

# Transmission of Sine Waves or of Pulses

**What is easier to understand?  
What is more adequate for the digital world?**

*Hermann Härtel  
Guest Scientist at  
Institute for Theoretical Physics and Astrophysics  
University Kiel, Germany*

*Ernesto Martin  
University Murcia, Spain*

## **Abstract**

The topic "Wave Transmission" is traditionally treated in the frequency domain, starting with the harmonic oscillator and a system of coupled oscillators and leading to solutions of the wave equation and to Fourier analysis, where the latter allows to describe any kind of pulses as the sum of sine waves. The question is, how many students are able to understand and master these powerful and demanding mathematical tools and how many reach a deeper understanding of the underlying processes. Another question is, how many newcomers with a weaker mathematical background may feel overburdened and may give up, either switching to other areas of study or even leaving the university.

Before the development of modern computers there were no alternatives to treat electric transmission processes but in frequency domain. With modern computers available, such processes, however, can be treated in time domain and this opens alternative approaches with an added didactical value.

Such an alternative has been developed in the form of program to simulate transmission processes based on a solution of the telegraph equations in time domain (available under <http://www.astrophysik.uni-kiel.de/~hhaertel>). All relevant line parameters are accessible for change, like frequency and form of the source, the form of single pulses, the impedance of the line and the resistance and capacitance of the load. The program allows to simulate and demonstrate a broad spectrum of situations and processes based on transmission, reflection and superpositions.

It visualizes transmission processes in mechanical systems (single tube and a closed circuit) serving as a preliminary stage for the main topic: transmission processes on an electric transmission line, where potential difference and current are indicated along the line in form a separate diagrams.

This program could support an introductory course before consideration in frequency domain with rather high mathematical demands are presented.