ECE 498CR – Digitally Assisted Circuit Design

Course Description:

The course will focus on the application of statistical and adaptive signal processing techniques to analog and mixed-signal circuit blocks since these techniques have become the most widely used methods to overcome design challenges in circuit design. The application of the above mentioned signal processing tools in circuit design will be established using the following three circuit blocks:

1. Analog to Digital Converters
2. High-speed communication links
3. Delta-sigma Digital to Analog Converters

Fundamental concepts related to each block will be introduced as needed. Modelling and impact of non-idealities like gain error, mismatch, ISI, and nonlinearity on the performance of each circuit block will be discussed. A mixture of analysis and intuition will be employed to illustrate the steps required to transform the given problem into an adaptive signal processing setting. This will be done through case studies and published papers in the relevant area.

Course Website: https://courses.grainger.illinois.edu/ECE498CR/sp2021/

Instructors:

Instructor	Email	Office Hrs
Chandrasekhar Radhakrishnan	cradhak@	Tue, 4:30 – 6:00 PM, on zoom

Meeting Times:

Mon, Wed – 8:00 AM – 9:15 AM

Prerequisites: ECE 310, ECE 313, ECE 342

Text and Resources:

- Course Notes and Published Papers
- **Optional**: Discrete-Time Signal Processing, 2nd Ed., Oppenheim, Schafer, Buck (OS).
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Teaching Assistants: TBA

Grading:

HW + Projects	**100%**

- Homework/Projects is due at 10:00 PM on the posted date on the website. Submissions will be using gradescope.

Syllabus and Lecture Schedule

Lecture	Topic
1.	Course Introduction, logistics, Review DTFT/DFT
2.	Review DTFT/DFT
3.	DTFT, DFT, Spectral Analysis of Sinusoidal Signals
4.	DFT analysis of sinusoidal signals contd.
5.	Sampling and quantization
6.	ADCs and performance parameters
7.	Introduction to Adaptive signal processing and mean square estimation
8.	LMS algorithm analysis
9.	Adaptive filtering (LMS) examples and applications
10.	Digital calibration principles in pipelined ADCs- overview of techniques in
11.	LMS based background calibration of pipelined ADC- capacitor and gain mismatch correction
12.	LMS based background calibration of pipelined ADC- capacitor and gain mismatch correction
13.	Pipelined ADC - principles, 4-bit ADC using 1-bit pipeline
14.	Pipelined ADC – 1.5 bit per stage pipeline overview
15.	Pipelined ADC Architecture, non-idealities
16.	Pipelined ADC, non-idealities and system level impact
17.	Introduction to high speed serial links in inter-IC communication
18.	non-idealities, models and performance parameters
19.	Equalizers - FIR and feed-forward equalizers, DFE
20.	DFE based ISI cancellation – overview and analysis of equalizer adaptation
21.	DFE based ISI cancellation – project overview
22.	Oversampling and noise shaping, Delta-sigma ADC
23.	Delta-sigma ADC, Delta-sigma DACs
24.	Delta-sigma DACs non-idealities
25.	Digital calibration principles for delta-sigma DACs
26.	Digital calibration principles for delta-sigma DACs
27.	Course Review