Fourier

About the program:

The program demonstrates the relationship between the time and the frequency domain.

A periodic signal is supposed at the input of a linear system. This signal can be expanded into its Fourier series as the sum of the harmonic sinusoidal signals. For linear systems one can use the superposition theorem. If the response of the system is calculated for the individual sinusoidal components of the input signal, theoretically the output time response can be obtained as a sum of these output components. The more Fourier components are taken into account the better is the approximation of both the input and the output signal.

The system is given by its difference equation. The reader can choose a first, a second order system or a general system of order k. For example the difference equation of the second order system is:

$$y[kh] = b_1 u[(k-d)h] + b_2 u[(k-d-1)h] - a_1 y[(k-1)h] - a_2 y[(k-2)h]$$

Default parameters: b_1=0.1; b_2=0.2; a_1=-1.5; a_2=0.8; d=1; T/h=20, n=1. Here k is the actual time point, h denotes the simulation step, a_i and b_i are the parameters of the system, T is the the time period of the periodic input signal. The parameters of the system can be changed. The number n of the Fourier terms can be set by the reader. One can see that the exact input and the exact output are better and better approximated with more Fourier terms.

How to use the program:

- The plot can be redrawn with the long button on the top.

- The program can simulate 1st order, 2nd order and k- order systems. This can be set with the choicebox under the button.

- Under the choicebox is the textfield, where the parameters can be set.

First order system:

Its pulse transfer function:

$$\frac{b \times z^{-1}}{1 + a \times z^{-1}}$$

The meaning of the variables:

- n: number of the sinusoidal components
- T/h : ratio of the sampling time and the time period
- d: discrete delay (min. 1)
- a: coefficient of the denominator
- b: coefficient of the numerator

Second order system:

Its pulse transfer function:

$$\frac{b_1 \times z^{-1} + b_2 \times z^{-2}}{1 + a_1 \times z^{-1} + a_2 \times z^{-2}}$$

The meaning of the variables:

- n: number of the sinusoidal components
- T/h : ratio of the sampling time and the time period
- d: discrete delay (min. 1)
- a_1: the first term of the denominator
- a_2: the second term of the denominator
- b_1: the first term of the numerator
- b_2: the second term of the numerator

System of order *k:*

- n: number of the sinusoidal components
- T/h : ratio of the sampling time and the time period
- d: discrete delay (min. 1)
- A: coefficients of the denominator (in array)
- B: coefficients of the numerator (in array)