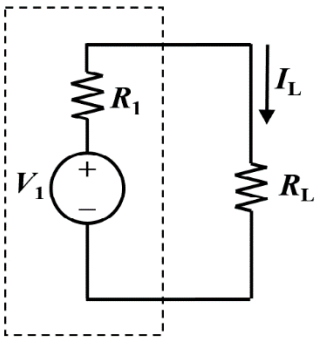
CG1111A Engineering Principles & Practice I

Tutorial 1 (22 & 23 Aug 2022)

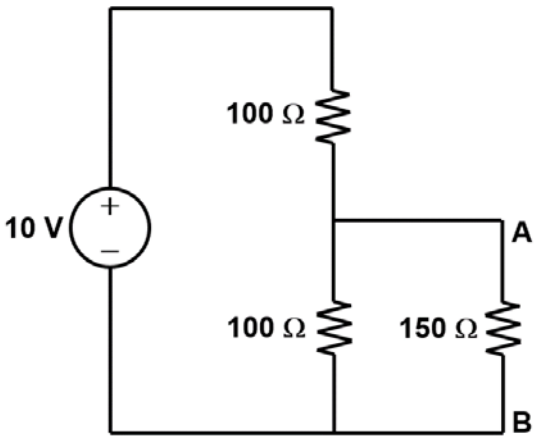
DC Circuit Principles

1. Consider the following battery with open-circuit voltage V_1 = 12 V, and internal resistance R_1 = 0.15 Ω. Find the load current I_L and the corresponding power efficiency η_L for the following load: (i) R_L = 10 Ω, and (ii) R_L = 1 Ω.



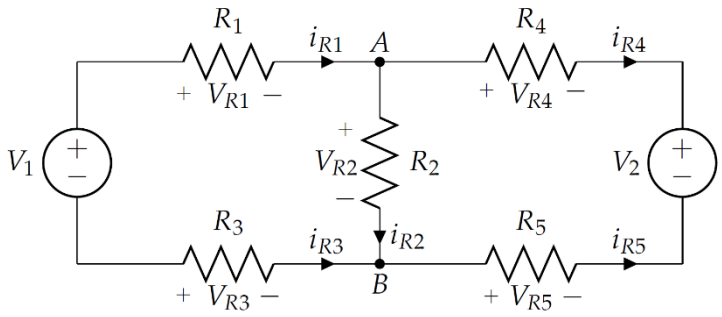
Ans: (i) I_L = 1.18 A, η_L = 98.5%
(ii) I_L = 10.4 A, η_L = 87.0%

2. The figure below shows a **loaded** voltage divider circuit. Calculate the voltage difference V_{AB} (given by $V_A - V_B$).



Ans: 3.75 V

3.



Considering the circuit diagram shown in the figure above, which one of the following correctly applies <u>both</u> KVL and KCL?

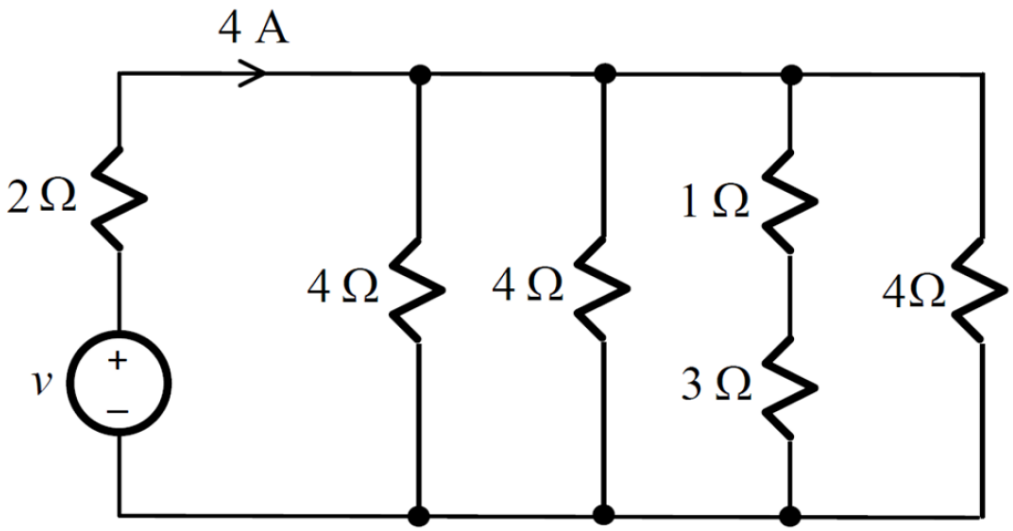
(a) $V_1 - V_{R1} - V_{R2} - V_{R3} = 0$; $i_{R1} - i_{R2} - i_{R4} = 0$

(b) $V_1 + V_{R3} - V_{R1} - V_{R2} = 0$; $i_{R1} + i_{R3} = 0$

(c) $V_2 + V_{R4} + V_{R2} + V_{R5} = 0$; $i_{R4} + i_{R5} = 0$

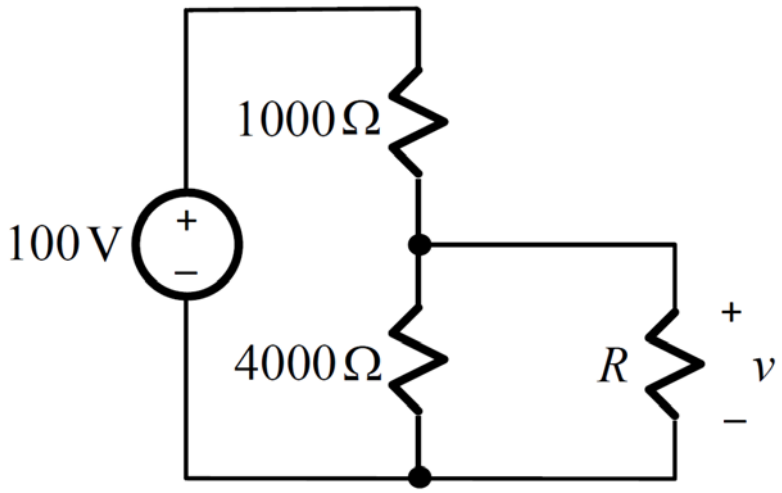
(d) $V_2 + V_{R4} - V_{R2} - V_{R5} = 0$; $i_{R3} - i_{R2} - i_{R5} = 0$

4. Determine the source voltage *v* and the voltage across the 3 Ω resistor in the following circuit.



Ans: *v* = 12 V, voltage across 3 Ω resistor = 3 V

5. The following circuit shows a common voltage divider for obtaining a certain voltage *v* across a load resistor *R*.



A novice may forget to include the loading effects of *R*. To understand these effects, determine *v* and the current in *R* when

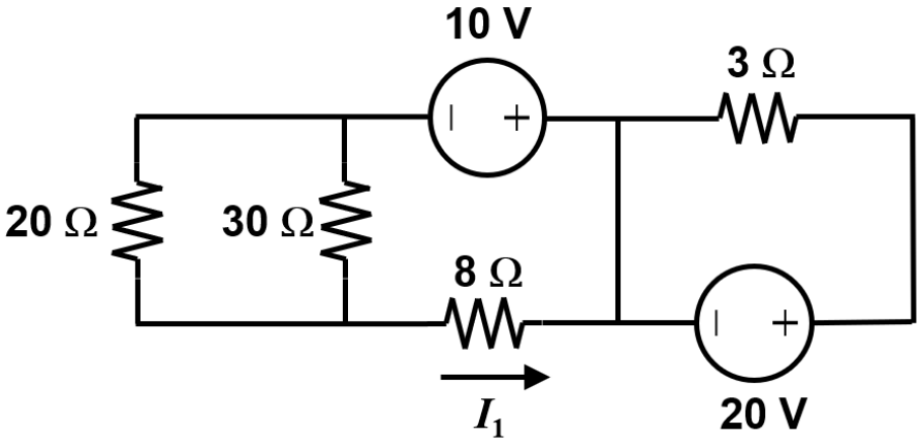
(i) $R = \infty$ (open-circuit)

(ii) $R = 8000\ \Omega$

(iii) $R = 200\ \Omega$

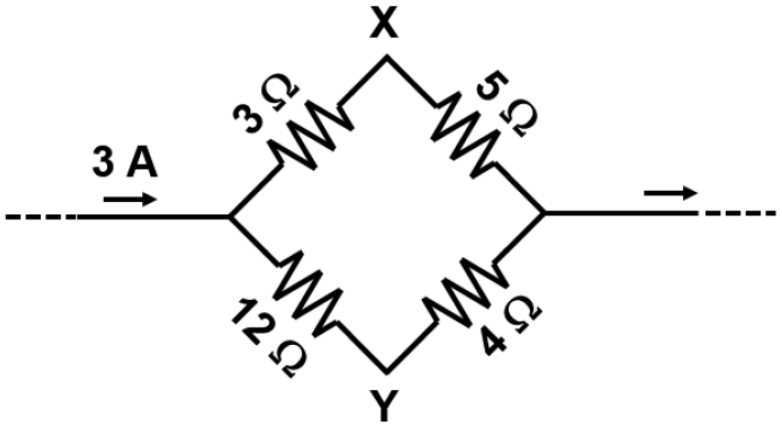
(iv) $R = 0$ (short-circuit)

6. For the circuit shown in the figure below, what is the value of current I_1?



Ans: −0.5 A

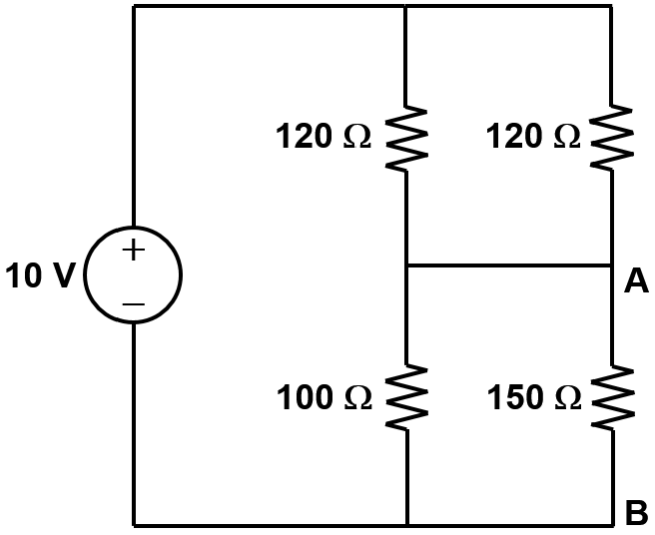
7.



A current of 3 A flows through a resistor network as shown in the figure above. What is the voltage difference V_{XY} (given by $V_X - V_Y$)?

Ans: 6 V

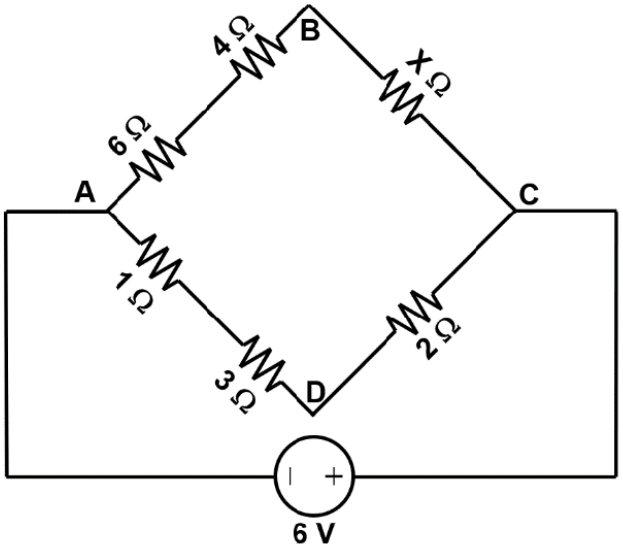
8.



What is the voltage difference V_{AB} (given by $V_A - V_B$)?

Ans: 5 V

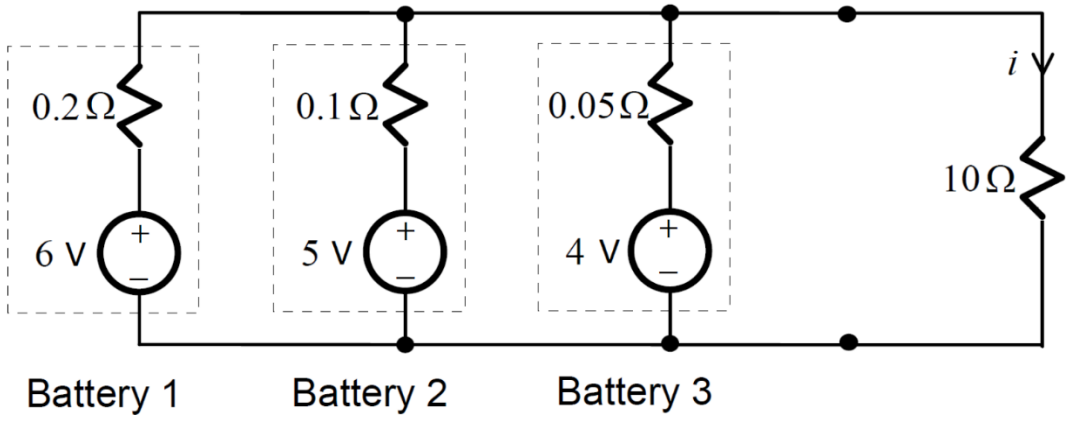
9.



For the circuit shown in the figure above, if the voltage difference V_{BD} (given by $V_B - V_D$) is 1 V, what is the value of resistance X?

Ans: 2 Ω

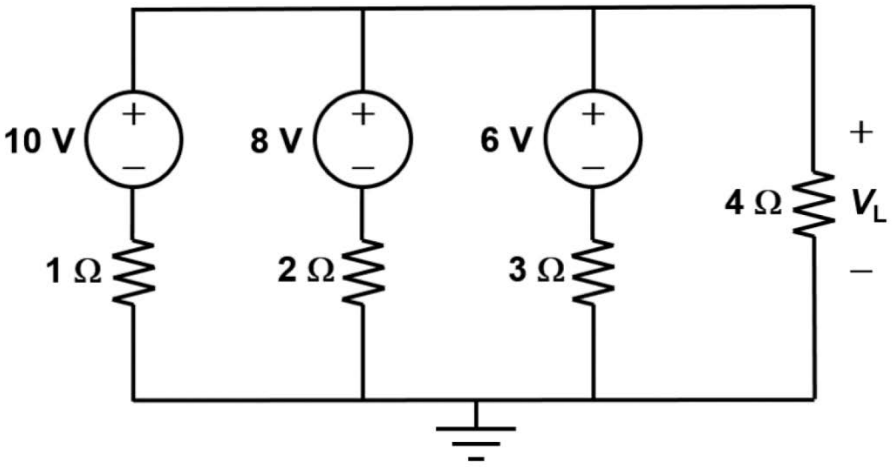
10.



The circuit above shows a 10 Ω load connected to three batteries in parallel. Using node voltage analysis method, determine the voltage across the 10 Ω load, and its current *i*.

Ans: V_L = 4.56 V, i = 0.456 A

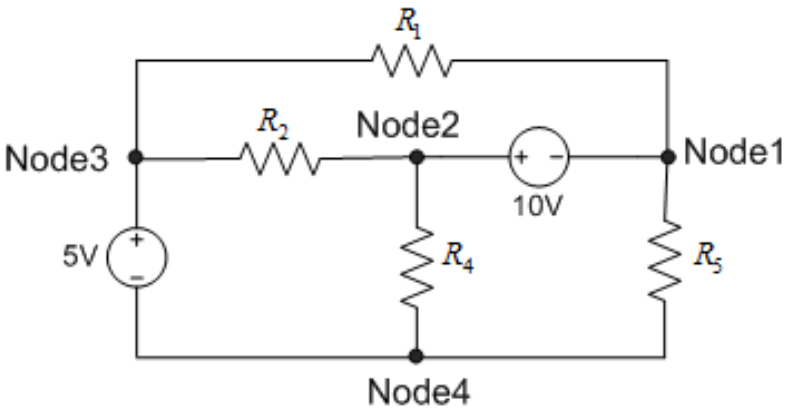
11.



For the circuit shown in the figure above, what is the voltage V_L? (Hint: Use Node Voltage Analysis method.) How much power is the 6 V source supplying/consuming?

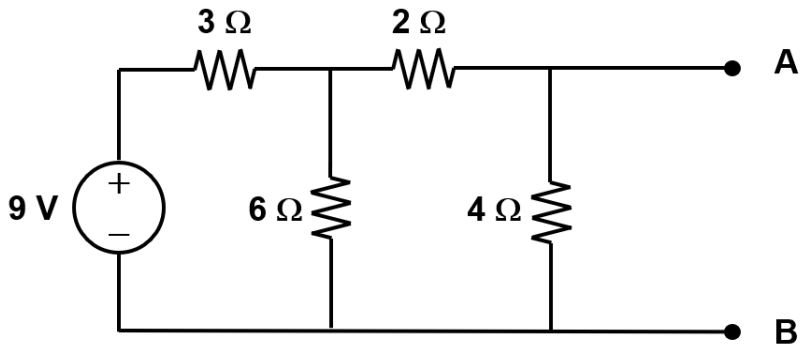
Ans: $V_L = 7.68$ V, 6 V source consuming 3.36 W

12. Consider the circuit given below. Suppose $\boldsymbol{R_5}$ is the load resistance, derive and draw the Thevenin equivalent circuit <u>as seen by $\boldsymbol{R_5}$</u>. clearly labeling Node 1 and Node 4 in the equivalent circuit.
(Assume that $R_1 = 1\ \Omega$, $R_2 = 2\ \Omega$, $R_4 = 1\ \Omega$)



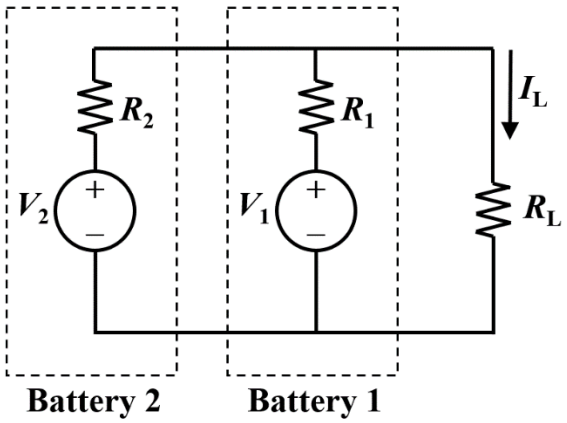
Ans: $V_T = -3$ V, $R_T = 0.4\ \Omega$

13. Find the Thevenin equivalent circuit as seen across node A and node B for the figure below.



Ans: V_T = 3 V, R_T = 2 Ω

14. Consider a battery with its circuit shown in the figure below.



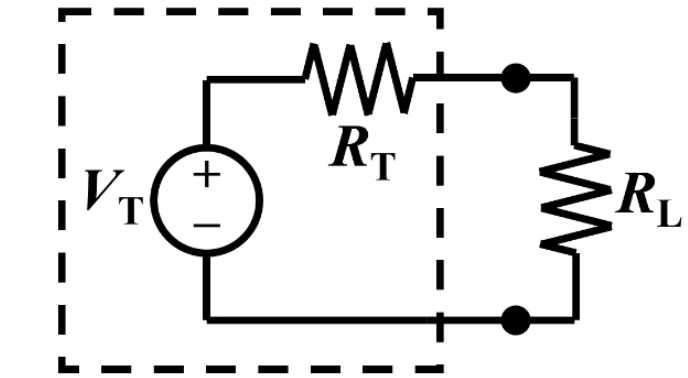
(i) If $V_1 = V_2$ = 12 V, R_1 = 0.15 Ω, R_2 = 0.28 Ω, find the Thevenin equivalent circuit as seen by the load R_L.

(ii) If the load R_L = 2.5 Ω, find the load current I_L, and the voltage across the load R_L.

(iii) Is the load voltage higher or lower compared to the cases where the load were to be powered by just battery 1 or battery 2 alone?

Ans: (i) V_T = 12 V, R_T = 0.098 Ω, (ii) I_L = 4.62A, 11.5 V, (iii) higher

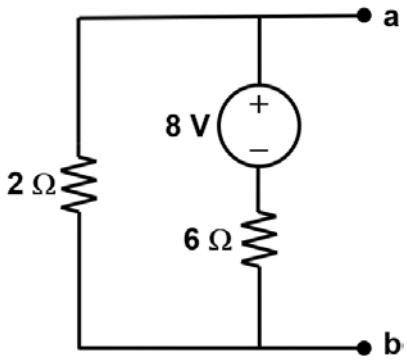
15. For the Thevenin equivalent circuit shown below, derive the **value of R_L** that causes **maximum power transfer** from the **source** to the **load R_L**.



Thevenin equivalent circuit

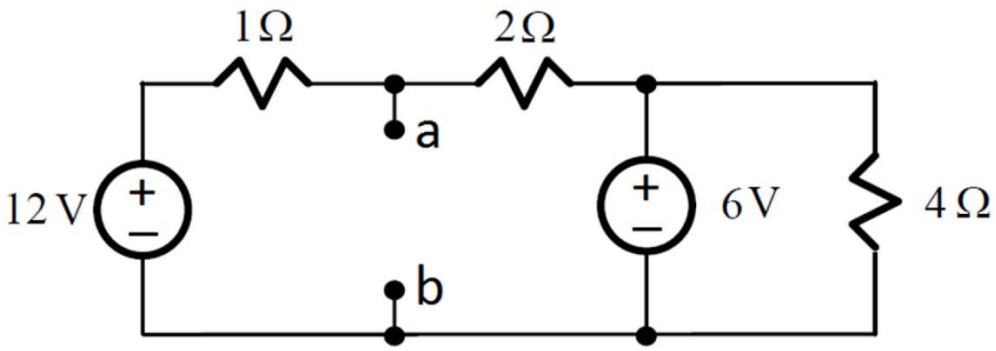
Ans: $R_L = R_T$

16. For the circuit shown in the figure below, determine the value of the load resistance R_L to be placed across the nodes **a** and **b**, in order for the load to draw maximum power. What is the value of this maximum power that the load R_L consumes?



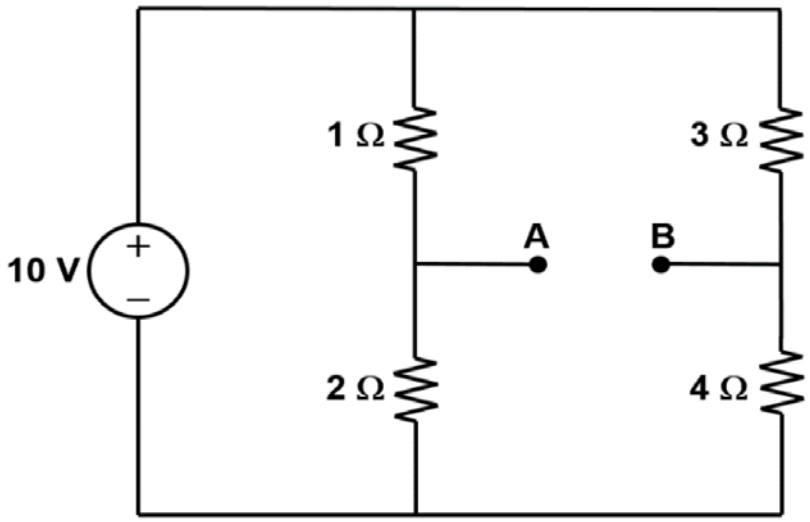
Ans: $R_L = 1.5\ \Omega$, $P_{max} = 0.67$ W

17. Determine the maximum power that can be obtained from terminals **a** and **b** of the following circuit:



Ans: 37.5 W

18.



What is the Thevenin resistance of the Thevenin equivalent circuit seen across nodes **A** and **B**?

Ans: 2.38 Ω