

Initial Remarks

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Digital Signal Processing and System Theory (DSS)

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Course of the Exercise

- you'll get hand-outs with problems and we recommend you to solve them at home as preparation for the exam
- the solutions to the problems will be presented in the exercises
- at any time you can ask your questions on the material

Exams

- see information in the lecture

Literature

- see information in the lecture

For updates and downloads please visit the teaching webpage <http://dss.kirat-online.de/index.php/teaching/lectures/> and click on the ADSP section.

Notation

Symbol	Meaning/Usage
t	Continuous time variable
n	Discrete time variable
$\delta_0(t)$	Continuous time impulse signal
$\gamma_0(n)$	Unit impulse signal (discrete)
$\gamma_{-1}(n)$	Unit step signal (discrete)
ω	Analog frequency in radians per second $\omega = 2\pi/T$
T	Sampling period in seconds
f	Analog frequency in Hz
f_s	Sampling frequency in Hz
Ω	Digital frequency in radians $\Omega = 2\pi f/f_s$
$v(t) \quad \circ \text{---} \bullet \quad V(j\omega)$	Continuous Time Fourier transform
$v(n) \quad \circ \text{---} \bullet \quad V(e^{j\Omega})$	Discrete Time Fourier Transform
$v(n) \quad \circ \text{---} \bullet \quad V(\mu)$	Discrete Fourier Transform

Problem 1 (relationship between continuous and discrete signals)

A complex-valued continuous-time signal $v_a(t)$ has the Fourier transform shown in figure 1. This signal is sampled to produce the sequence $v(n) = v_a(nT)$.

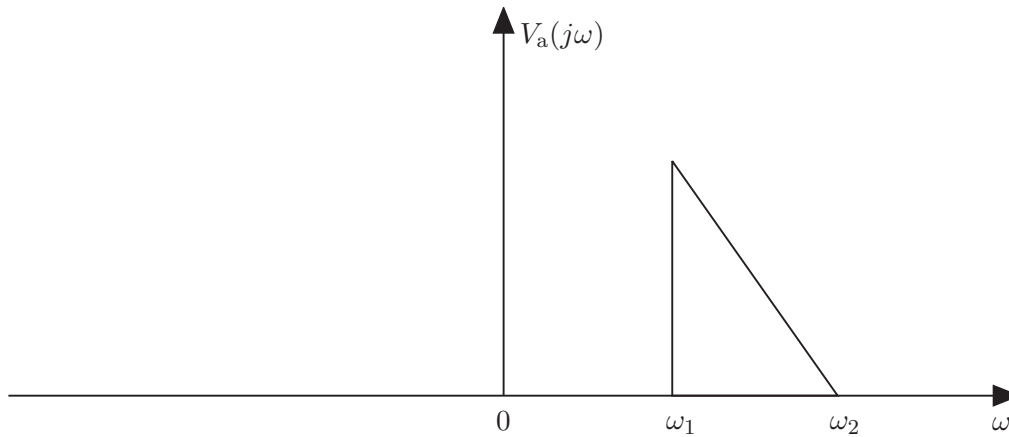


Figure 1: Fourier transform of $v_a(t)$

- (a) Sketch the Fourier transform $V(e^{j\Omega})$ of the sequence $v(n)$ for $T = \frac{\pi}{\omega_2}$.
- (b) What is the lowest sampling frequency that can be used without incurring any aliasing distortion, i.e. so that $v_a(t)$ can be recovered from $v(n)$?

Problem 2 (overall system for filtering a continuous-time signal in digital domain)

Figure 2 shows an overall system for filtering a continuous-time signal using a discrete-time filter. The frequency response of the ideal reconstruction filter $H_r(j\omega)$ and the discrete-time filter are shown below.

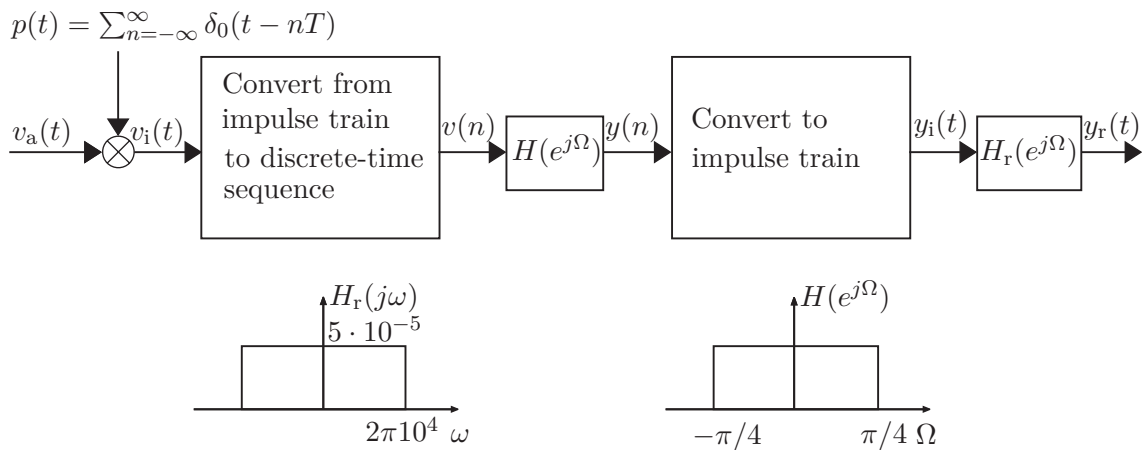


Figure 2: Overall system.

(a) For $V_a(j\omega)$ as shown in figure 3 and $1/T = 20kHz$ sketch $V_i(j\omega)$ and $V(e^{j\Omega})$.



Figure 3: Spectrum of $V_a(j\omega)$ and $H_{eff}(j\omega)$

For a certain range of values of T , the overall system, with input $v_a(t)$ and output $y_r(t)$, is equivalent to a continuous-time lowpass filter with frequency response $H_{eff}(j\omega)$ sketched in figure 3.

- (b) Determine the range of values of T for which the information presented above is true, when $V_a(j\omega)$ is bandlimited to $|\omega| \leq 2\pi \cdot 10^4$ as shown in figure 3.
- (c) For the range of values determined in (b), sketch ω_c as a function of $1/T$.

Note: This is one way of implementing a variable-cutoff continuous-time filter using fixed continuous-time and discrete-time filters and a variable sampling rate.