



# 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

## Master of Science Electronics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCELE01	Semiconductor Electronics: Devices and Applications	3-0-1	120	04

### • Course Learning Outcomes (CLOs)

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

- CLO 1:** Explain the fundamental principles of quantum mechanics, crystal structure, and band theory governing semiconductor materials, including concepts of energy bands, charge carriers, and density of states, with reference to both modern physics and traditional Indian knowledge perspectives (Vaisheshika & Agastya traditions).
- CLO 2:** Analyze carrier transport phenomena in semiconductors, including drift, diffusion, recombination mechanisms, and variation of Fermi level under different temperature and doping conditions.
- CLO 3:** Apply appropriate experimental techniques such as Hall effect and four-probe methods to determine semiconductor parameters like carrier concentration, mobility, and resistivity.
- CLO 4:** Examine the physics and operational characteristics of semiconductor junctions and interfaces, including P–N junctions, Schottky contacts, heterojunctions, and MOS structures.
- CLO 5:** Evaluate and design semiconductor-based electronic and optoelectronic devices such as diodes, solar cells, photodetectors, LEDs, and display systems for practical applications.
- CLO 6:** Assess the role of semiconductor devices in sustainable technologies (e.g., solar energy systems) while correlating modern material behavior with insights from Indian Knowledge Systems, particularly Agastya’s concepts of material and electrochemical phenomena.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Energy Flow and Atomic Concepts (Vaisheshika & Agastya Tradition) Basics of quantum mechanics: wave–particle duality, Schrödinger equation, and quantum states, Electrons in periodic potential and crystal lattice, Review of free	Classroom Lecture (CL), Seminars (Student-led and Faculty-	CLO1



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	electron theory and its limitations, Band theory of solids: Bloch theorem and Kronig–Penney model, Formation of energy bands, band gap, and Brillouin zones, Effective mass, carrier mobility, and concept of holes, Density of states and Fermi–Dirac distribution function, Intrinsic and extrinsic semiconductors	moderated), Inquiry-Based Learning	
II	Drift and diffusion current mechanisms, Continuity equation and carrier recombination processes, Hall effect and carrier concentration measurement, Four-probe technique for resistivity and conductivity measurement, Variation of Fermi level with temperature and doping, Types of semiconductors: crystalline, amorphous, and compound, Degenerate semiconductors and high doping effects, Material Behaviour and Electrochemical Concepts as given by Rishi Agastya	CL, PBL, ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)	CLO2, CLO3
III	P–N junction: formation, depletion region, and diode equation Junction capacitance and switching characteristics Metal–Semiconductor contacts: Ohmic and Schottky contacts Heterojunctions and band structure engineering Metal–Insulator–Semiconductor (MIS) structures, MOS capacitor basics, Interface states, surface charge, and interface traps	CL, ICT Enabled Learning, CBL	CLO4
IV	Optical absorption and recombination mechanisms, Photoconductors, Photodiodes and Photovoltaic cells: types and efficiency, Power generation using solar cells, Solar panels and grid-connected PV system, Light-emitting devices: LED and LASER fundamentals, Display technologies: LCD, OLED, and plasma displays	CL, Seminars, CBL, Micro-Projects/Mini Research Tasks	CLO5, CLO6

- **Assessment Methodologies**

- (A) **Internal Assessment**

- a. **Internal Formative assessment**

- (a) MCQ and Objective question Quiz
      - (b) Seminar/Presentation and Group Discussion
      - (c) Assignments

- b. **Internal Summative Assessment**



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## Master of Science Electronics Semester-I

(a) Mid-term test

### (B) Weightage of Learning Efforts for External Assessment

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	3	8	14
II	CLO2,CLO3	30	3	3	8	14
III	CLO4	30	2	2	7	11
IV	CLO5,CLO6	30	2	2	7	11
		<b>120</b>	<b>10</b>	<b>10</b>	<b>30</b>	<b>50</b>

### • Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Mid Term Test, Class Regularity, Group Discussion	50
2	End-Semester Examination	Written Exam	50

### (C) CLOs – PLOs Matrix

CLO	PLO										
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CLO1	3	1	–	2	–	1	1	–	1	–	2
CLO2	3	1	–	2	1	1	1	–	–	–	1
CLO3	3	1	–	2	1	1	1	–	–	–	1
CLO4	3	2	–	2	1	2	2	–	–	–	1
CLO5	2	3	1	2	1	2	3	1	2	1	2
CLO6	2	1	–	1	1	–	2	2	3	2	3

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



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## Master of Science Electronics Semester-I

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	Semiconductor Devices: Physics and Technology	S. M. Sze & M. K. Lee	3 <sup>rd</sup> Edition, 2012	Wiley
2	Semiconductor Devices: Basic Principles	Jasprit Singh	2 <sup>nd</sup> , 2001	Wiley
3	Solid State Electronic Devices	B. G. Streetman & S. Banerjee	7 <sup>th</sup> , 2015	Pearson
4	Principles of Electronic Materials and Devices	S. O. Kasap	4 <sup>th</sup> , 2018	McGraw Hill
5	Introduction to Solid State Physics	Charles Kittel	8 <sup>th</sup> , 2005	Wiley
6	Semiconductor Optoelectronic Devices	Pallab Bhattacharya	2 <sup>nd</sup> , 1997	Pearson/PHI
7	Optoelectronics: An Introduction	J. Wilson & J. Hawkes	3 <sup>rd</sup> , 1988	PHI
8	Introduction to Solid-State Devices	G. I. Yepifanov & Yu. A. Moma	1977	Mir Publishers
9	Science and Technology in Ancient India	S. N. Sen	1989	Indian National Science Academy (INSA)
10	Indian Physics: Outline of Early History (Online Resource)	Subhash Kak	2003	arXiv access (Open-research paper)



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## Master of Science Electronics Semester-I

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- **Online Resources (Open Source)**

<b>Sr. No.</b>	<b>Description of Resource(s)</b>	<b>Weblink</b>
1	NPTEL Course: Semiconductor Devices (IIT Faculty Lectures + Notes)	<a href="https://nptel.ac.in/courses/117102061">https://nptel.ac.in/courses/117102061</a>
2	NPTEL Course: Solid State Devices	<a href="https://nptel.ac.in">https://nptel.ac.in</a>
3	SWAYAM MOOCs on Semiconductor Devices and Solid State Electronics	<a href="https://swayam.gov.in">https://swayam.gov.in</a>
4	Virtual Labs (MHRD Initiative) – Semiconductor Device Experiments	<a href="https://www.vlab.co.in">https://www.vlab.co.in</a>
5	MIT OpenCourseWare – Solid State Physics / Semiconductor Devices	<a href="https://ocw.mit.edu">https://ocw.mit.edu</a>
6	Free Lecture Notes on Semiconductor Devices (TU Graz)	<a href="https://lampx.tugraz.at/~hadley/psd">https://lampx.tugraz.at/~hadley/psd</a>
7	Indian Physics: Outline of Early History – Research paper covering concepts of atomic theory, matter, and early Indian physics traditions by Subhash Kak	<a href="https://arxiv.org/abs/physics/0310001">https://arxiv.org/abs/physics/0310001</a>



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## Master of Science Electronics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCELE02	Integrated Circuit Applications and Intelligent Electronics	3-0-1	120	04

### • Course Learning Outcomes (CLOs)

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

- CLO 1:** Explain the principles of electronic system behavior, operational amplifiers, and active filter design while correlating system abstraction and decision flow with logical frameworks from Indian Knowledge Systems such as Nyāya
- CLO 2:** Analyze the performance of instrumentation amplifiers, first- and second-order active filters, and their applications in audio and signal processing systems.
- CLO 3:** Analyze and design higher-order filters (Butterworth, Chebyshev, Elliptic, Bessel), including cascade realization, GIC-based circuits, and evaluation of sensitivity and high-frequency limitations.
- CLO 4:** Apply principles of Phase Locked Loops (PLL) and utilize SPICE-based simulation tools to model, analyze, and validate electronic circuits under DC, AC, and transient conditions.
- CLO 5:** Apply fuzzy set theory and fuzzy logic concepts to design and evaluate decision-making circuits and electronic systems.
- CLO 6:** Evaluate and develop intelligent electronic systems using neural networks, and basic machine learning concepts while relating structured reasoning and decision-making to Nyāya logic and holistic system thinking.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Mapping of the electronic systems to universal system behaviour based on the Nyaya and other texts of Indian Knowledge Systems- System flow; abstraction; decision flow, Review of Operational Amplifier applications, Instrumentation Amplifier, Active Filters: Introduction and classification, First-order active filters, Second-order filter responses: Low Pass, High Pass, Band Pass, Notch filters, Audio filter applications: Equalizer and tone control circuits, State-variable and Biquad filters	CL, Seminars, Inquiry-Based Learning	CLO1, CLO2



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## Master of Science Electronics Semester-I

II	Higher-order filters: Butterworth, Chebyshev, Elliptic, Bessel responses, Higher-order filter realization and cascade design, Generalized Impedance Converter (GIC), Simulation of RLC ladder circuits, Filter sensitivity and Op-Amp frequency limitations, High-frequency filter considerations	CL, PBL, ICT-Enabled Learning	CLO3
III	Phase Locked Loop (PLL): Principles and building blocks Monolithic PLL ICs, Applications of PLL: Frequency multiplier, FSK demodulator, Frequency synthesizer, Clock generation and recovery Circuit Simulation: Introduction to SPICE tools (pSpice, LTSpice, PySpice), Circuit description techniques, DC, AC, and transient analysis, Simulation of Op-Amp circuits and filters	CL, ICT- enabled learning, Simulation- based learning	CLO4
IV	Nyāya Logic and Decision Systems -Logical inference; cause-effect reasoning; structured thinking, Fuzzy sets and operations, Fuzzy logic concepts and circuits, Applications of fuzzy systems in electronics, Introduction to Artificial Intelligence, Machine Learning concepts: supervised and unsupervised learning, Biological neuron and artificial neuron models, Neural network architectures. Learning algorithms (Perceptron, basic training methods). Introduction to Deep Learning	CL, Seminars, CBL, Mini Projects	CLO5, CLO6

- **Assessment Methodologies**

**(A) Internal Assessment**

**a. Internal Formative assessment**

- (a) MCQ and Objective question Quiz
- (b) Seminar/Presentation and Group Discussion
- (c) Assignments

**b. Internal Summative Assessment**

- (a) Mid-term tests

**(B) Weightage of Learning Efforts for External Assessment**

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	30	3	3	8	14
II	CLO3	30	3	3	8	14
III	CLO4	30	2	2	7	11
IV	CLO5, CLO6	30	2	2	7	11
		<b>120</b>	<b>10</b>	<b>10</b>	<b>30</b>	<b>50</b>



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### Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Mid Term Test, Class Regularity, Group Discussion	50
2	End-Semester Examination	Written Exam	50

### (C) CLOs – PLOs Matrix

CLO	PLO										
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CLO1	3	2	–	1	–	1	1	–	1	–	2
CLO2	3	2	–	1	1	2	1	–	–	–	1
CLO3	3	3	–	2	1	2	2	–	–	–	1
CLO4	2	1	–	3	2	2	2	1	–	1	2
CLO5	1	3	1	1	–	1	3	1	2	1	2
CLO6	2	3	2	1	–	1	3	2	2	2	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	Design with Operational Amplifiers and Analog Integrated Circuits	Sergio Franco	2014	McGraw-Hill
2	Op-Amps and Linear Integrated Circuits	Ramakant A. Gayakwad	4th Edition / 2015	Prentice Hall of India
3	Integrated Circuits	K. R. Botkar	1987 ISBN: 978-81-7409-208-3	Khanna Publishers
4	Applications and Design with Analog Integrated Circuits	J. Michael Jacob	2nd Edition / 1993	Prentice Hall



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5	SPICE for Circuits and Electronics using pSPICE	Muhammad H. Rashid	2nd Edition / 1999	Khanna Publishers
6	Introduction to Applied Fuzzy Electronics	Ahmad M. Ibrahim	1997 ISBN: 81-203-1487-5	Prentice Hall of India
7	Deep Learning	Ian Goodfellow, Yoshua Bengio, Aaron Courville	2016	MIT Press
8	Pattern Recognition and Machine Learning	Christopher M. Bishop	2006	Springer
9	The Navya-Nyāya Doctrine of Negation	B. K. Matilal	1968	Harvard University Press
10	Nyāya Sūtras of Gautama (with commentary)	Various (e.g., Ganganatha Jha / modern translators)	Early 20th century	Motilal Banarsidass

### • Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL Courses on Analog Circuits, AI & Machine Learning	<a href="https://nptel.ac.in">https://nptel.ac.in</a>
2	SWAYAM MOOCs on Electronics and AI	<a href="https://swayam.gov.in">https://swayam.gov.in</a>
3	MIT OpenCourseWare (Analog Circuits, Signals, AI)	<a href="https://ocw.mit.edu">https://ocw.mit.edu</a>
4	Virtual Labs (MHRD Initiative) – Circuit Simulation	<a href="https://www.vlab.co.in">https://www.vlab.co.in</a>
5	LTSpice Simulation Tool	<a href="https://www.analog.com/ltspace">https://www.analog.com/ltspace</a>
6	PySpice (Python-based Circuit Simulation)	<a href="https://pyspice.fabrice-salvaire.fr">https://pyspice.fabrice-salvaire.fr</a>
7	Analog Devices & Texas Instruments Application Notes	<a href="https://www.analog.com">https://www.analog.com</a> / <a href="https://www.ti.com">https://www.ti.com</a>
8	<i>Nyāya Sūtras (English translation and commentary)</i> – Foundational text on logic, inference, and reasoning systems in Indian philosophy	<a href="https://www.wisdomlib.org/hinduism/book/nyaya-sutras-of-gautama">https://www.wisdomlib.org/hinduism/book/nyaya-sutras-of-gautama</a>



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## Master of Science Electronics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEELE01	Microcontroller Systems: Architecture, Interfacing and Programming	3-0-1	120	04

- **Course Learning Outcomes (CLOs)**

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

- CLO1:** Students will be able to explain the fundamentals of microcontrollers and embedded systems, including the distinction between microprocessors and microcontrollers, and describe the architecture and memory organization of the 8051.
- CLO2:** Students will connect the concept of binary logic in Pingala's prosody to modern digital systems, demonstrating how recursive generation of meters parallels binary counting and coding in microcontrollers.
- CLO3:** Students will develop assembly programming skills for the 8051, applying addressing modes and instruction categories to write and execute programs for data transfer, arithmetic, logical, branch, and bit manipulation operations.
- CLO4:** Students will configure and implement system functions using timers, counters, interrupts, and serial communication, including waveform generation and interrupt-driven data transfer.
- CLO5:** Students will design and execute interfacing applications with the 8051, connecting it to LEDs, switches, LCDs, ADCs, and motors, and apply lab-based programming for control applications.
- CLO6:** Students will appreciate the richness of Indian Knowledge Systems by studying automata in *Samarangana Sutradhara*, comparing ancient mechanical devices with modern robotics, and simulating actuator control through 8051 programming to highlight continuity between traditional innovations and present-day embedded systems.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Binary Logic in Pingala's Prosody: Binary representation, recursive generation of meters, parallels with digital logic. Fundamentals & 8051 Architecture: Microprocessor vs Microcontroller, Embedded systems overview, 8051 architecture (registers, pin diagram, I/O ports, memory organization). External memory interfacing (ROM/RAM), address decoding, control signals.	Classroom Lecture (CL), Case-Based Learning (CBL), ICT-Enabled Learning (binary coding simulation), Reflective Practices (concept mapping of binary logic to digital systems)	<b>CLO1, CLO2</b>



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II	Instruction Set & Assembly Programming: Addressing modes, data transfer, arithmetic, logical, branch, bit manipulation instructions. Assembly language programming examples.	Classroom Lecture (CL), Problem-Based Learning (PBL), Simulation (assembly program execution), Self-Directed Learning (guided readings, practice tasks)	<b>CLO3</b>
III	Timers, Counters, Interrupts & Serial Communication: Operation of timers/counters, waveform generation. Interrupt system, external interrupts, serial communication basics, assembly programs for data transfer.	Classroom Lecture (CL), Micro-Projects (waveform generation tasks), ICT-Enabled Learning (virtual labs), Collaborative Learning (group debugging of interrupt programs)	<b>CLO4</b>
IV	Automata in Samarangana Sutradhara: Mechanical devices (self-moving chariots, automaton birds, temple mechanisms.: Interfacing 8051 with LEDs, switches, LCD, ADC (0804), DC motor, stepper motor. Lab-based programming for control applications. Introduction to higher microcontrollers (PIC, AVR, ARM Cortex-M).	Experiential Learning (lab-based interfacing), Case-Based Learning (ancient automata vs modern robotics), Collaborative Learning (group interfacing projects), ICT-Enabled Learning (motor control simulation)	<b>CLO5, CLO6</b>

- **Assessment Methodologies**

- (A) **Internal Assessment**

- a. **Internal Formative assessment**

- (a) MCQ and Objective question Quiz
      - (b) Seminar/Presentation and Group Discussion
      - (c) Assignments

- b. **Internal Summative Assessment**

- (a) Mid-term test

- (B) **Weightage of Learning Efforts for External Assessment**

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	30	3	3	8	<b>14</b>
II	CLO3	30	3	3	8	<b>14</b>
III	CLO4	30	2	2	7	<b>11</b>
IV	CLO5,CLO6	30	2	2	7	<b>11</b>
		<b>120</b>	<b>10</b>	<b>10</b>	<b>30</b>	<b>50</b>



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- Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Mid Term Test, Class Regularity, Group Discussion	50
2	End-Semester Examination	Written Exam	50

### (C) CLOs – PLOs Matrix

CLO	PLO										
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CLO1	3	2	2	2	1	–	1	1	–	–	1
CLO2	2	3	2	–	–	1	–	–	–	–	2
CLO3	2	3	3	2	1	–	1	1	–	–	2
CLO4	2	2	3	3	2	1	1	1	–	–	2
CLO5	2	2	3	2	3	2	2	1	1	2	2
CLO6	1	2	2	1	1	3	2	1	2	2	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	The 8051 Microcontroller and Embedded Systems	Muhammad Ali Mazidi, Janice Gillespie Mazidi, Rollin D. McKinlay	2006	PHI / Pearson
2	The 8051 Microcontroller	Kenneth J. Ayala	3rd Edition	Thomson/Cengage
3	Embedded Systems: Architecture, Programming and Design	Raj Kamal	Latest Edition	McGraw Hill
4	The 8051 Microcontroller and Embedded Systems	Muhammad Ali Mazidi, Janice Gillespie Mazidi, Rollin D. McKinlay	2006	PHI / Pearson



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### • Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	MikroE 8051 Programming Guide	<a href="https://www.mikroe.com/ebooks/architecture-and-programming-of-8051-mcus">https://www.mikroe.com/ebooks/architecture-and-programming-of-8051-mcus</a> ( <a href="#">mikroe.com in Bing</a> )
2	ARM Cortex-M Documentation	<a href="https://developer.arm.com/documentation">https://developer.arm.com/documentation</a> ( <a href="#">developer.arm.com in Bing</a> )
3	AVR Microcontroller Tutorials	<a href="https://www.electronics-tutorials.ws">https://www.electronics-tutorials.ws</a>
4	PIC Microcontroller Resources	<a href="https://www.microchip.com">https://www.microchip.com</a>
5	Pingala's Chandashastra (c. 200 BCE)	<a href="https://www.youtube.com/watch?v=xaPXwpNOSNM">https://www.youtube.com/watch?v=xaPXwpNOSNM</a>
6	Automata in Samarangana Sutradhara	<a href="https://www.youtube.com/watch?v=80fzsoJ79v0">https://www.youtube.com/watch?v=80fzsoJ79v0</a>



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## Master of Science Electronics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEELE02	Advanced Network Analysis	3-0-1	120	04

### • Course Learning Outcomes (CLOs)

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

- CLO1:** Apply fundamental circuit laws and network reduction techniques to analyze electrical networks.
- CLO2:** Formulate and solve first- and second-order network equations in the time domain.
- CLO3:** Use Laplace transform techniques to determine network response and system behavior.
- CLO4:** Analyze and interpret network functions using poles, zeros, and frequency response.
- CLO5:** Apply network theorems and two-port network parameters for solving complex circuits.
- CLO6:** Evaluate frequency-domain characteristics of circuits using Fourier analysis and filter theory.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Network elements: passive & active elements, linearity, bilateral/unilateral networks, Network variables and laws: KCL, KVL, Network reduction: series-parallel, star-delta transformation Source transformation, Mesh and nodal analysis (including matrix formulation) Transient analysis of R, L, C circuits, First-order circuits (RL, RC): natural and step response, Second-order circuits (RLC): underdamped, overdamped, critically damped response, Initial and final value conditions	Classroom Lecture (CL), Seminars (Student-led and Faculty-moderated), Inquiry-Based Learning	CLO1, CLO2
II	Laplace transform: definition, properties, ROC Initial and final value theorems, Inverse Laplace (partial fractions, convolution) Application to circuit analysis, Concept of system function Poles and zeros and their significance Network functions: impedance, admittance, transfer functions Stability criteria (basic concept), Frequency response from Laplace domain	CL, PBL, ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)	CLO3, CLO4



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## Master of Science Electronics Semester-I

III	Network theorems: Superposition, Thevenin and Norton, Maximum Power Transfer, Reciprocity, Millman's theorem Two-port networks: Z, Y, h, ABCD parameters, Conversion between parameters, Interconnection of two-port networks (series, parallel, cascade) Network topology: Graph theory basics, Trees, links, loops, cut-sets, Incidence matrix	CL, ICT Enabled Learning, CBL	CLO5
IV	Sinusoidal steady-state analysis Resonance in RLC circuits (series and parallel) Quality factor and bandwidth Passive filters: Low-pass, high-pass, band-pass, band-stop, Filter characteristics Attenuators and equalizers Fourier series: Trigonometric and exponential forms, Convergence conditions Fourier transform and properties Application to network analysis	CL, Seminars, CBL, Micro-Projects/Mini Research Tasks	CLO6

- **Assessment Methodologies**

- (A) **Internal Assessment**

- a. **Internal Formative assessment**

- (d) MCQ and Objective question Quiz
      - (e) Seminar/Presentation and Group Discussion
      - (f) Assignments

- b. **Internal Summative Assessment**

- (b) Mid-term test

- (B) **Weightage of Learning Efforts for External Assessment**

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	30	3	3	8	14
II	CLO3, CLO4	30	3	3	8	14
III	CLO5	30	2	2	7	11
IV	CLO6	30	2	2	7	11
		<b>120</b>	<b>10</b>	<b>10</b>	<b>30</b>	<b>50</b>



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## Master of Science Electronics Semester-I

### • Assessment and Evaluation

Sr.No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Mid Term Test, Class Regularity, Group Discussion	50%
2	End-Semester Examination	Written Exam	50%

### (C) CLOs – PLOs Matrix

CLO	PLO										
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CLO1	3	2	–	2	1	–	–	–	–	–	1
CLO2	3	2	–	2	1	1	–	–	–	–	1
CLO3	3	2	–	3	–	2	–	–	–	–	1
CLO4	3	2	–	3	–	3	1	–	–	–	1
CLO5	3	3	–	2	1	2	1	–	–	–	1
CLO6	3	2	–	3	–	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	Network Analysis	M.E. Van Valkenburg	3rd Edition	Prentice Hall of India
2	Network Analysis and Synthesis	C.L. Wadhwa	Latest Edition	New Age International Publishers
3	Networks and Systems	D. Roy Choudhury	Latest Edition	New Age International Publishers
4	Engineering Circuit Analysis	William H. Hayt, Jack E. Kemmerly, Steven M. Durbin	8th Edition	McGraw-Hill Education
5	Circuit Theory	A. Chakrabarti	Latest Edition	Dhanpat Rai & Co.



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Sr. No.	Title	Author(s)	Edition / Year	Publisher
6	Linear Systems and Signals	B.P. Lathi	2nd Edition	Oxford University Press

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL Course on Network Theory by IIT Kharagpur (Prof. A. Chakrabarti)	<a href="https://nptel.ac.in/courses/108105159">https://nptel.ac.in/courses/108105159</a>
2	NPTEL Course on Circuits and Systems (IIT Madras)	<a href="https://nptel.ac.in/courses/108106075">https://nptel.ac.in/courses/108106075</a>
3	MIT OpenCourseWare – Circuits and Electronics	<a href="https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/">https://ocw.mit.edu/courses/6-002-circuits-and-electronics-spring-2007/</a>
4	Lecture Notes on Network Analysis	<a href="https://lecturenotes.in/network-analysis">https://lecturenotes.in/network-analysis</a>
5	Network Theory Notes (Smartzworld)	<a href="https://www.smartzworld.com/notes/network-theory-pdf-notes-nt-pdf-notes/">https://www.smartzworld.com/notes/network-theory-pdf-notes-nt-pdf-notes/</a>
6	GATE/UGC-NET Electronics Preparation Resources (Made Easy / ACE Academy)	<a href="https://www.madeeasy.in/">https://www.madeeasy.in/</a> / <a href="https://www.aceacademy.org">https://www.aceacademy.org</a>



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## Master of Science Electronics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NEELE03	Biomedical and Analytical Instruments	3-0-1	120	04

### • Course Learning Outcomes (CLOs)

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

- CLO1:** Explain and apply the principles of pH measurement and spectroscopic techniques, including UV-Visible, IR, NMR, and HPLC, and demonstrate their application in chemical and biological analysis, while comparing modern pH measurement with Ayurvedic concepts of *Dravyaguna Vigyana*.
- CLO2:** Analyze instrumentation and applications of advanced spectroscopic and microscopic techniques such as Atomic Absorption Spectrophotometers, Gas Chromatography, HPLC, and Electron Microscopy, relating traditional methods of substance characterization with modern analytical tools.
- CLO3:** Interpret cardiovascular physiology using modern and traditional diagnostic approaches by explaining cardiovascular circulation, ECG waveforms, pacemakers, and sphygmomanometer methods, while integrating *Nadi Pariksha* (pulse diagnosis) with modern cardiovascular physiology.
- CLO4:** Demonstrate understanding of ultrasonic techniques and biomedical applications by describing ultrasonic transducers, transmission modes, multi-element systems, and their applications in medical imaging, connecting ultrasonic diagnostic methods with traditional approaches to organ health assessment.
- CLO5:** Evaluate renal physiology and artificial kidney technologies by analyzing kidney function, principles of hemodialysis machines, and artificial kidney systems, while comparing Ayurvedic perspectives on renal health with modern dialysis technologies.
- CLO6:** Integrate modern scientific methods with Indian Knowledge Systems for holistic biomedical analysis by synthesizing knowledge of spectroscopy, physiology, and diagnostic tools with IKS concepts (*Dravyaguna Vigyana*, *Nadi Pariksha*) to propose culturally resonant, interdisciplinary approaches in biomedical sciences.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	pH meters, Principle of pH measurements, Electrodes for pH measurements, Dravyaguna Vigyana and Spectroscopy : UV-Visible, IR, NMR, HPLC, and modern spectroscopic analysis) UV-Visible Spectrophotometer: Principle & Working, Infrared Spectrophotometer: Principle & Working	Classroom Lecture (CL), Case-Based Learning (CBL), ICT-Enabled Learning (Virtual Labs)	CLO1



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II	Atomic Absorption Spectrophotometers, NMR: Instrumentation & Applications, Gas Chromatography: Instrumentation & Applications, High Performance Liquid Chromatography (HPLC), Electron Microscope	Classroom Lecture (CL), Seminars (Student-led and Faculty-moderated), Industrial/Institutional Visit	CLO2
III	Nadi Pariksha and Cardiovascular Physiology: Cardiovascular circulation system, Electrocardiographs, Cardiac Muscle Physiology, ECG Machine: Leads & Wave Configuration, Sphygmomanometer method, Pacemakers: Need, External, Implantable, Recent Developments	Classroom Lecture (CL), Simulation and Role-Play (Diagnostic Scenarios), Collaborative Learning (Peer Discussion)	CLO3
IV	Ultrasonic transducers, Properties of Ultrasound, Modes of Transmission, Ultrasonic measuring system, Ultrasonographic techniques, Multi-element Transducer system, Applications, Kidney Function, Hemodialysis machines, Artificial Kidney & Dialysis	Classroom Lecture (CL), Micro-Projects/Mini Research Tasks, Reflective Practices (Learning Journals)	CLO4, CLO5, CLO6

### • Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment

- MCQ and Objective question Quiz
- Seminar/Presentation and Group Discussion
- Assignments

##### b. Internal Summative Assessment

- Mid-term test

#### (B) Weightage of Learning Efforts for External Assessment

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	3	8	14
II	CLO2	30	3	3	8	14
III	CLO3	30	2	2	7	11
IV	CLO4, CLO5, CLO6	30	2	2	7	11
		<b>120</b>	<b>10</b>	<b>10</b>	<b>30</b>	<b>50</b>



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## Master of Science Electronics Semester-I

### Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Mid Term Test, Class Regularity, Group Discussion	50%
2	End-Semester Examination	Written Exam	50%

### (C) CLOs – PLOs Matrix

CLO	PLO										
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CLO1	3	2	1	3	3	1	-	2	2	1	2
CLO2	3	3	2	3	3	2	1	2	2	1	2
CLO3	2	2	3	2	2	3	1	2	2	2	3
CLO4	2	2	2	3	3	3	2	2	2	2	3
CLO5	2	2	2	2	3	2	2	2	3	2	3
CLO6	3	2	2	2	3	3	2	3	3	2	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	Handbook of Biomedical Instrumentation	R.S. Khandpur	3rd Edition, 2024	McGraw Hill Education India (ISBN: 9789355325157)
2	A Course in Electrical and Electronic Measurements and Instrumentation	A.K. Sawhney	Latest Reprint	Dhanpat Rai & Co. (India) (ISBN: 9788177001006)



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3	Biomedical Instrumentation	Arumugam	2nd Edition	Anuradha Publications (India) (ISBN: 9788189801323)
4	Introduction to Instrumentation and Measurements (Special Indian Edition)	Robert B. Northrop	2nd Edition	CRC Press / Indian Edition (ISBN: 9788177588835)

### • Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL Online Course – Analytical Instrumentation (IIT Madras lectures on spectrophotometry, chromatography, electrodes)	<a href="https://nptel.ac.in/courses/115106145">https://nptel.ac.in/courses/115106145</a>
2	NPTEL Online Course – Biomedical Instrumentation (IIT Kharagpur/IIT Madras, ECG, dialysis, imaging systems)	<a href="https://nptel.ac.in/courses/108105048">https://nptel.ac.in/courses/108105048</a>
3	Virtual Labs – Electrical & Biomedical Measurements (MHRD Govt. of India initiative, simulation-based experiments for spectroscopy, pH meters, ECG)	<a href="https://vlab.amrita.edu/index.php?sub=BE">https://vlab.amrita.edu/index.php?sub=BE</a> ( <a href="#">vlab.amrita.edu in Bing</a> )
4	PubMed Central (PMC) – Open Access Biomedical & Analytical Research Articles (recent developments in chromatography, implantable devices, ultrasonography)	<a href="https://www.ncbi.nlm.nih.gov/pmc/">https://www.ncbi.nlm.nih.gov/pmc/</a> ( <a href="#">ncbi.nlm.nih.gov in Bing</a> )
5	Introduction to Dravyaguna Vigyana	<a href="https://www.youtube.com/watch?v=iD5zpMiZz80">https://www.youtube.com/watch?v=iD5zpMiZz80</a>
6	Physiology of the pulse from the purview of Nadi Vijnana	<a href="https://www.youtube.com/watch?v=uV5qQyk8FQE">https://www.youtube.com/watch?v=uV5qQyk8FQE</a>



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## Master of Science Electronics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCELE03	Practicals	0-8-1	120	04

### • Course Learning Outcomes (CLOs)

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

**CLO1:** Design and simulate digital circuits, predict expected outputs, implement in hardware, and analyze performance by comparing experimental results with theoretical and simulated outcomes.

**CLO2:** Write, simulate, and debug microcontroller assembly language programs, predict functional behavior, implement interfacing tasks, and validate results through execution and analysis.

**CLO3:** Perform experiments to measure semiconductor device characteristics, predict behavior using theory and analyze results to extract parameters and explain deviations.

**CLO4:** Explain working principles, predict instrument response, perform experiments using analytical and measuring instruments, and evaluate performance through observed results.

**CLO5:** Engage in pre-lab design and simulation, implement systems systematically, and ensure safe, ethical, and environmentally responsible laboratory practices.

**CLO6:** Critically analyze experimental data by comparing hardware, simulation, and theoretical results, explain discrepancies, and communicate findings through structured technical reports.

Unit	List of Suggested Practicals	Learning Pedagogies*	CLO(s)
I	Experiments based on basics of Digital Circuits	Suggested as follows:	CLO1, CLO5, CLO6
II	Experiments based on Microcontroller Assembly Language Programming and Simulation	PBL, ICT-Enabled Learning, Simulation, Inquiry-Based	CLO2, CLO5, CLO6
III	Experiments based on characterization of Semiconducting material/devices	Learning Self-Directed Learning	CLO3, CLO5, CLO6
V	Experiments based on Analytical and Measuring Instruments	Learning Self-Directed Learning	CLO4, CLO5, CLO6



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## Master of Science Electronics Semester-I

### Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment

- Performance of Experiment and Execution
- Writing of Laboratory Journal and Technical Documentation
- Viva Voce Assessment

##### b. Internal Summative Assessment

- Mid-term tests

#### (B) Weightage of Learning Efforts for External Assessment

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, CLO6	30	2	3	7	12
II	CLO2, CLO5, CLO6	30	3	3	7	13
III	CLO3, CLO5, CLO6	30	2	3	7	12
IV	CLO4, CLO5, CLO6	30	3	3	7	13
		120	10	12	28	50

#### □ Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	<ul style="list-style-type: none"><li>Experimental Performance and Execution</li><li>Results Reporting and Technical Documentation</li><li>Viva Voce Assessment</li><li>Laboratory Conduct and Practices</li><li>Regularity and Active Participation</li><li>Group Discussion and Collaborative Learning</li></ul>	50



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## Master of Science Electronics Semester-I

2	End-Semester Examination	Experimental Performance, Analysis, Reporting of Readings, and Conceptual Understanding	50
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### (C) CLOs – PLOs Matrix

CLO	PLO										
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CLO1	3	2	1	3	2	2	2	1	–	1	1
CLO2	2	2	3	2	2	1	2	1	–	1	2
CLO3	3	1	–	2	3	2	1	1	1	1	1
CLO4	2	1	–	2	3	2	1	1	1	1	1
CLO5	1	1	–	1	2	–	1	1	3	2	2
CLO6	2	1	–	2	2	1	1	3	1	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:

- i. Lab Manuals
- ii. Textbooks of respective course
- iii. Simulation Tools
- iv. Virtual Lab/NPTEL videos with facility for projection
- v. Hardware Setup
- vi. Computer and Printer Set up for documentation and graphs



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## Master of Science Electronics Semester-I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSE	P2S01NCELE04	Project Work	0-2-0	60	02

### • Course Learning Outcomes (CLOs)

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

**CLO1:** Design and analyze electronic circuits using analog and digital ICs, selecting appropriate components based on datasheet specifications

**CLO2:** Simulate electronic circuits using EDA tools to predict performance and validate design outcomes

**CLO3:** Operate electronic instruments (CRO/DSO, multimeter, function generator, power supply) to measure and interpret circuit behavior

**CLO4:** Design PCB schematics and layouts, and fabricate basic PCBs using standard techniques

**CLO5:** Implement and assemble electronic circuits on breadboard and PCB, troubleshoot faults, and optimize system performance

**CLO6:** Test, validate, and evaluate system performance, and communicate results through technical reports and presentations

Phase	Suggested Flow of Project Work	Learning Pedagogies*	CLO(s)
I	<p><b>Circuit Design, Simulation, Instrumentation, and PCB Development</b>  <i>Develop hands-on skills in circuit analysis, simulation, and PCB design.</i></p> <p>(A) Analysis of basic electronic circuits using analog and digital ICs            (B) Component selection and datasheet interpretation            (C) Hands-on use of electronic instruments            (D) Simulation and prediction of circuit performance using EDA tools            (E) Design and selection of a suitable project            (F) PCB schematic design and layout using tools            (G) Basic PCB fabrication techniques</p>	<p>Suggested as follows:</p> <p>PBL,            Collaborative Learning,            Experiential Learning,            Simulation, ICT-Enabled Learning,            Reflective Practices,            Reflective writing,</p>	<p>CLO1,            CLO2,            CLO3,            CLO4</p>
II	<p><b>Project Implementation, Testing, and Performance Evaluation</b>  <i>Apply hands-on skills for implementation, testing, and validation of the project.</i></p> <p>(A) Breadboard implementation and functional verification</p>	<p>Inquiry-Based Learning,            Self-Directed</p>	<p>CLO5,            CLO6</p>



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	(B) Troubleshooting and circuit optimization for improved performance (C) PCB assembly and soldering (D) Testing, validation, and performance evaluation of the system (E) Assembling and final hardware realization (F) Preparation of project report with analysis of simulation and experimental results (G) Presentation and viva voce based on design, testing, and performance	Learning	
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### Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment

- (a) Project Implementation and Hands-on Execution
- (b) Presentation

##### b. Internal Summative Assessment

- (a) Mid-term test

#### (B) Weightage of Learning Efforts for External Assessment

Phase	Aligned COs	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	30	2	4	6	12
II	CLO5, CLO6	30	3	3	7	13
		60	5	7	13	25

#### □ Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Assessment of conceptual understanding and hands-on skill development through project implementation, experimentation, testing, and viva voce evaluation	25



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## Master of Science Electronics Semester-I

2	End-Semester Examination	Final Project Evaluation (Design, Implementation, Testing, and Performance) Project Report and Technical Documentation Viva Voce Examination	25
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### (C) CLOs – PLOs Matrix

CLO	PLO										
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10	PLO11
CLO1	3	3	1	2	1	2	2	1	–	1	1
CLO2	2	2	1	3	1	1	2	1	–	1	2
CLO3	2	1	–	2	3	2	1	1	–	1	1
CLO4	2	3	1	2	2	1	2	1	1	1	2
CLO5	3	3	1	2	2	2	3	1	1	2	2
CLO6	2	2	–	2	2	1	2	3	1	2	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:

- Lab Manuals
- Textbooks of respective course
- Simulation Tools
- Virtual Lab/NPTEL videos with facility for projection
- Hardware Setup
- Computer and Printer Set up for documentation