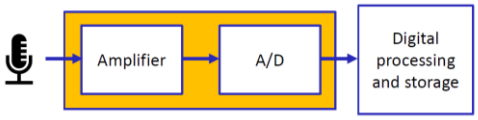
Analog Systems Design

1. Introduction

1. Analog Vs Digital
   - Analog : Continuous in Time and Amplitude
   - Digital : Discrete in Time and Amplitude

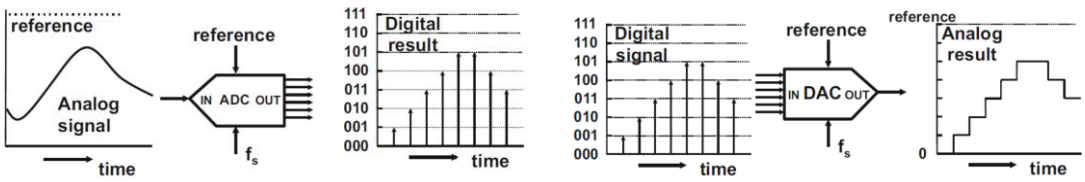
2. Why Digital ?
   - Less sensitive to noise
   - Easier to store (Digital Memories)
   - Easier to process (Digital Signal Processing DSP)
   - Amenable to automated design and testing
   - Direct beneficiary of Moor's law

3. Why Analog ?
   - All the physical signals in the world around us are analog
   - We always need an analog interface circuit to connect between our physical world and our digital electronics



4. ADC Functions
   - Convert analog signal (Continuous in time and amplitude) to a digital signal (Discrete in time and amplitude) by
     - Sampling : Discretization of analog signal in time domain
     - Quantization : Discretization of analog signals in amplitude domain
     - Linking to a reference (V_{FS})

5. DAC Functions
   - Convert digital signal (Discrete in time and amplitude) to an analog signal (Continuous in time and amplitude) by
     - Amplitude Restoration : Convert digital levels to voltage amplitude
     - Holding : Holding voltage amplitude to convert signal form DT to CT
     - Linking to a reference (V_{FS})



2. Sampling

1. Sampling introduction

- Sampling is time discretization
  - Converts a continuous time signal to a discrete time signal
  - The result is a sequence of samples
- The Sampling instants are defined by a clock signal controls an electronic switch e.g. MOS
- The sampled signal is stored as a voltage on a capacitor
- The circuits is called sample and hold S/H circuit

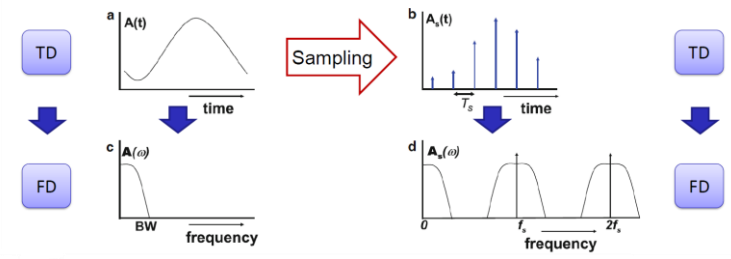
2. Time and Frequency domains

- $TD_{step} = \Delta t = 1/f_s = 1/FD\ period$
- $FD_{step} = \Delta f = 1/T_o = 1/TD\ period$

Time domain		Technique	Frequency domain		Where in the chain?
CT/DT	Periodic	↔	C/D	Periodic	
CT	Yes	CT Fourier series (CTFS)	Discrete	No	-
CT	No	CT Fourier transform (CTFT)	Continuous	No	Before S/H
DT	Yes	DT Fourier series (DTFS) → FFT	Discrete	Yes	After ADC
DT	No	DT Fourier transform (DTFT)	Continuous	Yes	After S/H

3. Discrete and periodicity

- Sampling causes “images” in the frequency domain
  - The sampled signal is folded around fs and its multiples
  - The part from 0 to fs/2 is the only part that has a physical meaning



4. Aliasing and Nyquist criterion

- Aliasing is an effect that causes different signals to become indistinguishable (or aliases of one another) when sampled
- Nyquist criterion $f_s \geq f_{nyq} = 2\ BW$