03.4 ssan.div Voltage and current dividers

In Lec. 01.2 fun.vdiv, we developed the useful voltage divider formula for quickly analyzing how voltage divides among series resistors. This can be considered a special case of a more general voltage divider equation for any elements described by an impedance. After developing the voltage divider, we also introduce the current divider, which divides an input current among parallel elements.

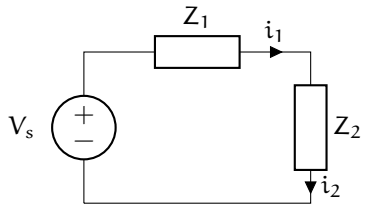

Figure div.1: the two-element voltage divider.

Voltage dividers

First, we develop the solution for the two-element voltage divider shown in Fig. div.1. We choose the voltage across Z_2 as the output. The analysis can follow our usual methodology of six steps, solving for v_2.

1. The circuit diagram is given in Fig. div.1.
2. The assumed directions of positive current flow are given in Fig. div.1.
3. The elemental equations are just generalized Ohm's law equations.

   

4. The KCL equation is
5. The KVL equation is
6. Solve.

   a) Eliminating i_2 and v_1 from KCL and KVL, our elemental equations become the following.

b) Eliminating i_1,

c) Solving for v_2,

A similar analysis can be conducted for n impedance elements.

Equation 1 general impedance voltage divider

Current dividers

By a similar process, we can analyze a circuit that divides current into n *parallel* impedance elements.

Equation 2 general impedance current divider

Example 03.4 ssan.div-1

re: voltage divider with impedance

Given the circuit shown with voltage source $V_s(t) = Ae^{j\phi}$ and output v_L, what is the ratio of output over input amplitude? What is the phase shift from input to output?