Centre for VLSI and Nanotechnology

B.Tech. Minor VLSI Design Course Book

Course Name: ENL 204 - Introduction to VLSI Design

Prerequisites: Nil

Offered in: Odd Semester (3rd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Elective

Course Theory Assessment: Midsem Exam (30%), Internal assessment through Assignments /Seminar /Quizzes (20%), End Semester Exam (50%).

Course Outcomes

Students will

1. Be able understand basic Flow of VLSI design
2. Be familiar with VLSI design and Technology.
3. Be able to link knowledge of CAD tools with VLSI system designs
4. Have the ability to formulate problems, problem solving skills.
5. Be able to analyze CMOS cells used in larger system design applications.

Relationship of Course Objectives to Program outcomes:

POs → COs ↓	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	1	2	2	1	1	1
CO2	3	3	2	3	3	-	1	1	-	1	-	-
CO3	3	2	3	2	2	-	1	-	1	1	1	-
CO4	3	3	3	2	1	2	2	-	1	1	1	-
CO5	3	3	3	3	2	3	-	-	2	1	1	1

Content (CO wise)

Application of Electronics in various applications and various fields of engineering. Electronic devices: active, passive, and interconnects. Classification of circuits Digital, Analog RF. Typical VLSI devices, Processor and Memories

VLSI fabrication technology, Miniaturization of devices, Foundry concept, the economy of the batch fabrication. Concepts of yield and reliability The figure of merit of VLSI devices, Area. Power, Delay,

Overview of VLSI design flow, EDA tools, synthesis, placement, routing, layout. Design optimization. Design rules, IP Design Methodology, SoC Physical Design Methodology Design for Testability (DFT), Design-for-Manufacturability (DFM)

Design implementation, Logic synthesis, RTL modeling, and simulation. Electronic circuits modeling and simulation by using SPICE. CMOS circuits' inverters, and design of basic gates.

Examples and Hands-on experiments with RTL simulation circuit simulation.

Design validation, functional testing, formal verification Physical Design Verification, Design Rule Checking (DRC) Layout-Versus-Schematic (LVS) Verification, Electrical Rule Checking (ERC), Lithography Process Checking (LPC), DRC Waivers

Text Books

1. Neil H. E. Weste and David Money Harris, CMOS VLSI design: A Circuits and Systems Perspective, Pearson Publications, 2010
2. Thomas Dillinger, VLSI Design Methodology development, Pearson Publications

Reference Books

1. Jan M. Rabaey, Digital Integrated Circuits: A design perspective, Pearson Publications 2016

Centre for VLSI and Nanotechnology

B.Tech. Minor VLSI Design Course Book

Course Name: ENL 303 – CMOS Digital Circuits Design

Prerequisites: Nil

Offered in: Even Semester (4th Semester)

Scheme and Credit: [(3-0-2); Credits: 4]

Type of Course: Elective

Course Theory Assessment: Midsem Exam (30%), Internal assessment through Assignments /Seminar /Quizzes (20%), End Semester Exam (50%).

Course Outcomes

Students will

1. Be able understand fundamentals of CMOS Digital Circuits
2. Be able to do the SPICE circuit simulations required for the IC Designs.
3. Be able to link knowledge of CAD tools with the digital circuits
4. Have the ability to formulate problems, problem solving skills on CMOS.
5. Be able to familiar with the CMOS logic gates and design styles.

Relationship of Course Objectives to Program outcomes:

POs → / COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	1	2	2	1	1	1
CO2	3	3	2	3	3	-	1	1	-	1	-	1
CO3	3	2	2	2	2	-	1	-	1	1	1	-
CO4	3	3	3	3	1	2	2	-	1	1	1	-
CO5	3	3	3	3	2	3	-	-	2	1	1	1

Content (CO wise)

Review of MOS transistor models, Non-ideal behavior of the MOS Transistor.

Transistor as a switch. Inverter characteristics. Integrated Circuit Layout: Design Rules, Parasitics.

Combinational Circuit Design: CMOS logic families including static, dynamic and dual rail logic.

Sequential Circuit Design: Static circuits. Design of latches and Flip-flops.

Delay: RC Delay model, linear delay model, logical path efforts.

Role of HDL in CMOS digital circuits design

Laboratory: Practical Based on SPICE simulation of the above Syllabus. Circuit Simulation: SPICE, Device characterization, Circuit Characterization.

Text Books

1. N.H.E. Weste and D.M. Harris, CMOS VLSI design: A Circuits and Systems Perspective, 4th Edition, Pearson Education India, 2011.

Reference Books

1. C. Mead and L. Conway, Introduction to VLSI Systems, Addison Wesley,1979.
2. J. Rabaey, Digital Integrated Circuits: A Design Perspective, Prentice Hall India, 1997.
3. P. Douglas, VHDL: programming by example, McGraw Hill, 2013

Centre for VLSI and Nanotechnology

B.Tech. Minor VLSI Design Course Book

Course Name: ENL304 – Device Physics

Prerequisites: Nil

Offered in: Odd Semester (5^{th} Semester)

Scheme and Credit: [(3-0-2); Credits: 4]

Type of Course: Elective

Course Theory Assessment: Midsem Exam (30%), Internal assessment through Assignments /Seminar /Quizzes (20%), End Semester Exam (50%).

Course Outcomes

Students will

1. Be able understand basic device physics required for the device modeling.
2. Be familiar with the MOS device structures.
3. Be able to link knowledge of device physics with the CMOS circuits.
4. Have the ability to formulate problems, problem solving skills.
5. Be able to formulate the device models for the ICs

Relationship of Course Objectives to Program outcomes:

POs → COs ↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	1	2	2	1	1	1
CO2	3	3	2	3	3	-	1	1	-	1	-	-
CO3	3	2	3	2	2	-	1	-	1	1	1	-
CO4	3	3	3	2	1	2	2	-	1	1	1	-
CO5	3	3	3	3	2	3	-	-	2	1	1	1

Content (CO wise)

Introduction to Semiconductor Physics, Review of Quantum Mechanics, Electrons in periodic Lattices, E-k diagrams

Boltzmann transport equation. Carrier statistics; Continuity equation, Poisson's equation and its solution; High field effects Semiconductor junctions:

Semiconductor junctions p-n junction models. Schottky, Homo- and Hetero-junction band diagrams and I-V characteristics, and small signal switching models;

MOS structures: Semiconductor surfaces; The ideal and non-ideal MOS capacitor band diagrams and CVs; Effects of oxide charges, defects and interface states; Characterization of MOS capacitors: HF and LF CVs,

The MOS transistor: Pao-Sah and Brews models; Short channel effects in MOS transistors. Circuit models of deep submicron transistor.

The bipolar transistor, Ebbers Moll model.

Laboratory: Practicals based on theory

Text Books

1. B. G. Streetman, and S. K. Banerjee, Solid State Electronic Devices, 7th edition, Pearson, 2014.

Reference Books

1. C.T. Sah, Fundamentals of solid state electronics, World Scientific Publishing Co Inc, 1991.
2. Y. Tsividis and M. Colin, Operation and Modeling of the MOS Transistor. Oxford Univ. Press, 2011
3. S. M. Sze and K. N. Kwok, Physics of Semiconductor Devices, 3rd edition, John Wiley & Sons, 2006.

Centre for VLSI and Nanotechnology

B.Tech. Minor VLSI Design Course Book

Course Name: ENL 401 –CMOS Analog Circuits Design

Prerequisites: Nil

Offered in: Even Semester (6th Semester)

Scheme and Credit: [(3-0-2); Credits: 4

Type of Course: Elective

Course Theory Assessment: Midsem Exam (30%), Internal assessment through Assignments /Seminar /Quizzes (20%), End Semester Exam (50%).

Course Outcomes

Students will

1. Be able to understand Frequency response, stability and noise issues in Analog Circuits.
2. Be able to do the implementation of linear and non – linear analog blocks implementation and their testing.
3. Be able to link knowledge of CAD tools with the analog circuits
4. Have the ability to formulate problems, problem solving skills on CMOS analog circuits.
5. Be able to familiar with the Analog CMOS logic circuit design styles.

Relationship of Course Objectives to Program outcomes:

POs → COs ↓	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	3	3	1	2	2	1	1	1
CO2	3	3	2	3	3	-	1	1	-	1	-	-
CO3	3	2	3	2	2	-	1	-	1	1	1	-
CO4	3	3	3	2	1	2	2	-	1	1	1	-
CO5	3	3	3	3	2	3	-	-	2	1	1	1

Content (CO wise)

Overview of noise in analog circuits. Basic analog MOS models, SPICE Models and frequency dependent parameters.

Current Mirrors: Current matching, temperature behavior, cascade current mirror.

Short channel Current Mirror design. Voltage references.

Single Stage Amplifier: Common Source amplifiers, Source follower, Current Source loads, Cascode Amplifier, level shifter. Output stage Class AB and Push-Pull amplifier. Frequency response and stability considerations.

Differential Amplifier: Source coupled pair. Source cross-coupled pair. Cascode loads. Wide swing differential amplifiers.

Operational Amplifiers: Two stage OA. Output buffer. OTA.

Data Converter fundamentals. DAC, ADC topology.

Laboratory: Practical Based on theory

Text Books

1. R. Jacob Baker, CMOS Circuit Design, Layout and Simulation, 4th edition Wiley, 2005.

Reference Books

1. P.R. Gray and R.G. Meyer, Analysis and design of Analog Integrated circuits, 3rd Edition, John Wiley and Sons, 1993.
2. B. Razavi, Design of Analog CMOS Integrated Circuits, Prentice-Hall,1998