

**EE 6360-001**  
**Exam 1**  
**October 6, 2007**

**Please Print.**

**Last Name**

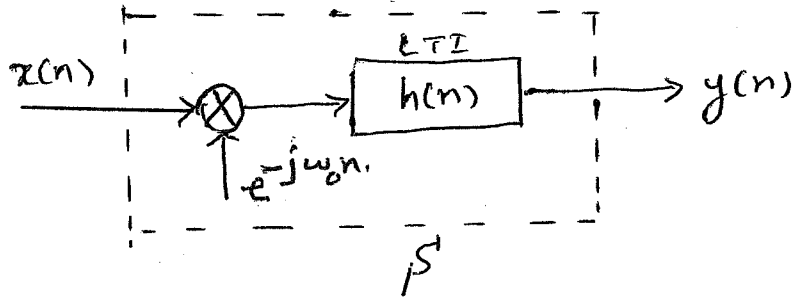
**First Name**

**Instructions**

1. Examination Duration: 2 hours.
2. ONE 8.5" x 11" sheet, with both sides of hand-written material, is allowed. No solved problems of any kind are allowed.
3. One calculator is allowed.
4. Answer in the space/sheets provided. **Highlight your answers.**
5. **Answer all questions. Part A has 6 questions, equally weighted for 60 points; Part B has 10 questions, equally weighted for 40 points. Show all steps/logic, unless the question instructs you otherwise. DO NOT RELY ON PARTIAL CREDIT, WHICH IS SOLELY AT THE DISCRETION OF THE INSTRUCTOR.**
6. Any copying or cheating will result in appropriate action as per university regulations.

**Part A:**

1. Shown below is a system  $S$  with input  $x(n)$  and output  $y(n)$ . The LTI system has a stable impulse response  $h(n)$ . The system is at rest. (a) Is the system  $S$  linear? (b) Is the system  $S$  time invariant? (c) Is the system  $S$  BIBO stable? You must prove or disprove the answers to your questions to receive credit.





2. Determine the autocorrelation of the finite sequence  $x(n) = 1, 0 \leq n \leq (N-1)$ , and  $x(n) = 0$  otherwise.



3. A causal, LTI system is described by the following LCCDE:

i.  $y(n) - \frac{1}{4} y(n-1) = x(n)$ ,  $n \geq 0$  with  $y(-1) = 1$ , and  $x(n) = (\frac{1}{2})^n u(n)$

Determine the complete response  $y(n)$ ,  $n \geq 0$ . Identify the zero input and zero state responses. Identify the homogeneous and particular solutions.

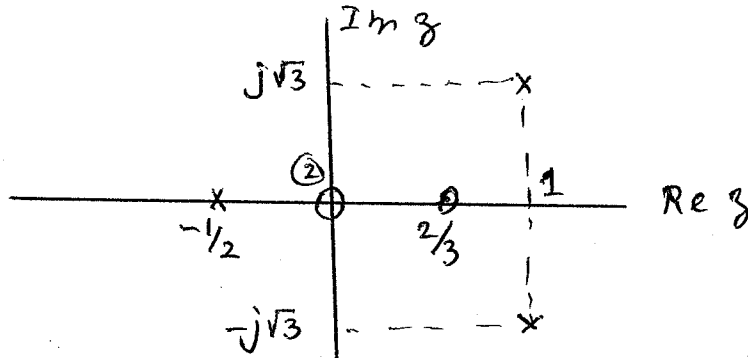


4. The input to an LTI system is given by  $x(n] = u(n) - u(n-3)$ , and the impulse response of the LTI system is given by  $h(n) = u(n) - u(n-6)$ . Determine and sketch the output,  $y(n)$ .



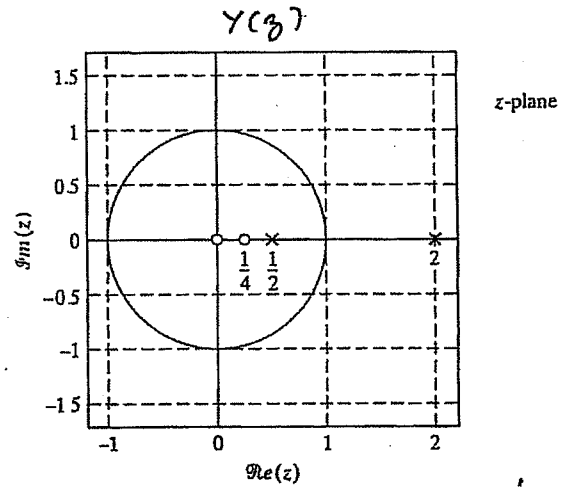
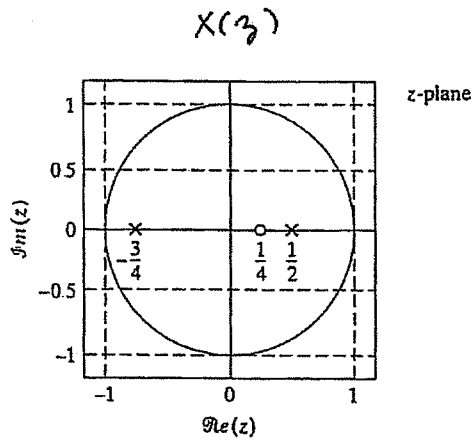


5. The pole-zero plot of an LTI system is shown below. The gain of the system is  $9/8$ . Determine all possible impulse response sequences associated with the information given. Comment on the stability of each sequence, giving appropriate reason. [Note: The zero at the origin is of multiplicity 2, i.e. it is a double zero at the origin.]





6. The signal  $y(n]$  is the output of an LTI system with impulse response  $h[n]$  for a given stable, input sequence  $x[n]$ . Throughout the problem, assume that  $y[n]$  is stable. The pole-zero configurations of  $X(z)$  and  $Y(z)$  are shown below. (a) What is the ROC of  $Y(z)$ ? (b) Is  $y[n]$  right-sided, left-sided or two-sided? (c) What is the ROC of  $X(z)$ ? (d) Is  $x[n]$  a causal sequence? (e) Draw the pole-zero plot of  $H(z)$  and specify its ROC. (f) Is  $h[n]$  causal, anti-causal or two-sided? [Note: Label your answers.]





**Part B: SHORT QUESTIONS** (Write only the answers. Do any scratch work needed on separate sheet(s), which should not be submitted. Credit is given only for correct answers.) (40 points)

1. Which of the following three DT sequences are (i) stable? (ii) causal?

(a)  $x(n) = (-1)^n u(-n)$ , (b)  $x(n) = (-1)^n u(n)$ , (c)  $x(n) = (-1/2)^n u(n) + (-1/2)^n u(-n)$

2. The CT signal  $x(t) = \sin(2\pi 10t + \pi/4)$  is sampled at the rate of 15 samples per second to obtain the DT signal  $x(n)$ , which is reconstructed at the rate of 30 samples per second to obtain  $y(t)$ . Write the expression for  $y(t)$ . Assume ideal C/D and D/C converters.

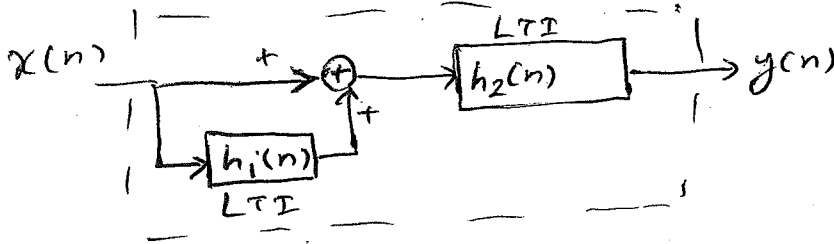
3. What is the DT sequence  $x(n)$  that corresponds to  $X(z) = (1+2z)(1+2z^{-1})$ ?

4. Which of the following DT signals are periodic? For periodic signals, write the corresponding fundamental periods.

(a)  $x(n) = \cos(1/3n)$ , (b)  $x(n) = \cos(3\pi/7)$ ,

(c)  $x(n) = \sum_{k=-\infty}^{\infty} w(n-4k)$ , with  $w(n) = \delta(n) - \delta(n-5)$

5. What is the impulse response,  $h(n)$  of the overall causal system shown below?



$$h_1(n) = \frac{1}{2} \delta(n-1)$$
$$h_2(n) = \left(\frac{1}{2}\right)^n u(n)$$

6. What is the LCCDE that describes the input-output relationship for the system shown in the previous question?

7. Draw a Direct Form II implementation of the system in #5 above.

8. A band pass signal extends from 88 kHz to 100 kHz. What is the minimum sampling in kHz in order to reconstruct the signal from the sampled values?
9. A signal is uniformly sampled at 1 kHz and using uniform binary quantization the data rate is 10 KBPS. The resulting SQNR is 50 dB. (a) Customer A desires an SQNR of at least 60 dB. What will be the smallest data rate to satisfy this requirement? What will be the new SQNR? (b) Customer B desires only a minimum SQNR of 40 dB. What will be the data rate to satisfy this requirement? What will be the new SQNR?
10. For each of the following cases, write the ROC of the z-transform (if it exists).  
(a)  $x_1(n) = (1/2)^n u(n+3)$ , (b)  $x_2(n) = (1/2)^n u(-n+3)$ , (c)  $x_3(n) = x_1(n) - x_2(n)$







