Indian Institute of Technology Bombay

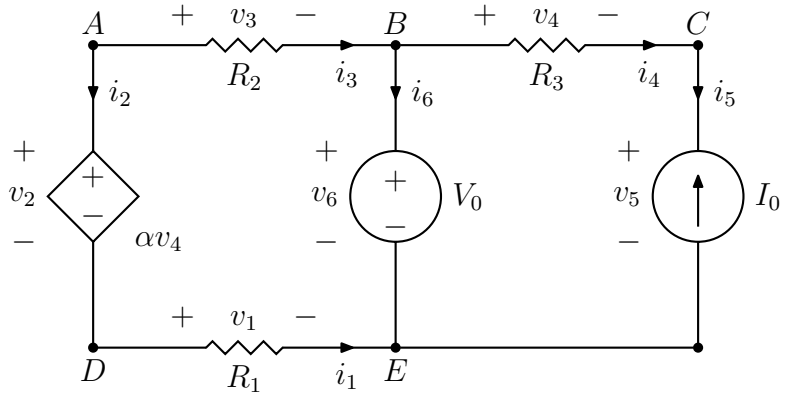
Dept of Electrical Engineering

Handout 2 **EE 101 Electrical & Electronic Circuits**

Tutorial 1 July 22, 2011

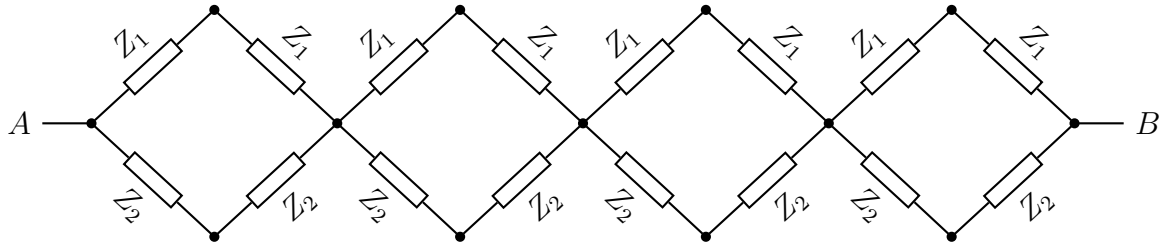
Question 1) Consider the circuit shown below. There are 6 components in this circuit other than wires (make sure you can count each of them). Each component is marked with a current and a voltage value, both represented by the same subscript. For example, current i_3 makes a voltage drop of v_3 across the resistor, as shown.

a) Write the current equations for each of the nodes $A, \cdots, E$ using Kirchhoff's current law(KCL). Denoting the currents as a column vector, $\bar{i} = [i_1, i_2, i_3, i_4, i_5, i_6]^T$, write KCL equations in matrix form. i.e. find A such that $A\bar{i} = 0$.



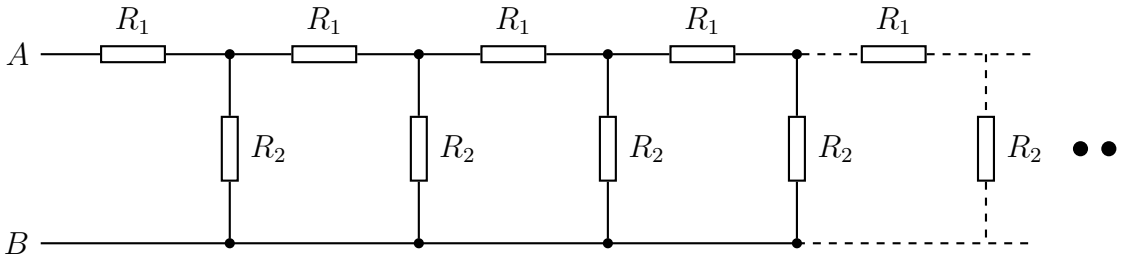
b) Suppose $V_0 = 10V$ and $I_0 = 0$, what is the current flowing through the resistor R_1. Using this, argue that the component voltages/currents marked in the picture need not be positive or negative.

Question 2) Find the equivalent for the following circuit, between terminals A and B for various conditions on the **impedance** Z_1 and Z_2.

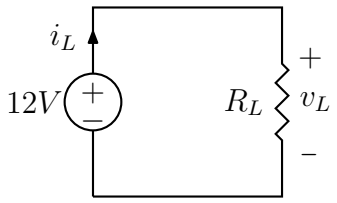


a) What is the equivalent resistance if $Z_1 = 1\Omega$ and $Z_2 = 2\Omega$.
b) What is the equivalent inductance if $Z_1 = 2H$ and $Z_2 = 4H$.
c) What is the equivalent capacitance if $Z_1 = 1.5F$ and $Z_2 = 3.0F$.

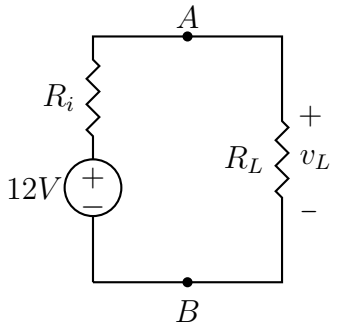
Question 3) Find the equivalent resistance of the infinite ladder network shown below.



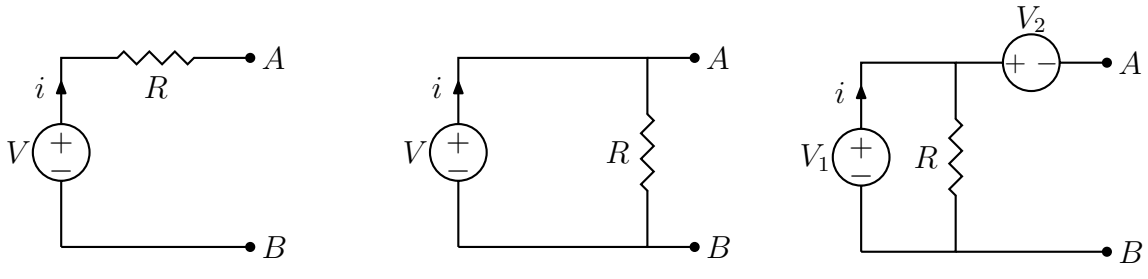
Question 4 An ideal voltage source is the one which maintains a fixed voltage across its terminals no matter how much current passes through it. The current supplied can vary, for example, due to a change in load resistance. Let us consider a standard battery, and argue whether it is a voltage source. Consider the model below.



a) When the load R_L is 100Ω, is this battery an ideal voltage source.
b) Due to some reason, the load is fluctuating between 100Ω to 200Ω, is this battery still an ideal voltage source.
c) Unfortunately life is not that ideal as it looks like, practical batteries have a small internal resistance, and a real circuit looks like,



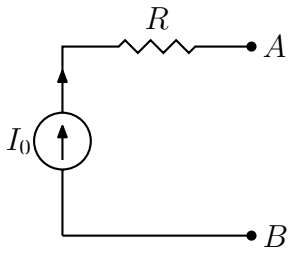
(Beware that this internal resistance is inherent inside the edge points (A and B) that we can access, and there is no way to physically take if off.) If $R_i = 10\Omega$, argue that the above source is not an ideal voltage source when the load varies between 20Ω and 100Ω.
d) When the load resistance is always 1000Ω and above, can this battery be considered as an ideal voltage source.
Question 5) Simplify the following circuits *if possible*. The sources are considered ideal.



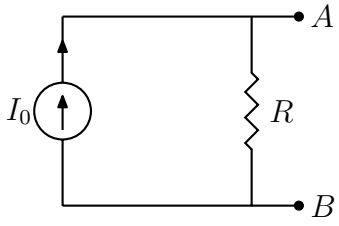
(a)

(b)

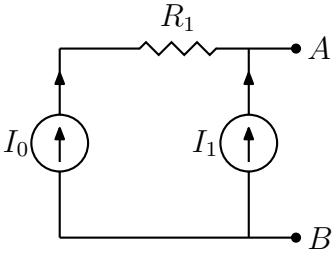
(c)



(d)



(e)



(f)