UNIVERSITY OF TWENTE

Department of Electrical Engineering, Mathematics and Computer Science

Exam Signals and Transforms on Friday April 7, 2017, 8.45 - 10.15 hours.

The solutions of the exercises should be clearly formulated. Moreover, in all cases you should motivate your answer!

You are not allowed to use a calculator. Besides pen and paper, the only thing you are allowed to use is one handwritten, singe-sided, A4-sized page of personal notes.

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1. Consider a filter for which the Fourier transform of the step response is given by:

$$\hat{g}(\omega) = \frac{\omega \sin \omega}{\omega^2 + 1}$$

   a) Determine the step response

   b) Determine the frequency response

   c) Consider the input:

$$u(t) = \operatorname{sgn}(t)$$

   Compute the corresponding output $y(t)$.

   d) Consider the input:

$$u(t) = \sin\left(\tfrac{\pi}{2} t\right)$$

   Compute the corresponding output $y(t)$ and show it is real-valued.

2. Determine the convolution of $f(t) = e^t \mathbb{1}(t)$ and $g(t) = e^{-2t} \mathbb{1}(t-1)$ via Fourier or Laplace transformation.

3. Given is the differential equation:

$$y^{(2)}(t) - 4y^{(1)}(t) + 5y(t) = 15u(t). \tag{1}$$

   a) Determine the impulse response of (1).

   b) Determine the step response of (1).

   c) As input we choose $u(t) = 2e^{-t} \mathbb{1}(t)$. Determine the solution for $t > 0$ of (1) with $y(0^-) = 5$, $y'(0^-) = 2$.

For the exercises the following number of points can be obtained:

Exercise 1. 10 points Exercise 2. 7 points Exercise 3. 10 points

The grade is determined by adding 3 points to the total number of points obtained and dividing by 3.