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

M.Sc. (Semiconductor Science and Technology) Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCSST01	Fundamentals of Semiconductor Science and Technology	4-0-0	120	04

- **Course Learning Outcomes (CLOs)**

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

CLO1: Analyze the different industry segments, fabrication workflows, supply chain dynamics, and government policies and initiatives like the India Semiconductor Mission (ISM).

CLO2: Apply the fundamental concepts of Semiconductor Physics like intrinsic and extrinsic semiconductors to determine the current-voltage (I-V) characteristics, and operational limits of standard P-N junction diodes.

CLO3: Evaluate the operational principles, theoretical limits (e.g., Shockley-Queisser Limit), and various parameters of photovoltaic devices and various photodetectors.

CLO4: Assess the structural design of Light Emitting Diodes (LEDs) and semiconductor lasers to differentiate between spontaneous and stimulated emission.

CLO5: Analyze the physical properties and current-voltage relationships of metal-semiconductor contacts and compare energy-band diagrams in semiconductor heterojunctions.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	**The Semiconductor Ecosystem and historical development in India:** Science Evolution from Ancient to Modern Age, History of Indian Semiconductor Industry, Overview of the Global Semiconductor Industry, Front-End and Back-End Processes in Semiconductor Industry, Industry Segments: Chip IP Cores, Electronic Design Automation (EDA) Tools, Specialized Materials and Chemicals, Wafer Fab Equipment (WFE), Fabless Companies, Integrated Device Manufacturers (IDMs) and Foundries, OSAT/ATMP, Clean Room Infrastructure and Overview of Semiconductor Chip Fabrication Process Flow, Semiconductor Supply Chain and Value Chain Dynamics with Global and National Perspectives, Government of India Initiatives such as the India Semiconductor Mission (ISM) and Production Linked Incentive (PLI) Scheme for Semiconductor Manufacturing.	CL, SM, Visit, COL, SDL	CLO1
II	**Semiconductor Diode:** Electricity Generation and Storage in Indian Scriptures, Bonds in Semiconductors, Commonly used Semiconductors (Si and Ge), Effect of Temperature on Semiconductors, Superiority of Silicon over Germanium, Intrinsic Semiconductor, Doping in Semiconductor, Extrinsic Semiconductor: N-Type	CL, SM, COL, IBL, SDL	CLO2

	Semiconductor and P-Type Semiconductor, P-N Junction, Nonuniformly Doped Junctions: Linearly Graded Junctions, Hyperabrupt Junctions, Properties of P-N Junction, Biasing of P-N Junction, I-V Characteristics of P-N Junction, Important Terms: Breakdown Voltage and Knee Voltage, Limitations in the Operating Condition of PN Junction: Maximum Forward Current, Peak Inverse Voltage (PIV) and Maximum Power Rating, Applications of P-N Junctions: Diode as Clipper and Clamper Circuit, Zener Diode.		
III	**Semiconductor Optoelectronics:** Properties of Light as explained by Sanskrit Slokas, Optical Absorption in Semiconductors, UV-VIS-NIR Spectroscopy, Determination of Optical Bandgap, Photocurrent in a P-N Diode, Application to a Solar Cell, Solar Cell Structure, Solar Cell I-V Characteristics, Theoretical Efficiency Limits (Shockley-Queisser Limit), Solar Cell Device Parameters: EQE, IQE, IPCE, FF, Photoconductive Detector, P-I-N Photodetector, Avalanche Photodiode, APD Design Issues. Light Emitting Diodes (LEDs): LED Structure and Operating Principle, Materials for Light Emitting Devices, LED Performance Issues, Light-Current Characteristics, Spectral Purity, Temporal Response, Advanced LED Structures, Heterojunction LED, Edge Emitting LED, Surface Emitting LED, Semiconductor Lasers: Spontaneous and Stimulated Emission-The Need for an Optical Cavity, The Laser Structure: Optical Cavity, Optical Absorption, Loss and Gain.	CL, SM, EL, IBL, SDL	CLO3, CLO4
IV	**Metal-Semiconductor junction, Semiconductor Heterojunctions and Metal interconnects:** Metal-Semiconductor Junction: Contacts Between Materials, Concept of Work Function and Electron Affinity, The Schottky Barrier Diode: QualitativeCharacteristics, Ideal Junction Properties, Nonideal Effects on the Barrier Height, Current-Voltage Relationship, Comparison of the Schottky Barrier Diode and the P-N Junction Diode, Metal-Semiconductor Ohmic Contacts: Ideal Nonrectifying Barriers, Tunneling Barrier, Specific Contact Resistance, Applications of Schottky Barriers. Semiconductor Heterojunctions: Heterojunction Materials, Energy-Band Diagrams, Two-Dimensional ElectronGas, EquilibriumElectrostatics, Current-Voltage Characteristics, Numerical Examples. Metal Interconnects: Interconnect Parameters.	CL, SM, COL, EL, IBL	CLO5

(*) 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)
(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) Assignment
(b) Seminars
(c) Class Regularity

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	2	5	6	13
II	**CLO2**	30	2	5	5	12
III	**CLO3, CLO4**	30	2	4	7	13
IV	**CLO5**	30	2	4	6	12
		120	**08**	**18**	**24**	**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	50

(C) CLOs – PLOs Matrix

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

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Principles of Electronics	V.K. Mehta & Rohit Mehta	12th Ed. (2020)	S. Chand Publishing
2	Semiconductor Devices: Physics and Technology	S.M. Sze & Kwok K. Ng	3rd Ed. (2012)	Wiley
3	Semiconductor Physics and Devices	Donald A. Neamen	4th Ed. (2021)	McGraw-Hill Education
4	Solid State Electronic Devices	Ben G. Streetman & Sanjay Banerjee	7th Ed. (2015)	Pearson
5	Modern Semiconductor Devices for Integrated Circuits	Chenming C. Hu	1st Ed. (2010)	Prentice Hall
6	Solid State and Semiconductor Physics	John P. McKelvey	Reprint (1982)	Krieger Pub. Co.

7	Metal-Semiconductor Contacts	William Rhoderick & Robert H. Williams	2nd Ed. (1988)	Oxford University Press
8	Semiconductor Devices: Basic Principles	Jasprit Singh	1st Ed. (2001)	John Wiley and Sons
9	Concise history of Science in India	D. M. Bose, S. N. Sen, B. V. Subbarayappa	2nd Ed. (2009)	Universities Press
10	Research Methodology for Natural Sciences	Prof. Soumitro Banerjee	2022	IISC Press

- **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	An NPTEL course on semiconductor physics and devices by Prof. Digbijoy N. Nath, IISc.	https://archive.nptel.ac.in/courses/108/108/108108122/
3	An NPTEL course on PN Junction Diode	nptel.ac.in/courses/117107095
4	A presentation notes one LED	https://archive.nptel.ac.in/content/storage2/courses/117104022/Lectures/Lec15.pdf
5	An NPTEL course on Research Methodology for Natural Sciences	https://nptel.ac.in/courses/127106227

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

M.Sc. (Semiconductor Science and Technology) Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCSST02	Evolution of Semiconductor Electronics	4-0-0	120	04

- **Course Learning Outcomes (CLOs)**

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

CLO 1: Analyze the operation and characteristics of BJTs in CB, CE, and CC configurations and determine operating points using load line analysis for amplifier applications.

CLO 2: Evaluate operational amplifier parameters to design and analyze practical circuits such as amplifiers, integrators, differentiators, comparators and data converters.

CLO 3: Apply number systems and Boolean logic to analyze digital circuits, including logic gates, TTL/CMOS families and their operating characteristics.

CLO 4: Design and simplify combinational and sequential circuits such as adders, multiplexers, flip-flops, registers and counters using Boolean expression.

CLO5: Analyze the structure and operation of semiconductor memories, microprocessors and microcontrollers and relate them to the evolution of integrated circuits and embedded systems.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	**The Bipolar Junction Transistor-BJT** Introduction of BJT, Transistor Action, Transistor Symbols, Transistor Circuit as an Amplifier, Transistor Connections: Common Base Connection, Characteristics of CB Transistor, Common Emitter Connection, Characteristics of CE Transistor, Simplified Transistor Current Relations, Common Collector Connection, Comparison of CB, CE and CC Transistor Action, Importance of CE Configuration, Transistor as an Amplifier in CE Arrangement, Transistor Load Line Analysis, Operating Point, Cut-off and Saturation Points, Minority Carrier Distribution: Forward-active Mode, Other Mode of Operation, Power Rating of Transistor, Numerical Examples.	CL, SM, CBL, COL, ICT, SDL	CLO1
II	**Non-linear Integrated Circuits** Operational Amplifier: Introduction, Common Mode Rejection Ratio (CMRR), Internal Circuit of Operational Amplifier, Schematic Symbol of Operational Amplifier, Inverting and Non-Inverting Input and Polarity Relation, Bandwidth, Slew Rate, OP-Amp with Negative Feedback, Pin Diagram, Applications: Inverting Amplifier, Noninverting Amplifier, Voltage Follower, Multistage OP-Amp Circuits, Summing Amplifier, Integrator, Differentiator and Comparator circuits, Schmitt Trigger: UTP and LTP Adjustments, Digital to Analog and Analog to Digital Convertors using Op-Amp, Numerical Examples.	CL, SM, COL, ICT, SDL	CLO2
III	**Digital Electronics** Invention of Zero by Aryabhatta, Coding in ancient India and Mahrishi Panini's contribution, Number System: Binary, Octal,	CL, SM, COL, ICT, PBL	CLO3

	Decimal, Hexadecimal, Conversion of Number System, Concept of Analog and Digital Signals, Basic Logic Functions, Basic Terms Related to Digital IC-Gates, RTL and DTL Gates, TTL Gates, Transfer Characteristics of TTL Gates, Current Source and Sinking, Calculation of Fanout of Standard TTL Gates, Brief Introduction to TTL Families (74S, 74L, 74LS, 74ALS), Open Collector Gates and Buffer Drivers, Tri-State Logic Gate. Basic n-MOS Inverter, CMOS Inverter, MOS Gate Circuits, Handling of Open and Unused Inputs of Logic Gates.		
IV	**Combinational, Sequential logic circuits and Memory** Moore's Law and Beyond, Small Scale to Ultra Large-Scale Integration (SSI-ULSI) Overview De Morgan's Theorems, Simplification of Boolean Expression. Binary Adder: Half and Full Adder, Subtractor, Flip-Flop: S-R, J-K, D and T Flip-Flop, Encoder, Decoders, Multiplexers, De-multiplexers, Registers, Counters. Semiconductor Memories: Read Only Memory and Random-Access memory, Expanding Memory Size. Introduction to Microprocessor, Microcontroller and Embedded System.	CL, SM, PBL, COL, ICT	CLO4, CLO5

(*) 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)
(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**

(D) Internal Assessment [Total: 50 Marks]

a. Internal Formative assessment

(d) Assignment
(e) Seminars
(f) Class Regularity

b. Internal Summative Assessment

(c) Quizzes
(d) Mid-term tests

(E) 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	2	5	5	12
II	**CLO2**	30	2	5	5	12
III	**CLO3**	30	2	4	7	13
IV	**CLO4, CLO5**	30	2	4	7	13
Total		**120**	**08**	**18**	**24**	**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	50

(F) CLOs – PLOs Matrix

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

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	-

M.Sc. (Semiconductor Science and Technology) Semester-I

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Principles of Electronics	V. K. Mehta, Rohit Mehta	12th Ed. (2020)	S. Chand Publication
2	Semiconductor Physics and Devices: Basic Principles	Donald A. Neamen	3rd Ed. (2003)	Tata McGraw-Hill
3	Integrated Circuits	K. R. Botkar	5th Ed. (2010)	Khanna Publishers
4	Electronic Principles	Albert Malvino & David Bates	9th Ed. (2020)	McGraw-Hill Education
5	Electronic Devices	Thomas L. Floyd	10th Ed. (2017)	Pearson Education
6	Op-Amps and Linear Integrated Circuits	Ramakant A. Gayakwad	4th Ed. (2015)	Pearson Education
7	Digital Electronics	A. Anand Kumar	4th Ed. (2016)	PHI Learning Pvt. Ltd.
8	Digital Fundamentals	Thomas L. Floyd	11th Ed. (2014)	Pearson Education
9	Metal-Semiconductor Contacts	William Rhoderick & Robert H. Williams	2nd Ed. (1988)	Oxford University Press
10	Concise history of Science in India	D. M. Bose, S. N. Sen, B. V. Subbarayappa	2nd Ed. (2009)	Universities Press
11	Research Methodology for Natural Sciences	Prof. Soumitro Banerjee	2022	IISC Press

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Academic resources on advanced semiconductor technology.	https://sites.google.com/view/advancedsemiconductors
2	Practical guide to building logic gates using transistors.	https://www.101computing.net/creating-logic-gates-using-transistors/
3	Video tutorial on designing NAND, AND, OR, and NOR gates.	https://www.youtube.com/watch?v=OWlD7gL9gS0
4	NPTEL course on device physics and circuits by Prof. M. Gopal.	https://onlinecourses.nptel.ac.in/noc21_ee80/preview
5	NPTEL course on integrated circuits by Prof. Sudeb Dasgupta.	https://onlinecourses.nptel.ac.in/noc21_ee86/preview
6	NPTEL course on digital system design by Prof. Gautam Saha.	https://onlinecourses.nptel.ac.in/noc25_ee20/preview
7	An NPTEL course on Research Methodology for Natural Sciences	https://nptel.ac.in/courses/127106227

M.Sc. (Semiconductor Science and Technology) Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	P2S01NCSST03	Physics of Condensed Matter	4-0-0	120	04

- **Course Learning Outcomes (CLOs)**

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

CLO 1: Analyze the quantum mechanical principles of solid-state materials including the Kronig-Penney model, energy band formation and Fermi-Dirac statistics to evaluate electrical conduction and carrier dynamics.

CLO 2: Apply crystallographic concepts such as crystal structures, Bravais lattices, and Miller indices, along with X-ray diffraction principles, to characterize materials and determine wafer orientations.

CLO 3: Evaluate the thermodynamics and mechanics of crystallographic imperfections including calculating point defect concentrations and analyzing the energetic impact of line and surface defects on material properties.

CLO 4: Interpret the fundamental thermal properties of solids by analyzing lattice vibrations, heat capacity, thermal conductivity and their mathematical temperature dependence.

CLO 5: Assess the physical properties of materials at cryogenic temperatures, compare various low-temperature generation techniques and to understand phenomena like superconductivity.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	**Introduction to the Quantum Theory of Solids** Early studies on Concepts of Atom by Mahrishi Kanad, Formation of Energy Bands, The Bloch theorem, The Kronig-Penney Model, The k-Space Diagram, Brillouin Zone, Electrical Conduction in Solids: The Energy Band and the Bond Model, Drift Current, Electron Effective Mass, Concept of the Hole, Metals, Insulators and Semiconductors, Direct and Indirect Bandgap in Semiconductor, Extension to Three Dimensions: The k-Space Diagrams of Si and GaAs, Distribution Function and the Fermi Energy, Fermi-Dirac Statistics, Density of States Function: Mathematical Derivation, Extension to Semiconductors.	CL, SM, CBL, PBL, SRP	CLO1
II	**Crystal Structure and its Characterization** Metal Casting in Ancient India, Concept of Solid, Introduction to Crystal Structures, Classification of Materials based on Structure: Amorphous, Polycrystalline and Single-Crystalline Materials, Relationship Between Grain Size and Grain Boundaries with Structure, Effects of Grain Boundaries on Material Properties, Classification of Crystal Systems, Lattice	CL, SM, CBL, COL, ICT	CLO2

	Parameters, Unit Cell and Bravais Lattices, Planes, Miller Indices, Symmetry Elements, Zones and Forms, Reciprocal Lattice and its Properties, X-ray Diffraction: Bragg's Law and its Derivation, X-ray Diffraction Techniques: PXRD, SCXRD, SAXS. Wafer Orientation and Alignment Marks: Wafer Flats and Surface Plane Identification for Si and GaAs. Typical Si and GaAs Wafer Specifications.		
III	**Defects in Solids** Introduction to Defects in Solids, Importance of Defects in Materials, Types of Defects in Crystals: Point Defects, Line Defects, Surface Defects, and Volume Defects, Point Imperfections (Frenkel and Schottky) and its Concentration, Expressions for the Number of Schottky and Frenkel Defects as well as Vacancies at given Temperature, Line Imperfections, Edge Dislocation, Screw Dislocation, Dislocation Density, Burgers Vector and Burgers Circuit, Dislocation Motion, Energy of a Dislocation, Slip Planes and Slip Directions, Surface Imperfections, Tilt and Twist Boundary, Stacking Faults: Stacking Faults in FCC Crystals, Stacking Faults in HCP Crystals.	CL, SM, COL, ICT, SDL	CLO3
IV	**Thermal Properties and Low Temperature Physics** Basics of Lattice Vibrations, Phonon Dynamics and Heat Transfer in Solid, Thermal Properties: Thermal Conductivity, Thermal Diffusivity, Heat Capacity, Temperature Dependence of Heat Capacity, Specific Heat of Solids, Thermal Expansion, Thermal Stresses and Thermoelectric Power. Overview of Temperature Scales and Thermometry, Properties of Materials at Low Temperatures: Thermal, Electrical and Mechanical Properties. Cryogenic Fluids: Helium, Nitrogen and Hydrogen. Design of LN_2 Cryostat, Low-temperature Generation Techniques: Joule-Thomson Expansion, Adiabatic Demagnetization Cooling. Dilution Refrigerator, Closed Cycle Refrigerator, Low Temperature Phenomena: Superconductivity.	CL, SM, PBL, ROL, ICT	CLO4, CLO5

- **(*) Learning Pedagogies/Methods**
  - (o)CL: Classroom Lecture
  - (p)SM: Seminars (Student-led and Faculty-moderated)
  - (q)CBL: Case-Based Learning
  - (r) MPR: Micro-Projects/Mini Research Tasks
  - (s) Visit: Industrial Visit/Field Visit/Institutional Visit
  - (t) PBL: Problem-Based Learning
  - (u)ROL: Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
  - (v)COL: Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)

(w) EL: Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
(x) SRP: Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
(y) ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
(z) RP: Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
(aa) IBL: Inquiry-Based Learning
(bb) SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

(G) Internal Assessment

a. Internal Formative assessment

(g) Assignment
(h) Seminars
(i) Class Regularity

b. Internal Summative Assessment

(e) Quizzes
(f) Mid-term tests

(H) 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**	30	3	4	5	12
II	**CLO2**	30	2	5	6	13
III	**CLO3**	30	3	4	5	12
IV	**CLO4, CLO5**	30	2	5	6	13
Total		**120**	**10**	**18**	**22**	**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	50

M.Sc. (Semiconductor Science and Technology) Semester-I

(I) CLOs – PLOs Matrix

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

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 Solid State Physics	Charles Kittel	8th Ed. (2015)	Wiley
2	Elements of Solid State Physics	J. P. Srivastava	(2009)	Prentice Hall of India
3	Solid State Physics: Structure and Properties of Materials	M. A. Wahab	2nd Ed. (2005)	Narosa Publishers
4	Elementary Solid State Physics: Principles and Applications	M. A. Omar	(1975)	Addison-Wesley
5	Elements of X-ray Diffraction	B. D. Cullity & S. R. Stock	3rd Ed. (2014)	Pearson
6	Introduction to Dislocations	D. Hull & D. J. Bacon	5th Ed. (2011)	Butterworth-Heinemann (Elsevier)
7	Low Temperature Physics	Christian Enns & Siegfried Hunklinger	(2005)	Springer-Verlag
8	Matter and Methods at Low Temperatures	Frank Pobell	3rd Ed. (2007)	Springer-Verlag
9	Experimental Techniques in Low-Temperature Physics	Guy K. White	3rd Ed. (1979)	Clarendon Press, Oxford
10	Solid State and Semiconductor Physics	John P. McKelvey	Reprint (1982)	Krieger Publishing
11	Semiconductor Material and Device Characterization	Dieter K. Schroder	3rd Ed. (2006)	Wiley-Interscience
12	Concise history of Science in India	D. M. Bose, S. N. Sen, B. V. Subbarayappa	2nd Ed. (2009)	Universities Press
13	Research Methodology for Natural Sciences	Prof. Soumitro Banerjee	2022	IISC Press

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Academic resources on advanced semiconductor technology.	https://sites.google.com/view/advancedsemiconductors
2	Video lecture covering the fundamentals of condensed matter physics.	https://www.youtube.com/watch?v=_Ckh-60B6LY
3	Video tutorial explaining crystal structure and characterization techniques.	https://youtu.be/d_dasJl8GrA?si=_qTK4H5co4n5Ea7X
5	Video lecture on elastic properties of materials by Prof. S. Sankaran (IIT Madras).	https://youtu.be/p0cPzZWvDfc?si=5cyG1L2qAyAFOdAi
6	NPTEL course on cryogenic engineering by Prof. M.D. Atrey (IIT Bombay).	https://nptel.ac.in/courses/112101004
7	An NPTEL course on Research Methodology for Natural Sciences	https://nptel.ac.in/courses/127106227

M.Sc. (Semiconductor Science and Technology) Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCSST04	Practical-1	0-8-0	120	04

- **Course Learning Outcomes (CLOs)**

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

CLO1: Analyze characteristics of transmission lines, including impedance, frequency response, and cutoff limits.

CLO2: Asses the performance of analog and digital electronic circuits using electronic design automation (EDA) tools.

CLO3: Evaluate the working principles and truth tables of sequential logic circuits.

CLO4: Analyze fundamental thermal and electrical properties of materials, such as thermoelectric power.

CLO5: Develop thin-film and determine the optical bandgap of the synthesized semiconductor materials using UV-Vis-NIR spectroscopy.

CLO6: Assess the dynamic optoelectronic properties of devices by analyzing their pulse photo response and transient behavior.

Unit	Course Content	Learning Pedagogies*	CLO(s)
1	Transmission Line-I	ROL, COL, EL	CLO1
2	Transmission Line-II	ROL, COL, EL	CLO1
3	Analog Circuits Simulation	SRP, ICT, SDL	CLO2
4	Digital Circuits Simulation	SRP, ICT, SDL	CLO2, CLO3
5	Thermoelectric Power Measurement	ROL, COL, EL, IBL	CLO4
6	Working of Flip-flop	PBL, COL, EL	CLO3
7	Thin Film Deposition and its Optical Bandgap Determination	ROL, COL, EL, IBL	CLO5
8	Pulse Photo Response	ROL, COL, EL, IBL	CLO6

- **(*) Learning Pedagogies/Methods**
  - (cc) CL: Classroom Lecture
  - (dd) SM: Seminars (Student-led and Faculty-moderated)
  - (ee) CBL: Case-Based Learning
  - (ff) MPR: Micro-Projects/Mini Research Tasks
  - (gg) Visit: Industrial Visit/Field Visit/Institutional Visit
  - (hh) PBL: Problem-Based Learning

(ii) ROL: Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
(jj) COL: Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
(kk) EL: Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
(ll) SRP: Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
(mm) ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
(nn) RP: Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
(oo) IBL: Inquiry-Based Learning
(pp) SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

(J) Internal Assessment [Total: 50 Marks]

a. Internal Formative assessment

(j) Preparation of Journal
(k) Practical Viva
(l) Laboratory Regularity

b. Internal Summative Assessment

(g) Mid-term Practical Examination
(h) Laboratory Performance

(K)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, CLO6**	**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

M.Sc. (Semiconductor Science and Technology) Semester-I

(L) CLOs – PLOs Matrix

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

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Microwave Engineering	David M. Pozar	4th Ed. (2011)	Wiley
2	Microelectronic Circuits	Adel S. Sedra, Kenneth C. Smith	8th Ed. (2019)	Oxford University Press
3	Digital Design	M. Morris Mano, Michael D. Ciletti	6th Ed. (2018)	Pearson
4	Introduction to Solid State Physics	Charles Kittel	8th Ed. (2004)	Wiley
5	Materials Science of Thin Films	Milton Ohring	2nd Ed. (2001)	Academic Press
6	Semiconductor Optoelectronic Devices	Pallab Bhattacharya	2nd Ed. (1996)	Prentice Hall

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL: Microwave Engineering	https://nptel.ac.in/courses/108101112
2	Virtual Labs: Digital Electronics	http://vlabs.iitkgp.ernet.in/dec/
3	NPTEL: Solid State Physics	https://nptel.ac.in/courses/115105099
4	Virtual Labs: Material Response to Microstructural changes	https://vlab.amrita.edu/?sub=1&brch=282
5	NPTEL: Transmission Lines	https://www.youtube.com/watch?v=0OwmYAljz4A&list=PL0925FD10648D664E
6	Home page for CircuitMaker software	https://circuitmaker.com/

M.Sc. (Semiconductor Science and Technology) Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCSST05	Practical-2	0-8-0	120	04

- **Course Learning Outcomes (CLOs)**

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

CLO 1: Evaluate the optoelectronic performance of photovoltaic devices by measuring V-I characteristics, spectral response, and External Quantum Efficiency (EQE).

CLO 2: Determine crystallographic parameters, such as the lattice constant, using X-ray diffraction (XRD) techniques to characterize semiconductor materials.

CLO 3: Design, implement, and verify fundamental digital logic gates and combinational circuits (adders/subtractors) using Boolean algebra and truth tables.

CLO 4: Analyze and implement operational amplifier-based circuits, including comparators, zero-crossing detectors, and Schmitt triggers, to evaluate their switching behavior.

CLO 5: Simulate and analyze the voltage, current and transient characteristics of electronic circuits.

Unit	Course Content	Learning Pedagogies*	CLO(s)
1	V-I Characteristics of a Solar Cell	ROL, COL, EL, IBL	CLO 1
2	Lattice Constant Determination Using XRD	ROL, COL, EL, IBL	CLO 2
3	Spectral Response and External Quantum Efficiency of a Solar Cell	ROL, COL, EL, IBL	CLO 1
4	Basic Logic-gates and Boolean Operations	PBL, COL, EL	CLO 3
5	Combinational Logic Circuits (Adders and Subtractors)	PBL, COL, EL	CLO 3
6	Schmitt Trigger Circuits (Inverting and Non-Inverting)	COL, EL, IBL	CLO 4
7	Voltage Comparator and Zero-Crossing Detector	PBL, COL, EL	CLO 4
8	Simulate and Analyze Electronic Circuits	SRP, ICT, SDL	CLO 5

- **(*) Learning Pedagogies/Methods**
  - (qq) CL: Classroom Lecture
  - (rr) SM: Seminars (Student-led and Faculty-moderated)
  - (ss) CBL: Case-Based Learning
  - (tt) MPR: Micro-Projects/Mini Research Tasks
  - (uu) Visit: Industrial Visit/Field Visit/Institutional Visit
  - (vv) PBL: Problem-Based Learning

(ww) ROL: Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
(xx) COL: Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
(yy) EL: Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
(zz) SRP: Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
(aaa) ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
(bbb) RP: Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
(ccc) IBL: Inquiry-Based Learning
(ddd) SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

(M) Internal Assessment [Total: 50 Marks]

a. Internal Formative assessment

(m) Preparation of Journal
(n) Practical Viva
(o) Laboratory Regularity

b. Internal Summative Assessment

(i) Mid-term Practical Examination
(j) Laboratory Performance

(N) 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

M.Sc. (Semiconductor Science and Technology) Semester-I

(O)CLOs – PLOs Matrix

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

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	Physics of Solar Cells (For V-I & EQE)	Peter Würfel	3rd Ed. (2016)	Wiley
2	Elements of X-Ray Diffraction (For Lattice Constant/XRD)	B.D. Cullity, S.R. Stock	3rd Ed. (2001)	Pearson
3	Digital Design (For Logic Gates & Adders)	M. Morris Mano, Michael D. Ciletti	6th Ed. (2018)	Pearson
4	Op-Amps and Linear Integrated Circuits (For Schmitt Triggers/Comparators)	Ramakant A. Gayakwad	4th Ed. (1999)	Pearson
5	SPICE for Circuits and Electronics Using PSpice (Adaptable for NGSPICE)	Muhammad H. Rashid	2nd Ed. (1995)	Prentice Hall

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	PV Education: Open-source textbook on solar cell	https://www.pveducation.org/
2	NPTEL: X-ray Crystallography & Diffraction: Video lectures	https://nptel.ac.in/courses/113106069
3	Virtual Labs (IIT Kharagpur): Digital Electronics.	http://vlabs.iitkgp.ernet.in/dec/
4	Virtual Labs (IIT Kharagpur): Basic Electronics	http://vlabs.iitkgp.ernet.in/be/
5	NGSPICE Open-Source Tutorials	https://ngspice.sourceforge.io/tutorials.html

M.Sc. (Semiconductor Science and Technology) Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	P2S01NCSST06	Research Project	0-2-0	60	02

- **Course Learning Outcomes (CLOs)**

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

CLO1: Identify and define a relevant problem in semiconductor science and technology through literature survey.

CLO2: Apply appropriate experimental, simulation, or analytical techniques to address the selected problem.

CLO3: Analyze and interpret the obtained results using scientific reasoning and data analysis tools.

CLO4: Develop technical documentation and present the findings effectively through written reports and oral presentations.

CLO5: Demonstrate independent learning, problem-solving ability, and research-oriented thinking.

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

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

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

- **Assessment Methodologies**

(P) 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

(Q) 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

(R) CLOs – PLOs Matrix

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

M.Sc. (Semiconductor Science and Technology) Semester-I

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	Electronic Instrumentation and Measurements	David A. Bell	2nd Ed. (2007)	Oxford University Press / PHI
11	Research Methodology for Natural Sciences	Prof. Soumitro Banerjee	2022	IISC Press

- **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	Complete Guide to Semiconductor Devices by Kwok K. Ng: A comprehensive handbook.	https://ieeexplore.ieee.org/book/5271197
4	NPTEL course on Semiconductor Physics and Devices by IISc	https://archive.nptel.ac.in/courses/108/108/108108122/