

Ex 2

Chapter 2. Linear Time-Invariant Systems (Continuous-Time)

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Math Problem: (5 × 6 points)

- The input step signal $x(t)$ and the impulse response $h(t)$ of a continuous time LTI system are given by

$$x(t) = u(t), \quad h(t) = e^{-\alpha t}u(t), \quad \alpha > 0$$

- Compute the output $y(t) = x(t) * h(t) = \int_{-\infty}^{\infty} x(\tau)h(t-\tau)d\tau$

Hint: consider both signals overlap period $[0..t]$ only for $t > 0$

Answer:

For $t < 0$, $x(t)$ and $h(t-\tau)$ 0

For $t > 0$, they $h(t-\tau) = e^{-\alpha(t-\tau)}$ $x(\tau) = 1$

Hence,

For $t < 0$, we have $y(t) =$ 0

For $t > 0$, we have $y(t) = x(t) * h(t) = \lim_{\alpha \rightarrow \infty} \sum_{\tau=-\alpha}^{\alpha} e^{-\alpha(t-\tau)}$

Thus, we can write the output as $y(t) = \int_{-\infty}^{\infty} x(\tau)h(t-\tau)d\tau$

MATLAB Problem: (7 × 10 points)

- Develop a MATLAB program to do the following tasks and submit your results including 7 charts and the MATLAB program ($\alpha=0.5$; $\tau=-10:0.01:10$)

Hint: use heaviside(x) to express a step signal

- Plot a chart indicating $x(\tau)$ signal
- Plot a chart indicating $h(\tau)$ signal
- Plot a chart indicating $x(t-\tau)$ signal ($t=-2$)
- Plot a chart indicating $h(t-\tau)$ signal ($t=-2$)
- Plot a chart indicating $x(t-\tau)$ signal ($t=3$)
- Plot a chart indicating $h(t-\tau)$ signal ($t=3$)
- Plot a chart indicating $y(\tau)$ signal