COMP.SGN.100 Introduction to Signal Processing,
Exercise 5, 20.-21.9.2021

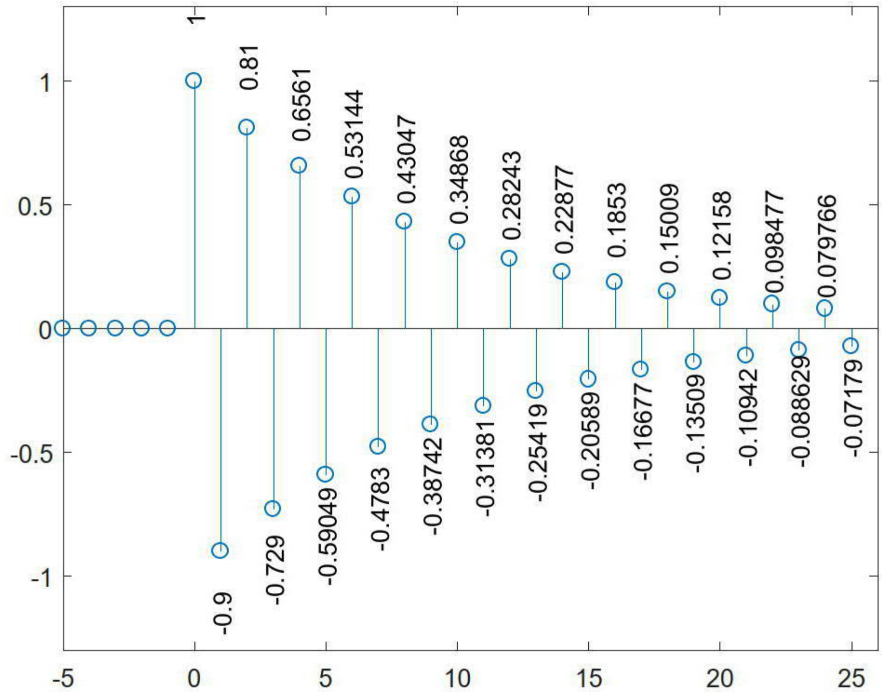
Pen & paper task solutions should be submitted to Moodle at least one hour before your exercise session. Matlab tasks are done during the exercise session.

Task 1. *(Pen & paper)* Calculate the Fourier series of the function

$$x(t) = \begin{cases} 1, & \text{when } -\frac{\pi}{4} \leq t \leq \frac{\pi}{4}, \\ 0, & \text{in other points of the interval } [-\pi, \pi]. \end{cases}$$

Outside the interval $[-\pi, \pi]$ the function $x(t)$ is periodic: $x(t) = x(t + 2\pi)$.

Task 2. *(Pen & paper)* Calculate the DTFT of the infinitely long signal shown in the figure.



Task 3. *(Matlab)* On p. 45 of the lecture handout the system $y(n) = 1.1y(n-1) + x(n)$ is stated not to be stable because for the input $u(n)$ the output grows without bound. Try this with Matlab as follows. First, generate the $u(n)$ signal as in Exercise 3, Task 3(b) (however, make the part consisting of ones a bit longer).

Matlab filters the signal `x` with the command

```
y=filter(b,a,x);
```

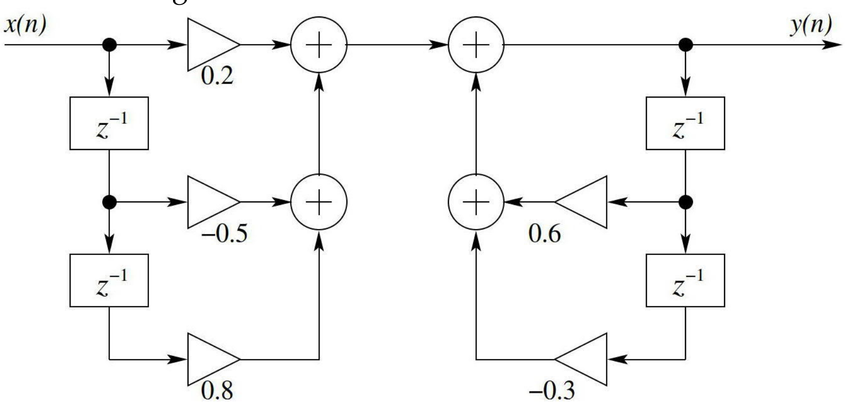
where the vector `b` contains the feedforward filter coefficients and the vector `a` feedback filter coefficients. Note the comment on p. 50 concerning the coefficients in Matlab.

Filter $u(n)$ with this system using the command `filter`. Plot the output using the command `stem`.

Task 4. *(Matlab)* Generate the impulse signal $\delta(n)$ as follows: `delta=[1,zeros(1,127)];` Filter (`filter`) this with the following systems and plot the outputs:

(a) $y(n) = 0.75y(n-1) + x(n)$,

(b) system in the figure below



(c) $y(n) = x(n) + 0.5x(n-1) + 1.25x(n-2) - 0.8y(n-1) + 0.8y(n-2)$.

One of these three systems is not stable. Can you tell by studying the impulse responses which of them it is?

Task 5. *(Matlab)* Plot the impulse responses in the previous task using Matlab's command `impz`. The input parameters are vectors `b` and `a`.