Exam in Signal analysis and representation, 7.5 credits.
Course code: dt8010
Date: 2011-10-28

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)
a) Determine the frequency description and sketch the magnitude and phase spectra of:

$$x(n) = 1 + \cos(\frac{\pi}{4}n) + 0.5\cos(\frac{3\pi}{4}(n-1)) .\ \text{(1p)}$$

b) Compute the output of the system:

$$y(n) = \frac{1}{2}\left[x(n) - x(n-8)\right]$$

when the input is x(n) for $-\infty < n < \infty$. (1p)

2. (2p)
A causal LTI system has the system function

$$H(z) = \frac{1 - z^{-1}}{1 - 0.25z^{-2}} .$$

a) Compute the poles and zeros of the system and sketch the pole-zero plot. (0.5p)
b) Determine the output of the system when x(n)=u(n). (1p)
c) Determine the output y(n) when the input is x(n)= cos(0.5πn) for $-\infty < n < \infty$. (0.5p)

3. (2p)
A causal FIR-system is described by its impulse response:

$$h(n) = 0.5\delta(n) + 0.7\delta(n-1) + 0.5\delta(n-2)$$

a) Compute the frequency response function H(ω), and sketch the magnitude and phase function for $0 \le \omega \le 2\pi$.
Present H(ω) as $H(\omega) = H_{real}(\omega)e^{-j\omega(M-1)/2}$ where $H_{real}(\omega)$ is a real function and M is the length of h(n). (1p)
b) Compute the cut-off frequency, i.e. compute the frequency where the magnitude function has decreased with the factor $\frac{1}{\sqrt{2}}$ relative the value when ω=0. (0.5p)
c) The input is x(n)=cos(ω_0n) for $-\infty < n < \infty$.
For which frequency ω_0 is the output y(n)=0? (0.5p)

4. (2p)
a) Sketch the signal x(n) and compute the N-point DFT for N=64 when

$$x(n) = \left(\delta(n) + \delta(n-4)\right)\left(u(n) - u(n-N)\right) .\ \text{(1p)}$$

b) Sketch the magnitude and phase of the DFT for k in the interval [0, N/2]. (1p)