Laboratory work 3

STUDYING OF PULSES AND RANDOM SIGNALS

A) Convolution

Convolution is a method to solve the time domain multiplication in frequency domain and vice versa. For example if the transfer function of a system (for instance filter) is known, one can apply the inverse Fourier transform into the transfer function to get the impulse response (time domain characteristics) of the system. Now the time domain output of the system can be calculated by convolving the input signal with the impulse response. Therefore, the system is examined in time domain.

On the other hand, waveform of the input and output signals can be known as well. In that case, the impulse response of the system can be derived by deconvolving the signals. After that, the Fourier transform of the impulse response tells us the transfer function of the system. In order to get the impuse response and the transfer function of the system, the time domain signal used as exitation signal must contain all the frequencies that are of interest (for example in case of an audio amplifier the exitation signal has to contain frequencies from 20 Hz to 20 kHz, e.g. bandlimited white noise). Thus, beforehand or afterwards computed convolution would be very usable in system design and examining.

● = do while working
@ = do afterwards (to the report)

1. In the preliminary questions, the time domain convolution of the rectangular and triangular pulse was done. Now it's time to do it with Matlab. ● Open the m-file (that assistant gives for you) in Matlab's editor and save it right away to the directory d:\sinkut with the same name. Print the m-file and make the needed changes to the macro. At the end, print the graphs.

●/@ What is similar and what does differ when comparing the result with the preliminary questions?

2. Consider that the triangular pulse is switched to a rectangular pulse, which has the same duration and amplitude as the triangular one. Derive the maximum of y(t). This is the case when the rectangular pulses are fully overlapped. **Let the assistant check the answer before continuing!**

Answer: _____

3. Change the triangular pulse in the program list to rectangular so that the duration and amplitude remain the same. Change also the title of the plot! Save the listing as konvo01 and run it. Change the scales if needed. At the end print the graphs.

@ Compare the result with theory in the course book. Similarities and differences?

3. ● Change the impulse response h(t) to

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ht = exp(-t*2).*rectpuls(t-4,8);
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The dot before the asterisk means that the corresponding elements in the vectors are multiplied with each other. The ht is now the impulse response of RC lowpass filter and it is bounded by rect-function (rectpuls) so that the durations of it is 0 – 8 seconds. The term exp means the power of e. The command rectpuls can be considered as unit step u(t).

@ Present the ht with mathematical expression.

● Save the listing as konvo02 and run it. Change the title and scales. Print the graphs for your group.

@ Derive H(f) from ht using Fourier or Laplace transform.
@ The rectangular pulse changes the shape when going through the RC filter. Explain the shape of the output signal with respect to charging and discharging of a capacitor. Sketch a diagram of a circuit where are components, voltage source, and a switch and the waveforms of the signals! The diagram should model the Matlab simulation above.