An extensive Analog Circuit Design Training for Electronics/Electrical Engineering Students

Background:

Analog design in the context of integrated circuit (IC) design is a discipline that focuses on the creation of circuits that operate in and are optimized for continuous time-domain behaviour.

Importance of Analog Design

Since all the basic devices in an IC respond to continuous time stimulus, analog design forms the foundation for all IC design. Modern IC technology presents many design challenges. There is significant variability in the manufacturing process for advanced technology nodes. The actual operation of the high number of devices on advanced ICs also causes variability. This variability manifests as changes in operating voltage, operating temperature, and in performance. Densely packed devices can also interact with each other and with the silicon substrate, package, and board to cause signal distortions. All of these effects can occur between devices and within a single IC as well.

Analog design must compensate for all these effects to ensure three basic qualities: fidelity/precision, consistency, and performance. Reliability analysis and signal integrity analysis are some of the activities that are used to model and mitigate these effects. Examples of the importance of these three items regarding IC applications are as follows:

- Fidelity/precision. Many analog designs form the foundation for circuits that sense the external conditions of an IC. Sensing ambient temperature, air pressure, motion, and light are fundamental parts of many internet of things (IoT) devices. Sensing light forms the basis of machine vision, for example. Accurately sensing these continuous time effects requires precise measurements, which translates into the need for excellent fidelity and precision for the analog circuit performing these measurements. Analog design ensures fidelity/precision.
- Consistency. Digital circuit design models the propagation of discrete "ones and zeros" to simplify the analysis of large numbers of devices. A "one" is typically the primary supply voltage and a "zero" is the absence of any voltage. For this model to work effectively, the performance of the circuit elements must be consistent across all the previously mentioned variability conditions. Consistency ensures voltages are at one of the reference levels of "one" or "zero." Analog design ensures these conditions are met.
- Performance. This parameter takes two basic forms: speed and power. All ICs have stringent requirements for speed to meet overall system throughput. They must also stay within a particular range of power dissipation. This item is driven by the need for systems to remain in acceptable thermal envelopes to ensure effective heat dissipation. The need for lower power is also driven by financial operating constraints. Analog design ensures power and speed are within acceptable bounds.

A career in VLSI offers numerous opportunities for growth and specialization. By pursuing targeted training, gaining practical experience, and developing essential soft skills, individuals can position themselves for success in this dynamic field.

Who can Take up this course: Students currently in their final year of their engineering graduation or who have already graduated can opt this course.

Theory Contents

Mirror, Reference Voltage, Generation, Adding PTAT and CTAT, Vref Circuit, Voltage Reference α calculation

8 Analog Comparator
8.1 What is Analog Comparator? Application Areas
8.2 Specifications of Comparator
8.3 Parameters of Comparator
8.4 Two stage OpAmp as Comparator
8.5 Opamp as Comparator
8.6 Comparator with Inverter Output
8.7 Advanced features of comparator-Offset and offset cancellation, Offset cancellation Scheme, Comparator with Hysteresis, Latched comparator or comparator with Latch

9 Ring Oscillator
9.1 Oscillator Basics
9.2 3 Stage Oscillator – Ring Oscillator
9.3 Ring Oscillator Using Digital Inverters
9.4 Propagation delay of Inverter
9.5 Limitations of Inverter based Ring Oscillator
9.6 Differential Delay cell-based RO
9.7 Designing differential delay cell

10 IPs using Analog Building Blocks
10.1 Phase Locked Loop: What is PLL? Block Diagram, PLL as Frequency Multiplier, Building Blocks of PLL, PFD + CP, Parameters of PLL
10.2 Digital to Analog Converter: What is a DAC? Binary Weighted Resistor, R-2R Ladder, Advanced DAC: Current Steering DAC
10.3 LDOs

Hands On Contents

Assignment & lab Sessions	Projects
1. NMOS Characterization. 2. Transconductance gm, small signal output impedance. 3. Characterization of various Nmos Configurations 4. Output Impedance (Rout) calculation. 5. Calculation of NMOS Length L for Current Source. 6. Performing W/L ratios. 7. Basic Current Mirror. 8. Common Source Amplifier. 9. Common Source Amplifier Nmos Diode connect Load. 10. CS Amplifier with current source load using PDM. 11. Basic Gates Design. 12. NMOS/PMOS pass transistor logic. 13. Propagation delay of NMOS & PMOS. 14. CMOS Inverter - DC & Transient Analysis. 15. CMOS inverter Switching Threshold voltage. 16. CMOS Inverter rise and Fall time. 17. Noise Margin Calculation. 18. Performing RTL Synthesis in Cadence. 19. Half adder Design 20. Full adder Design. 21. CMOS Inverter - DC & Transient Analysis. 22. CMOS inverter Switching Threshold voltage. 23. CMOS Inverter rise and Fall time. 24. Noise Margin Calculation. 25. Basic Gates Design. 26. NMOS/PMOS pass transistor logic. 27. Propagation delay of NMOS & PMOS. 28. Noise Margin Calculation. 29. Performing RTL Synthesis in Cadence. 30. Half adder Design 31. Full adder Design. 32. Ratioed Logic circuits. 33. Pseudo NMOS logic. 34. Multiplexers in various logic styles. 35. Logic Gates using multiplexers	1. Cascode current Mirrors 2. Low Voltage Cascode current Mirrors 3. Casocde CS Amplifier with current source load using PDM. 4. Triple Casocde CS Amplifier with current source load using PDM. 5. Differential Amplifier with active load using PDM. 6. Design of Telescopic Opamp using PDM 7. Parallel Adder Design.