T-61.3010 Digital Signal Processing and Filtering

(v. 1.0, 26.1.2009), Paper #1 (27.1., 28.1., 29.1.2009)

The problems marked with [**Pxx**] are from the course exercise material (Spring 2009), where **Pxx** refers to the problem.

In the end of this session **you should know**: (a) δ and μ notations, (b) how to compute signal period, (c) what moving average filter does, (d) how to read and recognize LTI systems in time-domain, and (e) to distinguish FIR and IIR filters and their properties.

NOTE! Exercise material (Spring 2009) is now available in the course web page (4-in-1), and is published as "prujut" in 2-in-1.

NOTE! Home exercises for mid term exam 1 will be published next week. Instructions and PDF papers are delivered by email.

1. [**19**] Sketch the following sequences around the origin
   a) $x_1[n] = \sin(0.1\pi n)$
   b) $x_2[n] = \sin(2\pi n)$
   c) $x_3[n] = \delta[n-1] + \delta[n] + 2\delta[n+1]$
   d) $x_4[n] = \delta[-1] + \delta[0] + 2\delta[1]$
   e) $x_5[n] = \mu[n] - \mu[n-4]$
   f) $x_6[n] = x_3[-n+1]$
2. [**20**] Which of the following signals are periodic? Determine the length of the fundamental period for periodic signals.
   a) $x(t) = 3\cos(\frac{8\pi}{31}t)$
   b) $x[n] = 3\cos(\frac{8\pi}{31}n)$
   c) $x(t) = \cos(\frac{\pi}{8}t^2)$
   d) $x[n] = 2\cos(\frac{\pi}{6}n - \pi/8) + \sin(\frac{\pi}{8}n)$
   e) $x[n] = \{\ldots, \underline{2}, 0, 1, 2, 0, 1, 2, 0, 1, \ldots\}$
   f) $x[n] = \sum_{k=-\infty}^{+\infty} \delta[n-4k] + \delta[n-4k-1]$
3. [**21**] Compute "a two-point moving average" temperature from daily temperatures in DSPVillage in early July:

July	1st	2nd	3rd	4th	5th	6th	7th
° C	12	16	15	22	20	24	23

4. [**23**] Express the input-output relations of the discrete-time systems in Figure 1.
5. [**27**] Impulse response $h[n]$ is the response of the system to the input $\delta[n]$.
   a) What is the impulse response of the system in Figure 1(a)? What is the connection to the difference equation? Is this LTI system stable/causal?

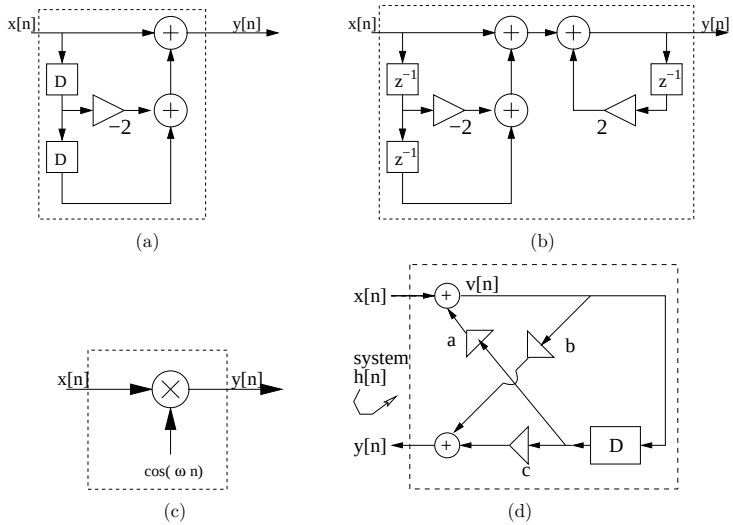

Figure 1: Discrete-time systems for Problems 4, 5, and **??**.

   b) What are the first five values of impulse response of the system in Figure 1(b)? Hint: Fetch the input $\delta[n]$ and read what comes out. Is it possible to say something about stability or causality of the system?
   c) What are the first five values of impulse response of the system in Figure 1(d)?