ANALOG IC DESIGN

1. GENERAL

1.1 COURSE NUMBER: ECE333

1.2 CONTACT HRS: 3-0-0 Credits: 9

1.3 SEMESTER OFFERED: 4th Year-ODD

1.4 PREREQUISITE: - Fundamental of Electronics Engineering, Analog Circuit, and System, Circuit Theory.

1.5 Syllabus Committee Member: Dr. Umakant Dhar Dwivedi, Dr. Abhishek Kumar Singh, Dr. Sajal Agarwal, Dr. Vijay Kumar Singh, Dr. Ankur Pandey.

2. OBJECTIVE: This course deals with the design of analog integrated circuits with an emphasis on the design of feedback circuits at the transistor level. This course is for first-year postgraduate students and final-year undergraduate students who have already taken a course on analog circuit design.

3. COURSE CONTENT:

Unit	Topics	Lectures
1. Negative feedback systems and stability	Negative feedback amplifier using an integrator; Frequency and time domain behavior; Loop gain and its implications; Negative feedback amplifier realization; Finite DC gain; Increasing DC gain; Effect of multiple poles; Negative feedback systems with multiple poles and zeros in the forward path; Stability analysis using Nyquist criterion; Nyquist criterion; Loop gain-Bode plot and time domain interpretation; Significance of 60-degree phase margin	10
2. Opamp at the block level & Frequency compensation	Concept of the opamp for realizing negative feedback circuits; Realizing a multi-stage opamp-frequency compensation-miller opamp; Realizing a multi-stage opamp; feedforward compensated opamp; Opamp as a general block; unity gain compensation; nonidealities swing limits, slew rate, offset; dc negative feedback around opamps	07

3. IC components and their models	IC components and their models; Mismatch; Layout considerations	03
4. Noise in resistors and MOS transistors and Review of basic amplifier stages	Noise models; Noise calculations; Noise scaling, Body effect in basic amplifier stages; Frequency response of a common source amplifier	03
5. Single-ended opamp design	Realizing a single-stage opamp-diff pair; small signal ac analysis; Single stage opamp-mismatch and noise; Single stage opamp-telescopic cascade; Replica biasing a cascade; Single stage opamp-folded cascade; Two-stage miller compensated opamp; Three stage opamp; CMRR of an opamp and opamp circuits	11
6. Fully differential opamp design	Fully differential opamps; Differential and common mode half circuits; common mode feedback; Fully differential miller compensated opamp-common mode feedback loop and its stability; Fully differential single stage opamp; Fully differential telescopic cascode opamp; Fully differential feedforward compensated opamp	05
7. Phase-locked loop (PLL) and a Reference voltage and current generators	Frequency multiplier-Phase locked loop; Lock range limitations; type II loop; Jitter & Phase noise; Continuous-time approximation; PLLtransfer functions; Reference feedthrough spurs; LC oscillators, Bandgap reference; Bandgap reference; Constant current and constant gm bias generators	11

4. READINGS

4.1 TEXTBOOKS:

1. Analog Circuit Design: Art, Science and Personalities (EDN Series for Design Engineers) (Paperback), Jim Williams, Newnes; Reprint edition, 1991.
2. Analog Integrated Circuit Design, David Johns and Ken Martin, John Wiley & Sons, 1997.
3. Mixed Analog Digital VLSI Devices and Technology (An introduction),Y. Tsividis, World Scientific, New Jersey, 2002.
4. Analysis and design of Analog Integrated Circuits, Gray, Hurst, Lewis, and Meyer, 4th Edition, John Wiley and Sons.
5. Design of Analog Integrated Circuits and Systems, K. R. Laker and W.M.C.Sansen, McGraw-Hill, January 1994.

4.2 REFERENCE BOOKS:

1. Behzad Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill, August 2000

5. OUTCOME OF THE COURSE: A strong foundation in Analog IC Design