Lecture 12: Filter Networks (continued)

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Abstract

Discussion of Variable Frequency Response Analysis. Introduction to the concept of transfer functions (also called network functions), poles and zeros, and prelude to Bode plots.

1 Overview

1.1 What we have seen so far

1. Though our lectures have been titled "Filter Networks", they fall under the broader category of "Variable Frequency Response Analysis". That is, we have so far studied circuits whose response to external stimuli depend on the frequencies of those stimuli.

2. We have seen the concepts of **gain**, **magnitude of the gain**, **phase of the gain**, etc of a frequency dependent network.

3. We have learnt some ways to identify whether a given electric circuit is low pass/band pass/etc.

4. We have also done some exercises in plotting/sketching the magnitude of the gain and the phase of the gain versus frequency. Such plotting/sketching has involved pains-taking calculation of several points along the curves.

1.2 What we will see in the next few lectures

1. We will use a tool called **Bode plot** to get a quick and fairly accurate estimate of how the frequency response of a network (or electric circuit) looks like.

2. We will look at the concept of **transfer functions**.

3. We will do a mid-term project that involves transfer functions, Bode plots, and filters.

By the way, Bode plot can be used to quickly identify if a certain transfer function that is given to us is a low pass filter, high pass filter, band pass filter or a band reject filter.

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2 Frequency response of some simple circuits

2.1 Example 1

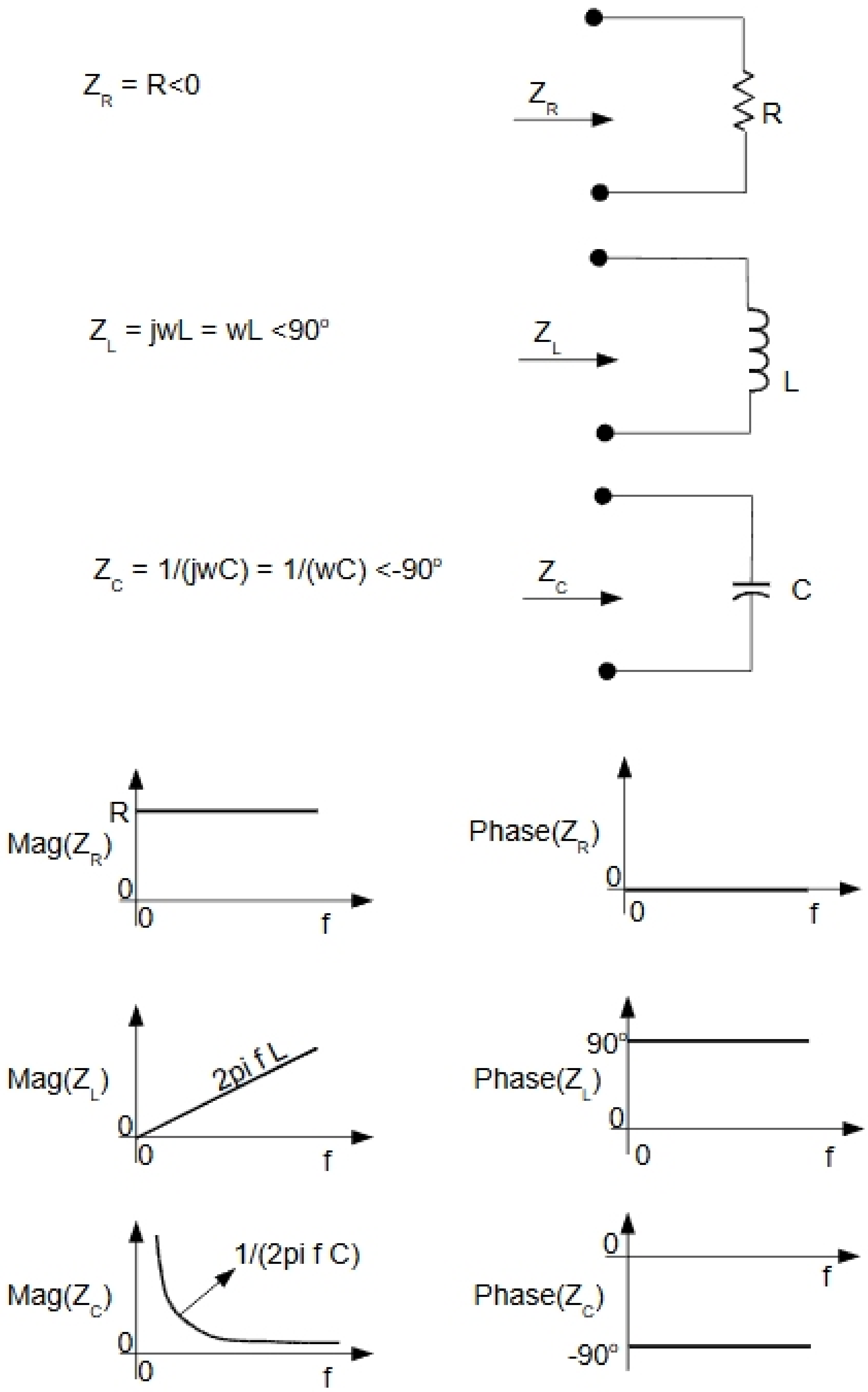

Figure 1:

2.2 Example 2

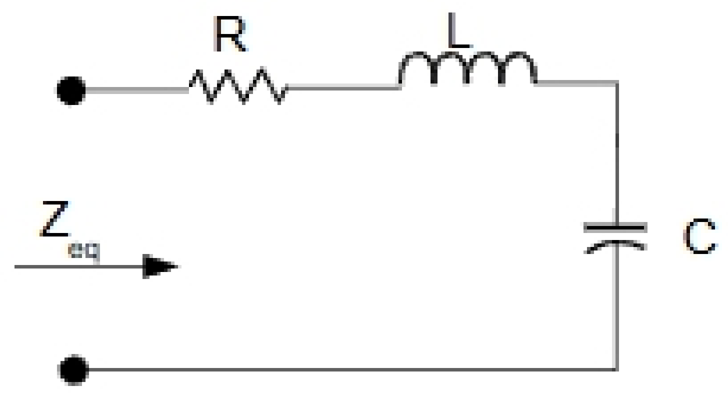

Figure 2:

$$Z_{eq} = R + j\omega L + \frac{1}{j\omega C} = \frac{(j\omega)^2 LC + j\omega RC + 1}{j\omega C} \quad (1)$$

Let,

$$s = j\omega \quad (2)$$

$$Z_{eq} = \frac{s^2 LC + sRC + 1}{sC} \quad (3)$$

$$|Z_{eq}| = \frac{\sqrt{(1 - \omega^2 LC)^2 + \omega^2 R^2 C^2)}}{\omega C}$$

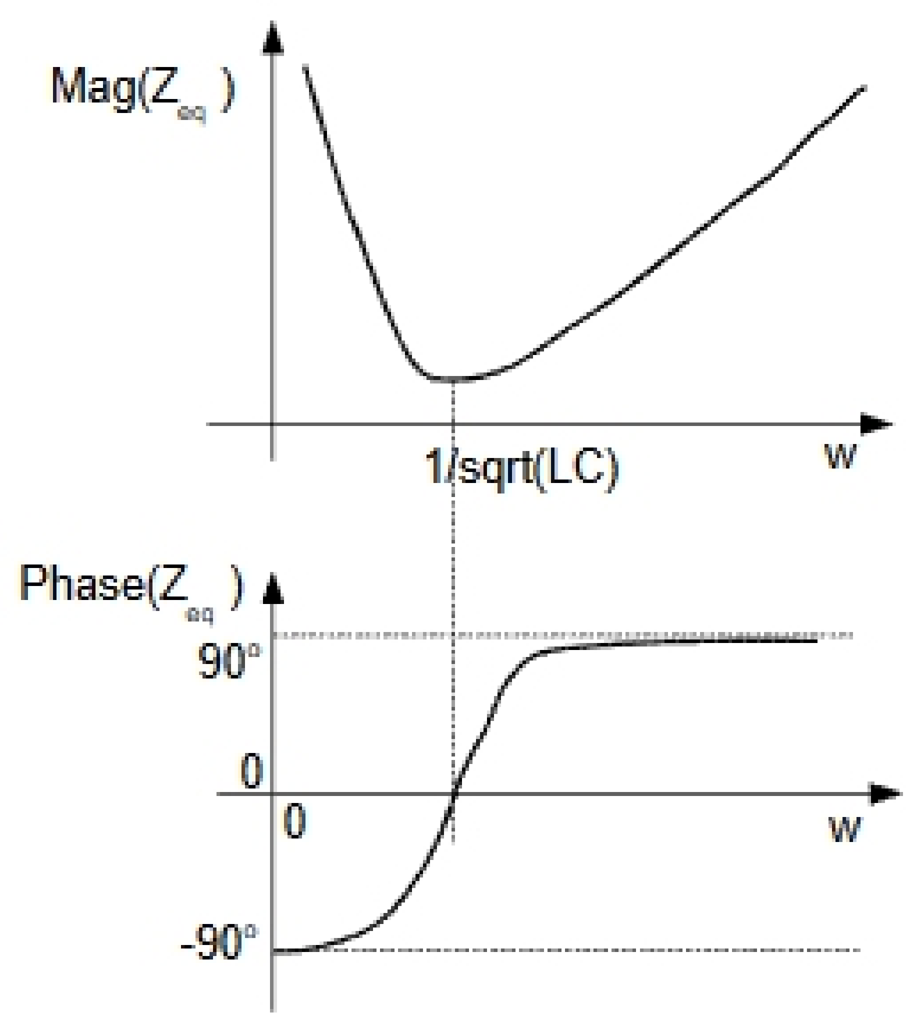

Figure 3:

From Equation (1):

$$\omega \longrightarrow 0 \quad Z_{eq} = \frac{1}{j\omega C} \quad \angle(Z_{eq}) = -90^\circ$$

$$\omega \longrightarrow \infty \quad Z_{eq} \longrightarrow j\omega L \quad \angle(Z_{eq}) = +90^\circ$$