MAE 143 A - Fall 2019

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Homework 2

1. Exercise 4.5 from Boulet FSS
2. Exercise 4.9 from Boulet FSS
3. Consider the linear time-invariant system described by the differential equation:

$$\dot{y} + y = \dot{u}$$

and answer the following questions:

a) Is the system BIBO stable?
b) Calculate the steady-state response to an input of the form

$$u(t) = e^{j\omega t}$$

c) Show how you can use the answer from part b) to calculate the steady-state response to an input of the form

$$u(t) = \cos(\omega t)$$

d) Evaluate the amplitude and the phase of the response calculated in b) and c) for $\omega = \{0, 1, 2, 3\}$, and $\omega \to \infty$.
e) Use the answer to part d) and problem 4.9 from Boulet to calculate the first 3 harmonics of the response of the system to the sawtooth input considered in P4.9.
f) Explain how would the response change if a constant of value 1 is added to the sawtooth signal of P4.9.

4. Consider the linear time-invariant system described by the difference equation:

$$y[n] = \alpha\, y[n-1] + (1-\alpha)\, u[n], \quad \alpha \in (0, 1)$$

and answer the following questions:

a) Is the system BIBO stable?
b) Calculate the steady-state response to an input of the form

$$u[n] = e^{j\omega T_s n}$$

c) Show how you can use the answer from part b) to calculate the steady-state response to an input of the form

$$u[n] = \cos(\omega T_s n)$$

d) Plot the magnitude of the response calculated in b) and c) when $T_s = 1$ when $\alpha = \{0, .1, .5, .9\}$ as a function of ω in the interval $[-\pi, \pi]$.
e) Repeat part d) in the interval $[-3\pi, 3\pi]$.

f) What is the response of the above system to inputs of the form

$$u[n] = cos(\omega T_s n), \quad \omega = \omega_0 + 2\kappa\pi/T_s$$

for various values of $\kappa \in \mathbb{Z}$? Explain in terms of your answer to part e).