TTK4225 System theory, Autumn 2023

Assignment 10

The expected output is a .pdf written in LaTeX or a Python notebook exported to .pdf, even if photos of your handwritten notes or drawings will work. Every person shall hand in her/his assignment, independently of whether it has been done together with others. When dealing with mathematical derivations, unless otherwise stated, explain how you got your answer (tips: use programming aids like Python, Matlab, Maple, or compendia like Rottmann's to check if you have obtained the right answer).

Question 1

Consider the time signal

$$x_1(t) = e^{3t} - 2te^{3t}.$$

Describe which dynamical system may admit $x_1(t)$ as a solution, and from which initial conditions.

Question 2

Consider the formula

$$\mathcal{L}\left[t^n e^{\lambda t}\right] = \frac{n!}{(s-\lambda)^{n+1}}.$$

Describe which concepts from the course may be somehow connected with this formula, and how you would use them to create a mnemonic for this formula.

Question 3

1. Design a LTI system in terms of an opportune ODE (thus, decide both the order of the system, and its actual parameters) for which the associate impulse response looks like a fastly vanishing oscillatory behavior on top of a slowly vanishing exponential decay;
2. create a poles-zeros map of the system you designed (hint, if you want to do it in a computer-aided fashion: use the available python notebooks code in GitHub);
3. describe how you may make the amplitude of the oscillatory behavior (note: only the amplitude; not the frequency of the oscillations) bigger or smaller by changing the parameters of the ODE describing the system.