

# ECE615 Mixed-Signal IC Design

## Lecture1 Slides

Vishal Saxena, Boise State University  
([vishalsaxena@boisestate.edu](mailto:vishalsaxena@boisestate.edu))

Mixed Signal IC Laboratory  
Boise State University

# Course Outline

**Instructor** : Vishal Saxena  
**Time** : Tuesday and Thursday, 4:30 to 5:45 PM  
**Course dates** : Tuesday, August 27 to Thursday, Dec 12  
**Location** : MEC 309  
**Holidays** : Nov 26 & 28, Thanksgiving break.  
**E-mail** : [vishalsaxena@u.boisestate.edu](mailto:vishalsaxena@u.boisestate.edu)  
**Website** : <http://lumerink.com/courses/ECE615/f13/ECE615.htm>

# Course Topics

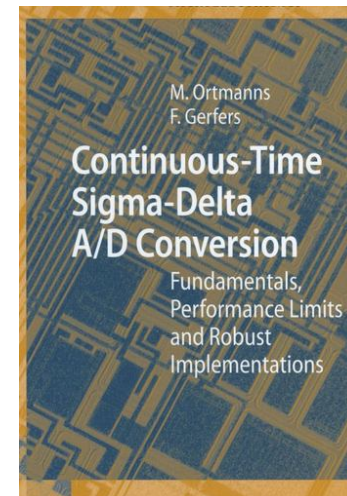
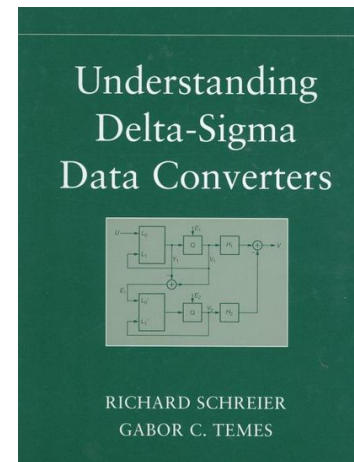
- ❑ Data Conversion and spectral estimation fundamentals
- ❑ Delta-Sigma modulator (DSM) architectures, decimation filters
- ❑ Discrete-time DSM design
  - System level design, noise budgeting, circuit optimization.
- ❑ Continuous-time (CT) DSM design
  - Effects of excess-loop delay and clock jitter in CT-DSMs
  - Tuning techniques for CT-DSMs.
- ❑ Flash ADCs and DACs employed in the CT-DSMs
- ❑ Bandpass and Complex DSMs.
- ❑ DAC mismatch error shaping

# Prerequisites

- ❑ Analog IC Design (ECE 511)
  - Op-amps, biasing, small-signal analysis.
- ❑ Digital Signal Processing
  - Fourier, DTFT, Laplace, z-transforms, poles and zeros.
- ❑ Basic knowledge of circuit simulation using Spice/Spectre and Matlab scripting.
- ❑ Circuit details are covered in ECE 614

# Textbook and References

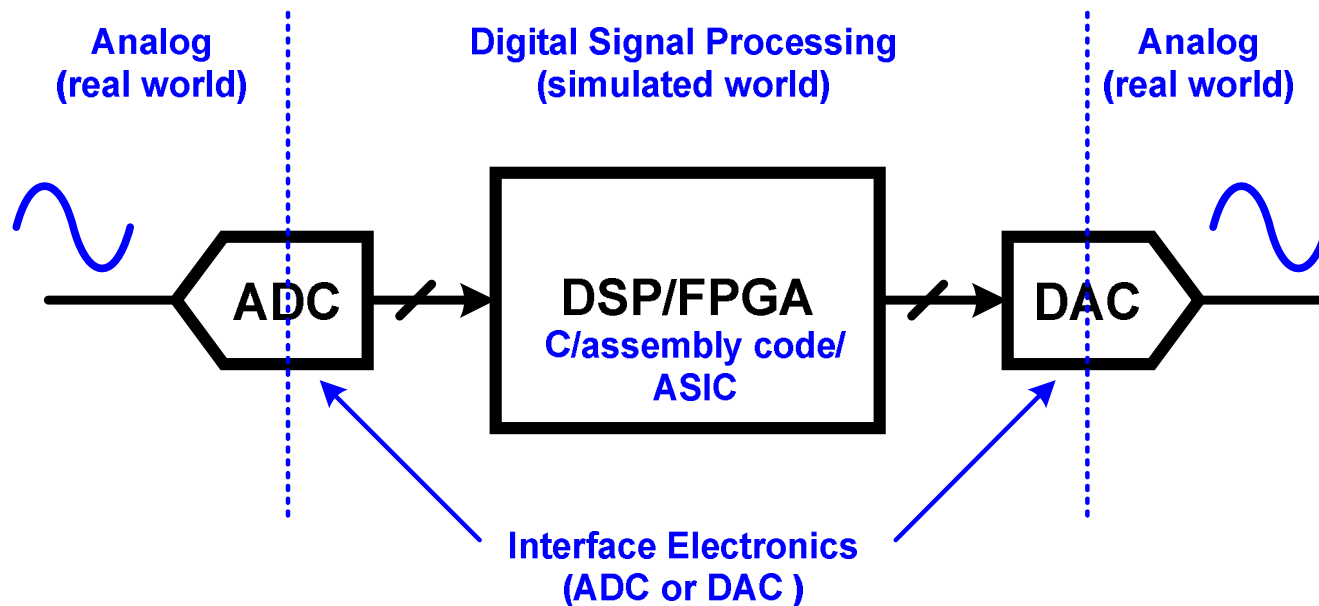
- Understanding Delta-Sigma Converters – Richard Schreier and Gabor Temes, Wiley-IEEE Press, 2005.
  - CT Sigma-Delta ADC – Ortmanns
- Matlab Delta-Sigma Toolbox by R. Schreier available for download [online](#). The toolbox manual is [here](#).
- The complete reference list for delta-sigma modulators is available [here](#).



# Course Pedagogy, Grading and Policies

- ❑ Combination of lecture notes, slides and simulation
  - Lecture notes will be posted online
  - Additional slides, Matlab code etc will also be posted.
- ❑ Workload (Grading)
  - Homeworks (25%): Weekly assignments combining Matlab and Spectre based design and simulation.
  - Midterm Exam (25%)
  - Project 1 (25%): Switched-capacitor delta-sigma modulator design.
  - Project 2 (25%): Continuous-time delta-sigma modulator design.
- ❑ Policies
  - Maximize learning!
  - No plagiarism, late work and net surfing in class.

# Data Converters



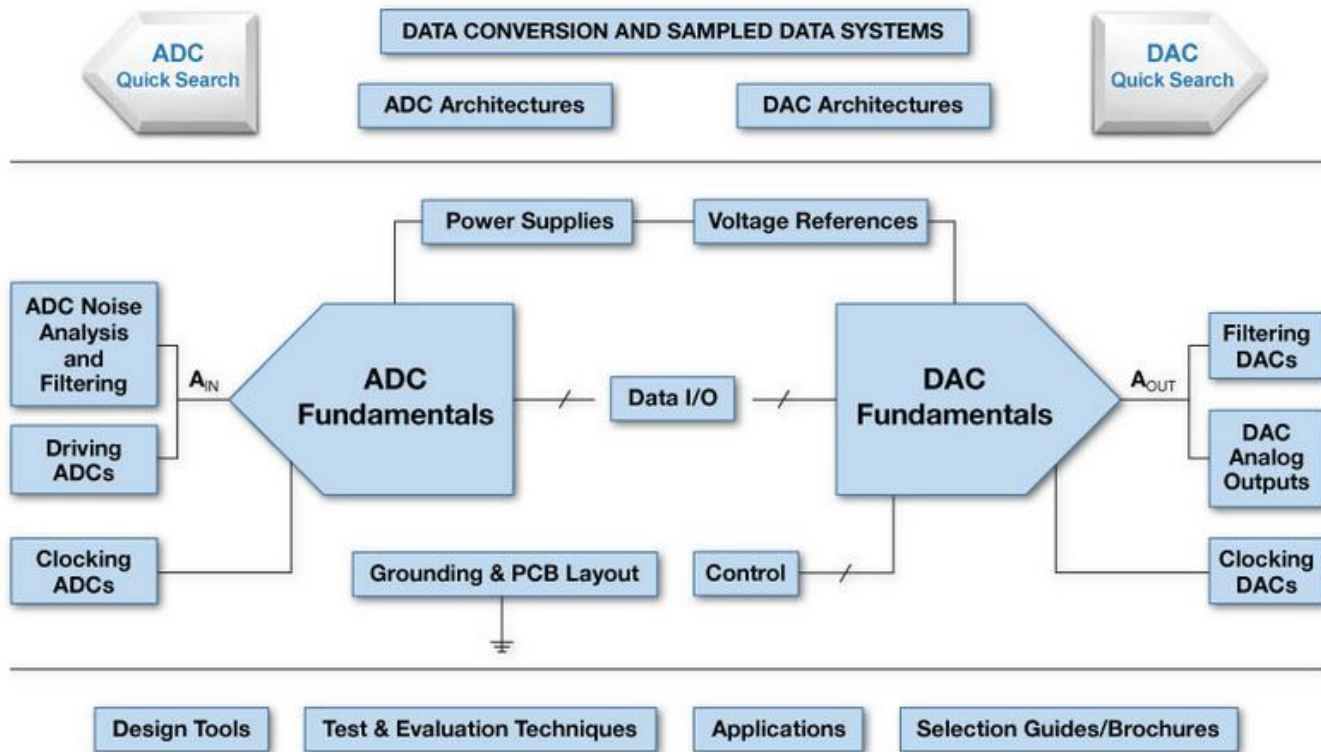
- ❑ Real world: Continuous-time, continuous-amplitude signals.
- ❑ Digital world: Discrete-time, discrete-amplitude signal representation.
- ❑ Interface circuits: ADC and DACs.
  - Varying speed and precision requirements.

# Data Conversion Scenarios

- ❑ Any application using a sensor and/or an actuator
  - Wireless: RF Rx and Tx chain
  - Twisted pair: ADSL modem
  - Coaxial: Cable modem
  - Serial/Optical links: 10G+ ADC for modulation and equalization
  - Audio Recording: 24-bit stereo ADCs
  - Audio players: stored data to speaker (audio DAC)
  - HDD read channel: Magnetic disk to microprocessor
  - Biomedical applications (e.g. sensing blood glucose level and actuating the insulin pump),.....
- ❑ Speed and resolution requirements vary with the application.

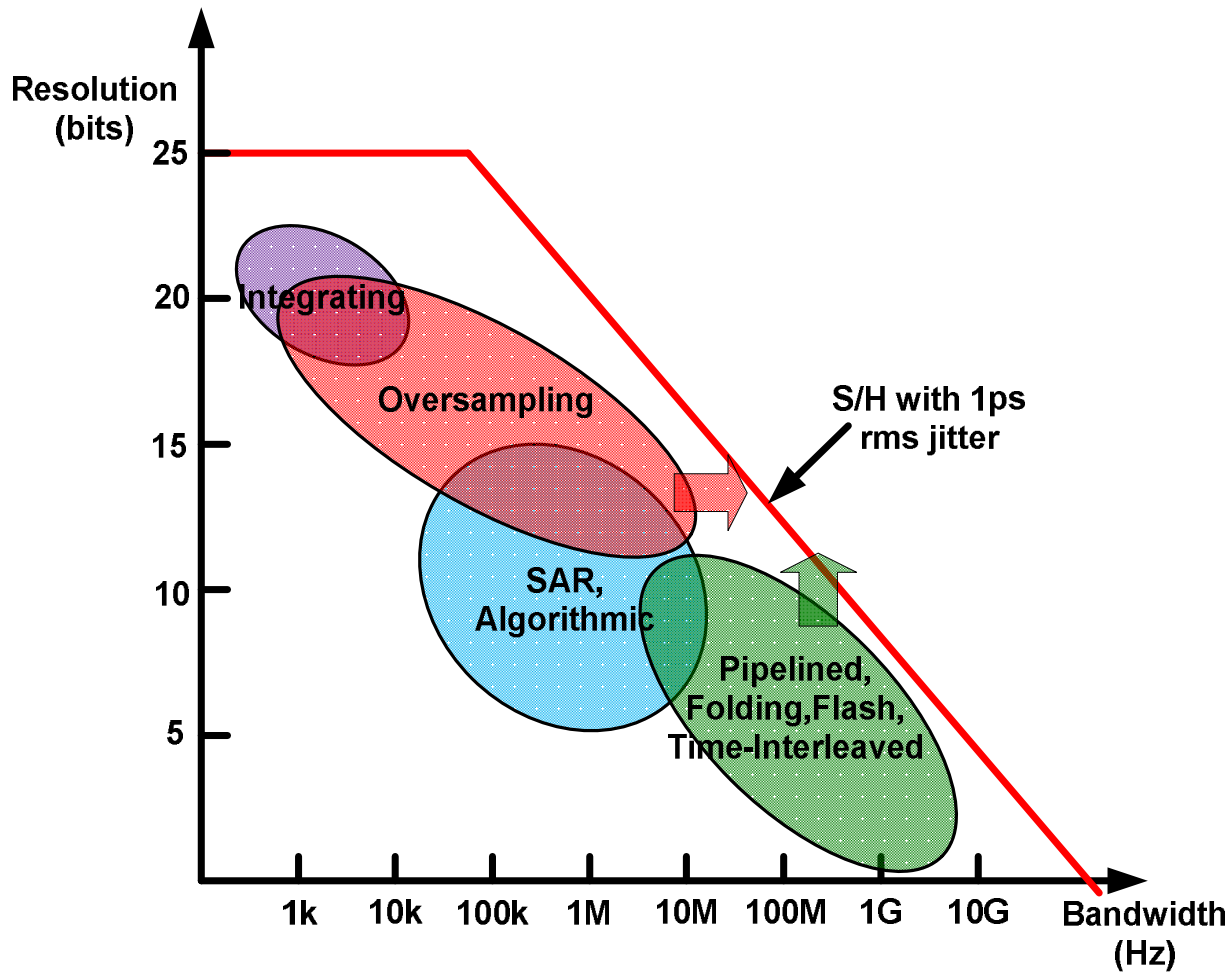


# Data Converters

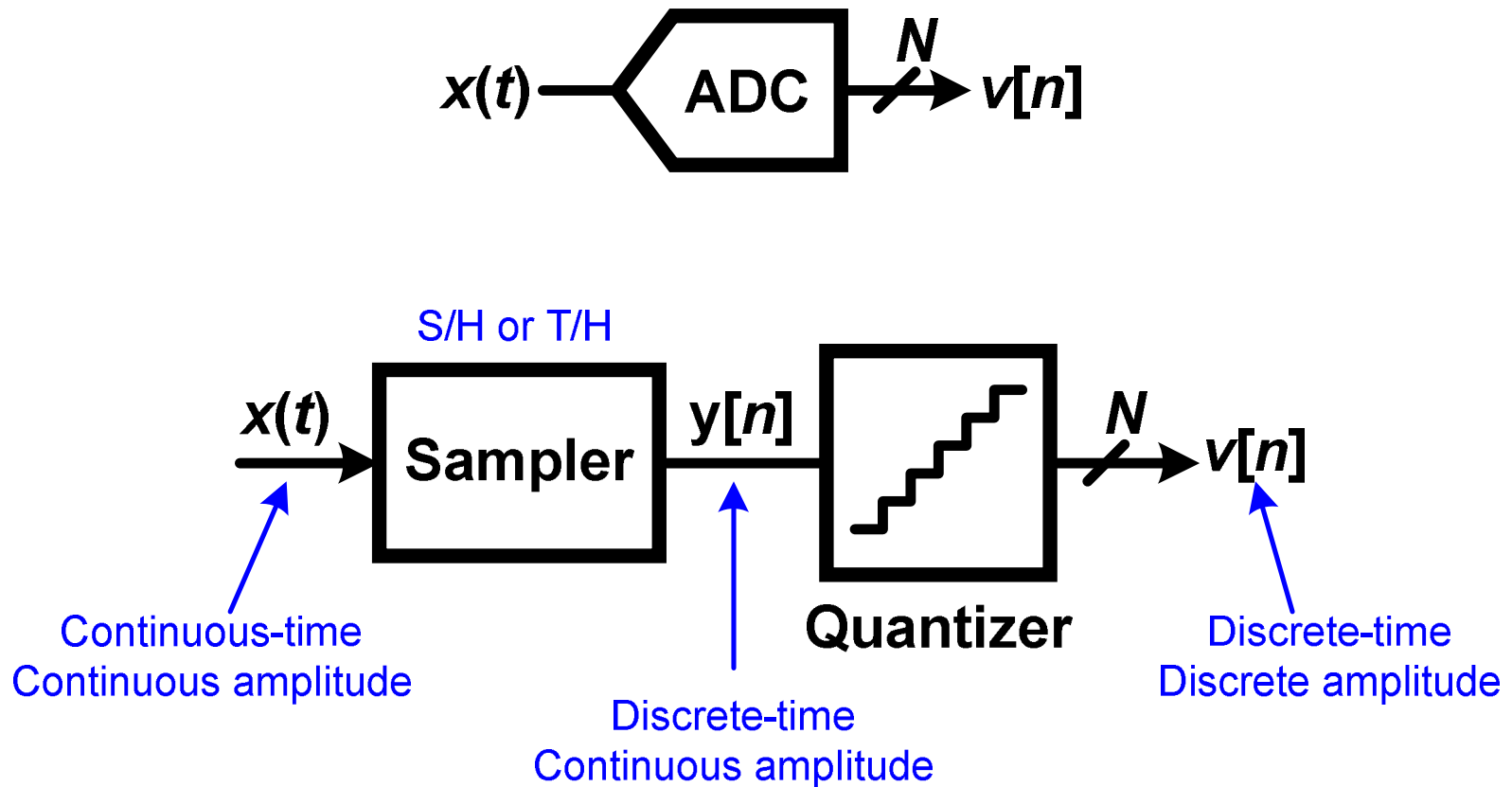


- ❑ <http://www.analog.com/en/data-conversion-knowledge-resource/conversions/index.html>

# Analog to Digital Converter Architectures



# Analog-to-Digital Converter (ADC)



# Sampling Process

- Refer to lecture notes.