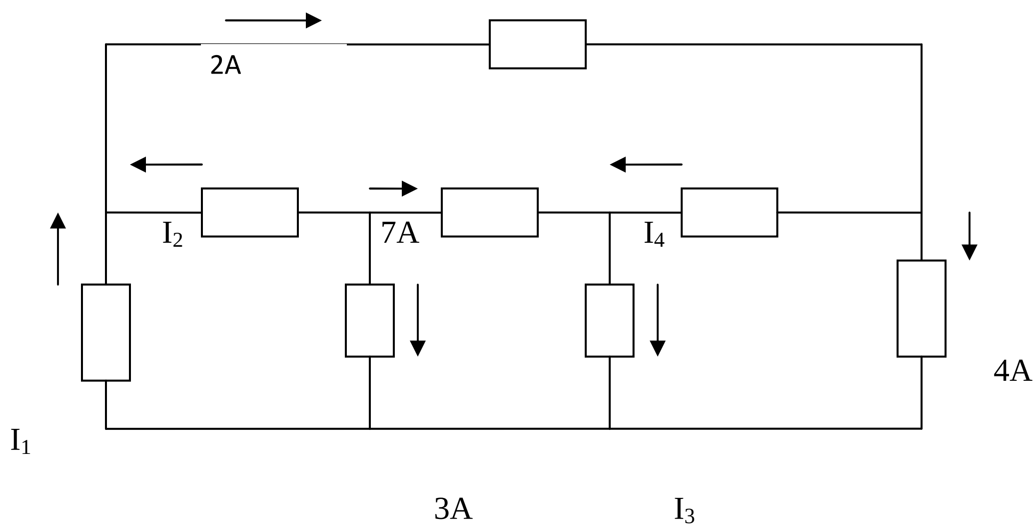
Midterm 1 Solutions

1.



At node 2,

$$3+7+I_2=0 \longrightarrow I_2=-10A$$

At node 1,

$$I_1+I_2=2 \longrightarrow I_1=2-I_2=12A$$

At node 4,

$$2=I_4+4 \longrightarrow I_4=2-4=-2A$$

At node 3,

$$7+I_4=I_3 \longrightarrow I_3=7-2=5A$$

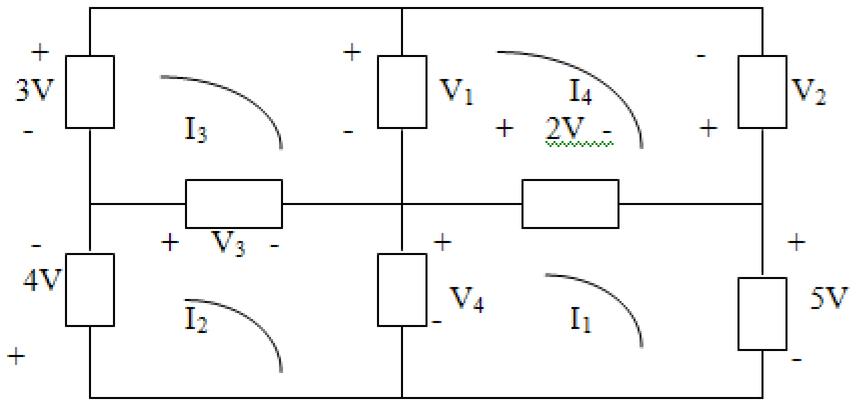
Hence,

$$\underline{I_1=12A, \quad I_2=-10A, \quad I_3=5A, \quad I_4=-2A}$$

Grading : “5” points for each node.

a. “1” point each sign/value of the current in each node.

2.



For mesh 1,

$$-V_4 + 2 + 5 = 0 \quad \longrightarrow \quad V_4 = 7V$$

For mesh 2,

$$+4 + V_3 + V_4 = 0 \quad \longrightarrow \quad V_3 = -4 - 7 = -11V$$

For mesh 3,

$$-3 + V_1 - V_3 = 0 \quad \longrightarrow \quad V_1 = V_3 + 3 = -8V$$

For mesh 4,

$$-V_1 - V_2 - 2 = 0 \quad \longrightarrow \quad V_2 = -V_1 - 2 = 6V$$

Thus,

$$\underline{V_1 = -8V, \quad V_2 = 6V, \quad V_3 = -11V, \quad V_4 = 7V}$$

Grading : “5” points for each mesh.

a. “1” point each sign/value of the voltage in each mesh.

3.

Starting from far right side of the network:

1. 1 & 1 in series resulting in 2 ohms.
2. 2 & 1 are in parallel resulting in 2/3 ohm.
3. 2/3 and 1 in series resulting in 5/3 ohm.
4. 5/3 and 1 in parallel resulting in 5/8 ohm.
5. 5/8 and 1 in series resulting in Req as:

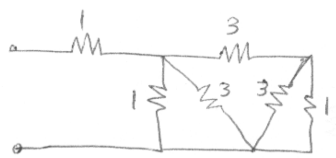
$$R_{eq} = 1 + 1//(1 + 1//2) = 1 + 1//(1+ 2/3) =1+ 1//5/3 = \underline{\mathbf{1.625\ \Omega}}$$

Grading: “2” points each part.

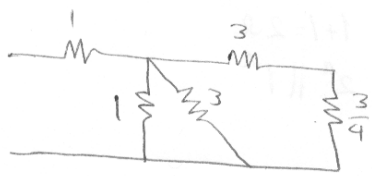
If you did Delta-Y:

“2” points for each part in the picture below.

Y → Δ :

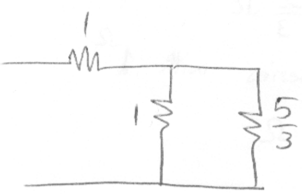
1. 

$1 \parallel 3 = \frac{3}{4}\ \Omega$

2. 

$3 + \frac{3}{4} = \frac{15}{4}\ \Omega$

$\frac{15}{4} \parallel 3 = \frac{5}{3}\ \Omega$

3. 

$\frac{5}{3} \parallel 1 = \frac{5}{8}\ \Omega$

4. 

Grading: "5" points each part.

5. $R_{eq} = 1 + \frac{5}{8} = \frac{13}{8}\ \Omega$

4.

1. 5 in parallel with 20 resulting in 4 ohms.
2. 15 & 15 & 15 are all in parallel resulting in 5 ohms all together.
3. 24 and 8 in parallel resulting in 6 ohms.
4. All the above are in series with the 4ohms and 5ohms also resulting in Req as:

$$R_{eq} = 4 + 5 // 20 + \frac{1}{3} x15 + 5 + 24 // 8 = 4 + 4 + 5 + 5 + 6 = 24$$

5. I = 48/24 = **2 A**

Grading: "2" points each part.

5.

Let R_1 and R_2 be in kΩ.

$$R_{eq} = R_1 + R_2 \| 5 \qquad (1)$$

$$\frac{V_0}{V_S} = \frac{5 \| R_2}{5 \| R_2 + R_1} \qquad (2)$$

From (1) and (2), $0.05 = \frac{5 \| R_1}{40} \longrightarrow 2 = 5 \| R_2 = \frac{5R_2}{5 + R_2}$ or $R_2 = 3.333$ kΩ

From (1), $40 = R_1 + 2 \longrightarrow R_1 = 38$ kΩ

Thus **$R_1 = 38$ kΩ, $R_2 = 3.333$ kΩ**

Grading: “7” points for equation (1).

“5” points for coming up with the equation 2.

“3” points for equation in the third line above ending with 2= 5 \\ R_2 .

“5” points calculating R_2 and R_1 finally.

If you go with KVL:

“7” points again for equation (1).

“3” points for writing down the correct KVL.

“5” points to end up with the equation (2) after the KVL or something like that to use the V_o /V_s ratio.

“5” points to calculate both R_1 and R_2 finally.

6.

As it can be seen from the network, the equivalent resistance between node “a” and “b” is the combination of one resistor “R” (which connects node “a” to “b”) in parallel with the rest of the network. Therefore, the result for R_{ab} should be less than or equal to R.

Grading: “20” point for anything between “0” and “R”.

“10” points for any effort that leads to R_{ab} greater than “R”.

No point for blank paper!