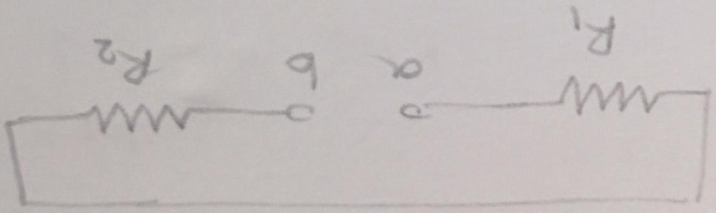
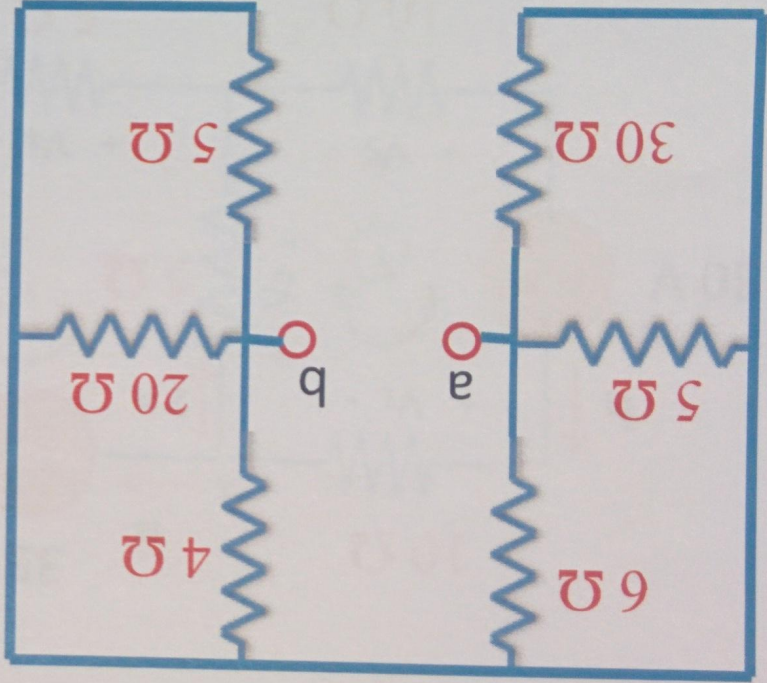


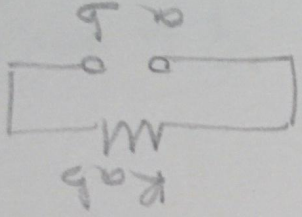
Question 1 (15 points)

Find the equivalent resistance across nodes "a" and "b".



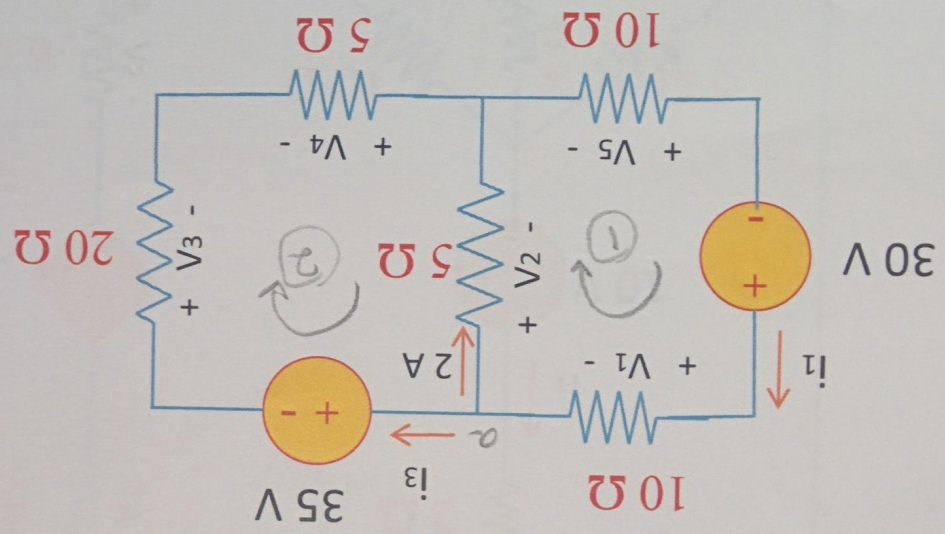
$$R_1 = (30 \parallel 6 \parallel 5) = 2.5\ \Omega$$

$$R_2 = (4 \parallel 20 \parallel 5) = 2\ \Omega$$



$$R_{ab} = R_1 + R_2 = 4.5\ \Omega$$

Question 2 (30 points).
 Find the current i_1 and i_3 . Also find voltages V_1 through V_5 .



At node a ,
 $i_1 = i_3 + 2$

KVL around loop ①

$$-30 + 10i_1 + 5.2 + 10i_1 = 0$$

$$20i_1 = 20$$

$$i_1 = 1 \text{ A}$$

KVL around loop ②

$$35 + 20i_3 + 5i_3 - 5.2 = 0$$

$$25i_3 = -25$$

$$i_3 = -1 \text{ A}$$

$$V_1 = 10 \cdot i_1 = 10 \cdot 1 = 10 \text{ V}$$

$$V_2 = 5 \cdot 2 = 10 \text{ V}$$

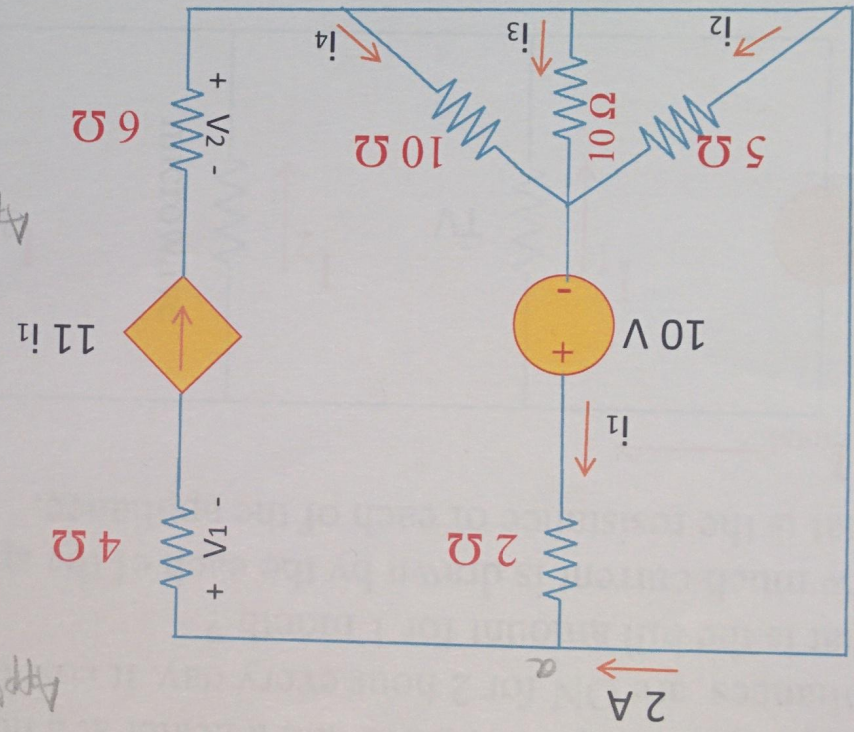
$$V_3 = 20 \cdot i_3 = 20(-1) = -20 \text{ V}$$

$$V_4 = -5 \cdot i_3 = -5(-1) = 5$$

$$V_5 = -10 \cdot i_1 = -10(1) = -10 \text{ V}$$

Question 3 (30 points)

Find currents i_1, i_2, i_3, i_4 and voltages V_1, V_2 .



$$V_1 = 11\Omega \cdot 4 = 8.8 \text{ V}$$

$$V_2 = -11\Omega \cdot 6 = -13.2 \text{ V}$$

At node a,

$$2 + i_1 = 11 i_1$$

$$10 i_1 = 2$$

$$i_1 = \frac{2}{10} = \frac{1}{5} \text{ A}$$

Applying KVL through loop containing,

$$10\text{V} - 2\Omega - 5\Omega,$$

$$-10 + 2 \cdot i_1 + 5 i_2 = 0$$

$$-10 + 2 \cdot \frac{1}{5} + 5 i_2 = 0$$

$$i_2 = 9.62 = \frac{48}{5} = 9.6 \text{ A}$$

Applying KVL through loop containing,

$$10\text{V} - 2\Omega - 10\Omega,$$

$$-10 + 2 i_1 + 10 i_3 = 0$$

$$-10 + 2 \cdot \frac{1}{5} + 10 i_3 = 0$$

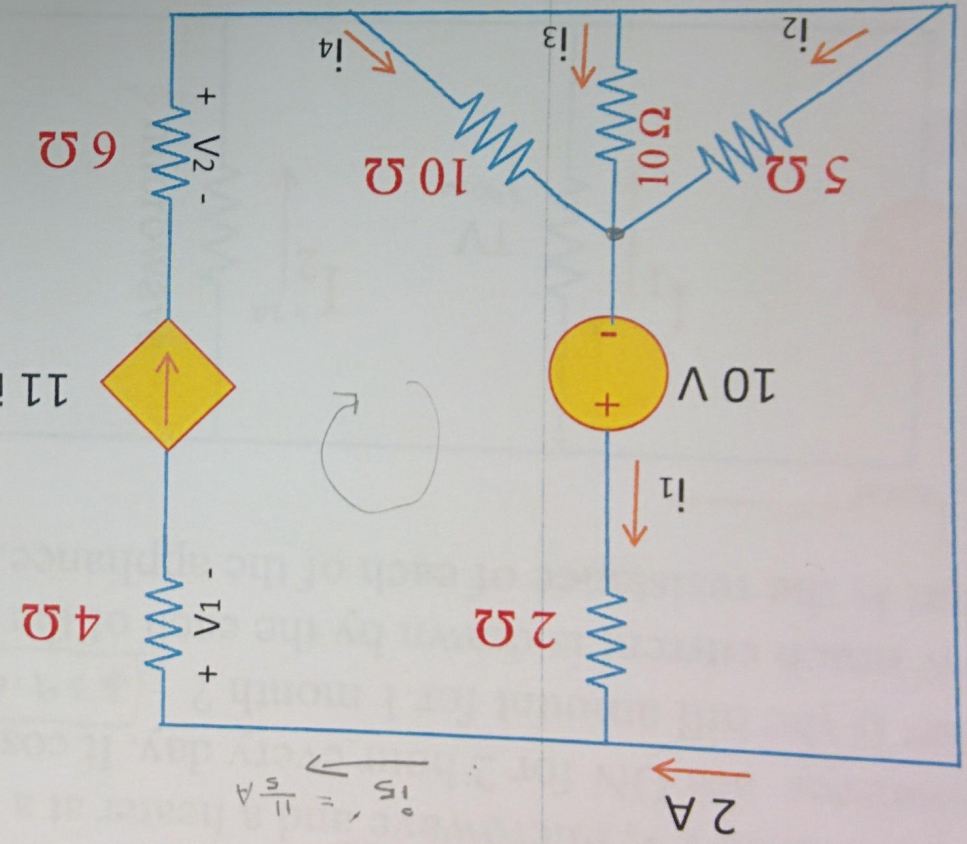
$$i_3 = 9.63 = \frac{48}{5} = 9.6 \text{ A}$$

At node b,

$$i_2 + i_3 + i_4 = i_1$$

$$i_4 = -2.68 \text{ A}$$

Question 3 (30 points)
 Find currents i_1, i_2, i_3, i_4 and voltages V_1, V_2 .



$$R_{eq} = \frac{100}{20} = 5$$

$$5.5 = \frac{10}{25} = 2.5 \Omega$$

$$V = IR \quad I = \frac{V}{R}$$

$$V = I_1 (R_{eq})$$

$$V = \frac{1}{5} (2.5) = 0.5V$$

$$I_2 = \frac{0.5V}{5\Omega} = \frac{1}{10} A$$

$$I_3 = \frac{0.5V}{10\Omega} = \frac{1}{20} A$$

$$I_4 = \frac{0.5V}{10\Omega} = \frac{1}{20} A$$

$$I_1 = \frac{5}{11} A$$

$$I_2 = \frac{1}{10} A$$

$$I_3 = \frac{1}{20} A$$

$$I_4 = \frac{1}{20} A$$

$$V_1 = (I_5)(4\Omega)$$

$$V_1 = \frac{5}{11} \cdot 4 = \frac{44}{11} V$$

$$V_1 = \frac{44}{11} V$$

$$V_2 = - (I_5)(6\Omega)$$

$$V_2 = - \left(\frac{5}{11}\right) \cdot 6 = -\frac{66}{11} V$$

$$V_2 = -\frac{66}{11} V$$

$$i_1 = \frac{1}{11} A$$

$$i_2 = \frac{1}{20} A$$

$$i_3 = \frac{1}{20} A$$

$$i_4 = \frac{1}{20} A$$

$$i_1 = i_2 + i_3 + i_4$$

$$i_1 = \frac{1}{20} + \frac{1}{20} + \frac{1}{20} = \frac{3}{20}$$

$$2 + i_1 = i_5 \rightarrow 2 + \frac{3}{20} = i_5$$

$$i_5 = \frac{43}{20}$$

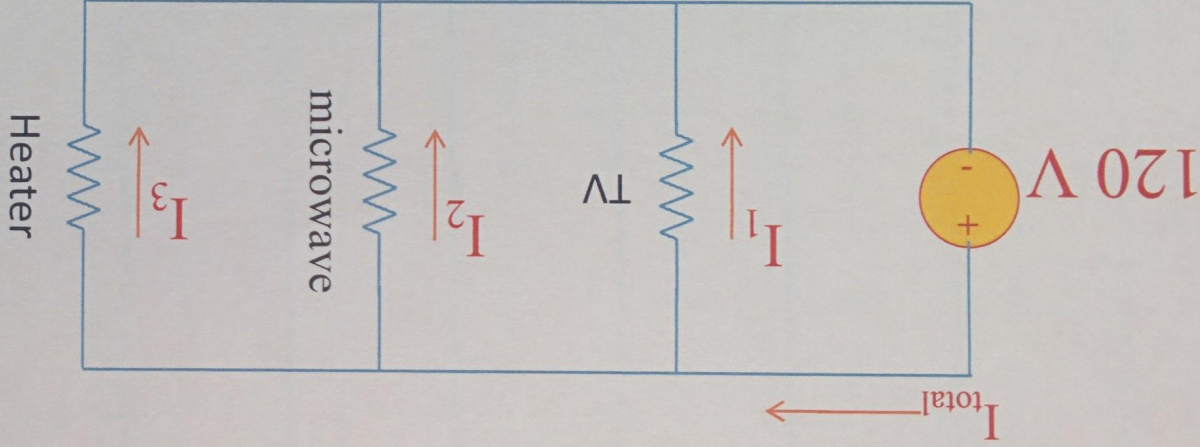
Question 4 (25 points)

Three appliances TV, microwave and a heater at a home are rated 240W, 360W and 6000W respectively. The appliances are ON for 2 hour every day. It cost 0.10\$ / kW-hr.

a) What is the bill amount for 1 month ?

b) How much current is drawn by the each of the appliances ?

c) What is the resistance of each of the appliance.



Appliance	Current Drawn	Resistance
Heater	50 A	2.4 Ω
Microwave	3 A	40 Ω
TV	2 A	60 Ω

a) Total power = $240 + 360 + 6000 = 6600 = 6.6 \text{ kW}$

Total power consumed per day = $6.6 \text{ kW} \times 2 \text{ hr} = 13.2 \text{ kW-hr}$

Cost per day = $13.2 \text{ kW-hr} \times 0.1 \text{ $/(kW-hr)} = 1.32 \text{ $}$

Cost per month = $1.32 \text{ $} \times 30 = 39.6 \text{ $}$

b) $P = VI$

$I_1 = \frac{240}{120} = 2 \text{ A}$

$I_2 = \frac{360}{120} = 3 \text{ A}$

$I_3 = \frac{6000}{120} = 50 \text{ A}$

$$c) R = V/I$$

$$R_{TV} = \frac{120}{2} = 60 \Omega$$

$$R_{Microphone} = \frac{120}{3} = 40 \Omega$$

$$R_{heats} = \frac{120}{50} = 2.4 \Omega$$