

1. (50 pts) Determine whether or not the following LTI systems are (1) causal, (2) BIBO stable. Make sure to state your reasoning.

(a) $h(t) = e^{-|t|}$

(b) $h(t) = e^{3t}u(-t)$

(c) $h(t) = \cos(3t)u(t)$

(d) $y(t) = \frac{dx(t)}{dt}$

(e) $y(t) = \int_{-\infty}^t x(\tau) d\tau$

2. (10 pts) An LTI system is specified by the following differential equation:

$$\frac{d^2y(t)}{dt^2} + \frac{dy(t)}{dt} + y(t) = x(t) + \frac{dx(t)}{dt}$$

Calculate the frequency response function $\hat{H}(\omega)$ for this system.

3. (20 pts) An LTI system has the frequency response $H(\omega) = 1/(j\omega + 3)$.

a. (5 pts) Write down the differential equation representation for this system.

b. (15 pts) Compute the output of this system if the input is:

(a) $x(t) = \delta(t)$

(b) $x(t) = 3\cos(4t)u(t)$

(c) $x(t) = 4u(t)$

3. (20 pts) We observe the following input-output pair for an LTI system:

$$x(t) = 1 + \cos(t) + \cos(2t) + \sin(3t)$$

$$y(t) = \cos(t) + \cos(2t) + 3\cos(3t)$$

Determine $y(t)$ in response to a new input $x(t) = 4 + 4\cos(t) + 2\cos(2t) + \cos(3t)$.