

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:

$$\begin{aligned}x(t) &= 1 + \cos(t) + \cos(2t) + \sin(3t) \\y(t) &= \cos(t) + \cos(2t) + 3\cos(3t)\end{aligned}$$

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