Problem 1

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1. (5%)

The output ($y(t)$) of a continuous-time system is related to its input ($x(t)$) as $y(t) = e^{-t}x(t-2)$, $t>0$. Determine whether the system is (a) stable (2%), (b) causal (1%), (c) linear (1%), and (d) time invariant (1%).

Problem 2
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6. (6%)

Find the Laplace transforms of the following functions.

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

(2) $h(t) = te^{-t}u(t)$

Problem 3

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8. (6%)

Find the locations of poles and zeros and discuss the causality and stability of the following s-domain transfer function.

$$H(s) = \frac{2s + 3}{s^2 + 3s + 2}$$

Problem 4

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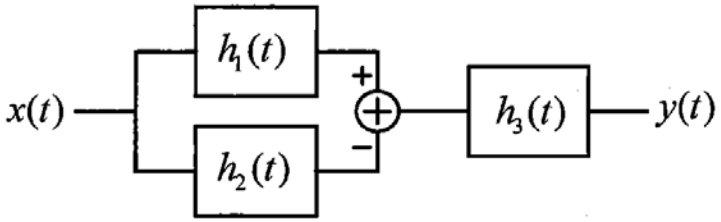
10. (8%)

Find the impulse response (i.e., $h(t)$) and the transfer function (i.e., $H(s)$) of the following CT LTI system. The input signal is $x(t)$ and the output signal is $y(t)$.



$h_1(t) = \delta(t),\ \ h_2(t) = e^{-t}u(t), and\ \ h_3(t) = e^{-t}u(t).$

Problem 5

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五、(15%)

(一) (5%) Determine the Fourier representation of the following signal

$$x(t) = 2e^{-t}u(t) - 3e^{-2t}u(t)$$

(二) (10%) Find the time-domain signals corresponding to the following Fourier transform representations:

~~(5%) $X(e^{j\Omega}) = \frac{1}{1-ae^{-j(\Omega+\frac{\pi}{4})}}$, $|a| < 1$~~

(5%) $Y(jw) = \frac{1}{2+j(w-3)} + \frac{1}{2+j(w+3)}$

Problem 6

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七、(10%)

A causal LTI system has an impulse response $h(t)$ that satisfies the differential equation

$$\frac{dh(t)}{dt} + 3h(t) = e^{-4t}u(t) + ce^{-5t}u(t),$$

where c is a constant. Moreover, the system output is $(2/15)e^{t}$ when the input to the system is e^{t}.

(一) (3%) Determine the constant c.

(二) (3%) If the transfer function of this system is $H(s)$, find its poles.

(三) (4%) Specify the region of convergence of $H(s)$ and tell whether or not the system is stable.

Problem 7

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二、(10%)

(a) (5%) The impulse response of an LTI system is $h(t)=\begin{cases}\cos(\pi t), |t|<0.5\\ 0, \quad \text{otherwise}\end{cases}$. Use linearity and time invariance to determine and plot the output $y(t)$ for $x(t)=\delta(t+1)-\delta(t-1)$.

Problem 8

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二、(10%)

(a) (5%) Consider an LTI system with input and output related through the equation:

$$y(t) = \int_{-\infty}^{t} e^{\tau - t} x(\tau - 1) d\tau$$

The impulse response $h(t)$ for this system = _____. Is the system causal? _____ (simply answer yes or no)

Problem 9

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七、(15%) Consider the continuous-time LTI system with input $x(t)$, output $y(t)$ and impulse response $h(t)$, for which we are given the following information:

$x(t) = 0$, $t > 0$ and $X(s) = (s + 2)/(s - 2)$, and $y(t) = -\frac{2}{3}e^{2t}u(-t) + \frac{1}{3}e^{-t}u(t)$.

(a) (10%) Determine the transfer function, $H(s)$, of the system (3%), its region of convergence (2%), and the impulse response $h(t)$ of the system (5%).

(b) (5%) What is the output $y(t)$ if the input to the LTI system is $x(t) = e^{-3t}$, $-\infty < t < \infty$?

Problem 10

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五、(5 pts) A continuous-time linear system S with input $x(t)$ and output $y(t)$ yields the following input-output pairs:

$$x(t) = e^{j2t} \xrightarrow{S} y(t) = e^{j3t}$$

$$x(t) = e^{-j2t} \xrightarrow{S} y(t) = e^{-j3t}$$

(一)(2 pts) Is this system linear time-invariant? Just simply answer yes or no.