ENEE 322  
Sections 0101 & 0102  
Spring 2017  

Homework #13

1) Consider the discrete system  
\[ y[n] = -\frac{x[n]}{4} + \frac{x[n-1]}{2} - \frac{x[n-2]}{4} : \]

a) Compute (and simplify) the impulse response \( h[n] \).

b) Plot the step response \( s[n] \) (i.e. the response to a step input \( u[n] \)), and \( u[n] \) on the same graph.

c) Compute (and simplify) the transfer function \( H(e^{j\omega}) \).

d) Compute (and simplify) the magnitude \( |H(e^{j\omega})| \). Characterize this filter as one of \{Low pass, Band pass, High pass, All pass, none of the above\} and justify your answer.

e) Compute (and simplify) the phase \( \angle H(e^{j\omega}) \). Is it continuous (up to jumps of \( 2\pi \))?

f) Graph a Bode plot of this transfer function (with \( \omega \) from 0 to \( \pi \)). Plot both amplitude and phase, with amplitude in dB and phase in radians.

2) For each of the following signals, using the definition of the Laplace transform, compute the Laplace transform, its region of convergence (ROC), its the zeros and poles. Sketch the ROC and the locations of zeros and poles.

a) \( x(t) = \delta(t) \)

b) \( x(t) = u(t) \)

c) \( x(t) = \delta(t - t_0) \)

d) \( x(t) = u(t - t_0) \)

e) \( x(t) = \delta'(t) \)

3) For each of the following signals, sketch (roughly) the signal and: compute the Laplace transform, its region of convergence (ROC), and its zeros and poles. Sketch the ROC and the locations of zeros and poles (Treat separately the cases of \( a > 0 \) and \( a < 0 \)).

a) \( x(t) = u(t)e^{-at} \)

b) \( x(t) = u(-t)e^{-at} \)

c) \( x(t) = u(t)\cos(2\pi f_0 t) \)

d) \( x(t) = u(-t)\cos(2\pi f_0 t) \)
4) For each of the following signals, sketch (roughly) the signal and: compute the Laplace transform, its region of convergence (ROC), and its zeros and poles. Sketch the ROC and the locations of zeros and poles. If the Laplace transform does not exist, (i.e. the ROC is the null set), point this out.

a) \( x(t) = u(t)e^{-5t} + u(t)e^{-2t} \)

b) \( x(t) = u(t)e^{-5t} - u(-t)e^{-2t} \)

c) \( x(t) = -u(-t)e^{-5t} + u(t)e^{-2t} \)

d) \( x(t) = -u(-t)e^{-5t} - u(-t)e^{-2t} \)

e) \( x(t) = e^{-5t}(u(t+1) - u(t)) \)

5) For each of the following causal systems, compute the Laplace transform, its region of convergence (ROC), and its zeros and poles. Which systems are stable, and why?

a) \( \ddot{y}(t) + 5\dot{y}(t) + 6y(t) = 5x(t) + 2\dot{x}(t) \)

b) \( \ddot{y}(t) + 3\dot{y}(t) + 2y(t) = 3x(t) + 2\dot{x}(t) \)

c) \( \ddot{y}(t) + \dot{y}(t) = x(t) + 2\dot{x}(t) \)