EECS 206, Winter 2002 FINAL EXAM Mond. Apr. 22, 2002 - 4:00-6:00pm

PRINT NAME:	**Lect. Sect.** **Lab Sect.**

Section 1: 126 students; Section 2: 84 students
Rooms: 1001 EECS (48 students: Labs 6(36) and 9 (12)) [room cap. 110],
1005 Dow (30 students: Lab 10) [room cap. 62],
1010 Dow (36 students: Lab 11) [room cap. 69],
220 Chrysler (96 students: Labs 5(34), 7(28), and 8(34)) [room cap. 234].

Instructions:

- Print your name
- Sign the pledge below
- Closed book and notes
- Three 8 1/2 x 11 sheets of paper allowed (both sides)
- Calculators allowed
- **Answer on this questionnaire**
- No scratch paper allowed
- Read the questions carefully

Grading:

- **Problems 1 to 7 are multiple-choice - No partial credit will be given.**
- **In Problems 8 to 11, partial credit will be given - You must show your derivations/calculations to get full credit.**

PLEDGE: I have neither given nor received any aid on this exam, nor have I concealed any violations of the Honor Code.

SIGNATURE:

DO NOT TURN THIS PAGE OVER UNTIL TOLD TO DO SO!

Good Luck!
Stéphane Lafortune
David Neuhoff

ANSWER PAGE FOR PROBLEMS 1 to 8 and Extra Credit

PROBLEM	CIRCLE YOUR ANSWER	Points
1	a b c d e	5
2	a b c d e	5
3	a b c d e	5
4	a b c d e	5
5	a b c d e	5
6	a b c d e	5
7	a b c d e	5
Extra	a b c	1

	YOUR TOTAL
Problems 1-7	/ 35
Problem 8	/ 17
Problem 9	/ 15
Problem 10	/ 16
Problem 11	/ 17
Extra Credit	/ 1
TOTAL	/100

ENTER YOUR ANSWERS IN THE TABLE ON PAGE 2

1. *(5 points)*
Continuous-time signals $x(t)$ and $y(t)$ have $E(x) = 1$, $E(y) = 2$, and $E(x+y) = 5$, where $E(\cdot)$ denotes energy. The (unnormalized) correlation $C(x,y)$ is

(a) 0

(b) 1

(c) $\sqrt{2}$

(d) 2

(e) Not enough information is given.

2. *(5 points)*
A periodic signal is given by the equation

$$x(t) = 5 + 8\cos(40\pi t - \pi/5) + \sin(60\pi t)$$

The Fourier coefficients C_k of $x(t)$ are computed for the fundamental period T_0 of $x(t)$. Which Fourier coefficients C_k are *different* from 0?

(a) C_0, C_4, C_6

(b) $C_0, C_4, C_{-4}, C_6, C_{-6}$

(c) $C_0, C_2, C_{-2}, C_3, C_{-3}$

(d) $C_0, C_{20}, C_{-20}, C_{30}, C_{-30}$

(e) $C_0, C_{40}, C_{-40}, C_{60}, C_{-60}$

ENTER YOUR ANSWERS IN THE TABLE ON PAGE 2

3. *(5 points)*
For a certain linear, time-invariant system

$$x_1[n] = 7\cos\left(\frac{\pi}{3}n - \frac{\pi}{3}\right) \longrightarrow y_1[n] = \sqrt{3}\cos\left(\frac{\pi}{3}n\right) \ .$$

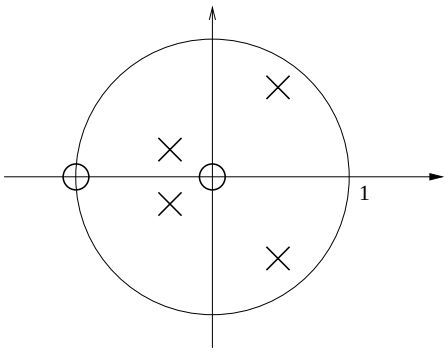
That is, when the input signal is $x_1[n]$ shown above, the output signal is $y_1[n]$ shown above. Now, if the input to this same system is

$$x_2[n] = 4\cos\left(\frac{\pi}{3}n - \frac{2\pi}{3}\right) \ ,$$

then the output is

(a) $y_2[n] = \frac{4}{7}\sqrt{3}\cos\left(\frac{\pi}{3}n - \frac{\pi}{3}\right)$
(b) $y_2[n] = \frac{4}{7}\sqrt{3}\cos\left(\frac{\pi}{3}n + \frac{\pi}{3}\right)$
(c) $y_2[n] = \frac{4}{7}\sqrt{3}\cos\left(\frac{\pi}{3}n - \frac{\pi^2}{9}\right)$
(d) $y_2[n] = \frac{7}{4\sqrt{3}}\cos\left(\frac{\pi}{3}n + \frac{\pi}{3}\right)$
(e) Not enough information is given.

4. *(5 points)*
Consider the following pole-zero plot of a System Function. At what angular frequency ($\hat{\omega}$) below is the magnitude of the corresponding Frequency Response Function largest?



(a) 0
(b) $\pi/3$
(c) $\pi/2$
(d) $3\pi/4$
(e) π

ENTER YOUR ANSWERS IN THE TABLE ON PAGE 2

5. *(5 points)*

We take the 12-point DFT of the periodic discrete-time signal $x[n]$ and obtain the following DFT coefficients:

$$X[k] = \begin{cases} \frac{1}{2}e^{j\pi/4} & k = 3 \\ 6 & k = 6 \\ \frac{1}{2}e^{-j\pi/4} & k = 9 \\ 0 & \text{else} \end{cases}$$

Which of the following is a possible expression for $x[n],\ 0 \le n \le 11$?

(a) $\cos(\frac{\pi}{2}n + \frac{\pi}{4}) + 6\cos(\pi n)$

(b) $6 + \cos(\frac{\pi}{4}n)$

(c) $6 + 2\cos(\frac{\pi}{2}n + \frac{\pi}{4})$

(d) $3 + \cos(\frac{\pi}{2}n + \frac{\pi}{4}) + 3\cos(\pi n)$

(e) None of the above.

6. *(5 points)*

Consider the continuous-time signal

$$\cos(2\pi(5500)t - \pi/3) - \cos(2\pi(500)t + \pi/3)$$

What is the *smallest* sampling frequency f_s (in samples per second) in the list below that does *not* result in aliasing?

(a) 1001

(b) 10001

(c) 11001

(d) 12001

(e) 24001

ENTER YOUR ANSWERS IN THE TABLE ON PAGE 2

7. *(5 points)*
A filter has impulse response

$$h[n] = \delta[n] + 2\delta[n-1] \ .$$

If the input to the filter is

$$x[n] = \delta[n] - 2\delta[n-2] \ ,$$

then the output is

(a) $y[n] = \delta[n] - 4\delta[n-2]$.
(b) $y[n] = \delta[n] + 2\delta[n-1] - 2\delta[n-2]$.
(c) $y[n] = 2\delta[n] - 2\delta[n-1] - 2\delta[n-2]$.
(d) $y[n] = 2\delta[n] + \delta[n-1] - 4\delta[n-2] - 2\delta[n-3]$.
(e) $y[n] = \delta[n] + 2\delta[n-1] - 2\delta[n-2] - 4\delta[n-3]$.

You must show your derivations/calculations to get full credit.

Problem 8: (17 points: 5 + 4 + 8)

The continuous-time signal

$$x(t) = 4\cos(2\pi(2)t) + 6\cos(2\pi(3)t) + 2\cos(2\pi(11)t)$$

is sampled at rate $f_s = 10$ samples per second creating the discrete-time signal $x[n]$.

(a) Find and plot the magnitude spectrum of $x(t)$.

(b) Find an expression for $x[n]$.

(c) Find and plot the magnitude spectrum of $x[n]$ for $\hat{\omega}$ between π and $-\pi$.

Answer for (b): $x[n] =$

Derivation of Answers for (a), (b), (c) and Magnitude Spectra for $x(t)$ and $x[n]$:

[Extra space for Problem 8]

You must show your derivations/calculations to get full credit.

Problem 9: (15 points)

Consider the filter described by the difference equation

$$y[n] = 2x[n] + 2x[n-1]$$

A periodic input signal $x[n]$ with period 4 is applied to this system, resulting in output $y[n]$. The 4-point DFT of $y[n]$ is:

$$Y[0] = 0 \qquad Y[1] = \sqrt{2}e^{-j\pi/4} \qquad Y[2] = 0 \qquad Y[3] = \sqrt{2}e^{j\pi/4}$$

Find an expression for the input $x[n]$.

Answer: $x[n] =$

Derivation of Answer:

You must show your derivations/calculations to get full credit.

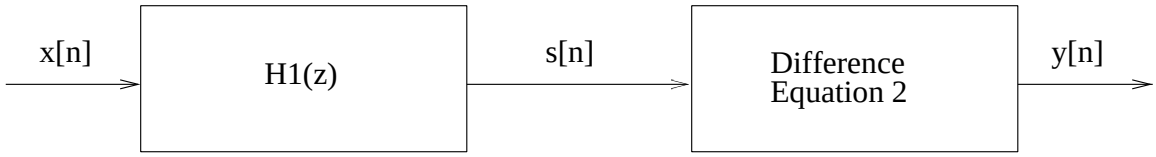
Problem 10: (16 points: 8 + 8)

Consider the following block diagram of two systems, where

$$H1(z) = \frac{z+1}{z}$$

and "Difference Equation 2" is

$$y[n] = -0.81y[n-2] + 5s[n]$$



(a) Find the System Function $H(z)$ from input $x[n]$ to output $y[n]$.

(b) Find and plot the poles and zeros of $H(z)$.

Answer for (a): $H(z) =$

Answer for (b): Poles at $z =$

Answer for (b): Zeros at $z =$

Derivation of Answers for (a) and (b) and Pole-Zero Plot:

[Extra space for Problem 10]

You must show your derivations/calculations to get full credit.

Problem 11: (17 points: 5 + 12)

Consider the filter described by the difference equation

$$y[n] = -\frac{1}{3}y[n-1] + 2x[n]$$

(a) Find an expression for the impulse response $h[n]$ of this filter.

(b) Find an expression for the output $y[n]$ due to input $x[n] = \cos(\frac{\pi}{2}n)$.

Answer for (a): $h[n] =$

Answer for (b): $y[n] =$

Derivation of Answers for (a) and (b):

[Extra space for any problem]

Extra Credit: (1 point) ENTER YOUR ANSWER ON PAGE 2

Which of the following MATLAB commands might return the text “Don’t ask!”?

(a) what
(b) why
(c) who

THE END