7. S. Wolf and R.F.M. Smith, Student Reference Manual for Electronic Instrumentation Laboratories, Pearson Education (2004).
8. David A. Bell, Electronic Instrumentation and Measurements, Prentice Hall of India, 2nd edition.

Suggestive readings

1. H & H: The Art of Electronics, by Paul Horowitz & Winfield Hill (2nd Edition).
2. U.A. Bakshi and A.V. Bakshi, Electronic Measurements and Instrumentation, Technical Publications.
3. Joseph J Carr, Elements of electronic instrumentation and measurement, Pearson Education (2005).
4. C.S. Rangan, G.R. Sarma and V.S. Mani, Instrumentation Devices and Systems, Tata McGraw Hill (1998).

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time

DISCIPLINE SPECIFIC ELECTIVE COURSE : VLSI Fabrication Technology (INDSE7D)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
VLSI Fabrication Technology (INDSE7D)	04	03	-	01	Course admission eligibility	semiconductor devices

Learning Objectives

The Learning Objectives of this course are as follows:

- Understanding of Semiconductor Materials and Properties.
- Understanding of Cleanroom Practices and Safety Protocols.
- Understanding the principles of photolithography, Etching and Thin-Film Deposition.
- Analyze Ion Implantation and Annealing.
- Describe Oxidation and Annealing and explore Chemical Mechanical Polishing (CMP).

Learning Outcomes

After successful completion of the course, students will be able to:

- Follow cleanroom practices and safety protocols in a controlled laboratory or cleanroom environment.
- Explain the principles of photolithography and how it is used in semiconductor fabrication.
- Perform or simulate basic etching and thin-film deposition processes.
- Describe ion implantation, annealing, and oxidation processes in semiconductor manufacturing.
- Construct process flows for specific semiconductor manufacturing steps, including process integration.

SYLLABUS OF DSE

UNIT – I **(07 hours)**

Introduction to VLSI Technology: Evolution from early transistors to integrated circuits, Moore's Law in driving the miniaturization of devices. Overview of the semiconductor industry.

Cleanroom Practices and Safety: Cleanroom protocols and contamination control, Safety measures in a cleanroom environment.

UNIT – II **(15 hours)**

Lithography: Photolithography fundamentals, Step-by-step lithography process, Advanced lithography techniques (e.g., EUV). **Etching and Film Deposition:** Chemical and physical etching processes, Thin-film deposition techniques (CVD, PVD, ALD), Plasma processing.

UNIT-III **(15 hours)**

Ion Implantation: Introduction to ion implantation, Doping profiles, and implantation techniques. **Oxidation and Annealing:** Thermal oxidation of silicon, Annealing processes for activation and diffusion.

UNIT – IV **(08 hours)**

Wafer Fabrication Steps: Wafer cleaning and preparation, Photomask and reticle fabrication, Pattern transfer processes, Advanced Process Integration, Multiple patterning and self-alignment techniques. Process flow for CMOS technology.

Practical component (TCAD Software/Virtual Labs/ Hardware) **(30 hours)**

1. Demonstration of semiconductor fabrication facility or cleanroom to observe the cleanroom environment, equipment, and safety protocols.
2. Virtual Fabrication of a P-N Junction Diode.

3. Virtual Fabrication of a NPN Transistor.
4. Virtual Fabrication of PNP Transistor.
5. Virtual Fabrication of N-channel MOSFET.
6. Virtual Fabrication of P-channel MOSFET.
7. Virtual Fabrication of a Silicon Photovoltaic (Solar) Cell.
8. Industry visit

Essential/recommended readings

1. "Introduction to Microfabrication" by Sami Franssila 2nd Edition, published in November 2010 by Wiley.
2. S.K.Gandhi, VLSI Fabrication principles,2nd Edition, published in April 1994 by Wiley-VCH
3. S.M. Sze, VLSI Technology, 2nd Edition, published in July 2017 by McGraw Hill Education
4. W.R. Runyan, Silicon Semiconductor Technology, 2nd Edition, published in 1990 by McGraw Hill.
5. P.Van Zant, Microchip Fabrication, A Practical Guide to Semiconductor Processing, 6th Edition, published in January 2014 by McGraw Hill.

Suggestive readings

1. BenG. Streetman, Solid State Electronic Devices, Prentice Hall.
2. "Microchip Fabrication: A Practical Guide to Semiconductor Processing" by Peter Van Zant
3. "Fundamentals of Semiconductor Manufacturing and Process Control" by Gary S. May and Costas J. Spanos
4. "Advanced Semiconductor Fundamentals" by Robert F. Pierret
5. "Semiconductor Manufacturing Technology" by Michael Quirk and Julian Serda
6. "Semiconductor Devices: Physics and Technology" by Simon M. Sze and Kwok K.Ng
7. "Process Technology for VLSI and ULSI" by C. Y. Chang and S. M. Sze

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC ELECTIVE – : Measurement Technology (INDSE7E)

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Measurement Technology (INDSE7E)	04	03	-	01	Course admission eligibility	Industrial instruments