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Question: (20 pts) Consider the following LTI system defined by the freq...

(20 pts) Consider the following LTI system defined by the frequency response below:

$$H(j\omega) = \frac{j\omega + 4}{-\omega^2 + 5j\omega + 6}$$

- (a) (5 pts) Find the differential equation which represents this system.
- (b) (5 pts) Find the impulse response of this system.
- (c) (5 pts) Find $Y(j\omega)$ when the input is $x(t) = e^{-4t}u(t) - te^{-4t}u(t)$.
- (d) (5 pts) Find the output $y(t)$ using the result you found in part c.

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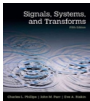
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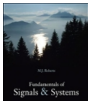
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Given: $H(j\omega) = \frac{j\omega + 4}{-\omega^2 + 5j\omega + 6}$

Convert it into s -domain — we get —

$$H(s) = \frac{s+4}{s^2+5s+6} \quad (I)$$

$$H(s) = \frac{s+4}{(s+3)(s+2)} \quad (II)$$

$\therefore H(s) = \frac{Y(s)}{R(s)} \rightarrow \text{d/p}$
 $R(s) \rightarrow \text{i/p}$

Transfer function

$\rightarrow (a): Y(s)/R(s) = \frac{s+4}{s^2+5s+6}$

$$Y(s)s^2 + 5sY(s) + 6Y(s) = sR(s) + 4R(s)$$

$$\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 6y(t) = \frac{dx}{dt} + 4x(t)$$

↓ differential eqn represent the system.

(b) Impulse response — use eqn (2)

$$H(s) = \frac{Y(s)}{R(s)} = \frac{s+4}{(s+3)(s+2)}$$

$x(t) = \delta(t)$ i/p
 $R(s) = 1$
 $\therefore Y(s) = H(s)$

$$\therefore Y(s) = \frac{A}{s+3} + \frac{B}{s+2}$$

$$A \Big|_{s=-3} = -1 \quad ; \quad B \Big|_{s=-2} = 2$$

Hence $Y(s) = \frac{-1}{s+3} + \frac{2}{s+2}$

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

(3) i/p: $x(t) = 2u(t) = (e^{-4t} - te^{-4t})u(t)$

then $R(s) = X(s) = \left(\frac{1}{s+4} - \frac{1}{(s+4)^2} \right)$

$$R(s) = \frac{(s+3)}{(s+4)^2} \quad (III)$$

\therefore from eqn (2)

$$H(s) = \frac{Y(s)}{R(s)} = \frac{Y(s)}{X(s)} = \frac{(s+4)}{(s+2)(s+3)}$$

use eqn (3)

$$\therefore Y(s) = \frac{s+4}{(s+2)(s+3)} \times \frac{s+3}{(s+4)} = \frac{1}{(s+4)(s+2)} \quad (A)$$

$\therefore Y(j\omega) \Big|_{s=j\omega} = \frac{1}{(4+j\omega)(2+j\omega)} = \frac{1}{(8-\omega^2) + 6j\omega}$

(4) from eqn 4: $Y(s) = \frac{1}{(s+4)(s+2)} = \frac{A}{s+4} + \frac{B}{s+2}$

$$A \Big|_{s=-4} = -\frac{1}{2} \quad ; \quad B \Big|_{s=-2} = \frac{1}{2}$$

$\therefore Y(s) = \frac{-1/2}{s+4} + \frac{1/2}{s+2}$

Ans: $y(t) = \left(-\frac{1}{2}e^{-4t} + \frac{1}{2}e^{-2t} \right) u(t)$ Ans

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Q: This is an discrete time LTI system represented by the following frequency response: $H(e^{j\omega}) = \frac{1}{1 - 2e^{-j\omega}}$ (a) Determine the difference equation which represents this system. (b) Find a block diagram representation of this system using unit delay operators and adders. (c) Find the impulse response of this system.

A: [See answer](#)

Q: (20 pts) This is a LTI system defined by the frequency response below: $H(j\omega) = \frac{1}{j\omega + 4 - \omega^2 + 5j\omega + 6}$ (a) Firstly determine the differential equation that represents the system above. (b) Determine the impulse response of the system. (c) Find $Y(j\omega)$ when the input is $x(t) = e^{-4t}u(t) - te^{-4t}u(t)$. d) Find the output $y(t)$

A: [See answer](#)

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