 2 + v_1 = 0 \Leftrightarrow v_1 = 128 - (8 + 12 + 4) \times 2 = 80\ V$$

$$i_1 = \frac{v_1}{6 + 10} = 5\ A$$

$$i_3 = i_1 - 2 = 3\ A$$

$$v_g = v_1 + 24i_3 = 152\ V$$

$$i_4 = 2 + 4 = 6\ A$$

$$\boldsymbol{i_g = -i_4 - i_3 = -9\ A}$$

b/

$$\boldsymbol{p_{8\Omega} = 8 \times 2^2 = 32\ W}$$
$$\boldsymbol{p_{4\Omega} = 4 \times 2^2 = 16\ W}$$
$$\boldsymbol{p_{24\Omega} = 24 \times 3^2 = 216\ W}$$
$$\boldsymbol{p_{10\Omega} = 10 \times 5^2 = 250\ W}$$

$$\boldsymbol{p_{12\Omega} = 12 \times 2^2 = 48\ W}$$
$$\boldsymbol{p_{4\Omega} = 4 \times 6^2 = 144\ W}$$
$$\boldsymbol{p_{6\Omega} = 6 \times 5^2 = 150\ W}$$
$$\boldsymbol{p_{12\Omega} = 12 \times 4^2 = 192\ W}$$

c/ $\boldsymbol{v_g = v_2 - 4 \times (-i_4) = 128 - 4 \times (-6) = 128 + 24 = 152\ V}$

Problem 5: (30 marks)

Using Delta to Wye or Wye to Delta transformation to determine:

a. Current I_s (*Hint: Redraw the circuit with a Y (Wye) configuration*) in Figure 5.1.
b. Current I (*Hint: Redraw the circuit with a Delta configuration*) in Figure 5.2.
c. The equivalent resistor R_{ab} in Figure 5.3.

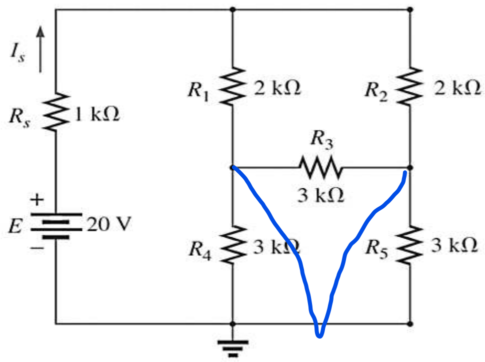


Figure 5.1

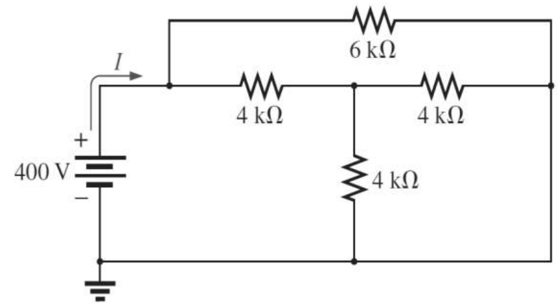


Figure 5.2

100 Ω

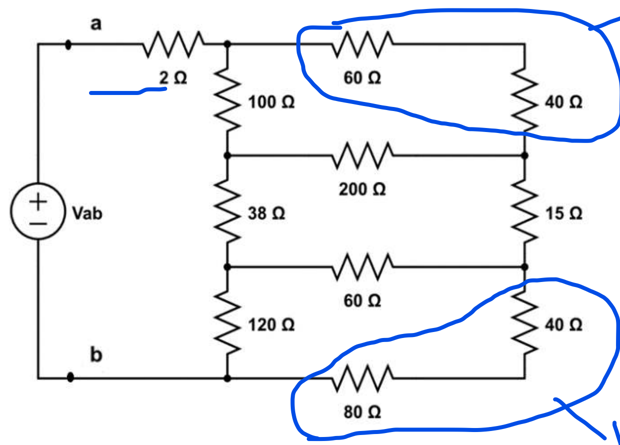
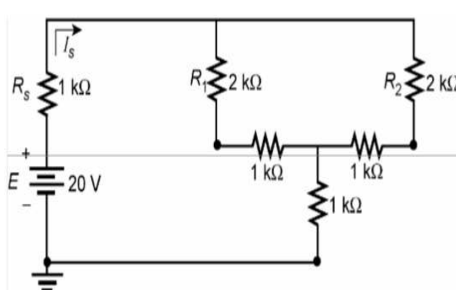


Figure 2.3

120 Ω

Solution

a/



Consider R_3, R_4 and R_5, we transform them into R_a, R_b and R_c

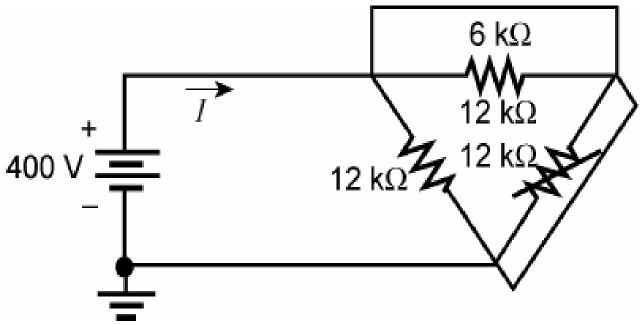
Due to $R_3 = R_4 = R_5$, so we have: $R_a = R_b = R_c = \frac{3\times3}{3+3+3} = \mathbf{1\ k\Omega}$

$R_{(eq)} = 1 + [(2+1) \parallel (2+1)] + 1 = 1 + 1.5 + 1 = 3.5\ k\Omega$

$$I_s = \frac{E}{R_{eq}} = \frac{20}{3.5} = \mathbf{5.71\ mA}$$

b/

$R_a = R_b = R_c = 12\ k\Omega$

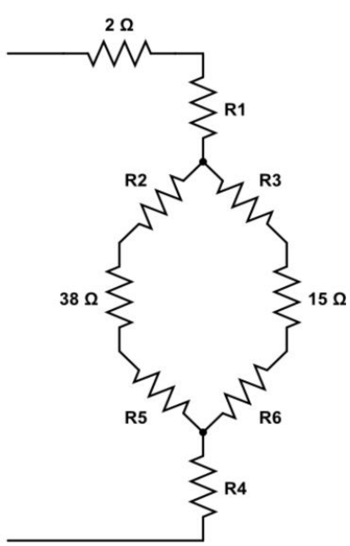


$R_{eq} = 12 \,||\, 6 \,||\, 12 = 3\ (k\Omega)$

$$I = \frac{400}{3} = \mathbf{133.3\ (mA)}$$

c/

Using Delta to Wye transformation, we get the new circuit:



$R_1 = \frac{100\times100}{400} = 25\Omega$

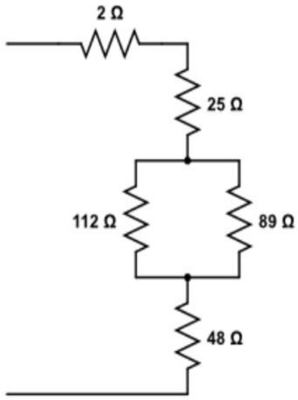
$R_2 = \frac{100\times200}{400} = 50\Omega$

$R_3 = \frac{200\times100}{400} = 50\Omega$

$R_4 = \frac{120\times120}{300} = 48\Omega$

$R_5 = \frac{120\times60}{300} = 24\Omega$

$R_6 = \frac{60\times120}{300} = 24\Omega$



$$R_{ab} = 2 + 25 + \frac{112 \times 89}{112 + 89} + 48 = 124.6\ \Omega$$