# Final Examination – EE092IU

Date: Jan 6th, 2020

Duration: 120 minutes

| SUBJECT: DIGITAL SIGNAL PROCESSING – EE092IU | |
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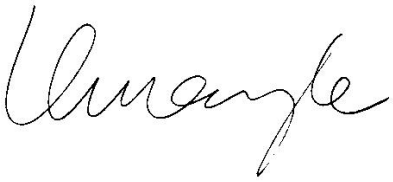
| Dean of School of Electrical Electronics Engineering<br><br>Signature:<br><br><br><br>Full name: | Lecturer: Prof. Dr. Thuong Le-Tien<br>(Cell : 0903 787 989)<br>Signature:<br>  <br>Full name: THUONG LE-TIEN |

## INSTRUCTION:

- **One A4 page of notes is allowed in the exam**
- **Mobile phones are prohibited during the exam!**

**Question 1: (20marks)**

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 2: (20marks)**

A discrete time signal x(n) is defined as

$$x(n) = \begin{cases} 1 + \frac{n}{3}, & -3 < n < -1 \\ 1 & 0 \le n \le 3 \\ 0, & elsewhere \end{cases}$$

a. Determine its values and sketch the signal x(n)

b. Sketch the signals that result if:

First fold x(n) and then delay the resulting signal by four samples

First delay x(n) by four samples and then fold the resulting signal

c. Sketch the signals x(-n+4)

d. Compare the results in part (b) and (c) and derive a rule for obtaining the signal x(-n+k) from x(n)

e. Express the signal x(n) in terms of signals δ(n) and u(n)?

**Question 3: (20 marks)**

A linear time-invariant system is characterized by the system function

$$H(z) = \frac{3 - 4z^{-1}}{1 - 3{,}5z^{-1} + 1.5z^{-2}}$$

Specify the ROC of H(z) and determine h(n) for the following conditions:

a. The system is stable

b. The system is causal

c. The system is anticausal.

d. Realize the Direct form I and Canonical form of the system?

**Question 4: (20 marks)**

Determine all possible signals and their ROCs that can have the following z-transforms

$$X(z) = \frac{1}{1 - 1{,}5z^{-1} + 0.5z^{-2}}$$

$$Y(z) = \frac{1}{1 - z^{-1} + 0.25z^{-2}}$$

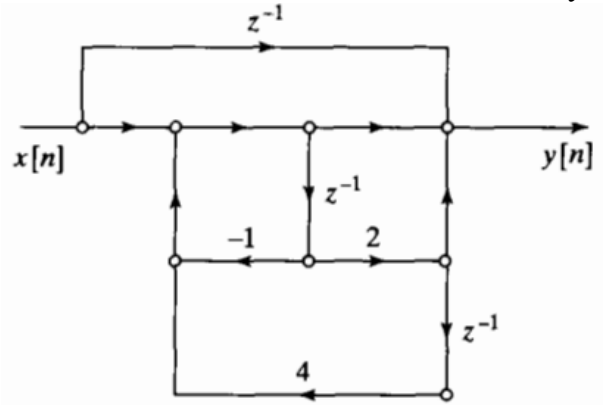
**Question 5: (20 marks)**

The given figure shows the signal flow graph for a causal discrete time LTI system. Branches without gains explicitly indicated have a gain of unity

a. Defining the note names then writing the node equations, Determine the impulse response h(n), then calculate h(1) (i.e. h(n) at n-1)

b. Determine the difference equation (I/O equation) relating x(n) and y(n)

c. Realize the direct form 1 and canonical form of the system.




**Good lucks!**