**ECE 381 Introduction to Digital Signal Processing**

**Final**

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**INSTRUCTOR:** Jiang Li, Associate Professor, ECE Department.  
            Office: 231D KH, Phone: 683-6748, Email: [JLi@odu.edu](about:blank)

Office Hours: TR 10:00-11:30AM (Other times by appointment)

**Open book exam, however, you should do the work by your own.**

1. (20 points)

a). (8 points) for *x1*[*n*] = *u*[-*n*-1] + (1/2)*nu*[*n*], compute power *Px* of *x1*[*n*].

b). (8 points) for *x2*[*n*] = 3*nu*[-*n*-1] + (1/2)*nu*[*n*], compute energy *Ex* of *x2*[*n*].

c). (4 points) for *x3*[*n*] = *x2*[*n*-10], compute energy *Ex* of *x3*[*n*].

1. (20 points) Let Z{}denote the one-sided Z-transform, “•” denote multiplication and “\*” denote linear convolution, compute the following expressions:

a). (4 points)if *x*[*n*] = *u*[*n*] - *u*[*n*-5], what is *x*(*z*)=Z{*x*[*n*]}? (1 point) if *y*(*z*) = *x*(*z*/2), what is *y*[*n*]? (3 points)

b). (3 points) Z{(1/3)*nu*[*n*-2]} • Z{(1/2)n-1u[*n*+2]}

c). (5 points) Z{(*u*[*n*+3]- *u*[*n*]) \* (*u*[*n*]-*u*[*n-*3])}

d). (8 points) Show each step graphically in the following convolution

(*u*[*n*]- *u*[*n-*3]) \* (*u*[*n*]-*u*[*n-*6])

1. (15 points) Based on the pole-zero location of the systems, roughly sketch the amplitude response of these filters (from 0 to π).

a). (4 points)



b). (4 points)



c). (4 points)



d). (3 points). What types of filters (low-pass, high-pass etc.) are in the problem 3a), 3b) and 3c), respectively?

4. (20 points, 5 points each) Two finite length signals, *x*1[*n*] and *x*2[*n*] are given as:

*x*1[*n*] = 2(*u*[*n*+2] – *u*[*n-*4])

*x*2[*n*] = *u*[*n*] – *u*[*n-*7]

Let *y*[*n*] be the linear convolution of *x*1[*n*] and *x*2[*n*]

1. Determine *y*[*n*].
2. Compute 10-point circular convolution of *x*1[*n*] and *x*2[*n*].
3. Compute 6-point circular convolution of *x*1[*n*] and *x*2[*n*].
4. What is the minimum value for *N* that will make the *N*-point circular convolution of *x*1[*n*] and *x*2[*n*] the same as the linear convolution *y*[*n*]?

5. (25 points, 5 points each) An LTID system has the following impulse response

*h*[*n*] = (1/3)*nu*[*n*] + (1/5)n*u*[*n*]

1. Find the system function H(z) of the system and the associated ROC.
2. Use the DFII form to realize the system.
3. Find the difference equation corresponding to this system.
4. Is the system stable? Is the system causal? Prove or justify your answers.
5. Find the output of the system for the input

, for all *n*.