DISCIPLINE SPECIFIC CORE COURSE – 18: Semiconductor Device Technology

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		
Semiconductor Device Technology	4	3	-	1	Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices	Semi-conductor Devices (DSC 3, Sem I)

Learning Objectives

The Learning Objectives of this course are as follows:

- The course deals with properties of materials required for Semiconductor Devices
- It deals with various processing steps
- It gives an account of how the Semiconductor Devices are fabricated (with details of all processes involved)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Summarize the developments in the field of microelectronics technologies
- Describe the crystal growth, diffusion, oxidation, lithography, etching and various film deposition processes.
- Explain the process sequence for PN junction, BJT, CMOS and BiCMOS fabrication

SYLLABUS OF ELDSC-18 Total Hours- Theory: 45 Hours, Practicals: 30 Hours

UNIT – I (11 Hours)

Semiconductor materials: Single crystal, polycrystalline and amorphous forms. Properties of Silicon and Gallium Arsenide. Materials used for doping Silicon and Gallium Arsenide

Crystal growth techniques: Starting material (SiO_2), MGS, EGS, Growth of bulk Silicon single crystals using Czochralski (CZ) technique, Doping while crystal growth (Distribution of dopants, Effective Segregation Coefficient), Float Zone (FZ) technique, GaAs bulk single crystal growth by LEC technique, Bridgman-Stockbarger technique.
Wafer Cleaning Technology : Basic Concepts, Wet cleaning, Dry cleaning

UNIT – II (12 Hours)
Epitaxy Deposition: Vapor-Phase Epitaxy, Molecular Beam Epitaxy, Growth of GaAs films by MOCVD.
Oxidation: Importance of Silicon Dioxide in Silicon, Thermal Oxidation Process, Kinetics of Growth for thick and thin Oxide, Dry and Wet oxidation. Effects of high pressure and impurities on oxidation rates, Impurity redistribution during Oxidation, Oxide Quality, Chemical vapour deposition of silicon oxide, properties of silicon oxide, step coverage, P-glass flow

UNIT – III (11 Hours)
Diffusion: Thermal Diffusion, Diffusion Equation, Diffusion Profiles. Extrinsic Diffusion Concentration Dependent Diffusivity, Lateral Diffusion, Doping through Ion Implantation, and its comparison with Thermal Diffusion.
Lithography: Clean room, Optical Lithography, Electron beam lithography, Photoresist, Photo masks, Wet Chemical Etching, Common etchants

UNIT – IV (11 Hours)
Metallization: Filament evaporation, e-beam evaporation, sputtering techniques used for metals (Aluminium, Gold, Copper etc..) deposition on Silicon and GaAs
Process Integration (IC): Isolation techniques. Fabrication of Monolithic Resistor, Inductor, Capacitor. PN junction, BJT, NMOS, PMOS, CMOS structures.
Concept of Bipolar Technology and MOSFET Technology for Devices

Practical component (if any) – Semiconductor Device Technology
(Scilab/MATLAB/other Simulation Software)

Learning outcomes

The Learning Outcomes of this course are as follows:

- Operate the advanced computer simulations tools as well as visit research laboratories for better understanding of semiconductor fabrications processes.
- Perform the simulation of semiconductor crystal growth and device fabrication processes like oxidation and diffusion.
- Perform experiments to calculate the electronic parameters like resistivity, mobility, carrier concentration and band gap etc in semiconductors.
- Operate the deposition system for fabrications of thin films

LIST OF PRACTICALS (Total Practical Hours- 30 Hours)

1. To measure the resistivity of semiconductor crystal with temperature by four –probe method.

2. To determine the type (n or p) and mobility of semiconductor material using Hall effect.
3. CZ technique Simulation
4. Float zone technique Simulation
5. Oxidation process Simulation
6. Diffusion Process Simulation
7. To design a pattern using photolithographic process and its simulation
8. Process integration simulation
9. Determination of Optical Bandgap through transmission spectra.
10. Visit to Research Lab/institutions to see the live demonstrations of the processes and preparation of a report.

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than nine.

Essential/recommended readings

1. Gary S.May and S.M.Sze , Fundamentals of Semiconductor Fabrication, John Wiley& Sons(2004)

Suggestive readings

3. Ludmila Eckertova, Physics of Thin films, 2nd Edition, Plenum Press (1986).

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