1. A causal LTI system is implemented by the difference equation

$$y(n) = 2\,x(n) - 0.5\,y(n-1).$$

   (a) Find the frequency response $H^f(\omega)$ of the system.

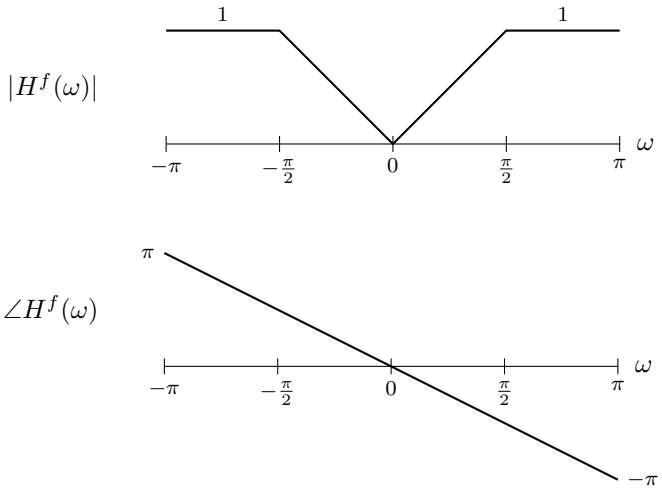
   (b) Plot the pole-zero diagram of the system. Based on the pole-zero diagram, roughly sketch the frequency response magnitude $|H^f(\omega)|$.

   (c) Indicate on your sketch of $|H^f(\omega)|$, its exact values at $\omega = 0,\ 0.5\pi$, and π.

   (d) Find the output signal $y(n)$ produced by the input signal

$$x(n) = 3 + \cos(0.5\,\pi n).$$

2. A discrete-time LTI system has the frequency response:



   (a) Find the output signal $y(n)$ produced by input signal

$$x(n) = 1 + 2\cos(0.2\pi n + 0.3\pi) + 3\,(-1)^n.$$

   (b) Is this a real system? Justify your answer.

3. The frequency response of a discrete-time LTI system is given by

$$H^f(\omega) = \begin{cases} 0, & 0 \le |\omega| \le 0.4\pi \\ -\mathrm{j}, & 0.4\pi < \omega < \pi \\ \mathrm{j}, & -\pi < \omega < -0.4\,\pi \end{cases}$$

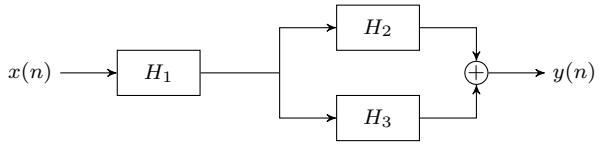
   (a) Sketch the frequency response magnitude $|H^f(\omega)|$ for $|\omega| \le \pi$.

   (b) Sketch the frequency response phase $\angle H^f(\omega)$ for $|\omega| \le \pi$.

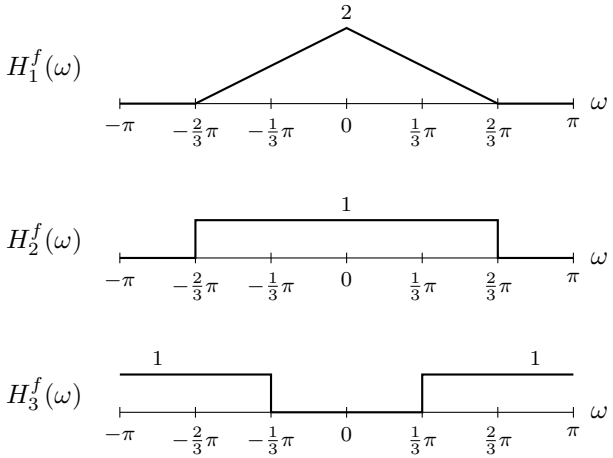
   (c) Find the output signal $y(n)$ produced by the input signal

$$x(n) = \sin(0.6\,\pi\,n).$$

4. Accurately sketch the frequency response of the total system,



   where the frequency responses of the LTI subsystems are:



5. Matching problem (input / system / output): next page

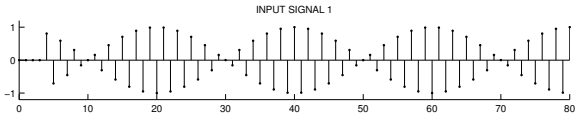
6. Matching problem (pole-zero diagram / frequency response): next page

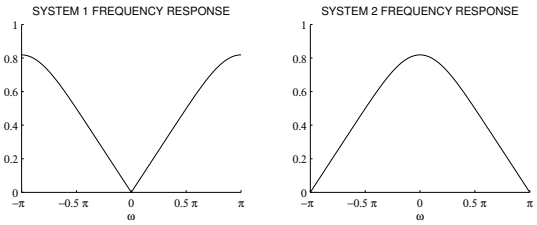
5.

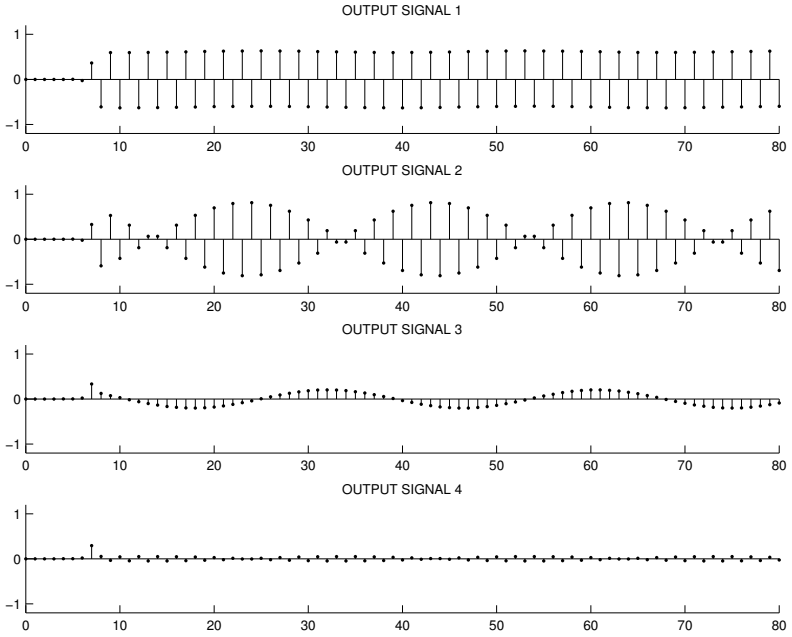
Each of the two discrete-time signals below are processed with each of two LTI systems. The frequency response magnitude $|H^f(\omega)|$ are shown below. Indicate how each of the four output signals are produced by completing the table below.

Input signal 1 is given by: $\cos(0.95\,\pi\,n)\,u(n-4)$

Input signal 2 is given by: $0.25\,\cos(0.07\,\pi\,n)\,u(n-4) + 0.75\,(-1)^n\,u(n-4)$







Input signal	System	Output signal
1	1	
1	2	
2	1	
2	2	

6.

Match the pole-zero diagrams with the frequency responses.