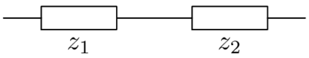
Complex Electronics

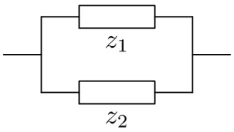
Introduction

In AC circuits there are three types of passive components that have a characteristic called 'impedance' (z) that can be modelled using complex numbers:

- Resistors. A resistor is a device with purely real impedance. The impedance of a resistor is constant (i.e. it does not change with frequency): $z_r = r$ (where r is the 'resistance' of the component).
- Capacitors. A capacitor is a device with purely imaginary impedance, and whose impedance is inversely proportional to frequency (ω): $z_c = \frac{1}{\omega c i}$ (where c is the 'capacitance' of the component).
- Inductors. An inductor is another device with purely imaginary impedance, and whose impedance is directly proportional to frequency (ω): $z_l = \omega l i$ (where l is the 'inductance' of the component.

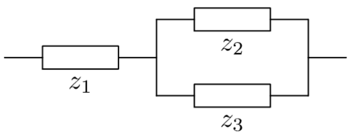
Components can be combined in two ways:

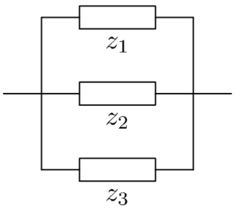
- Components in series 

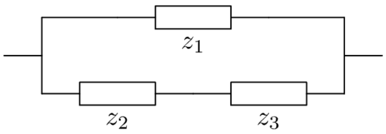
have a total impedance that is the sum of the impedance of individual components: $z = z_1 + z_2$
- Components in parallel 

have a total impedance that is the reciprocal of the sum of the reciprocals of the impedances of the individual components: $z = \frac{1}{\frac{1}{z_1}+\frac{1}{z_2}}$ or more simply $\frac{1}{z} = \frac{1}{z_1} + \frac{1}{z_2}$.

Each of these can be extended to more than two components, and various combinations of series and parallel combinations are possible resulting in infinitely many possibilities.







Investigation

Starting with individual components, then for various combinations of two or more components of different types, investigate how the modulus and argument of total impedance z changes with changing frequency ω.