

EE 123 DIGITAL SIGNAL PROCESSING, Spring 2009

Midterm # 1, March 5, Thursday, 9:30-10:50 am

Name _____

Closed book. Two letter-size crib-sheets are allowed. Show all your work. Credit will be given for partial answers.

Problem	Points	Score
1	35	
2	30	
3	35	
Total	100	

1. Consider the LTI system:

$$y[n] - 1.1y[n-1] + 0.3y[n-2] = x[n].$$

a) (10 points) Write the transfer function and determine if the system is BIBO stable.

b) (15 points) Use z-transforms to find the output $y[n]$ when $x[n] = (0.6)^n u[n]$ where $u[n]$ is the unit step function.

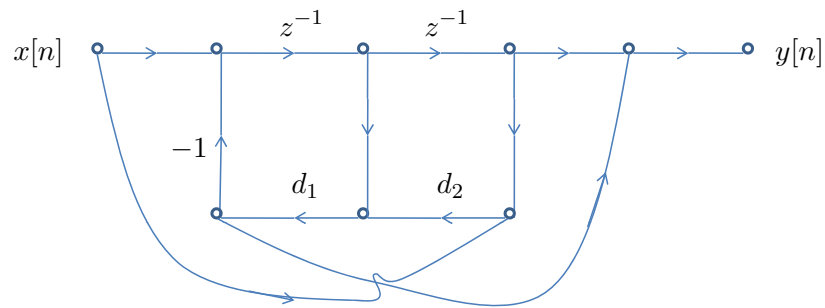
Now consider the median filter:

$$y[n] = \text{median}\{x[n], x[n-1], x[n-2], x[n-3], x[n-4]\}.$$

c) (10 points) Find the impulse and step responses, and determine if this filter is BIBO stable.

Additional workspace for Problem 1

2. a) (15 points) Find the transfer function implemented by the flow diagram:



- b) (15 points) Assume that this system is implemented with $(B + 1)$ -bit two's complement fixed point arithmetic, and the products are rounded to $(B + 1)$ bits. Draw a linear noise model and write an expression for the output noise variance.

Additional workspace for Problem 2

3. The following are the first 7 samples of a 12-point DFT $X[k]$ of a length-12 real sequence $x[n]$:

$$X[k] = \{11, 8 - 2j, 1 - 12j, 6 + 3j, -3 + 2j, 2 + j, 15\} \quad 0 \leq k \leq 6.$$

a) (10 points) Determine the remaining 5 samples of $X[k]$.

b) (15 points) Evaluate the following values: i) $x[0]$, ii) $x[6]$, iii) $\sum_{n=0}^{11} x[n]$.

c) (10 points) The 12-point DFT of another length-12 sequence $y[n]$ is given by:

$$Y[k] = \begin{cases} 12 & \text{if } k = 0 \\ 0 & \text{if } 1 \leq k \leq 11. \end{cases}$$

Calculate the 12-point circular convolution of $x[n]$ and $y[n]$.

Additional workspace for Problem 3.

