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ECEN 380
1/18/2025

PS02: 1/4
1.64(b), 1.64(h), 1.75(b),
1.77(b), 1.78(b), 1.95

1.64 b. Determine whether
1.) memoryless
2.) stable
3.) causal
4.) linear
5.) time variant

b.) $y[n] = 2x[n]u[n]$ ← unit step

Doesn't depend on past or future → $\boxed{\text{Memoryless}}$ /

Depends only on present → $\boxed{\text{Causal}}$ /

Output is finite → $\boxed{\text{Stable}}$ /

$x[n] = ax_1[n] + bx_2[n]$

$y[n] = 2(ax_1[n] + bx_2[n])u[n]$

$x[n] = ax_1[n] \rightarrow y[n] = 2ax_1[n]u[n]$

$x[n] = bx_1[n] \rightarrow$ " $= 2bx_2[n]u[n]$

$2ax_1[n]u[n] + 2bx_2[n]u[n]$

$2u[n](ax_1[n] + 2bx_2[n])$ → $\boxed{\text{Linear}}$ /

$y_2[n] = 2x_1[n-n_0]u[n]$

$y_1[n-n_0] = 2x_1[n-n_0]u[n-n_0]$ $\quad y_1[n-n_0] \neq y_2[n]$ → $\boxed{\text{Time Variant}}$ /

1.64h Determine :

1.) Memoryless
2.) Stable
3.) Causal
4.) Linear
5.) Time Varient

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

Relies on past & future $\longrightarrow$ $\boxed{\text{NOT Memoryless}}$

$|x(t)| \leq M < \infty \rightarrow x(t) = \sin(t^3) \rightarrow y(t) = 3t^2 \cos(t^3) \rightarrow$ $\boxed{\text{UN-stable}}$

Relies on future $\longrightarrow$ $\boxed{\text{NOT Causal}}$

$x(t) = a\, x_1(t) + b\, x_2(t)$

$H\{x(t)\} \rightarrow y(t) = \frac{d}{dt}(a x_1(t) + b x_2(t))$

$= \frac{d}{dt} a x_1(t) + \frac{d}{dt} b x_2(t)$

$H\{a x_1(t)\} \rightarrow y(t) = \frac{d}{dt} a x_1(t)$

$H\{b x_2(t)\} \rightarrow y(t) = \frac{d}{dt} b x_2(t)$

$H\{x(t)\} = H\{a x_1(t)\} + H\{b x_2(t)\}$

$\hookrightarrow$ $\boxed{\text{Linear}}$

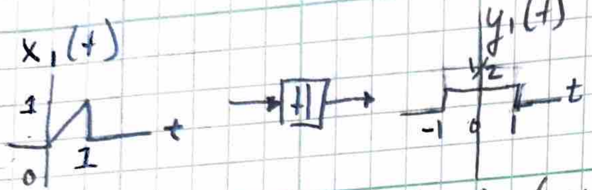
$y_1(t) = \frac{d}{dt} x(t)$

$y_1(t-t_0) = \frac{d}{dt} x(t-t_0)$

$H\{x(t-t_0)\} \rightarrow y(t) = \frac{d}{dt} x(t-t_0) \longrightarrow$ $\boxed{\text{Time Invariant}}$

1.75b A system H has input-output pairs given. Determine:

1.) Memoryless
2.) Causal
3.) Linear
4.) Time variant



Output starts before input → $\boxed{\text{NOT Memoryless}}$

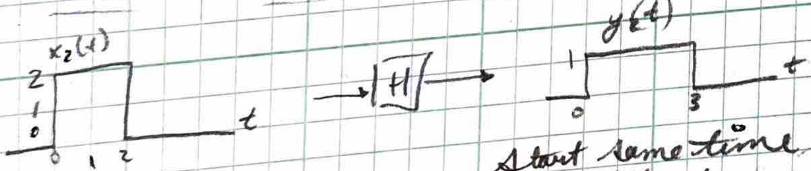
→ $\boxed{\text{NOT Causal}}$

Linear: $x_1(t) = ax_1(t) + bx_2(t)$

$y_1(\ ) = ?$ → don't know, only one signal

Time Variant:

$y(t-t_0) \overset{?}{=} H\{x(t-t_0)\}$ → don't know w/out equations

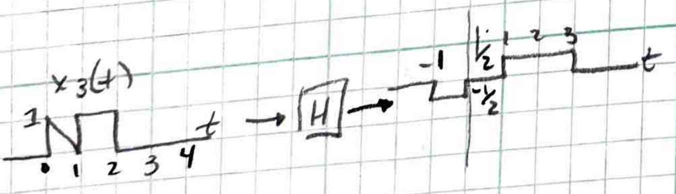


Start same time → $\boxed{\text{NOT Causal}}$

End diff. times → $\boxed{\text{NOT memoryless}}$

Linear → Don't know, only one signal

Time Variant → $\boxed{\text{Don't know}}$



Start different, end different

→ $\boxed{\text{NOT Causal}}$

→ $\boxed{\text{NOT Memoryless}}$

Linear/Time Variant

→ $\boxed{\text{DON'T KNOW}}$

Start/end same

→ $\boxed{\text{Causal}}$

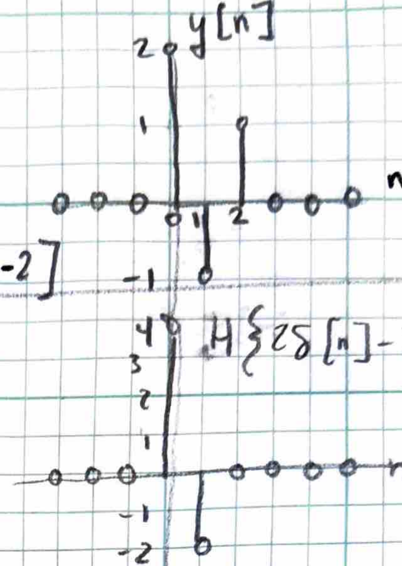
→ $\boxed{\text{Memoryless}}$

Linear/Time → $\boxed{\text{DON'T KNOW}}$

1.77 b 4/4

a discrete-time system is both linear and in-variant.

Input: $x[n] = \delta[n]$



Find output due to input:

$$x[n] = 2\delta[n] - \delta[n-2]$$

$H\{2\delta[n] - \delta[n-2]\}$

$x[0] = 2(2) - 0 = 4$
$x[1] = 2(-1) - 0 = -2$
$x[2] = 2(1) - 2 = 0$

1.78 b

$x(t) = x_e(t) + x_o(t)$

↳ even and odd components of $x(t)$, for all t, $-\infty < t < \infty$

$x[n] = x_e[n] + x_o[n]$

show that:

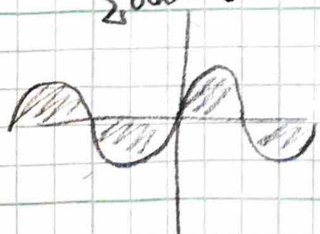
$$\sum_{n=-\infty}^{\infty} x^2[n] = \sum_{n=-\infty}^{\infty} x_e^2[n] + \sum_{n=-\infty}^{\infty} x_o^2[n]$$

$(x[n])^2 = (x_e[n] + x_o[n])^2$

$x^2[n] = x_e^2[n] + 2x_e[n]\,x_o[n] + x_o^2[n]$

$y[n] = 2x_e[n]\,x_o[n]$

$\sum \text{odd} = 0$



$y[-n] = 2x_e[-n]\,x_o[n]$

$= 2x_e[n](-x_o[n])$

$= -2x_e[n]\,x_o[n] = -y[n] \rightarrow$ odd

* sum of odd of y-axis symmetric function $\rightarrow 0$

$$\boxed{\begin{aligned} x^2[n] &= x_e^2[n] + x_o^2[n] \\ \sum_{n=-\infty}^{\infty} x^2[n] &= \sum_{n=-\infty}^{\infty} x_e^2[n] + \sum_{n=-\infty}^{\infty} x_o^2[n] \end{aligned}}$$

Problem 1.95:

Write a set of MATLAB commands for approximating the following continuous-time periodic waveforms:

(a) Square wave of amplitude 5 volts, fundamental frequency 20 Hz, and duty cycle 0.6

(b) Sawtooth wave of amplitude 5 volts and fundamental frequency of 20 Hz

Plot five cycles of each of the waveforms.

```
%% Part (a)
amplitude = 5;    % Volts
fund_freq = 20;   % Hz
duty_cycle = 0.6; % Duty cycle
t = 0:0.001:5 * 1/fund_freq + 1;     % Time
squarewave = amplitude * square(2 * pi * fund_freq * t, duty_cycle * 100);
plot(t, squarewave);
axis([0 0.26 -6 6])
title('Problem 1.95a: Seth Ricks');
xlabel('Time (seconds)');
ylabel('Amplitude (V)');
grid on

%% Part (b)
amplitude = 5;    % Volts
fund_freq = 20;   % Hz
t = 0:0.001:5 * 1/fund_freq + 1;     % Time
Sawtooth = amplitude * sawtooth(2 * pi * fund_freq * t);
plot(t, Sawtooth);
axis([0 0.26 -6 6])
title('Problem 1.95b: Seth Ricks');
xlabel('Time (seconds)');
ylabel('Amplitude (V)');
grid on
```