Approval: 5th Senate Meeting

Course Name : VLSI Technology
Course Number : EE-611
Credits : 3-0-0-3
Intended for 4th year B. Tech. (EE) and MS, Ph.D.
Prerequisites : EE 160 Applied Electronics, EE 208P Digital System Design Practicum, Semiconductor devices or Instructors consent
Core or Elective : Elective
Semester : Even/Odd

Preamble: VLSI Technology course designed to build up the in depth understanding among the B.Tech students and MS Ph.D. scholars about the VLSI state of art Technology. This course consists the class lectures based on advanced device fabrication technology which also includes the hands-on assignments of future device structures in the Nanoelectronics and VLSI Technology Lab. The major goal of this course is to make the students familiarized with device fabrications and demonstrate the basic concepts of device fabrications such as Clean room, Vacuum technology, thin films deposition by physically and chemically etc. Additionally, to illustrate the students the concepts discussed in the class room teaching and to give an opportunity to build, feel and test real systems in the lab. In addition to this, class room discussion with regard to advanced lithography, MOS, MOSFET, CMOS device fabrication and characterization also included. Moreover, the application orientated devices such as MEMS, Bio sensors will also be fabricated by the students and scholar in the nanoelectronics and VLSI technology lab. As summarized, the objective of this course is to provide an understanding of microelectronics fabrication processing technologies**.**

Course Outline:

Unit 1: Vacuum Technology No. of Lectures 5

Principles of vacuum pumps in range of 10^{-2}torr to 10^{-11}torr, principle of different vacuum pumps, roots pump, rotary, diffusion, turbo molecular pump, cryogenic-pump, ion pump, Ti-sub limitation pump, importance of measurement of vacuum, Concept of different gauges, bayet- albert gauge, pirani, penning, pressure control.

Unit 2: Conditions for the Formation of Thin Films No. of Lectures 5

Environment for thin film deposition, deposition parameters and their effects on film growth, formation of thin films (sticking coefficient, formation of thermodynamically stable cluster – theory of nucleation), capillarity theory, microstructure in thin films, adhesion, properties of thin films, Mechanical, electrical, and optical properties of thin films, few applications of thin films in various fields, Quartz crystal thickness for measurement of film thickness

Unit 3 Physical Vapor Deposition Electrical Discharges for Thin Film Deposition No. of Lectures 8

Thermal evaporation, resistive evaporation, Electron beam evaporation, Laser ablation, Flash and Cathodic arc deposition, Sputtering, Glow discharge sputtering, Magnetron sputtering, Ion beam sputtering, Ion plating, oxidizing and Nitriding, Atomic layer deposition (ALD), Importance of ALD technique, Atomic layer growth, Physics and technology.

Unit 4 Chemical Vapor Deposition Techniques No. of Lectures 8

Advantages and disadvantages of Chemical Vapor deposition (CVD) techniques over PVD techniques, reaction types, boundaries and flow, Different kinds of CVD techniques: Metallorganic CVD (MOCVD), Thermally activated CVD, Spray pyrolysis, etc.

Unit 5 Lithography and Pattern Transfer No. of Lectures 8

Overview of Lithography, Optics of Lithography: Metrics, Optics of Micro-Lithography, Aligners, Photomasks, Photoresists, Components of Photoresist, Metrics, Photoresist processing, Multi-layer resist, positive, negative and image reversal, Advanced Lithography: E-beam Lithography, Soft Lithography, Etch verses Lift Off.Basic Concepts of Etching,Wet Etching, Specific Wet Etches : Silicon, Silicon Dioxide, Aluminum, Dry (Plasma) Etch etc.

Unit 6 MEMS and CMOS Manufacturing Technologies No. of Lectures 8

Anisotropic Etching, Description of the Process and Testing, Bulk Micromachining :DRIE-Based, Wet Processes, Surface Micromachining, Wafer Bonding, Introduction of Front end (Fusion Bonding), Back end (Anodic Bonding), Plastic Processes,Molding,Embossing,LIGA , interconnects, CMOS process etc.

Mini-project: The students will also carry out a mini-project involving the exposure of lab work. The aim of this project will be to understand, solve and implement solutions to real world problems.

Reference Books:

1. S. Franssila Introduction to Microfabrication Wiley 2010 (2nd ed.) ISBN 978-0-470-74983-8.
2. James D. Plummer, Michael D. Deal and Peter B. Griffin, Silicon VLSI Technology: Fundamentals, Practice and Modeling, Prentice Hall, Upper Saddle River, New Jersey,2000,ISBN 0-13-0850037-3.
3. Richard C. Jaeger, Introduction to Microelectronic Fabrication, Prentice Hall, 2002. (2nd ed.) ISBN 0-201-44494-1.
4. Gary S. May, Simon M. Sze, Fundamentals of Semiconductor Fabrication, Wiley, 2004.
5. Methods of Experimental Physics (Vol 14) by G.L.Weissler and R.W. Carlson Vacuum Physics and Technology"
6. Vacuum Physics and Techniques by T.A. Delchar, Chapman and Hall
7. Evaporation: Nucleation and Growth Kinetics" by J.P. Hirth and G.M.Pound, MEMS Manufacturing Technologies Pergamon Press