Online Midterm Examination – EE092IU

DSP-Paper No.2; Date: April 25th, 2020

Duration: 90 minutes (9am-10:30am)

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

INSTRUCTION:

- **Any of notes is allowed in the exam**
- **Student should correctly pick up the instructed exam paper**
- **Student's scanned exam-paper should be submitted no later than 10:40am (the system will be locked after this deadline!)**
- **Answer 4 of 5 questions**

Question 1: (25 marks)

How many bits are needed in an A/D converter if we want a signal-to-quantization noise ratio SQNR (non-normalized SNR) of at least 90dB? Assume that $x_a(t)$ is Gaussian with a variance σ^2_x and that the range of the quantizer extends from $-3\sigma_x$ to $3\sigma_x$; that is $X_{max}=3\sigma_x$

Question 2: (25 marks)

Assuming a DSP system with a sampling time interval of 125msec,

a. Convert the following analog signals x(t) to the digital signal x(n)
   $x(t) = 10 \exp(-5000t)\, u(t)$
b. Determine and plot the sample values from the obtained digital function

Question 3: (25 marks)

By definition, the first and second of Fibonacci numbers are 0 and 1 (e.g. x(0)=0 and x(1)=1), and each subsequent number is the sum of the previous two.

a. Write the first ten-values of the Fibonacci sequence
b. Express and sketch the sequence in (a) versus the Delta function (Impulse) as a recursive form.
c. Assumed the signal x(n) in (a) is the input of a system with the impulse response h(n)={-1.2.0.1}. Using the convolution table to calculate the output signal y(n)=x(n)*h(n).
d. Repeat the question (c) by using the 4-samples-block- Over Add Block algorithm?

Question 4: (25 marks)

Using the given Discrete Time Fourier Transform (DTFT) of a sample function and the delay property of the Fourier transform in the time domain, find a difference equation (I/O equation) to implement a digital filter that has a unit sample (Impulse) response as follows,

$$h(n)=\left(\frac{1}{4}\right)^n \cos\left(\frac{n\pi}{3}\right)u(n)$$

Hint: given the function $x(n)=(a)^n u(n)$ *then* $DTFT[x(n)]=\frac{1}{1-ae^{-j\omega}}$;

H(ω)=Y(ω)/X(ω)

Question 5: (25 marks)

The Impulse response h(n) of a filter is non zero over the index range of n be [0,3]. The input signal x(n) to this filter is non zero over the index range of n be [5,10]. Consider the direct and LTI forms of convolution

$$y(n)=\sum_m h(m)x(n-m)=\sum_m x(m)h(n-m)$$

a. Determine the overall index range n for the output y(n). For each n, determine the corresponding summation range over m, for both the direct and LTI forms.
b. Assume h(n) = {-1, 2, 1, 3} and x(n) = 1 over their respective index ranges. Calculate and sketch the output y(n). Identify (with an explanation) the input on/off transient and steady state parts of y(n).

Good lucks!