ELE4211 VLSIC DESIGN & FABRICATION

Hours per Semester				Weighted Total Mark	Weighted Exam Mark	Weighted Continuous Assessment Mark	Credit Units
LH	PH	TH	CH	WTM	WEM	WCM	CU
45	30	00	60	100	60	40	4

Rationale

The course introduces the concepts and physical procedures involved in the design, integration and manufacture of semiconductor devices and circuits. The course teaches fundamental design principles and simulations of hands-on experience in fabricating integrated circuits based on silicon technology but extendable to other materials. By the end of the course, the students should understand the broad aspects of semiconductor processing for integrated circuits and various junction devices, including testing and evaluation, concepts of yield, lab procedures including safety, assembly and packaging.

Course Objectives

By the end of the course students should be able to:

- Be conversant with the terminology and theory involved in the design and fabrication of semiconductor devices.
- Know the processes for the design, large scale integration and manufacture of semiconductor devices.

Detailed Course Content:

Terminology: [12 Hours]

wafers, masks and photolithography; Diffusion; Dopants, and metals. Integrated n-channel, silicon-gate MOSFET; A CMOS transistor pair design; Bipolar technologies: npn epitaxial silicon bipolar transistor; Schottky diodes; resistors;

Large-scale integration (LSI): [33 Hours]

MOSFET gate-array USIC; Fabrication processes: silicon diode growth by dry oxidation; ion implantation; forming the poly-silicon gates; insulation; and contact windows; metal removal by reactive ion itching (RIE); and wire bonding. Very large-scale Integration: Advantages of integration and problems associated with integrated circuits.

Learning Outcomes

- Identify some contributors to VLSI and ASIC design and relate their achievements to the knowledge area.
- Define a semiconductor.
- Explain the difference between MOS and CMOS transistors.
- Define a sequential circuit.
- Identify some memory devices related to VLSI circuits.
- Define the meaning of a chip.
- Give an example of an ASIC chip design.
- Describe how computer engineering uses or benefits from VLSI and ASIC design.
- Understand the current carrying mechanism and the I/V characteristics of intrinsic and doped semiconductor materials.
- Understand how these quantities reflect the ability of the inverter to operate in the presence of noise.
- Understand how changing the configuration of the inverter and the MOSFETS that make it up changes the VTC and thus the inverter's operation.
- Understand the method to perform circuit design for CMOS logic gates.
- Understand the techniques, such as Euler paths and stick diagrams, used to optimize the layout of CMOS logic circuits.
- Understand how the size for each transistor in a CMOS logic gate can be determined.

- Understand how to use charge storage (capacitance) and feedback to store values in CMOS logic.
- Understand the circuit design, functionality, advantages, and disadvantages of dynamic latches in CMOS.
- Understand how we organize memory systems and why we do not typically organize them in the most simplistic arrangement such as in a one-dimensional word array.
- Understand the basic steps of photolithography, its limitations, and how that determines minimum line width and device sizes.
- Understand the processing steps required for fabrication of CMOS devises and the general results of each step.

Method of Teaching /Delivery
The course will be taught by using lectures, tutorials and assignments.

Mode of Assessment
Assignments, tests and final examination. Their relative contributions to the final grade are :

Requirement	Percentage contribution
Course work (Assignments, tests)	40%
Final examination	60%
Total	100%

Recommended Books and References

[1] David A. Hodges, Horace G. Jackson, and Resve A. Saleh, *Analysis and Design of Digital Integrated Circuits*, Third Edition, , McGraw-Hill, 2004.
[2] Jan M. Rabaey, Anantha P. Chandrakasan, and Borivoje Nikolic, *Digital Integrated Circuits*, Second Edition, Prentice-Hall, 2002.
[3] Neil H. E. Weste and Kamran Eshraghian, *Principles of CMOS VLSI Design*, Second Edition, Addison Wesley, 1993.
[4] Neil H. E. Weste and David Harris, *Principles of CMOS VLSI Design*, Third Edition, Addison Wesley, 2004.
[5] Sung-Mo (Steve) Kang and Yusuf Leblebici *CMOS Digital Integrated Circuits Analysis and Design*, Third Edition, , McGraw-Hill, 2002.
[6] David A. Johns and Ken Martin, *Analog Integrated Circuit Design*, Wiley, 1997.
[7] *Roubik Gregorian,* Introduction to CMOS Op-Amps and Comparators, *Wiley, 1999.*
[8] R. Jacob Baker,CMOS; *Circuit Design, Layout, and Simulation*, Revised Second Edition, Wiley- IEEE Press, 2008.
[9] R. Jacob Baker, *CMOS Mixed-Signal Circuit Design*, Second EditionWiley-IEEE Press, 2009.
[10] Adel S. Sedra, Kenneth C. Smith, *Microelectronic Circuits*, Fifth Edition, Oxford University Press, 2003.
[11] R. L. Geiger, P. E. Allen, and N. R. Strader, *VLSI Design Techniques for Analog and Digital Circuits*, McGraw-Hill, 1990.
[12] *John P. Uyemura, Brooks/Cole,* Physical Design of CMOS Integrated Circuits Using L-Edit, *1995.*
[13] Clein, Newnes, *CMOS IC Layout*, Dan, 2000.
[14] Ron Kielkowski, Inside *SPICE: Overcoming the Obstacles of Circuit Simulation*, Second Edition, McGraw-Hill, Inc., 1998. ISBN 0-07-913712-1
[15] Daniel Foty, *MOSFET Modeling with SPICE*, Prentice Hall, 1997.
[16] *Yannis P. Tsividis,* Operation and Modeling of the MOS Transistor, *McGraw-Hill, 1987.*
[17] Ben Streetman, Sanyay Banerjee, *Solid State Electronic Devices*, Fifth Edition, Prentice Hall, 2000.
[18] James D. Plummer, Michael D. Deal, Peter B. Griffin, *Silicon VLSI Technology*, Prentice Hall, 2000.