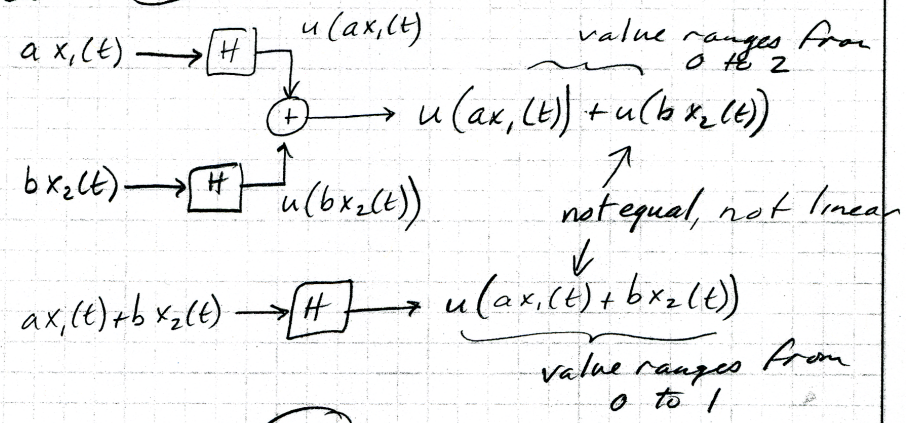
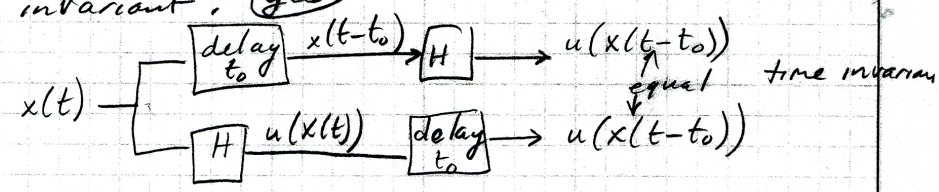
① Text, 4-6

$y(t) = u(x(t))$

linear? no



time invariant? yes



stable? Yes

$u(t)$ has a value bounded by 0 to 1, so $u(x(t))$ has a value bounded by 0 to 1

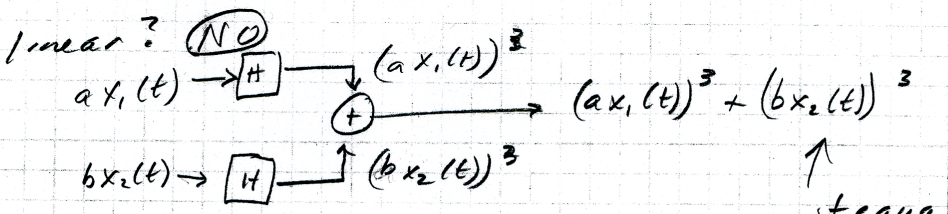
non invertible? Yes

$u(t)$ has a value of either 0 or 1, and there are infinitely ~~many~~ values of $x(t)$ that makes $u(x(t))=0$, and $u(x(t))=1$. Given a value of $y(t)=0$ or $y(t)=1$, there is no way to determine the value of $x(t)$.

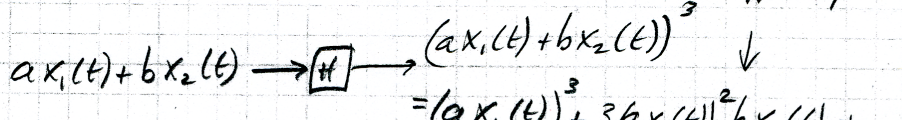
(2) Text 4-18

$y(t) = (x(t))^3$

linear? NO

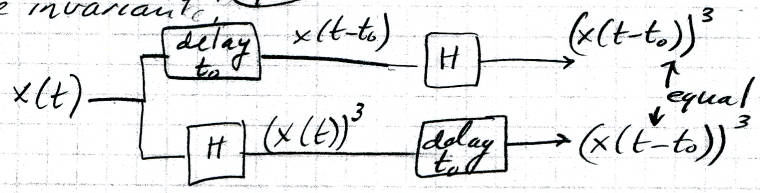


not equal



$= (ax_1(t))^3 + 3(ax_1(t))^2 bx_2(t) + \ldots$

time invariant? yes



BIBO stable? assume $|x(t)| < M < \infty$

yes then $|y(t)| = |(x(t))^3| < M^3 < \infty$

Causal? yes - output at time t does not depend on future inputs

memoryless? yes - output at time t <u>only</u> depends on input at time t

Invertible? yes

$y(t) = (x(t))^3$

so $x(t) = \sqrt[3]{y(t)}$ (as long as $x(t)$ is real valued)

3 Text, 4-21

$$y(t) = \int_{-\infty}^{t+3} x(\lambda)\, d\lambda$$

<u>linear?</u> YES

$$a x_1(t) \rightarrow \boxed{H} \rightarrow \int_{-\infty}^{t+3} a x_1(\lambda)\, d\lambda$$

$$b x_2(t) \rightarrow \boxed{H} \rightarrow \int_{-\infty}^{t+3} b x_2(\lambda)\, d\lambda$$

$$\oplus \rightarrow \int_{-\infty}^{t+3} [a x_1(\lambda) + b x_2(\lambda)]\, d\lambda$$

equal

$$a x_1(t) + b x_2(t) \rightarrow \boxed{H} \rightarrow \int_{-\infty}^{t+3} [a x_1(\lambda) + b x_2(\lambda)]\, d\lambda$$

<u>Causal?</u> No

Because the upper limit is $t+3$, when computing $y(t)$ you need to know the values of $x(t)$ up to $x(t+3)$ - these are future values.

<u>Invertible?</u> yes

From calculus

$$\frac{d}{dt} y(t) = \frac{d}{dt} \int_{-\infty}^{t+3} x(\lambda)\, d\lambda$$

$$= x(t+3) \underbrace{\frac{d}{dt}(t+3)}_{1} - x(-\infty) \underbrace{\frac{d}{dt} x(-\infty)}_{0}$$

derivative of a scalar value

$$y'(t) = x(t+3)$$

let $t \rightarrow t-3$

so $y'(t-3) = x(t)$

This provides a way to calculate $x(t)$ given $y(t)$

TOPS 35500