ESE 305 —*Deterministic Signals & Systems*

Electrical Engineering Department
SUNY at Stony Brook

Final Exam — N. Phamdo
Closed Books, Closed Notes, 3 hours — December 16, 1997

---

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)** $y(t) = 5\int_{-\infty}^{t} x(\tau)d\tau + 2x(t)$.

   (b) **(5 pts)** $y(t) = e^{x(-t)}$.

   (c) **(5 pts)** $y[n] = x[n]x[n-3]$.

   (d) **(5 pts)** $y[n] = 3x[n] + 4x[n-1]$.

2. **(10 Pts Total)** A discrete-time LTI system has impulse response $h[n] = 0.9^n u[n]$.

   (a) **(2 pts)** Is this system causal? Explain.

   (b) **(2 pts)** Is it BIBO stable? Explain.

   (c) **(6 pts)** Suppose the system input is $x[n] = 0.8^n u[n]$. Determine the system output $y[n]$. [Hint: You may do this by direct convolution or take the z-transform, applying the convolution property and then take the inverse z-transform.]

3. **(15 pts Total)** A continuous-time LTI system has frequency response:

$$H(j\omega) = \begin{cases} |\omega| & \text{if } |\omega| < 20\pi \\ 20\pi & \text{if } 20\pi \le |\omega| < 30\pi \\ 0 & \text{if } |\omega| \ge 30\pi \end{cases} .$$

   Let $x(t) = 4\cos(9\pi t) + 12\sin(23\pi t) + 29\cos(44\pi t)$ be the system input.

   (a) **(3 pts)** Plot $H(j\omega)$.

   (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 $y(t)$.

4. **(15 Pts Total)** Let

$$\begin{aligned} x[n] &= 0.5^n u[n] + (-3)^n u[-n-1], \\ h[n] &= 0.7^n u[n]. \end{aligned}$$

   (a) **(3 pts)** Find the z transform, $X(z)$, of $x[n]$ and specify its ROC.

(b) **(3 pts)** Find the z transform, $H(z)$, of $h[n]$ and specify its ROC.

(c) **(4 pts)** Let $y[n] = h[n] * x[n]$. Find the z transform, $Y(z)$, of $y[n]$ and specify its ROC.

(d) **(5 pts)** Determine $y[n]$.

5. **(20 Pts Total)** True or False. Briefly explain your answers.

(a) **(2 pts)** The signal $x(t) = t^2 u(t)$ is a bounded signal.

(b) **(2 pts)** The signal $x[n] = \frac{\sin(n)}{n}$ is an even signal.

(c) **(2 pts)** If an LTI system is invertible, then its inverse is an LTI system.

(d) **(2 pts)** The serial concatenation of two LTI systems is an LTI system.

(e) **(2 pts)** A discrete-time periodic signal $x[n]$ with period N has a Fourier series representation which is periodic with period N.

(f) **(2 pts)** If a signal $x(t)$ is bandlimited in the range -1000 Hz to 1000 Hz ($X(j\omega) = 0$ if $|\frac{\omega}{2\pi}| > 1000$), then the Nyquist sampling rate is 4000 samples/sec.

(g) **(2 pts)** An anti-aliasing filter is used in digital-to-analog conversion to prevent aliasing.

(h) **(2 pts)** A continuous-time LTI system, $H(s)$, is BIBO stable if and only if the ROC of $H(s)$ contains the unit circle.

(i) **(2 pts)** A discrete-time LTI system which has two poles at $+0.9j$ and $-0.9j$ and two zeros at $+1$ and -1 is a bandpass filter.

(j) **(2 pts)** If $x[n] = \delta[n] + \delta[n-1]$ is the input to an LTI system and if the output $y[n]$ is measured, then for any other input the corresponding output can be predicted exactly.

Enjoy your holiday !!!
