Homework 2: Discrete-Time Models

- Assigned on 3/8, 2019. Due on 3/22, 2019

- Problem 2-1:
  - Derive the formulas of the DT State-Space System with Inner Time Delay
  - See pages 20-21 of Lecture Note: DCS-11.
  - Reference:
    - Bjorn Wittenmark, "Sampling of a system with a time delay,“ IEEE Transactions on Automatic Control, Vol. 30, No. 5, pp. 507-510, May 1985.
    - https://ieeexplore.ieee.org/document/1103985

- Problem 2-2:
  - Derive the discrete-time system corresponding to the following continuous-time system when a zero-order-hold circuit is used:

$$\begin{aligned} \frac{d}{dt}\mathbf{x} &= \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}\mathbf{x} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \\ y &= \begin{bmatrix} 1 & 0 \end{bmatrix}\mathbf{x} \end{aligned}$$

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- Problem 2-3:
  - Use the z-transform to determine the output sequence of the difference equation:

$$y[k+2] - 1.5y[k+1] + 0.5y[k] = u[k+1]$$

  - When *u[k]* is a step at *k = 0* and when *y[0] = 0.5* and *y[-1] = 1*.

- Problem 2-4:
  - Sample the continuous-time system:

$$\frac{d}{dt}\mathbf{x}(t) = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}\mathbf{x}(t) + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(t-0.2)$$

  - Using the sampling interval *h = 0.3*. Determine the pulse-transfer operator.