Problem 1

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三、(10 points) Find the **Laplace transform** of $x(t) = \frac{d^2}{dt^2}(e^{-3(t-2)}u(t-2))$.

Problem 2

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六、(10%) Consider a continuous-time LTI system for which the input $x(t)$ and output $y(t)$ are related by the differential equation

$$\frac{d^2y(t)}{dt^2}+\frac{dy(t)}{dt}-2y(t)=x(t).$$

Suppose the system is stable. Determine $y(t)$ as $x(t)=\sum_{n=1}^{\infty}u(t-n)$, where $u(t)$ denotes the unit step function.

Problem 3

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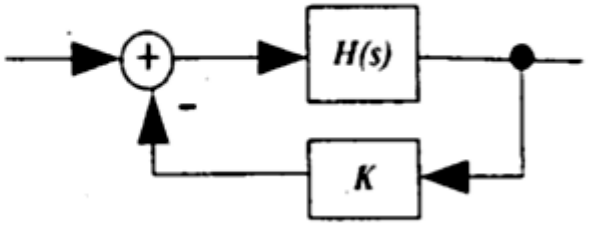
5. Consider a feedback system shown below, where $H(s) = \dfrac{s+2}{s^2+2s+4}$

(a) Find the smallest positive value of K for which the closed-loop impulse response doesn't exhibit any oscillatory behavior. **(5%)**



Problem 4

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一、**(5%)** Please define a linear system in terms of mathematical expression.

二、**(10%)** Please define the properties of causality and stability for a Linear Time-Invariant (LTI) System in terms of mathematical expression.

三、**(10%)** Please define an eigenfunction for an LTI system with impulse response $h(t)$; and show its transfer function H(s) as the corresponding eigenvalue.

Problem 5

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3. (10%) A second-order continuous-time linear dynamic system is characterized by the following equation:

$$\ddot{y} + 2\beta\dot{y} + \omega_o^2 y = \alpha x,$$

where $x(t)$ denotes the input, $y(t)$ denotes the output, and let us assume that $\beta > 0$ and $\beta^2 < \omega_o^2$.

~~(a) (3%) Make a sketch of the impulse response of the system.~~

(b) (3%) Calculate the transfer function $H(j\omega) \triangleq \frac{Y(j\omega)}{X(j\omega)}$.

~~(c) (4%) Make a sketch of the magnitude response of $H(j\omega)$. If $\beta^2 \ll \omega_o^2$, what is the approximate frequency at which the magnitude response reaches its maximum?~~

Problem 6

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四. (一)(10%) Consider a continuous-time linear time-invariant system with impulse response $h(t)=e^{-t}u(t)$. Determine the output $y(t)$ of the system when the input is $x(t)=u(t+1)-u(t-1)$.

Problem 7

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六. Given a linear time-invariant (LTI) system with system function

$H(s)=\frac{s-1}{(s+1)(s-2)}$, please determine the impulse response $h(t)$ and show its corresponding region of convergence (ROC) if

(一)(10%) the system is known to be causal;

(二)(10%) the system is known to be stable.

Problem 8

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14. Determine the continuous-time signal corresponding to the following unilateral Laplace transform,

$$X(s) = s\frac{d^2}{ds^2}\left(\frac{1}{s^2+25}\right).$$

(10%)

Problem 9

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11. Consider a linear time-invariant system with impulse response $h(t) = e^{-t}u(t+1)$. Determine the output $y(t)$ of the system when the input is $x(t) = \sin^2 t$.

(10%)

Problem 10

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10. The bilateral Laplace transform of a continuous-time signal $x(t)$ is specified by,

$$X(s)=\frac{s+4}{(s+2)(s^2+6s+13)} \quad \text{with ROC}: -3<\text{Re}(s)<-2$$

Which of following answers is (are) correct?

(A) $x(t)=\frac{2}{5}e^{-2t}u(t)-\frac{2}{5}e^{-3t}\cos(2t)u(t)+\frac{3}{10}e^{-3t}\sin(2t)u(t)$

(B) $x(t)=-\frac{2}{5}e^{-2t}u(-t)-\frac{2}{5}e^{-3t}\cos(2t)u(t)+\frac{3}{10}e^{-3t}\sin(2t)u(t)$

(C) $x(t)=-\frac{2}{5}e^{-2t}u(-t)+\frac{2}{5}e^{-3t}\cos(2t)u(t)-\frac{3}{10}e^{-3t}\sin(2t)u(t)$

(D) $x(t)=\frac{2}{5}e^{-2t}u(t)+\frac{2}{5}e^{-3t}\cos(2t)u(-t)-\frac{3}{10}e^{-3t}\sin(2t)u(-t)$

(6%)