1)

Design a real causal continuous-time LTI system with poles at

$$p_1 = -1 + 2j, \qquad p_2 = -1 - 2j,$$

zeros at

$$z_1 = 2j, \qquad z_2 = -2j,$$

and a dc gain of unity.

(a) Write down the differential equation to implement the system.

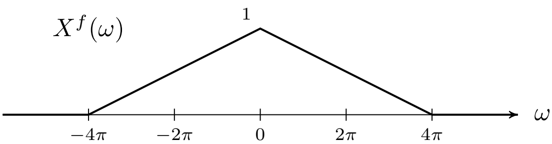
(b) Sketch the pole/zero diagram.

(c) Sketch the frequency response magnitude $|H^f(\omega)|$. Mark the dc gain point and any other prominent points on the graph.

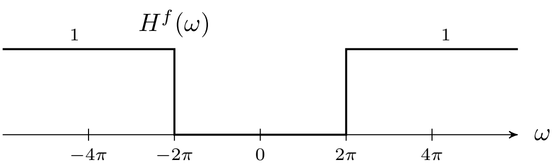
(d) Write down the form of the impulse response, as far as it can be determined without actually calculating the residues. (You do not need to complete the partial fraction expansion.)

2)

The signal $x(t)$ has the spectrum $X^f(\omega)$ shown.



The signal $x(t)$ is used as the input to a continuous-time LTI system having the frequency response $H^f(\omega)$ shown.

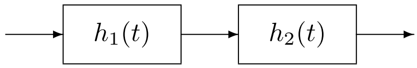


Accurately sketch the spectrum $Y^f(\omega)$ of the output signal.

3)

Two continuous-time LTI system are used in cascade. Their impulse responses are

$$h_1(t) = \text{sinc}(3\,t) \qquad h_2(t) = \text{sinc}(5\,t).$$



Find the impulse response and sketch the frequency response of the total system.

4)

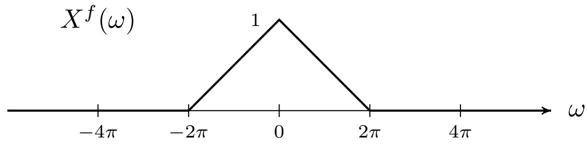
The signal $x(t)$ is given the product of two sine functions,

$$x(t) = \sin(\pi\, t) \cdot \sin(2\pi\, t).$$

Find the Fourier transform $X^f(\omega)$.

5)

A continuous-time signal $x(t)$ has the spectrum $X^f(\omega)$,



(a) The signal $g(t)$ is defined as

$$g(t) = x(t)\cos(4\pi t).$$

Accurately sketch the Fourier transform of $g(t)$.

(b) The signal $f(t)$ is defined as

$$f(t) = x(t)\cos(\pi t).$$

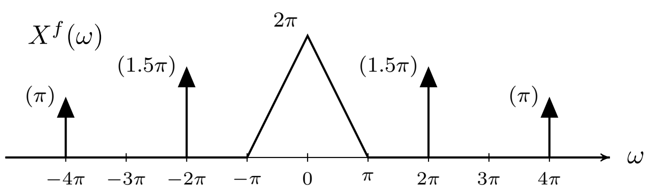
Accurately sketch the Fourier transform of $f(t)$.

6)

A continuous-time LTI system has the impulse response

$$h(t) = \delta(t) - 3\ \text{sinc}(3t)$$

The input signal $x(t)$ has the spectrum $X^f(\omega)$ shown,



Find the output signal $y(t)$.