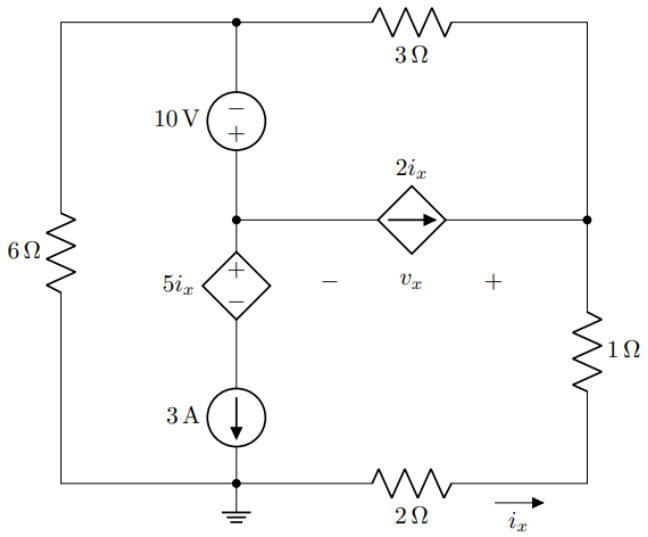
Mid-Term Sample Questions

■ Question *[CO3] [15 marks]*

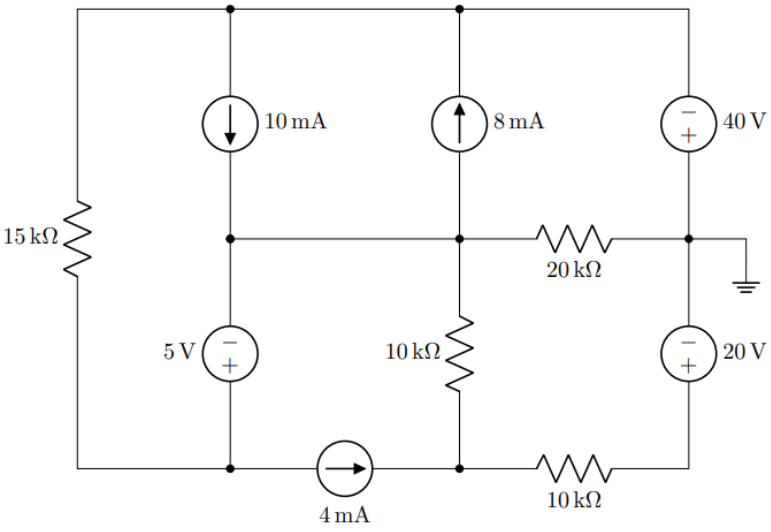


Apply Nodal/Mesh analysis to answer the following questions:

(a) ***[12 marks]*** Find all the node voltages/mesh currents in the circuit.

(b) ***[3 marks]*** Find v_x, the voltage across the $2i_x$ dependent current source.

■ Question *[CO3] [16 marks]*



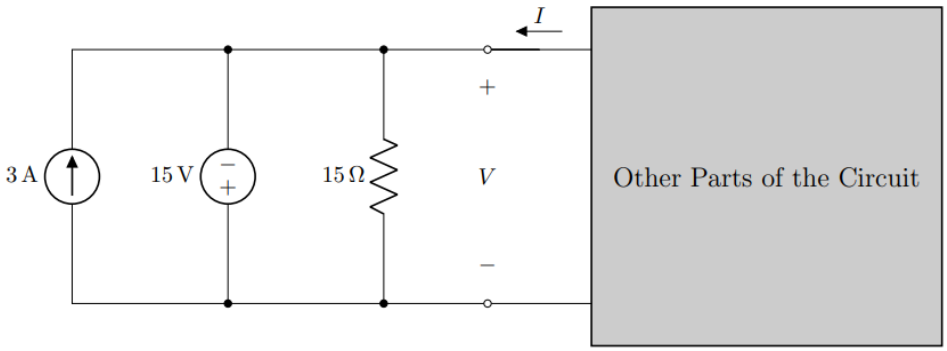
Apply Nodal/Mesh analysis to answer the following questions:

(a) ***[12 marks]*** Find all the node voltages/mesh currents in the circuit.

(b) ***[4 marks]*** Determine the power associated with the 5 V source in the circuit (with appropriate $\pm$ sign and unit). Also, specify whether the power is being supplied/consumed.

■ Question *[CO3] [12 marks]*

(a) You break open your phone charger and find the following circuit. The greyed-out part doesn't contain anything interesting, but the left part of the circuit catches your eye.

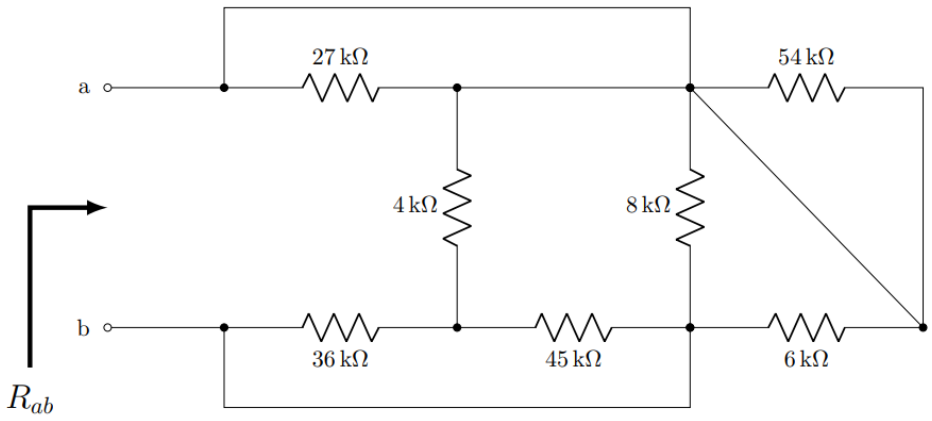


(i) ***[2 marks]*** **Determine** $I - V$ characteristics of the left part of the circuit. i.e. Write an equation that will always hold irrespective of what is inside the greyed-out box.
Hint: The equation cannot have any variables other than V and/or I. Everything else should just be a number.

(ii) ***[2 marks]*** Based on your answer in (i), plot the $I - V$ characteristics of the subcircuit in the following grid.

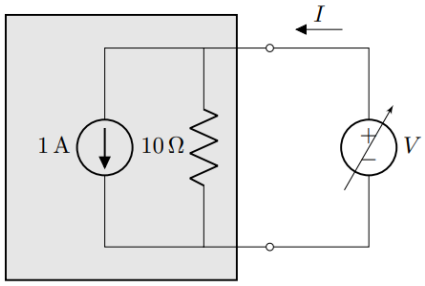
(b) ***[2 marks]*** You notice that the left part of the circuit can actually be replaced with one single equivalent circuit element. Redraw the **reduced equivalent circuit.**

(c) ***[6 marks]*** Determine the equivalent resistance between terminals $a - b$ for the following circuit.



■ Question *[CO1, CO3] [20 marks]*

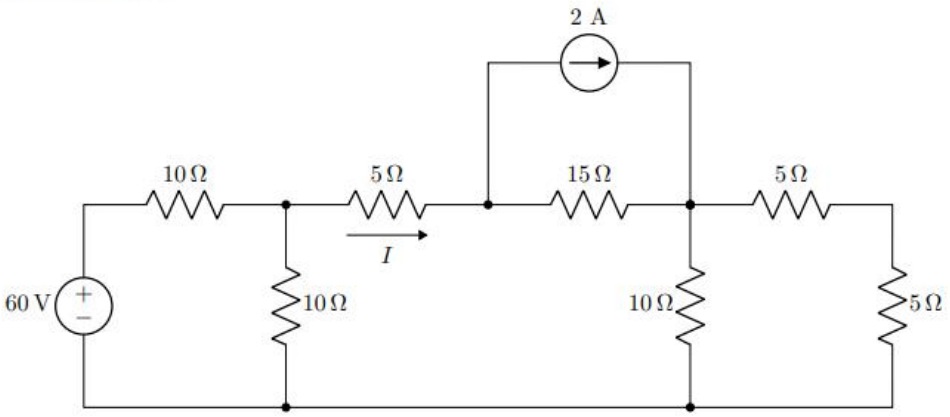
(a) In order to test the $I - V$ characteristics of a two-terminal linear circuit (inside the gray box), the following circuit was constructed.



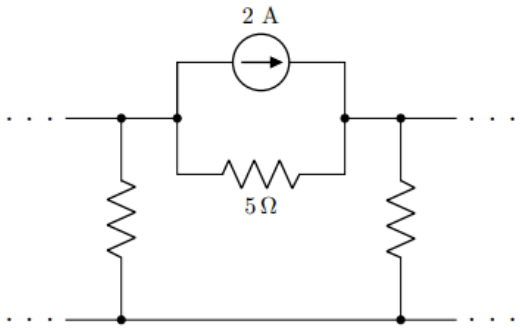
(i) *[1 mark]* **Determine** the relationship between I and V, where V is the applied voltage difference across the test circuit that is varied and I is the current through it. In the following box write I in terms of V.

(ii) *[2 marks]* Based on your answer in (i), plot the $I - V$ characteristics of the test circuit in the following grid.

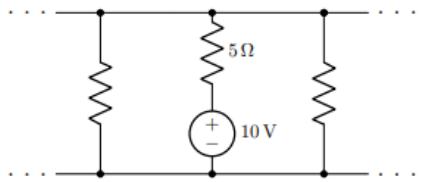
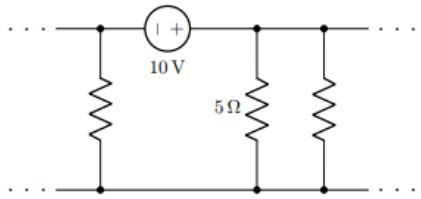
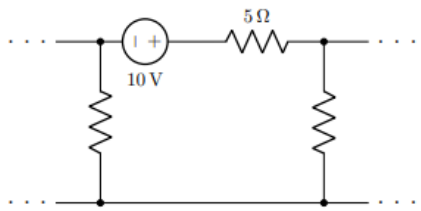
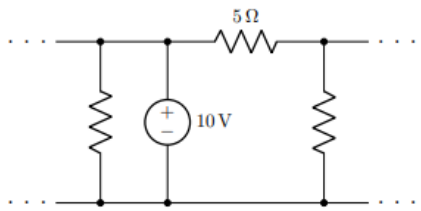
(c) *[15 marks]* **Determine** the current I as shown in the circuit below using **Source Transformation**.



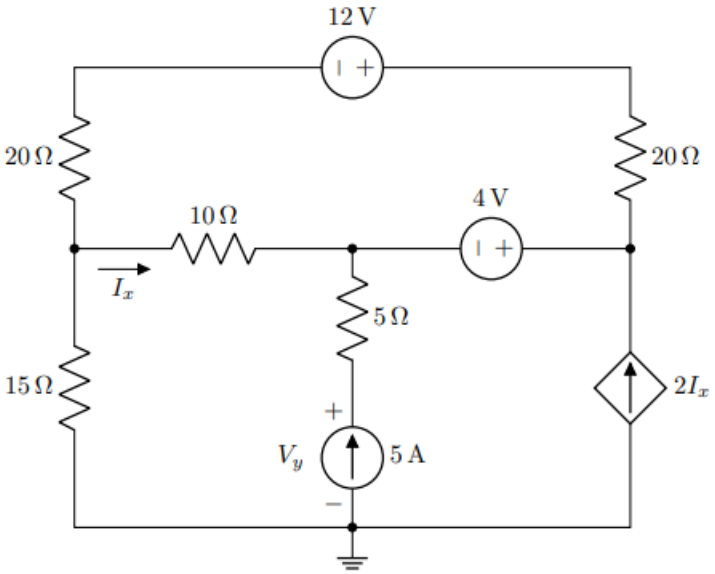
(b) *[2 marks]* Which one is the correct **Source Transformation** of the following circuitry?



Cross-out or fill-in the checkbox (☐) at the top-left corner of the correct answer.

☐ 	☐ 
☐ 	☐ 

■ Question *[CO2, CO4] [20 marks]*



Apply Nodal/Mesh analysis to answer the following questions:

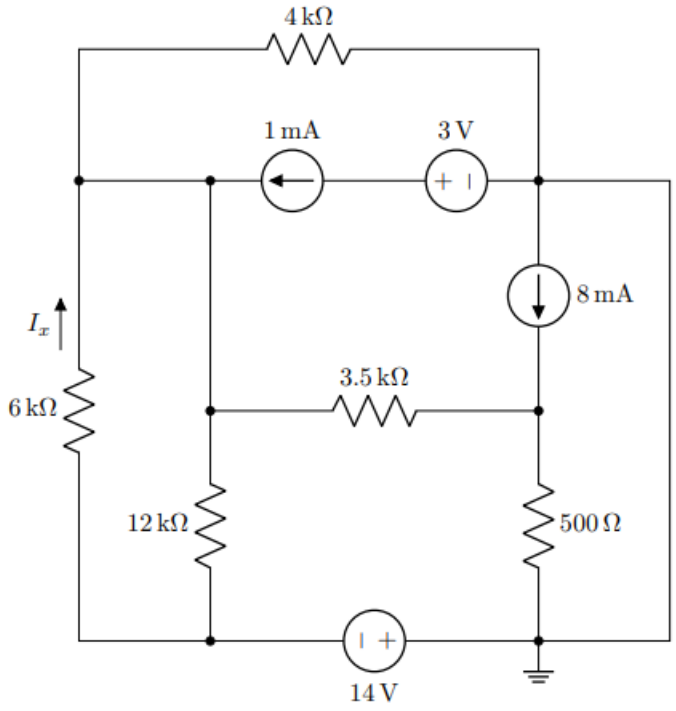
(a) ***[1 mark]*** Which analysis method should be more advantageous in solving the above circuit?

(b) ***[15 marks]*** Find all the node voltages/mesh currents in the circuit.

(c) ***[2 marks]*** Find V_y, the voltage across the 5 A current source.

(d) ***[2 marks]*** How much **power** is the 5 A current source consuming/supplying to the circuit? Also mention whether the source is supplying or consuming power.

■ Question *[CO2, CO4] [16 marks]*



Apply Nodal/Mesh analysis to answer the following questions:

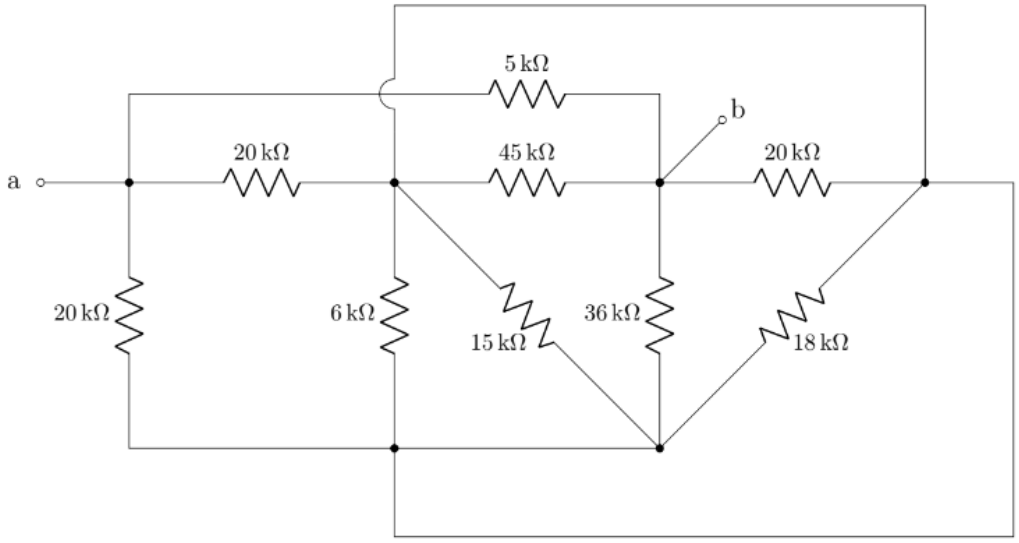
(a) ***[1 mark]*** Which analysis method should be more advantageous in solving the above circuit?

(b) ***[14 marks]*** Find all the node voltages/mesh currents in the circuit.

(c) ***[1 mark]*** Find I_x, the amount of current through the 6 kΩ resistor.

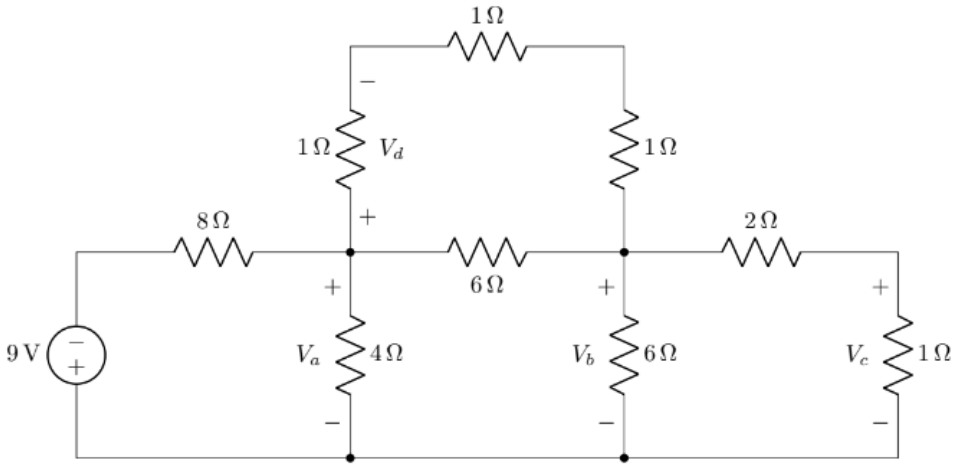
■ Question *[CO1] [10 marks]*

Determine the equivalent resistance between terminals a and b.



■ Question *[CO1] [10 marks]*

Determine V_a, V_b, V_c, and V_d using Voltage Division Rule only. Don't calculate currents or use Ohm's Law.

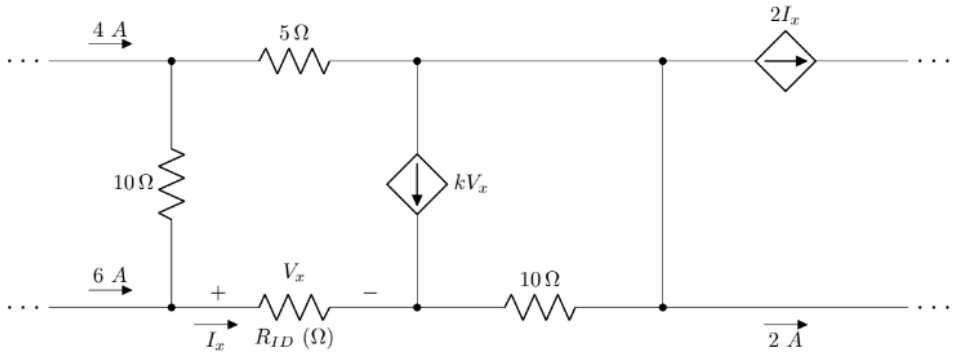


■ Question *[CO1] [10 marks]*

For the circuit shown below, R_{ID} is the sum of first and last digit of your student ID, in Ohm (Ω) units.

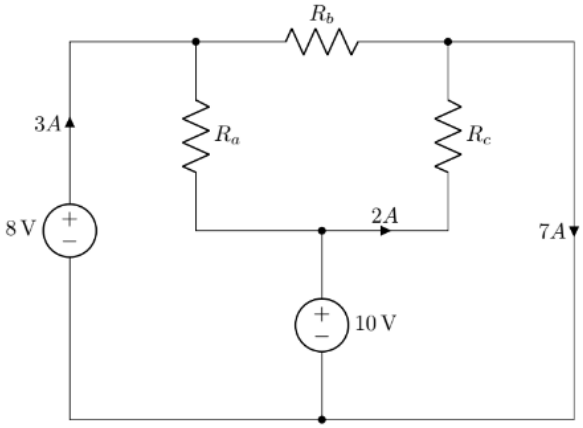
(a) ***[4 marks]*** Determine the values of I_x and V_x.

(b) ***[6 marks]*** Determine the value of k. [*Hint: KCL can be applied to any surface or box made up by enclosing several nodes or circuit components.*]



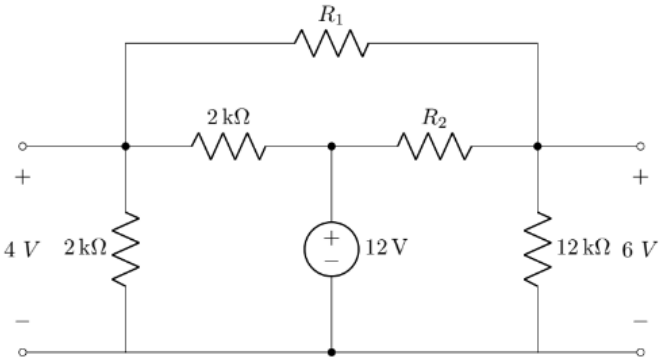
■ Question *[CO3] [10 marks]*

Determine the values of R_a, R_b, and R_c if the branch currents are 3 A, 2 A, and 7 A as shown in the following circuit.



■ Question *[CO3] [10 marks]*

Determine the values of R_1 and R_2 for the circuit shown below.



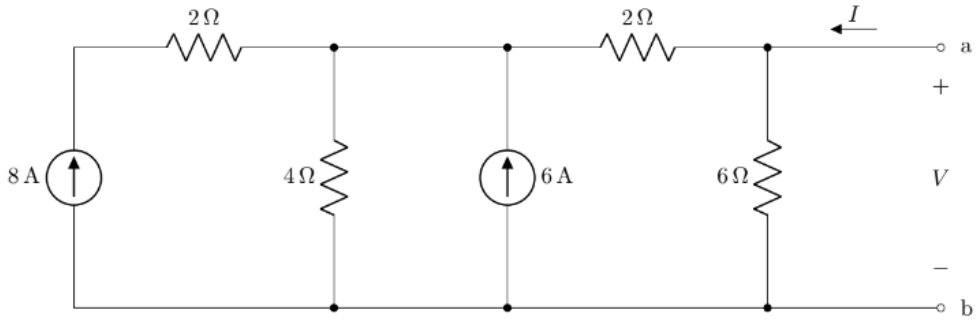
■ Question *[CO1] [10 marks]*

(a) ***[5 marks]*** From the *Circuit 1*, derive a relation between I and V. You are not allowed to use any technique other than KCL, Ohm's Law, and Voltage Divider Rule to derive.

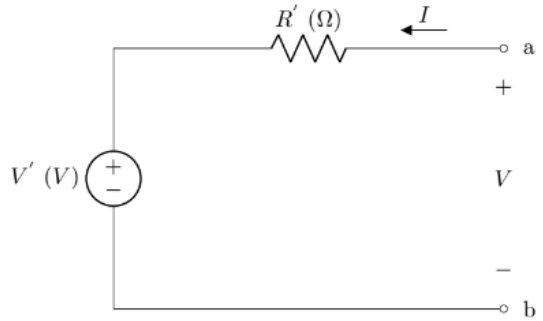
(b) ***[1 mark]*** Draw the $I - V$ curve derived in (a). A template has been given in the next page.

(c) ***[2 marks]*** For the *Circuit 2*, determine $V^{'}$ and $R^{'}$ so that it produces the same $I - V$ curve as in (a).

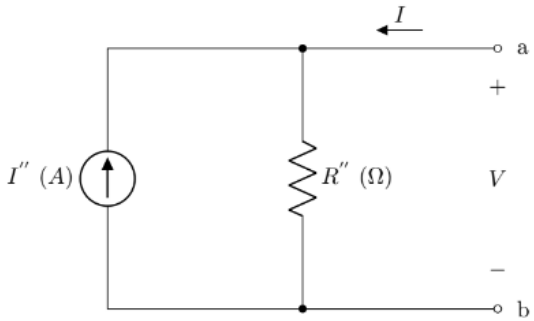
(d) ***[2 marks]*** Now, for the *Circuit 3*, determine of $I^{''}$ and $R^{''}$ so that it produces the same $I - V$ curve as in (a). What is your conclusion from (a), (c), and (d)?



Circuit 1



Circuit 2



Circuit 3

■ Question *[CO3] [10 marks]*

The following are equations obtained by applying KVL to a linear circuit consisting of 3 meshes, where I_1, I_2, and I_1 are mesh currents. Draw a circuit diagram which validates the equations.

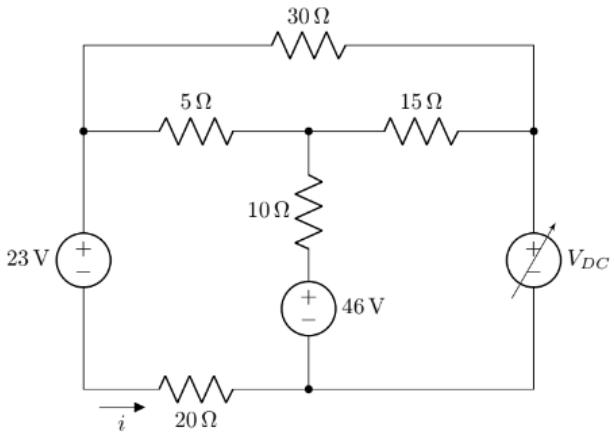
$$15I_1 - 10I_2 = -10 \tag{1}$$

$$10I_1 - 22I_2 + 10I_3 = 0 \tag{2}$$

$$10I_2 - 15I_3 = 12 \tag{3}$$

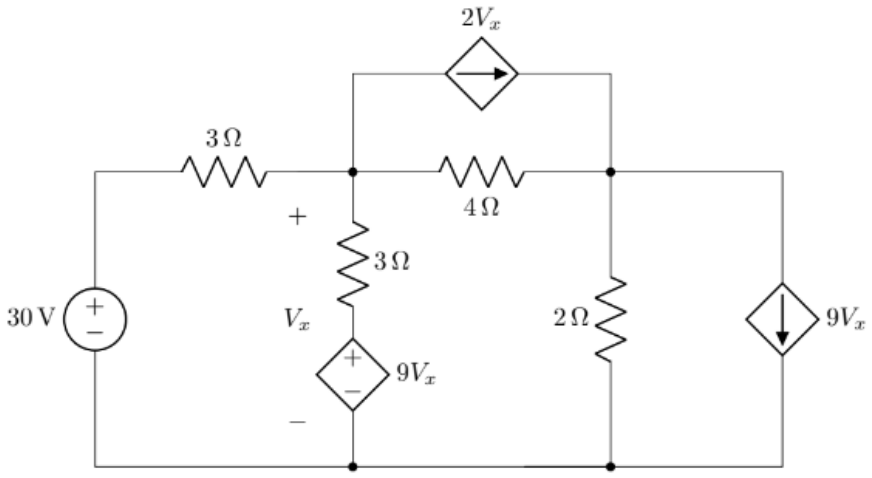
■ Question *[CO3] [10 marks]*

The variable V_{DC} source has been adjusted in the following circuit so that the current i is zero. Determine the value of V_{DC}.



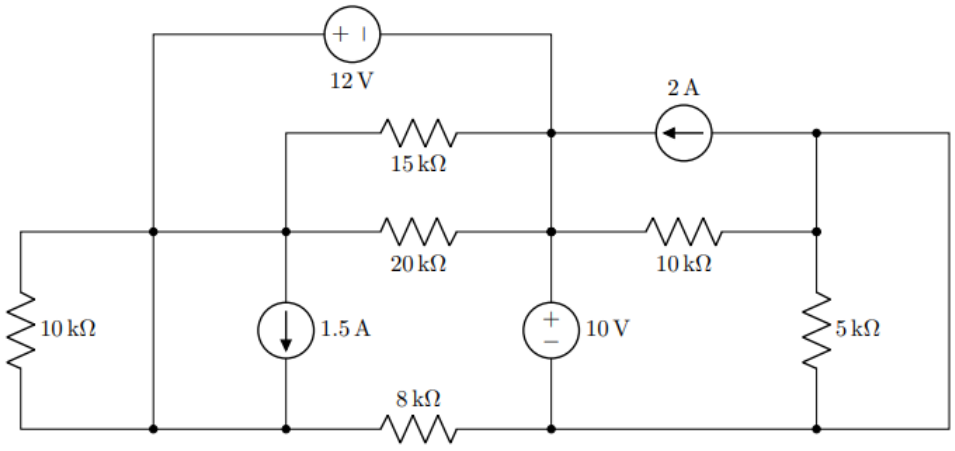
■ Question *[CO2] [10 marks]*

Apply Source Transformation to reduce the following circuit to a single loop. Then determine V_x.



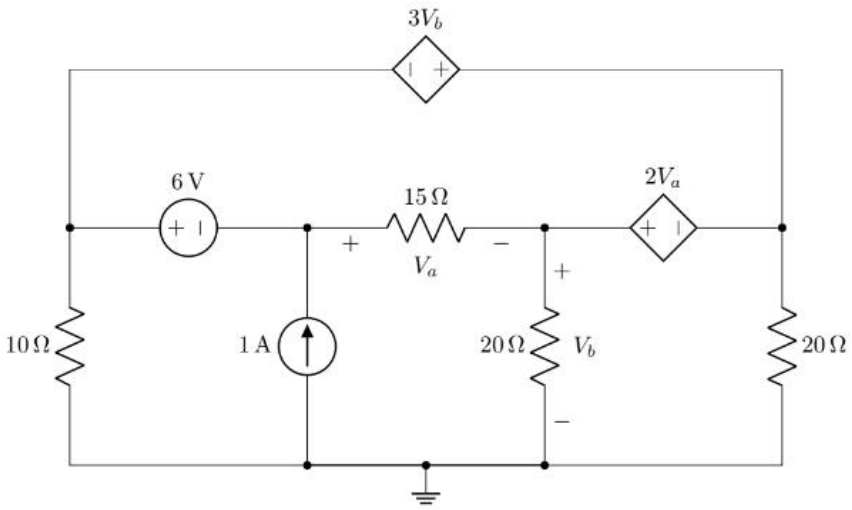
■ Question *[CO1, CO3] [5 marks]*

(a) ***[2 marks]*** *[CO1]* How many nodes are there in the following circuit? Mark all the nodes in the circuit diagram.



■ Question *[CO3] [10 marks]*

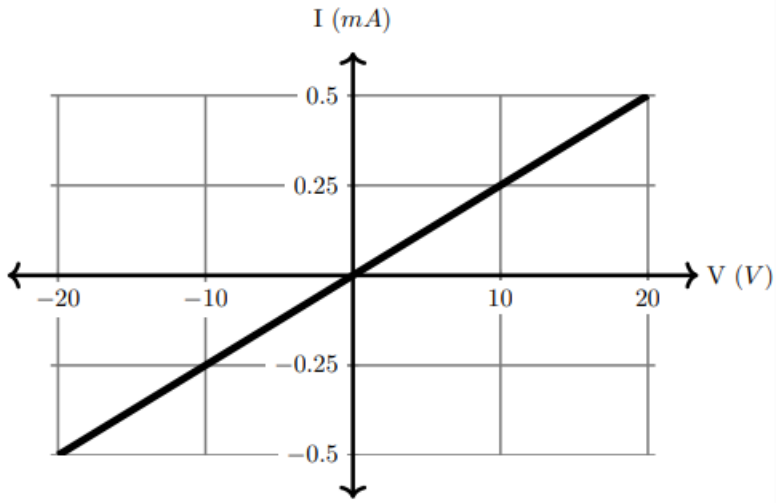
Use Nodal Analysis in the following circuit to determine all the node voltages.



(b) *[CO3]* Use the plot in the left for question (i) and the right for question (ii).

(i) ***[1 mark]*** Draw an approximate $I-V$ characteristic of a $-2\ V$ voltage source. Label the axes appropriately.

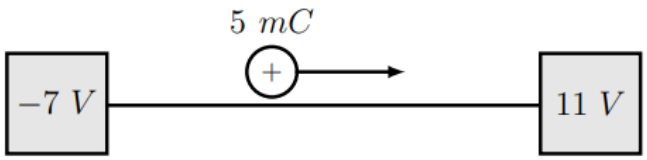
(ii) ***[2 marks]*** Determine the value of resistance (with appropriate unit) from the $I-V$ characteristic shown below.†



■ Question *[CO1] [5 marks]*

Put a checkmark (✓) in the box to indicate your answer. Each question has only one possible answer.

Consider the following diagram for questions (a) and (b).



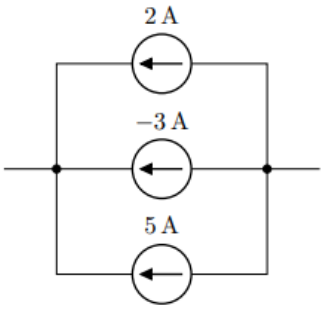
(a) *[1 mark]* What is the work done on/by the system shown above?

☐ $-0.9\ J$ ☐ $-90\ mJ$ ■ $90\ mJ$ ☐ $0.09\ mJ$

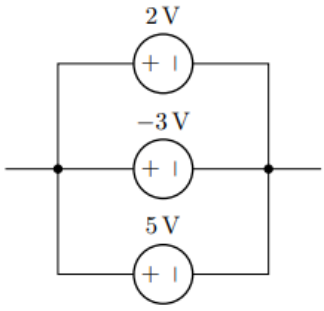
(b) *[½ mark]* The work has been done - ■ **on the system** ☐ by the system

(c) *[1 mark]* Select whether or not the connections shown below are "Legal" or "Illegal".

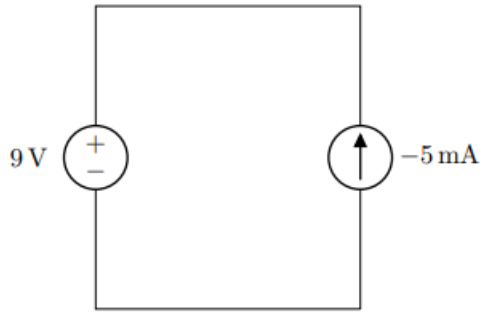
■ **Legal** ☐ Illegal



☐ Legal ■ **Illegal**



Consider the following circuit for questions (d) and (e).

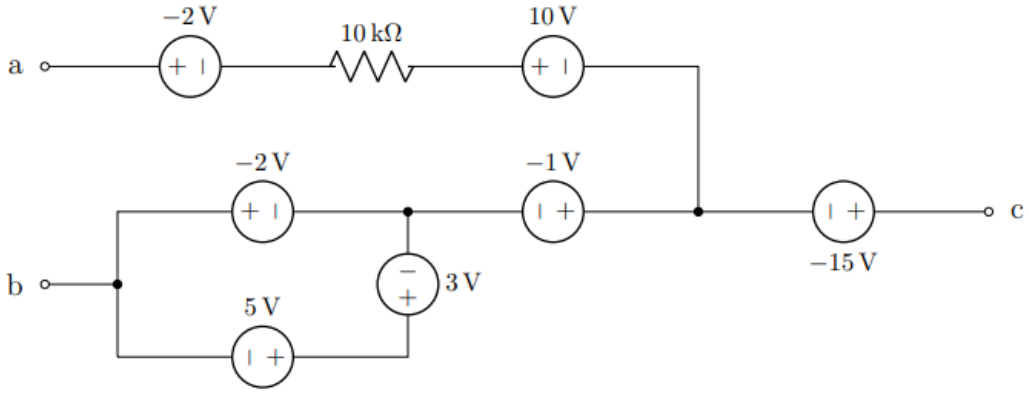


(d) ***[2 marks]*** What is the power of the voltage source (with appropriate ± sign and unit)?††

(e) ***[½ mark]*** Based on your answer in (d), is the voltage source supplying/consuming power?

■ Question *[CO1] [4 marks]*

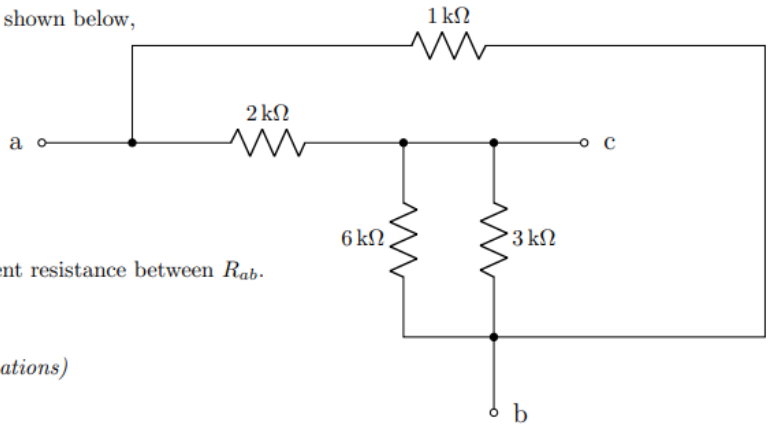
For the circuit shown below,



(a) Determine V_{ac} and V_{bc}.

■ Question *[CO3] [6 marks]*

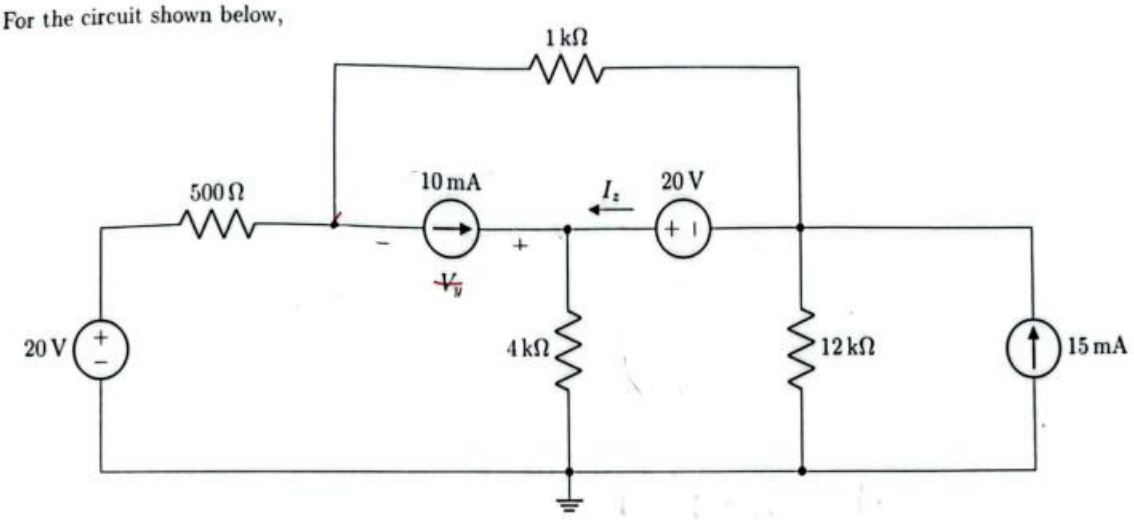
From the following portion of a circuit shown below,



(a) *[2 marks]* Determine the equivalent resistance between R_{ab}.
(b) *[2 marks]* Determine R_{bc}.
(c) *[2 marks]* Determine R_{ca}.
(Must specify all series-parallel combinations)

■ Question *[CO3] [22 marks]*

For the circuit shown below,



(a) *[14 marks]* **Apply Nodal/Mesh Analysis** to **identify** the values of the node voltages/mesh currents. (Equations must be highlighted using boxes).
(b) *[4 marks]* Determine the voltage V_y.
(c) *[4 marks]* Determine the current I_z.

■ Question *[CO3] [10 marks]*

Apply Source Transformation to reduce the following circuit to a single loop. Then determine I_y.