# EC ENGR 113 (Digital Signal Processing)

September 27, 2022

# 1 9.26 1m

- syllabus

## 1.1 ece102: signals & systems

- signals were modeled as functions of time
  - $x(t) : t \in \mathbb{R}$ (continuous time)
  - $x : \mathbb{R} \to \mathbb{R}, \mathbb{C}$
  - sampling $t = nT_s$
    - $T_s$ = sampling interval
    - $n$ = integer
    - $t - x$ plot $\overset{sampling}{\longrightarrow}$ $n - x$ plot
    - $x(t)$ bandlimited ($|X(f)| \leq f_{\max}$) then if sampling rate is $f_s > 2f_{\max}$ (nyquist rate) then it is possible to recover the original signal
    - sampling at lower rate then there will be aliasing
- sytems
  - $x(t) \to \boxed{S} \to y(t)$
  - $x[n] \to \boxed{S} \to y[n]$

## 1.2 three ways tor write out signals

- mathematical expression
  - $x[n] = 3\cos(2n), n \in \mathbb{Z}$
- tabular list of significant samples
  - $x[n] = \{-1, 8, 0, 5, -2\}, n \in \mathbb{Z}$
    - underspecified signal: loss of indices
    - typically put an arrow underneath the 0 index
    - convention: any sample not listed has 0 amplitude
- plotting

## 1.3 signal operations

- arithmetic
  - $g[n] = x[n] + A$
  - $g[n] = Bx[n]$
  - signal addition: $g[n] = x_1[n] + x_2[n]$
  - signal multiplication: $g[n] = x_1[n] \cdot x_2[n]$
- time shifting
  - ece102
    - $x(t) \to x(t - \tau)$ delays signal by shifting it right
    - $x(t) \to x(t + \tau)$ advances signal by shifting left
  - ece113

        * $g[n] = x[n-k], k > 0$
- time scaling
  - ece102
    * $x(at), a > 1$: contraction
    * $x(at), 0 < a < 1$: dilation
  - ece113
    * $g[n] = x[2n]$ (downsampling)
    * $g[n] = x\left[\frac{1}{2}n\right]$ (upsampling)
    * $g[n] = x[-n]$ (time reversal)

## 1.4 basic signals

- $\delta(t)$ from ece102 $\rightarrow$ hard concept to grasp
- $\delta[t]$ from ece113 $\rightarrow$ : )
  - $\delta[n] = \begin{cases} 1 & n = 0 \\ 0 & n \neq 0 \end{cases}$
  - $\delta[n]$ does not have complexities of $\delta(t)$
- sampling property of $\delta$
  - $x[n] * \delta[n] = x[0] \cdot \delta[n] = x[0]$
  - $x[n] * \delta[n-k] = x[k] \cdot \delta[n-k] = x[k]$