Final Examination –EE092IU

Date: June 15th, 2021

Duration: 90 minutes

SUBJECT: DIGITAL SIGNAL PROCESSING – EE092IU	
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INSTRUCTION: Answer 4 of 5 questions

Question 1: (25 marks)

Consider a causal LTI system whose system function is

$$H(z)=\frac{1-\frac{1}{5}z^{-1}}{1-\frac{1}{4}z^{-1}+\frac{5}{24}z^{-2}+\frac{1}{12}z^{-3}}$$

a. Draw the signal flow graphs for implementations of the system in each of following forms: Direct form I; Canonical (Direct form II)
b. By writing the system function in the product of a first and a second order functions, draw the signal flow graph of the system in Cascade form.
c. Specify the Poles and Zeros of the function H(z) then draw the pole/zero pattern
d. Determine the ROC of the system and the corresponding h(n).
e. Write the difference equations

Question 2: (25 marks)

Given the following transfer functions,

1. $H(z)=\frac{z-7}{z^2+\frac{1}{9}}$ causal
2. $H(z)=\frac{z-7}{z^2+\frac{1}{9}}$, anticausal
3. $H(z)=\frac{z}{(z^2+z+1)(z-0.7)}$ h(n) is two sided;
4. $H(z)=\frac{z+1}{z-1}$ causal

a. Determine whether each of the following represents a stable system?
b. Specify their possible solutions for h(n) of each transfer function?

Question 3: (25 marks)

Consider the analog signal $x_a(t) = 3 \cos 100\pi t$

a. Determine the minimum sampling rate required to avoid aliasing?
b. Suppose that the signal is sampled at the rat $F_s = 200$Hz. What is the discrete time signal obtained after sampling?
c. Suppose that the signal is sampled at the rate $F_s = 75$Hz. What is the discrete time signal obtained after sampling?
d. What is the frequency $0 < F < F_s/2$ of a sinusoid that yields samples identical to those obtained in part (c)?
e. Specify the first ten samples of the signal in (b) then calculate the 4-DFT of this sequence.
f. Repeat the question (e) by calculating the 4-FFT.

Question 4: (25 marks)

A causal digital filter having the transfer function h(n) is:

$$h(n) = -2\delta(n) + 3\delta(n-1) + 2\delta(n-2) + h(n-1) + h(n-2) + h(n-3).$$

a. Write the first ten number of the sequence, h(n) for n=0, 1, …,9 ?
b. Calculate the mod-4 wrapped version of h(n)?
c. Calculate the 4-FFT of the sequence in (a).
d. Finally, compute the 4-point IFFT of the result and verify that you recover.

Question 5: (25 marks)

In the given figure, H(z) is the system function of a causal LTI system.

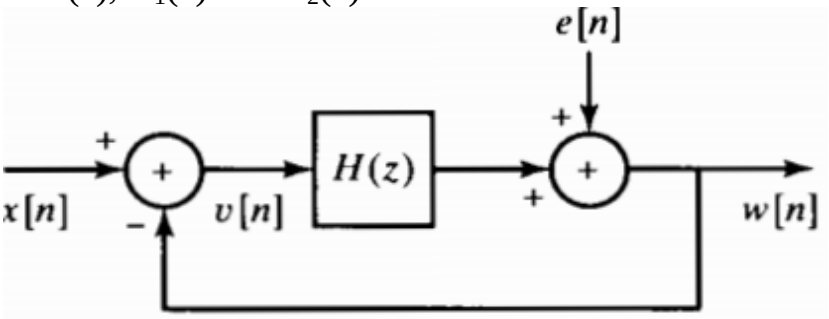
a. Write an expression for W(z) in the form:

$$W(z) = H_1(z)\, X(z) + H_2(z)\, E(z),$$

Where $H_1(z)$ and $H_2(z)$ are expressed in terms of H(z); X(z) and E(z) are the z-transform of x(n) and e(n).

b. For the special case: $H(z) = \dfrac{z^{-1}}{1 - z^{-1}}$ determine $H_1(z)$ and $H_2(z)$?

c. Are the systems H(z), $H_1(z)$ and $H_2(z)$ stable?



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Good lucks!