E9-252: Mathematical methods and techniques in signal processing

Home Work #1 (Due 3rd September 2013 in class)

Review of signals and systems

Late Submission Policy: Actual points scored = Correct points scored * $e^{-\#\text{days late}}$

**Problem Sets:**

1) Using the definition of linearity, examine if the ideal delay and the moving average systems are linear. (5 pts)
2) A discrete LTI system has an impulse response $h[n]$. If the input $x[n]$ is periodic with period $N$, i.e., $x[n+N]=x[n]$, examine if the output $y[n]$ is periodic. (5 pts)
3) Consider the first order difference operation:

$y[n]=x[n]-x[n-1]=\nabla x[n].$

(a) Show that the system is LTI.

(b) Find and sketch the frequency response of the system.

(c) Is convolution operation commutative? Prove your result.

(d) Suppose $x[n]=f[n]*g[n]$, show that $\nabla x[n]=f[n]*\nabla g[n]=\nabla f[n]*g[n]$ (* is the discrete convolution operation) .

(e) Find the impulse response of a system $h_i(n)$ which when cascaded with the first order difference system can recover the input. i.e.,

$h_i[n]*\nabla x[n]=x[n]$ .

(12 pts)

4) Obtain the state variable representation of the following transfer function from first principles. (Moon and Stirling, problem 1.4.15 (c))

$$H(z)=\frac{1-2z^{-1}}{1+0.5z^{-1}+0.06z^{-2}}.$$ (8 pts)

5) Let $S=[A,b,c^T,d], d\neq 0$ denote the state variable representation of an LTI system $H(z)$. What would be the state variable representation of $1/H(z)$? Express your answer in terms $A,b,c^T,d$ . (Moon and Stirling, problem 1.4.21) (10 pts)

6) Problem 1.4.30 parts (a) and (b) from Moon and Stirling. (10 pts)