EENG/INFE 420: Digital Signal Processing  
Spring 2012-2013  

MIDTERM EXAM

Name(full): ____________________________  
St. Number: ____________________________  
Lecturer: Assoc. Prof. Dr. Erhan A. Ince

Read the following instructions carefully:

1) Please put your name on both the question paper and the answer sheet.
2) Use front and back of each page on the answer booklet to answer each question.
3) Please answer any FOUR questions.
4) After the exam submit both the question paper and your solution booklet.

Problem 1

(i) State the definitions for linearity and time invariance.

Examine the following systems with respect to the properties said beside them

(ii) \( y[n] = x[n] - x[n-1] \), \( y[n] = nx[n] \) : Time invariant vs. time varying

(iii) \( y[n] = nx[n] \), \( y[n] = x^2[n] \) : Linear vs. non-linear

(iv) \( y[n] = x[n] - y[n-1] \), \( y[n] = x[n]+5x[n-1] \) : Recursive vs. non-recursive

Problem 2

Determine the zero-input response of the system described by the second order difference equation given below

\[ y[n] - 3y[n-1] - 4y[n-2] = 0 \]

given that \( y[-2] = 0 \) and \( y[-1] = 5 \).
Problem 3

A backward-difference system which is represented by the system equation below is one of the simplest filters

\[ y[n] = x[n] - x[n - 1] \]

For this system

(a) Find the Z-transform of the system equation
(b) Determine the system function
(c) Sketch the magnitude square of the frequency response of the system
(d) Based on your answer in part (c), state what the filter type is (lowpass, highpass, bandpass, bandstop).

Problem 4

Consider the discrete time signal given below

\[ x[n] = \begin{cases} 
-1 & n = 0 \\
2 & n = 1 \\
2 & n = 2 \\
1 & n = 3 \\
0 & \text{otherwise}. 
\end{cases} \]

(a) Calculate the 4-point DFT \( X[k] \) of \( x[n] \).
(b) Given \( h[n] \) below, compute the circular convolution between \( x[n] \) and \( h[n] \).

\[ h[n] = \{2, 1, 1\} \]

Problem 5

Determine the z-transforms of the following sequences and their respective ROCs:

(a) \( x_1[n] = \alpha^n u[n - 2] \)
(b) \( x_2[n] = \alpha^n u[-n - 3] \)