Lund University
Department of Electrical and Information Technology

Systems and Signals, EITF75
Task 2 (out of 2)

Deadline: Complete the task, and hand it in in the course mailbox at the third floor no later than October 12, 23.59.

Observe: To simplify the grading procedure:
- Solve one problem per paper sheet
- Write your name on every paper

Statements must be well motivated by reasoning and/or equations
Points from the tasks will be added to the examination score
Maximum total score (exam + 2 tasks) = 5.0+0.5+0.5=6.0p
Grading: 3 (>2.9p), 4 (>3.9p), 4 (>4.9p)

Problem 1. The following signals and difference equations are given. All variables are real valued

Difference equation 1: $y(n) = -a_1y(n-1) - a_2y(n-2) + x(n), \quad a_2>0$

Difference equation 2: $y(n) = -2y(n-1) - 4y(n-2) + b_0 x(n) + b_1x(n-1) + b_2 x(n-2)$,

Signal 1: $y_1(n) = [2 \quad -1 \quad 5 \quad -1 \quad 2]$

Signal 2: $y_2(n) = [5 \quad 0 \quad 0 \quad 0 \quad 0]$

Signal 3: $y_3(n) = [4 \quad 3 \quad 2 \quad 1 \ ]$

(Correctly solving 5 of the problems gives 0.2p. Solving at least 3 gives 0.1p.)

a. Which signal(s) have linear phase ?

b. Which signal(s) are minimum phase ?

c. Provide conditions for a_1 and a_2 so that Difference equation 1 is: (i) decaying to 0, (ii) has magnitude growing unbounded, (iii) oscillating

d. Provide condition(s) for (b_0, b_1, b_2) so that Difference equation 2 has stable output for stable input signal (BIBO)

e. Can any of the 3 signals be the output of any of the difference equations? If, yes, which pairs, and what inputs x(n) are required?

f. Determine the linear convolution of signal 1 and 3

g. Make a plot of the Fourier transform (both phase and amplitude) of signal 1.

Problem 2 (0.1p). Consider an analog signal x(t), and assume that its Fourier transform satisfies

$$|X(F)| > A, \ \ |F| \leq F_{0,} \qquad |X(F)| = 0, \ \ |F| > 2F_0$$

but that no other conditions on X(F) are given. Sample the signal with sampling rate $F_s=1.5F_0$ and denote the output as x(n). Provide an example of a Fourier transform X(F) such that x(n)=δ(n).

Problem 2 (0.1p). Consider the sampling of a signal x(t) at a sampling rate of F_s=10000Hz. Let the highest frequency component of X(F) be F_{max}, i.e.,

$$|X(F)| = 0, \ \ |F| > F_{max}.$$

Provide a necessary condition on the relation between $F_{max}$and F_s for x(n)=δ(n) to happen.

Problem 3 (0.1p). Consider the three signals

$$x_1(n) = 0.8^n u(n) \ \ x_2(n) = 0.5^n u(n) \ \ \ x_3(n) = 0.2^n u(n)$$

Find

$$y(n) = x_1(n) * x_2(n) * x_3(n)$$