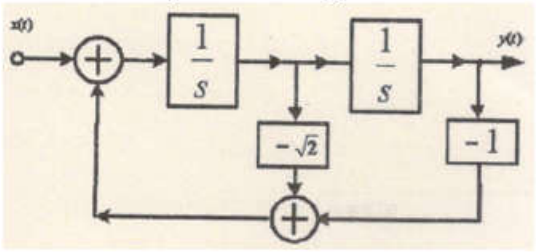
Discussion problem assignment:

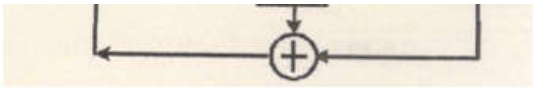
第一题：

1. A continuous-time causal LTI system is shown in the figure. Determine the system function and its unit impulse response. Is this system a low-pass filter?



解答：

Solution:



(1). 由系统框图可得系统函数表达式 $H(s)=\dfrac{1}{(s^2+\sqrt{2}s+1)}$

对应的两个极点的位置： $s=\dfrac{-\sqrt{2}\pm\sqrt{2-4}}{2}=-\dfrac{\sqrt{2}}{2}\pm\dfrac{\sqrt{2}}{2}j$

(2). 由系统因果性，可得ROC为 $\mathrm{Re}\{s\}>-\sqrt{2}/2$

(3). 反变换求单位冲激响应，可以考虑部分分式展开，也可以参考表9-2的常用LT变换对，可得

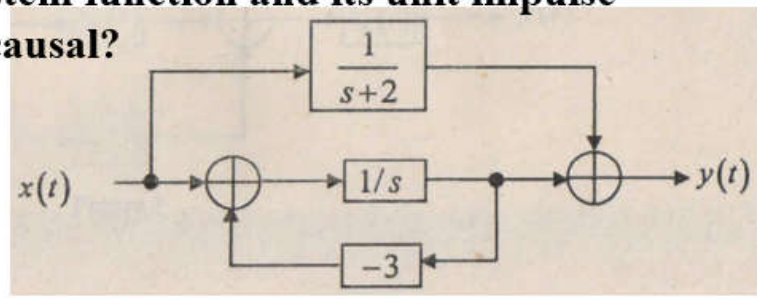
$$H(s)=\frac{1}{(s^2+\sqrt{2}s+1)}=\frac{1}{(s+\frac{\sqrt{2}}{2})^2+(\frac{\sqrt{2}}{2})^2}\qquad \mathrm{Re}\{s\}>-\sqrt{2}/2$$

$$h(t)=[e^{-\frac{\sqrt{2}}{2}t}\sin(\tfrac{\sqrt{2}}{2}t)]u(t)$$

(4). 参考基于几何法求FT幅度响应的方法，可知，这两个极点成共轭对出现，系统幅度响应应该是带通特性

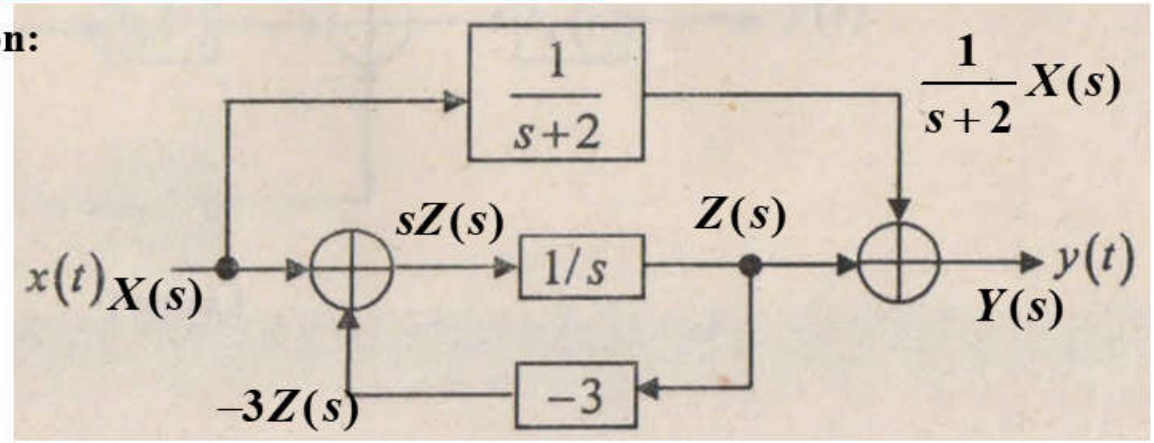
第二题：

2. A stable system with input x(t) and output y(t) is defined in the figure. Determine the system function and its unit impulse response. Is this system causal?



解答：

Solution:



(1). 由系统框图中各信号定义可得

$$Y(s)=\frac{1}{s+2}X(s)+Z(s) \qquad sZ(s)=X(s)-3Z(s)$$

由等式二得 $Z(s)=\frac{1}{s+3}X(s)$ $\quad \therefore Y(s)=\frac{1}{s+2}X(s)+\frac{1}{s+3}X(s)$

(2). 由此得到系统函数为 $H(s)=\frac{Y(s)}{X(s)}=\frac{1}{s+2}+\frac{1}{s+3}$

对应的两个极点在 -2 和 -3。考虑到系统稳定，可得系统ROC为

$$\mathrm{Re}\{s\}>-2$$

(3). 反变换得系统单位冲激响应 $h(t)=e^{-2t}u(t)+e^{-3t}u(t)$

(4). 由ROC或者反变换结果，都可得出系统满足因果性条件