20VL001 - Analog IC Design

COURSE OBJECTIVE

This course covers the analysis and design of analog integrated circuits starting from basic building blocks to different implementations of the amplifiers in CMOS technology.

COURSE OUTCOMES:

CO1: Gain knowledge on the basics of MOS in depth and apply them to different circuits.

CO2: Design basic building blocks of analog ICs.

CO3: Design optimal single stage amplifiers for various applications.

CO4: Identify the circuit designs with suitable topologies to meet the specifications of the system.

CO5: Acquire knowledge on non idealities of the circuits.

CO6: Develop a procedure for optimal compensation of op-amp against process, supply and temperature variations.

UNIT –I

CMOS device fundamentals: Basic MOS models, device capacitances, parasitic resistances, substrate models, transconductance, output resistance, frequency dependence of device parameters.

UNIT –II

Current Mirrors and Single stage amplifiers: CMOS current mirror, Common source amplifier, common drain amplifier or source follower, Common gate amplifier, Source degenerated current mirror, High output impedance current mirrors; Casode current mirror, Wilson current mirror, Cascode gain stage , MOS differential pair, Differential Amplifiers

UNIT –III

Frequency Response of Amplifiers: Miller effect, Common Source amplifier, Source follower amplifier, Common gate amplifier, Cascode gain stage, BandGap references

UNIT –IV

Feedback topologies and Noise: Input mixing, Output sampling, Noise: Statistical characteristics, types of noise, Noise summation, Noise spectral density, White noise, 1/f or flicker noise, Noise bandwidth, Non Linearity of Differential circuits, Capacitor non linearity, Miss match analysis, offset cancelation techniques

UNIT – V

CMOS Operational Amplifiers: Classification of Op Amps, Design of Op Amps, Compensation of Op Amps, Performance parameters, Design of two-stage Op Amps, Gain boosting, common mode feedback, Input range, slew rate, Power supply rejection, Noise in Op Amps, Stability and frequency Compensation, Buffered Op-amps, High speed / Frequency Op-amps, Differential output op-amps, low noise and low voltage op-amps.

LABORATORY EXPERIMENTS

LIST OF EXPERIMENTS

I) Design and simulate the following analog circuits.

1. Verify the characteristics of nMOS and pMOS Transistor
2. Common Source, Common Drain and Common gate Amplifiers
3. Current Mirror and Cascoded Current Mirror
4. Differential Amplifier
5. Bandgap reference circuit
6. CMOS Op-amp single Stage
7. Two stage operational amplifier
8. Folded cascode amplifier
9. Telescopic cascode amplifier
10. Push Pull Amplifier
11. Current Controlled Voltage source
12. Common mode feed-back circuits

II) Layouts

TEXT BOOKS:

1. BehzadRazavi,DesignofAnalogCMOSintegratedcircuits,McGraw-HillInternational edition.
2. D. A. Johns and Martin, Analog Integrated Circuit Design, John Wiley,1997.
3. Paul R Gray and Robert G Meyer, Analysis and Design of Analog Integrated Circuits, third edition.
4. Phillip E.Allen and Douglas R.Holberg, CMOS Analog Circuit Design, Oxford University Press, 2007.

REFERENCE BOOKS:

1. R Gregorian and G C Temes, Analog MOS Integrated Circuits for Signal Processing, John Wiley,1986.
2. R L Geiger, P E Allen and N R Strader, VLSI Design Techniques for Analog &Digital Circuits, McGraw Hill,1990.
3. Gray, Wooley, Brodersen, “Analog MOS Integrated circuits”, IEEE press,1989.
4. Alan B. Grebene, “Bipolar and MOS Analog Integrated Circuit Design”, Wiley, 2002.