University of Illinois **Spring 1998**
ECE 310 **Profs. Bresler & Ramchandran**

Mideterm Exam I

Monday, February 23, 1998

Problem	Pts.	Score
1	12	
2	14	
3	20	
4	11	
5	10	
6	7	
7	6	
8	8	
9	5	
10	7	
11 (Xtra)	5	
12 (Xtra)	6	
Total		

Name _____
Section: 11:00 3:00 PM

Score _____

Please do not turn this page over until told to do so.

You may not use any books, calculators, or notes other than handwritten one side of a 8.5" x 11" sheet of paper. Backs of pages may be used for scratch work if necessary.

Grading of multiple choice problems: unless indicated otherwise, a wrong answer will earn -1 point for the problem (or part of problem.) No answer (blank) will earn 0 points.

GOOD LUCK!

$\cos(\pi/3) = 0.5 \quad \cos(\pi/6) = \sqrt{3}/2 \quad \cos(\pi/4) = \sqrt{2}/2 \quad \tan(\pi/6) = \sqrt{3}/3 \quad \tan(\pi/4) = 1 \quad \tan(\pi/3) = \sqrt{3}$

(12 Pts) 1. Indicate whether the following systems are linear or nonlinear, shift-invariant or shift-varying, and causal or noncausal by filling in the appropriate blanks.
Grading: Correct answer = +2 pts.; Incorrect answer= -2 pts.; No answer (blank) = 0 points. The minimum total score on this problem is 0 pts.

(a) $y(n) = (0.2)^{|n|} \ \log[x(n)]$

Linear or Nonlinear?

Shift-invariant or shift-varying?

Causal or noncausal?

(b) $y(n) = (\frac{1}{3})^{n^2} \sum_{m=-3}^{3} 2^m x(n-m)$

Linear or Nonlinear?

Shift-invariant or shift-varying?

Causal or noncausal?

(14 Pts) 2. A causal system with output y_n is described by the equation

$$y_n - \frac{1}{3}y_{n-1} = 1 + \left(\frac{1}{3}\right)^n \quad n \geq 0, \quad y_{-1} = 4.5$$

The total response of the system is $y_n = \frac{3}{2} + n\left(\frac{1}{3}\right)^n \quad n \geq 0$.

Find the following solutions

Homogeneous

Zero input

Particular

Zero State

Steady state

Transient

(20 Pts) 3. A sequence x_n is input to a linear shift-invariant system with unit pulse response h_n to produce the zero-state output sequence y_n, where x_n and h_n are given by:

$$x_n = \begin{cases} 1 & -3 \le n \le 1 \\ \left(\frac{1}{2}\right)^{n-2} & 2 \le n \le 10 \\ 0 & else \end{cases} \qquad h_n = \begin{cases} 1 & -5 \le n \le 7 \\ 0 & else \end{cases}$$

Answer the following questions:

(i) y_n is zero for what value(s) of n?

Answer:

(ii) The value of y_n at $n = 5$ is what?

Answer:

(iii) The maximum value of y_n occurs at what value(s) of n?

Answer:

(iv) The Region of Covergence of $Y(z)$, the two-sided z-transform of y_n is what?

Answer:

(11 Pts) 4. For the sequence $x(n)$ defined below, answer the following questions:

$$x(n) = \begin{cases} 1 & 3 \leq n < \infty \\ 0 & else \end{cases}$$

(i) The one-sided z-transform $X(z)$ of $x(n)$ is what? (Give closed-form expression.)

X(z)=	ROC:

(ii) The <u>one-sided</u> z-transform of $y_1(n) = x(n-8)$ is what? (Express your answer in closed form or in terms of $X(z)$.)

$Y_1(z) =$	ROC:

(iii) The <u>one-sided</u> z-transform of $y_2(n) = x(n+8)$ is what? (Express your answer in closed form or in terms of $X(z)$.)

$Y_2(z) =$	ROC:

(iv) The <u>two-sided</u> z-transform of $y(n) = x(n+8)$ is what? (Express your answer in closed form or in terms of $X(z)$.)

$Y(z) =$	ROC:

(10 Pts) 5. The two-sided z transform $X(z)$ of:

$$x(n) = \begin{cases} \left(\frac{1}{3}\right)^{n+2} & n \geq 8 \\ (-2)^{n-3} & n \leq 2 \\ 0 & else \end{cases}$$

is what? (mark all correct answers)

(a) $\frac{z}{9(z-\frac{1}{3})} + \frac{8z^{-3}}{8(z+2)}$ (b) $\frac{z^{-8}}{9(z-\frac{1}{3})} + \frac{z^{-3}}{8(z+2)}$ (c) $\frac{z}{9(z-\frac{1}{3})} + \frac{8z^{-3}}{8(z+2)}$

(d) $\frac{z^{-7}}{(3^{10})(z-\frac{1}{3})} + \frac{64z^{-2}}{(z+2)}$ (e) $\frac{z^{-7}}{9(z-\frac{1}{3})} + \frac{8z^{-2}}{(z+2)}$ (f) $\frac{z^{-7}}{(3^{10})(z-\frac{1}{3})} - \frac{z^{-2}}{(z+2)}$

(g) none of the above

The ROC for $X(z)$ is: | ROC: |

(7 Pts) 6. Find the partial fraction expansion for $X(z)$

$$X(z) = \frac{16z^{-1}}{(1-4z^{-2})(0.5+z^{-1})} =$$

(6 Pts) 7. The one sided z transform of a right sided sequence $x(n)$ is

$$X(z) = \frac{1}{z^8(z+3)^2}, \quad |z| > 3$$

Find $x(n)$ *for all* n

$x(n) =$

(8 Pts) 8. The one sided z transform of a *real* sequence x_n is

$$X(z) = \frac{(1+j)z}{z+1/4-j\sqrt{3}/4} + \frac{Bz}{z+1/4+j\sqrt{3}/4}, \quad |z| > \frac{1}{2}, \qquad (j = \sqrt{-1}).$$

(i) Find B, $\boxed{B =}$

(ii) x_n has the form $x_n = a\cos(bn+c)d^n u_n$. Find the unknown constants.

$\boxed{d =}$ $\boxed{c =}$ $\boxed{b =}$ $\boxed{a =}$

(5 Pts) 9. The value of

$$\sum_{m=-\infty}^{3} (-2)^{n-m} 4^m$$

is what ? (mark all correct answers):

(a) $-(1/4)(-2)^n$ (b) 0 (c) 4^n (d) $-(16/3)(-2)^n$

(e) $-(1/12)(-2)^n$ (f) $-(1/12)(4)^n$ (g) $-\infty$ (h) $+\infty$

(i) None of the above

(7 Pts) 10. For the causal system shown above, the difference equation relating the input and output is what? (mark the correct answer(s)):

(a) $y(n) - (1/4)e^{j\frac{\pi}{3}}y(n-1) = (1/3)x(n-1)$

(b) $y(n) + (1/4)e^{j\frac{\pi}{3}}y(n-1) = (1/3)x(n-1)$

(c) $y(n) + (1/4)e^{j\frac{\pi}{3}}y(n-1) = (1/3)x(n)$

(d) $y(n) - (1/4)e^{j\frac{\pi}{3}}y(n-2) = -(1/3)x(n-1)$

(e) $y(n) + (1/4)e^{j\frac{\pi}{3}}y(n-1) = -(1/3)x(n-1)$

(f) $y(n) - (1/4)\cos(\pi/3)y(n-1) = (1/3)x(n-$

(g) None of the above

b) The transfer function $H(z)$ of the system has pole(s) at: (mark the correct answer(s)):

(a) $z = 0.5e^{j\pi/3}, 0.5e^{-j\pi/3}$

(b) $z = 0.5e^{j\pi/3}, -0.5e^{j\pi/3}$

(c) $z = 0.5e^{j\pi/6}, 0.5e^{-j\pi/6}$

(d)$z = 0.5e^{j\pi/6}, -0.5e^{j\pi/6}$

(e) $z = -1/3, (1/4)e^{j\frac{\pi}{3}}$

(f) $z = -0.5\cos(\pi/3), 0.5\sin(\pi/3$

(g) None of the above

(5 Pts) 11. Extra Credit Fill in the correct *real* gains in block diagram below, so that it represents the same system as in Problem 10 above. The complex input and output are denoted $x(n) = x_R(n) + x_I(n)$, $y(n) = y_R(n) + y_I(n)$.

(6 Pts) 12. Extra Credit Find the values of the unit pulse response $h(n)$, for the indicated values of n, of the system whose output $y(n)$ is related to its input $x(n)$ by the equation

$$y(n) = -y(n-6) + 2x(n) + x(n-5)$$

n	0	1	5	6	11	12
$h(n)$						