



SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

P.G. Diploma in Semiconductor Science and Technology Semester-II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	PGD02CSST01	Advanced Semiconductor Devices, Packaging and PCB Design	4-0-0	120	04

• Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Analyze the operational principles and characteristics of advanced field-effect transistors and MOS technologies.

CLO2: Evaluate the construction, switching characteristics, and control mechanisms of power semiconductor devices for applications in industrial and renewable energy systems.

CLO3: Examine the fundamentals of electronic systems packaging and its applications in a smartphone.

CLO4: Analyze the heat transfer mechanism under the thermal management of a packaged device.

CLO5: Design and validate comprehensive PCB layouts by applying routing guidelines, mechanical and electrical considerations and Design Rule Checking (DRC) to generate manufacturing-ready Gerber files.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Advanced Semiconductor Devices Field-Effect Transistors: Limitations of BJT, advantages of FET, Fundamentals of JFET and MESFET, I-V characteristics, Important Device Parameters of FETs, MOSCAP: Accumulation, Depletion and Inversion, Capacitance-Voltage (C-V) Characteristics of MOSCAP, CMOS, MOSFET Structures and Operation: Depletion-Mode and Enhancement-Mode MOSFETs, Transfer characteristics of MOSFET, MODFET, Important Device Parameters of FETs, Numerical Examples, Advanced MOS Technologies.	CL, ICT, SDL	CLO1
II	Power Semiconductor Devices and Applications Introduction, Scope and Application to Power Electronics, Fundamentals of Power Electronic Systems and Its Historical Evolution, Classification of Power Converters and Their Applications, Construction and Characteristics of Thyristors, Construction and Applications of a Power MOSFET, IGBT, IGCT and GTO, Comparative Analysis of Various Controllable Switches, Applications of Power Electronic Devices: Electric Vehicles (EVs), Renewable Energy Systems (Solar And Wind Inverters), Industrial Motor Drives.	CL, CBL, IBL	CLO2



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III	Fundamentals of Packaging Anatomy of an Electronic Packaged System from a Packaging Point of View, Fundamentals of Packaging, Systems Packaging Involving Electrical, Mechanical and Materials Technologies, Nomenclature, Devices and Moore's Law, Electrical Anatomy of a Package, Fundamentals of Electrical Package Design, Anatomy of a Thermal Package System, Fundamentals of Heat Transfer, Anatomy of a Smartphone and Smartphone Packaging Technologies.	CL, SM, ROL	CLO3, CLO4
IV	PCB Design and Technology PCB Advantages, Electronic Components, Surface Mount Devices (SMD), Classification of PCB (single, double, multilayer, flexible boards), PCB Manufacturing Process, PCB Standards, Schematic Diagram, Mechanical and Electrical Design Considerations, Component Placement and Mounting, Routing Guidelines, Netlist Generation, Tracks, Pads, Vias, Grounding and Power Planes, Design Rule Checking (DRC), Gerber and Drill Files, Footprints and Libraries, Copper-Clad Laminates and their Properties, Soldering Techniques, Etching and Plating Techniques, PCB Testing and Quality Control, PCB Prototyping Machines, Auto Routing, Recent Trends and Environmental Concerns	CL, MPR, ICT, EL	CLO5

(*) Learning Pedagogies/Methods

- CL: Classroom Lecture
- SM: Seminars (Student-led and Faculty-moderated)
- CBL: Case-Based Learning
- MPR: Micro-Projects/Mini Research Tasks
- Visit: Industrial Visit/Field Visit/Institutional Visit
- PBL: Problem-Based Learning
- ROL: Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
- COL: Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
- EL: Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
- SRP: Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
- ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- RP: Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- IBL: Inquiry-Based Learning
- SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

• Assessment Methodologies

(A) Internal Assessment [Total: 50 Marks]

a. Internal Formative assessment

- Assignment
- Seminars
- Class Regularity



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b. Internal Summative Assessment

- (a) Quizzes
- (b) Mid-term tests

(B) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1	30	3	4	5	12
II	CLO2	30	2	5	5	12
III	CLO3, CLO4	30	2	5	6	13
IV	CLO5	30	2	6	5	13
		120	09	20	21	50

• Assessment and Evaluation

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Mid-term tests, Seminars, Assignments, Quizzes, Class Regularity	50
2	End-Semester Examination	Written Exam Project Evaluation (Report, Presentation, Viva)	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	3	2	1	2	2	-	-	-	-
CLO2	3	1	2	1	3	1	-	-	-	-
CLO3	1	-	1	-	-	1	-	-	-	-
CLO4	2	1	3	1	2	-	-	-	-	-
CLO5	1	2	-	3	1	-	1	-	-	-

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-



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• Suggested Learning Materials Books:

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Semiconductor Devices: Basic Principles	Jasprit Singh	1st Ed. (2001)	John Wiley & Sons
2	Semiconductor Devices - An Introduction	Jasprit Singh	1994	McGraw-Hill Inc.
3	Physics of Semiconductors and their Heterostructures	Jasprit Singh	1993	McGraw-Hill Inc.
4	Electronic Devices and Components	J. Seymore	1989	Longman Scientific & Technical
5	Power Electronics: Devices, Circuits, and Applications	Muhammad H. Rashid	4th Ed. (2013)	Pearson / Prentice Hall
6	Power Electronics: Converters, Applications, and Design	Ned Mohan, Tore M. Undeland	2nd Ed. (2003)	Wiley
7	Fundamentals of Power Semiconductor Devices	B. Jayant Baliga	2019	Springer
8	Power Electronics Semiconductor Devices	Robert Perret	2009	Wiley
9	Principles of Electronics	V. K. Mehta, Rohit Mehta	12th Ed. (2020)	S. Chand Publication
10	Fundamentals of Device and Systems Packaging: Technologies and Applications	Rao R. Tummala	2nd Ed. (2020)	McGraw Hill
11	Semiconductor Packaging: Materials Interaction and Reliability	Chen, Andrea	1 st Ed. (2016)	McGraw-Hill Education
12	Semiconductor Advanced Packaging	John H. Lau	1st Ed. (2021)	Springer
13	Printed Circuit Board – Design & Technology	Walter C. Bosshart	2008	Tata McGraw Hill
14	Printed Circuit Board –Design, Fabrication, Assembly & Testing	R.S. Khandpur	1 st Ed. (2005)	Tata McGraw-Hill Education Pvt. Ltd.
15	Printed Circuit Board Design Using Autocad	Chris Schroeder	1998	Newnes Publisher
16	Printed Circuits Handbook	Clyde F. Coombs, Jr, Happy T. Holden	6 th Ed. (2016)	McGraw-Hill Education



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• Online Resources (Open Source)

Sr.No.	Description of Resource(s)	Weblink
1	A Google Sites page with resources on advanced semiconductor technology.	https://sites.google.com/view/advancedsemiconductors
2	NPTEL course on High-Speed Devices and Circuits with focus on heterojunctions	https://archive.nptel.ac.in/courses/117/106/117106089/
3	NPTEL lectures on MESFETs: I-V characteristics and velocity-field relation	https://archive.nptel.ac.in/courses/117/106/117106089/
4	Video lecture explaining MODFET (HEMT) fundamentals and operation	https://www.youtube.com/watch?v=FHGopzr64XY
5	Video lecture on MOSFET operation and characteristics	http://www.youtube.com/watch?v=MUBiC9yz2fc
6	NPTEL course covering MOSCAP concepts and C-V characteristics	https://archive.nptel.ac.in/courses/108/106/108106181/
7	NPTEL course on High-Speed Devices and Circuits with focus on heterojunctions	https://archive.nptel.ac.in/courses/117/106/117106089/
8	NPTEL courses on Power Electronics covering devices, converters and applications	https://nptel.ac.in/courses/108102145
9	NPTEL Course on Electronic Packaging and Manufacturing.	https://onlinecourses.nptel.ac.in/noc22_me61/preview
10	NPTEL Course on An Introduction to Electronics Systems Packaging	https://nptel.ac.in/courses/108108031
11	NPTEL Course on Electronic Systems Design: Hands-on Circuits and PCB Design with CAD Software.	https://nptel.ac.in/courses/108102481



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	PGD02CSST02	Semiconductor Manufacturing and Characterization Technologies	4-0-0	120	04

• Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

- CLO1: Evaluate fundamental vacuum science principles, encompassing the operation of rotary and diffusion pumps, ionization gauges and helium leak detection methodologies critical to process environments.
- CLO2: Analyze physical, chemical, and solution-processed thin film deposition techniques including PVD, CVD and Liquid Phase Exfoliation to determine their efficacy in semiconductor fabrication.
- CLO3: Examine growth of crystals by various processes such as Czochralski, Bridgeman, Direct Vapour Transport (DVT) and Chemical Vapour Transport (CVT) techniques followed by wafer shaping.
- CLO4: Apply advanced electron microscopy and spectroscopy techniques such as SEM, TEM, XRD, and Raman Spectroscopy to characterize the structural integrity and elemental composition of synthesized materials.
- CLO5: Evaluate vacuum measurement protocols and to understand how parameters affects the vacuum conditions.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Generation and Measurement of Vacuum Complete Vacuum System, History of Pump and Gauge Manufacturing in India, Fundamentals of Vacuum Science and Ranges, Vacuum Pumps, Classification of Vacuum Pumps: Rotary Pump, Diffusion Pump, Molecular Drag Pump, Gettering and Ion Pumping, Sputter Ion Pump, Measurement of Pumping Speed, Classification of Gauges: McLeod Gauge, Thermal Conductivity Gauge, Hot Cathode Ionization Gauge, Bayard-Alpert Gauge, Cold Cathode Ionization Gauge, Penning Gauge, Magnetron Gauge. Introduction of Vacuum Leak and its measurement methods, Preventing Leaks in Semiconductor Process Systems.	CL, SDL, Visit	CLO1, CLO5
II	Thin Film Deposition Techniques Coatings in Ancient India and their Applications, Spin Coating for Photoresist Deposition, Physical Vapour Deposition (PVD) and Chemical Vapour deposition (CVD), Thermal Evaporation, Flash Evaporation, Sputtering: DC, Radio Frequency and Magnetron Sputtering, E-Beam Deposition Method, Pulsed Laser Deposition (PLD), Atomic Layer Deposition (ALD), Epitaxial Method: Molecular Beam Epitaxy (MBE). Solution processed deposition techniques: Electrodeposition, Electrophoresis method.	CL, SM, ROL	CLO2



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III	Crystal Growth and defect Metal Casting in Ancient India, Concept of Solid, Introduction to Crystal Structures, Material classification based on Structure: Amorphous, Polycrystalline and Single-Crystalline Materials, Crystal Growth: Silicon Crystal Growth from Melt: Starting Material, The Czochralski Technique, Dopant Distribution and Effective Segregation Coefficient, Silicon Float-Zone Process, GaAs: Starting Materials and Crystal Growth Techniques, 2D materials Growth: Direct vapour transport (DVT) and chemical vapour transport (CVT) techniques, Introduction and Importance of Defects in Solids, Types of Defects, Dislocation and Stacking Faults in crystal, EDA tools for crystal growth, Wafer shaping.	CL, ICT, IBL	CLO3
IV	Characterization Techniques: Life and Work of Sir C. V. Raman, Electron Microscopy: Scanning electron microscopy (SEM), Transmission Electron Microscopy (TEM), Energy Dispersive Analysis by X-ray (EDAX), Electron Beam-Induced Current (EBIC), Atomic Force Microscopy, Low Energy Electron Diffraction-LEED, Reflection High Energy Electron Diffraction-RHEED, X-ray Diffraction (XRD), Auger Electron Spectroscopy-AES, X-Ray Photoelectron Spectroscopy-XPS, Raman Spectroscopy, Rutherford Back Scattering (RBS), Secondary Ion Mass Spectrometry (SIMS).	CL, CBL, PBL	CLO4

(*) Learning Pedagogies/Methods

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- RP: Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- IBL: Inquiry-Based Learning
- SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

• Assessment Methodologies

(A) Internal Assessment [Total: 50 Marks]

a. Internal Formative assessment

- Assignment
- Seminars
- Class Regularity



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b. Internal Summative Assessment

- (a) Quizzes
- (b) Mid-term tests

(B) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO5	30	3	4	5	12
II	CLO2	30	2	5	5	12
III	CLO3	30	2	5	6	13
IV	CLO4	30	2	6	5	13
		120	09	20	21	50

• Assessment and Evaluation

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Mid-term tests, Seminars, Assignments, Quizzes, Class Regularity	50
2	End-Semester Examination	Written Exam Project Evaluation (Report, Presentation, Viva)	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	2	-	1	-	1	2	-	3	-	-
CLO2	2	-	1	1	1	3	-	2	1	1
CLO3	2	3	2	1	1	3	-	1	-	1
CLO4	2	1	2	1	2	3	-	1	1	1
CLO5	2	1	2	1	2	3	-	3	-	1

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-



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Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Vacuum Science and Technology	V. V. Rao, T. B. Ghosh, K. L. Chopra	2001	John Wiley & Sons
2	Vacuum Technology and Applications	D. J. Hucknall	1991	McGraw-Hill Inc.
3	Handbook of Thin Film Technology	L. I. Maissel, R. Glang (Eds.)	1970	Longman Scientific & Technical
4	Thin-Film Deposition: Principles and Practice	D. L. Smith	1995	Pearson / Prentice Hall
5	The Materials Science of Thin Films	M. Ohring	2nd Ed. (2002)	Wiley
6	Thin Film Phenomena	K. L. Chopra	1969	Springer
7	Thin Film Processes	J. L. Vossen, W. Kern (Eds.)	1991	Wiley
8	Handbook of Semiconductor Wafer Cleaning Technology	W. Kern (Ed.)	1993	S. Chand Publication
9	Concise history of Science in India	D. M. Bose, S. N. Sen, B. V. Subbarayappa	2nd Ed. (2009)	McGraw Hill
10	Research Methodology for Natural Sciences	Prof. Soumitro Banerjee	2022	McGraw-Hill Education
11	Introduction to Solid State Physics	Charles Kittel	8th Ed. (2015)	Springer
12	Elements of Solid State Physics	J. P. Srivastava	(2009)	Tata McGraw Hill
13	Solid State Physics: Structure and Properties of Materials	M. A. Wahab	2nd Ed. (2005)	Tata McGraw-Hill Education Pvt. Ltd.
14	Elementary Solid State Physics: Principles and Applications	M. A. Omar	(1975)	Newnes Publisher
15	Elements of X-ray Diffraction	B. D. Cullity & S. R. Stock	3rd Ed. (2014)	McGraw-Hill Education
16	Introduction to Dislocations	D. Hull & D. J. Bacon	5th Ed. (2011)	Butterworth-Heinemann



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				(Elsevier)
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• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	Google Sites resource on advanced semiconductor and thin film technology	https://sites.google.com/view/advancedsemiconductors
2	Video lecture on vacuum systems and thin film basics	https://youtu.be/nLohZYiiHuc
3	Lecture on thin film deposition and growth mechanisms	https://youtu.be/PPRHodMRzbg
4	Lecture on characterization techniques and applications	https://youtu.be/7hRiTvgCITQ
5	An NPTEL course on Research Methodology for Natural Sciences	https://nptel.ac.in/courses/127106227
6	Video lecture covering the fundamentals of condensed matter physics.	https://www.youtube.com/watch?v=_Ckh-60B6LY
7	Video tutorial explaining crystal structure and characterization techniques.	https://youtu.be/d_dasJl8GrA?si=_qTK4H5co4n5Ea7X
8	Video lecture on elastic properties of materials by Prof. S. Sankaran (IIT Madras).	https://youtu.be/p0cPzZWvDfc?si=5cyG1L2qAyAFodAi



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	PGD02CSST03	Nanofabrication and Device Simulation	4-0-0	120	04

• Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

- CLO1: Evaluate various thin film formation, oxidation, deposition and lithography techniques for semiconductor device fabrication by correlating process parameters with material properties, resolution and device performance.
- CLO2: Analyze wet and dry etching processes and advanced impurity doping techniques to determine their influence on junction formation, defect control and semiconductor device characteristics.
- CLO3: Simulate semiconductor fabrication process flows using appropriate deposition, etching and implantation methods for nanoscale device manufacturing applications via TCAD.
- CLO4: Develop and simulate semiconductor device structures using TCAD tools such as Silvaco platform for extraction of device parameters and performance analysis.
- CLO5: Optimize semiconductor device performance through TCAD-based process calibration, geometry scaling, stress analysis and parameter variation studies under different operating conditions.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Film Formation and Lithography The clean Room, Thermal Oxidation, Thin Oxide Growth, Chemical Vapor Deposition of Dielectrics: Silicon Dioxide, Deposition Methods, Properties of Silicon Dioxide, Step Coverage, P-Glass Flow, Silicon Nitride, Low and High Dielectric Constant Materials and Materials Options, Chemical Vapor Deposition of Polysilicon and Metallization. Optical Lithography: Exposure Equipment, Masks, Photoresist, Spin Coating, Pattern Transfer, Wet Photoresist Stripping, Dry Photoresist Stripping, Resolution Enhancement techniques, Advanced Lithography: Electron Beam Lithography: Electron Resist, The Proximity Effect, Ion beam lithography, Extreme-Ultraviolet Lithography.	CLO1	CL, ICT, Visit
II	Etching and Impurity Doping Wet Chemical Etching, Dry Chemical Etching, Impurity Doping: Basic Diffusion Process, Extrinsic Diffusion, Diffusion Related Processes, Ion-Implantation: Range of Implanted Ions, Implant Damage and Annealing, Rapid Thermal Annealing, Millisecond Annealing, Implantation Related Processes: Multiple Implantation and Masking, Tilt Angle Ion-Implantation, High-Energy High-Current Implantation, Doping profile extraction from C-V Measurements.	CLO2	CL, PBL, IBL



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III	Fundamentals of Technology Computer Aided Design (TCAD) Introduction, The Need and Role of TCAD, Challenges, 2D versus 3D TCAD, Design Flow, Process Compact Model, Process-Aware Design, Design for Manufacturing, Simulation Methodology, Device Simulation, Overview of Simulation Procedure, Stress Model in Front-End-of-Line Structures, Physically Based Simulation, Process Simulation, Numerical Methods, TCAD Calibration, Overview of various TCAD tools.	CLO3	CL, SDL, ROL
IV	Semiconductor Device Simulation using TCAD Silvaco Tool: Mask Views, ATHENA, ATLAS, Physical Structure, Structure Editing, Meshing, Mesh Definition, Regions and Materials, Electrodes, Victory Cell, Victory Process, Victory Stress, Victory Stress features and capabilities, Victory Device, Synopsys TCAD Platform: Taurus-Device, Taurus-Process, Device simulation: Programming to design advanced semiconductor devices, Extraction and analysis of device characteristics, Device performance under different geometry, Device scalability, parameter variation and performance optimization.	CLO4, CLO5	CL, ICT, SRP, MPR, CBL

(*) Learning Pedagogies/Methods

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• Assessment Methodologies

(A) Internal Assessment [Total: 50 Marks]

a. Internal Formative assessment

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- Quizzes
- Mid-term tests



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(B) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

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CLO2	3	2	2	1	1	3	1	1	-	1
CLO3	2	3	2	2	1	1	1	-	-	1
CLO4	2	3	3	3	2	2	1	-	-	1
CLO5	2	3	3	3	3	1	2	-	-	1

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2	VLSI Technology	S. M. Sze	2nd Ed. (1983)	McGraw-Hill Book Company



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P.G. Diploma in Semiconductor Science and Technology Semester-II

3	Fabrication Engineering at the Micro and Nano Scale	Stephen A. Campbell	3rd Ed. (2008)	Oxford University Press
4	The Science and Engineering of Microelectronic Fabrication	Stephen A. Campbell	2nd Ed. (2001)	Oxford University Press
5	VLSI Fabrication Principles: Silicon and Gallium Arsenide	Sorab K. Gandhi	2nd Ed. (1994)	John Wiley and Sons Inc.
6	Silicon VLSI Technology: Fundamentals, Practice and Modeling	James D. Plummer, Michael D. Deal, Peter B. Griffin	2000	Prentice Hall Inc.
7	Semiconductor Material and Device Characterization	Dieter K. Schroder	3rd Ed. (2008)	Wiley-IEEE Press
8	Computer Aided Design of Micro and Nanoelectronic Devices	Chinmay Kumar Maiti	2016	World Scientific Publishing
9	Introducing Technology Computer-Aided Design (TCAD): Fundamentals, Simulations, and Applications	Chinmay Kumar Maiti	2017	Pan Stanford publishing
10	3D TCAD simulation for Semiconductor process, Devices and Optoelectronics	Simon Li and Yue Fu	2012	Springer New York, NY

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	Google Sites resource on advanced semiconductor and thin film technology	https://sites.google.com/view/advancedsemiconductors
2	YouTube video demonstrating the 300mm Silicon Wafer Manufacturing Process	https://www.youtube.com/watch?v=jnnXZa_hWq4
3	NPTEL Lectures on doping and iron implantation	https://www.youtube.com/watch?v=nFb8ZVt8ahE
4	Silvaco official webpage	https://silvaco.com/
5	NPTEL Course on Semiconductor device modeling and Simulation	https://nptel.ac.in/courses/108105188
6	NPTEL Course on Modeling and TCAD	https://nptel.ac.in/courses/108105713



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	Simulation of Solar PV Cell				
Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	PGD02CSST04	Practical-1	0-8-0	120	04

• Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Design and develop PCB layouts using CAD software by applying electronic design rules and component placement strategies.

CLO2: Fabricate, assemble and test printed circuit boards for validating circuit functionality and hardware reliability.

CLO3: Simulate ion implantation and semiconductor device characteristics using SRIM/TRIM and TCAD tools to investigate device behaviour and process parameters.

CLO4: Develop Arduino-based interfacing systems using programming. Analyze electronic circuits using simulation platforms such as LTspice.

CLO5: Evaluate the performance characteristics, spectral response and analytical behaviour of solar cells using experimental techniques and Python-based data analysis.

Unit	Course Content	Learning Pedagogies*	CLO(s)
1	PCB Design using CAD	ROL, COL, EL	CLO1
2	PCB Fabrication and Testing	EL, PBL, COL	CLO2
3	Ion Implantation Simulation	SRP, ICT, SDL	CLO3
4	TCAD Simulation of Semiconductor Devices	ROL, ICT, IBL	CLO3
5	Arduino Interfacing and Programming	PBL, COL, EL	CLO4
6	Simulation and Analysis of Electronic Circuits using LTspice	ROL, COL, ICT	CLO4
7	Characteristics of Solar Cell	SRP, ICT, SDL	CLO5
8	Spectral Response of Solar Cell and its Analysis using Python	ROL, IBL, ICT, SDL	CLO5

(*) Learning Pedagogies/Methods

- CL: Classroom Lecture
- SM: Seminars (Student-led and Faculty-moderated)
- CBL: Case-Based Learning
- MPR: Micro-Projects/Mini Research Tasks
- Visit: Industrial Visit/Field Visit/Institutional Visit
- PBL: Problem-Based Learning
- ROL: Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
- COL: Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
- EL: Experiential Learning (Community Engagement, Internship-linked Activities, Practice-



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based Tasks)

- (j) SRP: Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
- (k) ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (l) RP: Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- (m) IBL: Inquiry-Based Learning
- (n) SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

Assessment Methodologies

(A) Internal Assessment [Total: 50 Marks]

a. Internal Formative assessment

- (a) Preparation of Journal
- (b) Practical Viva
- (c) Laboratory Regularity

b. Internal Summative Assessment

- (a) Mid-term Practical Examination
- (b) Laboratory Performance

(B) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
Practical	CLO1, CLO2, CLO3, CLO4, CLO5	120	10	20	20	50

Assessment and Evaluation

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Mid-Term Practical Exam, Lab Performance, Record/Journal, Internal Practical Viva, Attendance	50
2	End-Semester Examination	End-Term Practical Exam with Viva.	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	2	3	2	3	2	-	2	-	-	1
CLO2	2	2	3	3	3	2	1	1	-	2
CLO3	3	3	3	2	3	3	-	1	-	1
CLO4	2	3	2	3	2	-	3	-	1	-
CLO5	2	2	3	1	3	2	-	-	3	-



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Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

• Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Printed Circuit Board – Design, Fabrication, Assembly & Testing	R.S. Khandpur	1 st Ed. (2005)	Tata McGraw-Hill Education Pvt. Ltd.
2	Printed Circuit Board Design Using Autocad	Chris Schroeder	1998	Newnes Publisher
3	Introducing Technology Computer-Aided Design (TCAD): Fundamentals, Simulations, and Applications	Chinmay Kumar Maiti	2017	Pan Stanford publishing
4	3D TCAD simulation for Semiconductor process, Devices and Optoelectronics	Simon Li and Yue Fu	2012	Springer New York, NY

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	A Google Sites page with resources on advanced semiconductor technology.	https://sites.google.com/view/advancedsemiconductors
2	NPTEL Lectures on doping and iron implantation	https://www.youtube.com/watch?v=nFb8ZVt8ahE
3	Silvaco official webpage	https://silvaco.com/
4	NPTEL Course on Semiconductor device modeling and Simulation	https://nptel.ac.in/courses/108105188
5	NPTEL Course on Modeling and TCAD Simulation of Solar PV Cell	https://nptel.ac.in/courses/108105713
6	NPTEL Lectures on doping and iron implantation	https://www.youtube.com/watch?v=nFb8ZVt8ahE
7	Web page for Arduino	https://www.arduino.cc/



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	PGD02CSST05	Practical-2	0-8-0	120	04

• Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Analyze crystal structure parameters and lattice behaviour using X-ray diffraction and lattice dynamics experiments.

CLO2: Evaluate electrical and transport properties of semiconductor materials through resistivity, Hall effect and I-V-T Characteristics of a Diode.

CLO3: Investigate acoustic and ultrasonic properties of materials using interferometric measurement technique.

CLO4: Examine the operational characteristics and switching behaviour of SCR, DIAC and TRIAC devices for power electronic applications.

CLO5: Interpret images and experimental data to correlate structural morphology with material properties.

Unit	Course Content	Learning Pedagogies*	CLO(s)
1	Determination of Lattice Constant using X-Ray Diffraction (XRD)	ROL, COL, EL	CLO1
2	Study of Lattice Dynamics	ROL, IBL, EL	CLO1
3	Four Probe Resistivity	SRP, ICT, SDL	CLO2
4	Ultrasonic Interferometer	PBL, COL, EL	CLO3
5	Characteristics of SCR, DIAC and TRIAC	ROL, COL, EL, IBL	CLO4
6	Image Processing and Analysis	ICT, ROL, SDL	CLO5
7	Hall Effect Measurement of Semiconductor Material	SRP, ICT, EL	CLO2
8	I-V-T Characteristics of Diode	ROL, COL, EL, IBL	CLO2

(*) Learning Pedagogies/Methods

(a) CL: Classroom Lecture

(b) SM: Seminars (Student-led and Faculty-moderated)

(c) CBL: Case-Based Learning

(d) MPR: Micro-Projects/Mini Research Tasks

(e) Visit: Industrial Visit/Field Visit/Institutional Visit

(f) PBL: Problem-Based Learning

(g) ROL: Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)



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- (h) COL: Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
- (i) EL: Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
- (j) SRP: Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
- (k) ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (l) RP: Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- (m) IBL: Inquiry-Based Learning
- (n) SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

• Assessment Methodologies

(A) Internal Assessment [Total: 50 Marks]

a. Internal Formative assessment

- (a) Preparation of Journal
- (b) Practical Viva
- (c) Laboratory Regularity

b. Internal Summative Assessment

- (a) Mid-term Practical Examination
- (b) Laboratory Performance

(B) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/Analyse & above (A)	
Practical	CLO1, CLO2, CLO3, CLO4, CLO5	120	10	20	20	50

• Assessment and Evaluation

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Mid-Term Practical Exam, Lab Performance, Record/Journal, Internal Practical Viva, Attendance	50
2	End-Semester Examination	End-Term Practical Exam with Viva.	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	2	3	1	2	3	-	1	-	-
CLO2	3	2	3	2	3	2	1	-	1	2
CLO3	2	1	2	1	2	1	-	3	-	-
CLO4	2	2	3	3	2	-	2	-	-	2
CLO5	2	2	3	1	3	2	-	-	2	-



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Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

• Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Elements of X-Ray Diffraction (For Lattice Constant/XRD)	B.D. Cullity, S.R. Stock	3rd Ed. (2001)	Pearson
2	Introduction to Solid State Physics	Charles Kittel	8th Ed. (2015)	Springer
3	Elements of Solid State Physics	J. P. Srivastava	(2009)	Tata McGraw Hill
4	Principles of Electronics	V.K. Mehta & Rohit Mehta	12th Ed. (2020)	S. Chand Publishing

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	A Google Sites page with resources on advanced semiconductor technology.	https://sites.google.com/view/advancedsemiconductors
2	NPTEL: X-ray Crystallography & Diffraction: Video lectures	https://nptel.ac.in/courses/113106069
3	Four Probe Study Material	courses/115103030/module5/lec24/5.html
4	NPTEL Video for Hall effect	http://digimat.in/nptel/courses/video/115103134/L03.html
5	Material for Lattice Dynamics	https://web.bits-pilani.ac.in/uploads/6.Lattice%20dynamics.pdf



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Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	PGD02CSST06	Research Project	0-2-0	60	02

• Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Identify and formulate semiconductor and electronic design automation (EDA) related problems through systematic literature review and technical investigation.

CLO2: Apply EDA tools, simulation platforms and appropriate analytical methodologies to design, model and evaluate semiconductor devices and electronic circuits.

CLO3: Analyze simulation outputs, circuit responses and experimental data using scientific reasoning and computational techniques for performance optimization.

CLO4: Develop professional technical documentation and communicate project outcomes effectively through reports, design files, demonstrations and presentations.

CLO5: Demonstrate independent learning, innovation, teamwork and research-oriented problem-solving skills in semiconductor and EDA-based project development.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Research Project	SM, ROL, IBL, SDL, PBL, COL, EL, ICT, RP	CLO1, CLO2, CLO3, CLO4, CLO5

(*) Learning Pedagogies/Methods

- CL: Classroom Lecture
- SM: Seminars (Student-led and Faculty-moderated)
- CBL: Case-Based Learning
- MPR: Micro-Projects/Mini Research Tasks
- Visit: Industrial Visit/Field Visit/Institutional Visit
- PBL: Problem-Based Learning
- ROL: Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
- COL: Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
- EL: Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
- SRP: Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
- ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)



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(l) RP: Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)

(m) IBL: Inquiry-Based Learning

(n) SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

Assessment Methodologies

(A) Internal Assessment [Total: 25 Marks]

a. Internal Formative assessment

(a) Continuous Progress Monitoring

(b) Performance and Regularity

b. Internal Summative Assessment

(a) Internal Presentation

(b) Project Report

(B) Weightage of Learning Efforts for External Assessment [Total: 25 Marks]

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO2, CLO3, CLO4, CLO5	60	04	07	14	25

Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Continuous Progress Monitoring, Performance and Regularity, Internal Presentation, Project Report	50
2	End-Semester Examination	Project Evaluation: Final Report, Presentation and Viva Voce	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	2	2	2	1	2	-	1	-	-	-
CLO2	2	3	2	3	2	1	2	-	-	1
CLO3	2	3	3	2	3	-	2	-	1	-
CLO4	1	2	2	2	2	-	1	-	-	1
CLO5	2	2	3	2	2	1	2	-	1	-



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Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

• Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Introduction to Semiconductor Manufacturing Technology	Stephen A. Campbell	2nd Ed. (2008)	McGraw-Hill Education
2	Research Methodology: Methods and Techniques	C.R. Kothari	2nd Ed. (2004)	New Age International
3	3D TCAD simulation for Semiconductor process, Devices and Optoelectronics	Simon Li and Yue Fu	2012	Springer New York, NY
4	SPICE for Circuits and Electronics Using PSpice	Muhammad H. Rashid	2nd Ed.	Cengage Learning
5	Research Methodology for Natural Sciences	Prof. Soumitro Banerjee	2022	IISC Press
6	The Electronic Design Automation Handbook	Dirk Jansen	1st Ed. (2003)	Springer New York, NY

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	A Google Sites page with resources on advanced semiconductor technology	https://sites.google.com/view/advancedsemiconductors
2	Silvaco official webpage	https://silvaco.com/
3	NPTEL Course on Semiconductor device modeling and Simulation	https://nptel.ac.in/courses/108105188
4	NPTEL course on Semiconductor Physics and Devices by IISc	https://archive.nptel.ac.in/courses/108/108/108108122/