

Electrical Engineering Department
SUNY at Stony Brook

Final Exam

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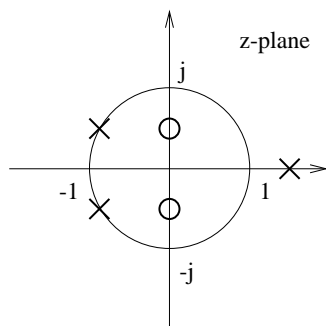
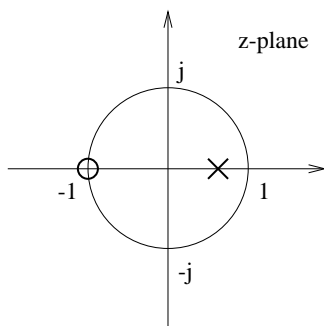
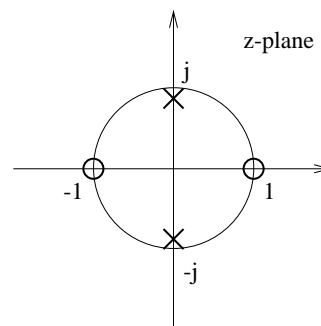
Closed Books, Closed Notes, 3 hours

December 17, 1998

1. **(20 Pts Total)** Determine whether each of the following systems is (i) linear, (ii) time-invariant, (iii) causal, (iv) BIBO stable, or (v) memoryless.

- (a) **(5 pts)** $y(t) = x(t)x(t-4)$.
 (b) **(5 pts)** $y(t) = 42x(t) + x(t-2)$.
 (c) **(5 pts)** $y[n] = \min\{x[n-1], x[n], x[n+1]\}$.
 (d) **(5 pts)** $y[n] = (x[n])^2 + x[n-1] + 1$.

2. **(15 Pts Total)** Consider three causal discrete-time LTI systems: $h_1[n]$, $h_2[n]$, and $h_3[n]$. These systems are described by the pole-zero plots given below.

Pole-Zero of $H_1(z)$ Pole-Zero of $H_2(z)$ Pole-Zero of $H_3(z)$

- (a) **(9 pts)** Which of the three systems are BIBO stable? Explain.
 (b) **(6 pts)** Assume that the pole of $H_2(z)$ is at 0.7 and assume that $h_2[0] = 5$. Find $h_2[n]$ for all n .
3. **(10 Pts Total)** A continuous-time LTI system has impulse response $h(t) = e^{-2t}u(t)$.
- (a) **(2 pts)** Is this system causal? Explain.
 (b) **(2 pts)** Is it BIBO stable? Explain.
 (c) **(6 pts)** Suppose the system input is $x(t) = e^{-4t}u(t)$. Determine the system output $y(t)$. [Hint: You may do this by direct convolution or take the Laplace transform, applying the convolution property and then take the inverse Laplace transform.]

4. **(15 pts Total)** A continuous-time LTI system has frequency response:

$$H(j\omega) = \begin{cases} 1 & \text{if } |\omega| < 50\pi \\ 0 & \text{if } |\omega| \geq 50\pi \end{cases} .$$

Note that $H(j\omega)$ is a low-pass filter. Let $x(t) = 1 + 4 \cos(33\pi t) + 9 \cos(330\pi t)$ be the system input.

- (a) **(3 pts)** Determine the period of $x(t)$.
- (b) **(4 pts)** Determine and plot the Fourier Transform, $X(j\omega)$, of $x(t)$.
- (c) **(4 pts)** Determine and plot the Fourier Transform, $Y(j\omega)$, of the system output $y(t)$.
- (d) **(4 pts)** Determine the system output $y(t)$.
5. **(20 Pts Total)** True or False. Briefly explain your answers.

- (a) **(2 pts)** Aliasing occurs when the sampling rate is greater than two times the signal bandwidth in Hz.

- (b) **(2 pts)** The low-pass filter:

$$H(j\omega) = \begin{cases} 1 & \text{if } |\omega| < 50\pi \\ 0 & \text{if } |\omega| \geq 50\pi \end{cases} .$$

is invertible.

- (c) **(2 pts)** Given the impulse response, $h(t)$, of an LTI system, for every input signal, $x(t)$, the output signal, $y(t)$, can be predicted exactly.
- (d) **(2 pts)** If two periodic signals have the same period, then their Fourier series coefficients will be exactly the same.
- (e) **(2 pts)** If two discrete-time signals have the same Fourier transform, then the two signals are exactly the same.
- (f) **(2 pts)** The following is a valid region of convergence (ROC) for a Laplace transform:

$$-9 < \text{Re}\{s\} < -4.$$

- (g) **(2 pts)** A continuous-time LTI system, $H(s)$, with ROC

$$-4 < \text{Re}\{s\} < 9,$$

is BIBO stable.

- (h) **(2 pts)** The signal $x[n] = \frac{-\sin(n)}{n}$ is an even signal.
- (i) **(2 pts)** A causal LTI system is always memoryless.
- (j) **(2 pts)** If a signal, $x(t)$, is real and even, then its Fourier transform, $X(j\omega)$, is also real and even.

Have a wonderful holiday !!!
