Concordia UNIVERSITY

FACULTY OF ENGINEERING AND COMPUTER SCIENCE

COURSE Discrete Time Signals and Systems		NUMBER ELEC 342	SECTION AA
EXAMINATION FINAL	DATE June 16, 2016	TIME & PLACE Room: 2:00am -5:00 pm	# OF PAGES 4
PROFESSOR Dr. W. Lynch		LAB INSTRUCTOR	
MATERIALS ALLOWED ☒ YES (PLEASE SPECIFY) (below) CALCULATORS ALLOWED O NO ☒ YES			
SPECIAL INSTRUCTIONS: Answer all questions.			

Name: ______________________________ I.D.: ______________________

Surname, given names

This is a closed book exam.

Only an official calculator with the ENCS stamp is allowed.

Students may bring into the exam three 8.5x11 inch pages on which anything may be written. Both sides may be written on.

If you have any difficulty you may try to make REASONABLE assumptions. State the assumptions and how those assumptions limit your answers. Show all your work in detail and justify your answers.

Marks are given for how an answer is arrived at, not just the answer itself.

<u>Students MUST take this question paper home with them.</u>

Concordia University
ELEC 342 Discrete Time Signals and Systems
Final Exam – Summer 2016

Students are allowed three 8.5*11 inch formula sheets. Anything can be written on these sheets and both sides may be written on. The ENCS calculator, pens, pencils, erasers and straightedges are also allowed.

If you have difficulty you may try making REASONABLE assumptions. State the assumption and how the assumption limits your answer.

Show all your work and justify all your answers. Marks are given for how an answer is arrived at not just the answer itself.

1. An electrical signal is known to vary between -5V and 0V. We would like that the quantization noise has a variance of less than 1/300.

   a) Design a quantizer to do this. Your design should include: the step size Δ, The lowest reconstruction level, the highest reconstruction level, the number of reconstruction levels and the number of bits for each sample. **(4 marks)**
   b) No doubt in your answer above you contrived to make the number of reconstruction levels a power of 2. Why did you do that? **(2 marks)**
   c) What is a mid-step quantizer? **(2 marks)**
   d) What is a mid-riser quantizer? **(2 marks)**
   e) What are the advantages and disadvantages between mid-step and mid-riser quantizers? **(2 marks)**
   f) Design a new quantizer with the same requirement on noise, but where the input signal is known to vary between -10V and +10V. Your design should include: the step size Δ, The lowest reconstruction level, the highest reconstruction level, the number of reconstruction levels and the number of bits for each sample.Comment on whether you should use a mid-step or mid-riser quantizer. **(4 marks)**

2. Given x[k] and h[k] below, find y[k] where y[k]=x[k]*h[k]. Here "*" means convolution. You must use convolution in the time domain to find y[k]. **(6 marks)**

$$x[k] = 2^{k-3}u[k-3]$$
$$h[k] = 0.5(u[k-1] - u[k-100])$$

3. For the Fourier transform for discrete time signals X(ω) what is the "highest" frequency? Explain. **(3 marks)**

4. A continuous time signal $x_c(t)$ is composed of a summation of 4 sinusoidal signals with frequencies F_1, F_2, F_3, and F_4 all measured in Hz. The signal is sampled at a sampling rate of 8 kHz. The resulting discrete time signal is converted back to continuous time. The continuous time signal resulting from that is passed through an ideal analog low pass filter with cutoff 3.8 kHz. See the diagram. The output of the filter y(t) is a signal composed of three sinusoidal signals with frequencies 450 Hz, 625 Hz and 950 Hz.

a) Give possible values for F_1, F_2, F_3, and F_4. **(4 marks)**

b) For each of for F_1, F_2, F_3, and F_4, are the values you chose uniquely determined? (i.e could you have given different answers) (answer yes or no for each of the four frequencies.) **(4 marks)**

c) For any of the frequencies above that you answered as not being unique in the question above, give an alternative value. Note that your answers here ***must not*** be any of the numbers you provided in your answer to a) **(4 marks)**

5. A causal LTI system has poles and zeros as follows. Poles: $z = 0.9e^{j\pi/4}, 0.9e^{-j\pi/4}, 0.8$. Zeros are at $z = -1, 1.1e^{j3\pi/8}, 1.1e^{-j3\pi/8}$.

a) Draw a pole zero diagram. Be sure to mark the ROC. **(3 marks)**

b) Is this system stable? Justify your response. **(2 marks)**

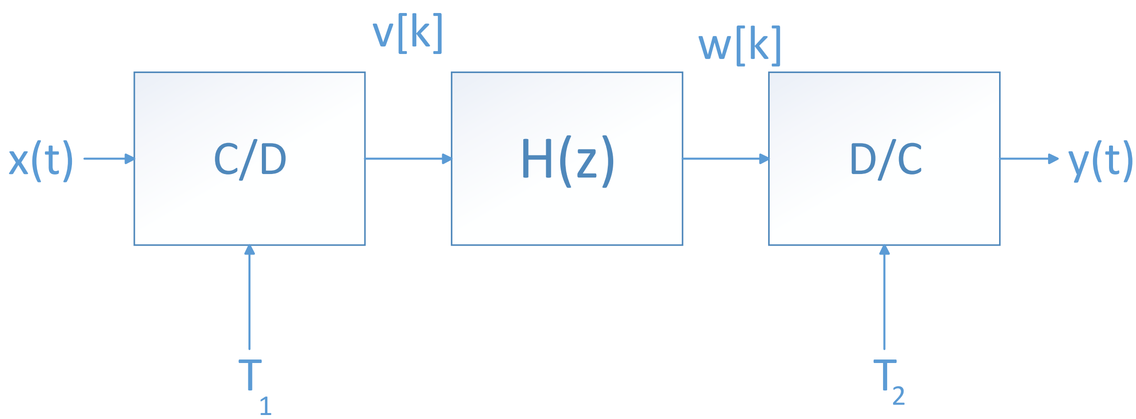
c) Is the impulse of this system of finite duration? Justify your response. **(2 marks)**

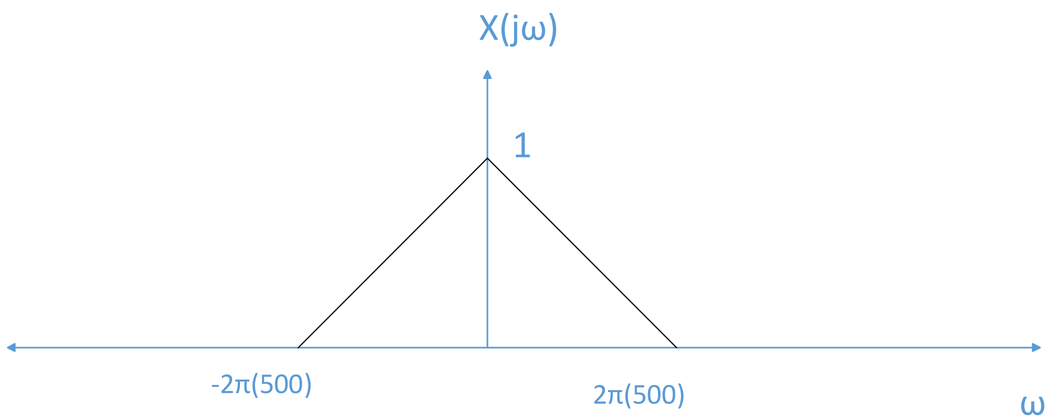
d) Is the impulse response of this system real? Justify your response. **(2 marks)**

e) Assuming that there are no poles or zeros at z=0, and that the impulse response h[k] has h[0]=2, determine the transfer function H(z). Be sure to state the ROC. **(5 marks)**

f) Does this system have an inverse system? Justify your response. **(2 marks)**

6. Consider the block diagram shown along with the spectrum of the continuous time input. The discrete time filter H(z) is an ideal bandpass filter with a passband from 0.2π to 0.3π and a pass band gain of 1. If T_1=0.0005 seconds and T_2=0.0005 seconds sketch the spectrum of v[k], w[k] and y(t). Be sure to mark all interesting points on your sketches. **(10 marks)**





7. We wish to design a discrete time low pass filter with passband ripple 0.15 and stopband ripple 0.12. The pass band is 0 to 0.3π rad/s and the stopband extends upwards from 0.4π to π rad/s.
   a. Make a sketch of this specification. Include in your sketch shaded regions indicating forbidden zones where the frequency response of the designed filter must not go. Be sure to mark the values of all interesting points. **(4 marks)**
   b. If the input to the designed filter is

      $x(k) = \cos(0.1\pi k) + \cos(0.35\pi k) + \cos(0.4\pi k)$

      describe what the output y(t) will be. Express your ideas as clearly as you can. **(4 marks)**

8. Consider a discrete time LTI system with the following frequency response

$$H(\omega) = \frac{e^{-2j\omega}}{(1+7e^{-j\omega})(1-0.5je^{-j\omega})}$$

- **a.** What is the transfer function H(z) for this system?. **(2 marks)**
- **b.** Write down the impulse response h[k]. **(4 marks)**
- **c.** Find the output y[k], when the input is $x[k] = e^{j0.5\pi k} + 5\delta[k]$. **(4 marks)**
- **d.** Write down a Linear Constant Coefficient Difference Equation (LCCDE) that will implement this system. **(3 marks)**

Total 84 marks