Homework 01

1. ***Sources***: Consider the following two circuits. Assume that the two circuits are equivalent with respect to their properties at the two terminals.

   (a) Based on the circuit elements shown in the figure, give the output-voltage-versus-output-current function of the LHS (left-hand side) circuit. Sketch the function (Suggestion: *y*-axis = V and *x*-axis = I) .
   (b) Give the output-current-versus-output-voltage function of the RHS (right-hand side) circuit. Sketch the function (Suggestion: *y*-axis = I and *x*-axis = V).
   (c) The two functions you sketched should be linear functions (straight lines). Can the two functions be identical?
   (d) How can one show that the two functions are identical?
   (e) For the two circuits to be equivalent, which two quantities (one of them a voltage and the other one a current) must be identical?

2. ***Linear and non-linear circuits***: There are linear circuits and non-linear circuits.
   (a) Define a linear circuit (in words).
   (b) Define a non-linear circuit (in words).
   (c) List all linear circuit elements that you know of.
   (d) List some non-linear circuit elements.
   (e) Is a real voltage source (ideal voltage source plus internal resistance) a linear circuit element? Justify your answer.
   (f) Is a real current source (ideal current source plus internal conductance) a linear circuit element? Justify your answer.
   (g) Draw an example of a linear circuit having an input and an output.
   (h) Draw an example of a non-linear circuit having an input and an output.
   (i) Is a linear circuit or a non-linear circuit generally simpler to analyze? Explain your answer.

3. ***Superposition principle***: This problem concerns the superposition principle.
   (a) Which condition must be met for us to be allowed to apply the superposition principle?
   (b) Express the superposition principle in your own ***words***.
   (c) Express the superposition principle by using an ***equation***.
   (d) Which type of system prevents us from applying the superposition principle?