Exam in Signal analysis and representation, 7.5 credits.
Course code: dt8010
Date: 2009-01-05

Allowed items on the exam:
Tables of Signal processing formulas.
Tables of Mathematical formulas.
Calculator.

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Maximum points: 8.
In order to pass the examination with a grade 3 a minimum of 3.3 points is required.
To get a grade 4 a minimum of 4.9 points is required, and to get a grade 5 a minimum of 6.5 points is required.

Give your answer in a readable way and motivate your assumptions.

Good Luck!

1. (2p)

Determine the frequency description and sketch the magnitude function of the following signals:

a) $x_1(n) = \cos\left(2\pi \frac{3}{8} n\right) \quad -\infty \le n \le \infty$ (1p)

b) $x_2(n) = \cos\left(2\pi \frac{3}{8} n\right) \cdot w(n)$ where $w(n) = \begin{cases} 1 & 0 \le n \le 99 \\ 0 & otherwise \end{cases}$ (1p)

Hints:
a) Fourier series expansion of a periodic discrete time signal.
b) $w(n) \cdot \cos(2\pi f_0 n) \leftrightarrow \frac{1}{2}[W(f - f_0) + W(f + f_0)]$.

2. (2p)
A *noncausal* FIR-system of type high-pass can be designed according to:

$$h_{hp}(n) = (-1)^n h_{lp}(n) \text{ where}$$
$$h_{lp}(n) = \{h(-1), h(0), h(1)\} = \{0.2, \underline{0.4}, 0.2\}.$$

a) Compute the frequency response function H(ω) of the *causal* FIR-system h(n)=h_{hp}(n-1) and sketch its magnitude- and phase-function for -π ≤ ω ≤ π.
Present H(ω) as $H(\omega) = H_{real}(\omega) e^{-j\omega(M-1)/2}$ where H_{real}(ω) is a real function and M is the length of h(n). (1.5p)
b) Determine the steady state response y(n) of the system to the input signal

$$x(n) = 1.2 + 0.8\sin\left(\frac{\pi}{2} n\right).$$ (0.5p)

3. (2p)
An LTI-system is described by its impulse response:

$$h(n) = \left[5\left(\frac{3}{4}\right)^n - 4\left(\frac{1}{2}\right)^n\right] u(n).$$

a) Plot the pole-zero pattern of the system and determine if the system is stable. (0.7p)
b) Determine the response of the system when x(n)=u(n) and y(-1)=0, y(-2)=1. (1.3p)

说明是求y(n)

4. (2p)
An LTI-system is described by its impulse response

$$h(n) = \delta(n) + 0.3\delta(n-1) + 0.1\delta(n-3).$$

a) Compute by convolution the output signal y(n) when the input signal is $x(n) = \{\underline{3}, 1, 2, 1\}$. (0.7p)
b) The N-point DFT and IDFT is computed by the Matlab commands: X=fft(x,N); respectively x=ifft(X,N);. Write the necessary Matlab commands to compute y'(n) by using N-point DFT and IDFT. N should be specified as the minimum value to achieve y'(n)=y(n). (0.5p)
c) Determine y'(n) when N=4. (0.8p)