# 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. Electronics Semester-II

| Course Type | Course Code | Course Title | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| | | | L-P-T | | |
| DSC | P2S02NCELE01 | Electromagnetics and Antenna Technology | 3-0-1 | 120 | 04 |

**Course Learning Outcomes (CLOs)**

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

**CLO1:** Explain the fundamental electromagnetic laws, Maxwell's equations and vector calculus to analyze and solve problems in electrostatics, magnetostatics and time- varying fields using mathematical formulations with conceptual understanding of energy fields and space (Akasha) from Indian Knowledge Systems.

**CLO2:** Evaluate electromagnetic wave propagation in different media, calculate wave parameters and apply Poynting's theorem for energy analysis, with interpretation of wave behavior as structured vibrations (Nāda) and resonance.

**CLO3:** Design and analyse Transmission lines using telegraphic equations and Smith charts, design matching devices for RF/microwave circuits, incorporating principles of wave transmission and resonance analogous to vibration-based systems.

**CLO4:** Analyze TE/TM modes in rectangular and circular waveguides; evaluate waveguide components including junctions, isolators, and circulators, with understanding of guided and directional energy propagation in light of traditional insights on wave behavior.

**CLO5:** Design various antennas (dipole arrays, Yagi-Uda, horn, parabolic reflectors); calculate antenna parameters and select appropriate systems for communication applications, correlating antenna resonance and radiation with structural resonance concepts from Indian Knowledge Systems.

**CLO6:** Analyze microwave tubes, solid-state devices and detectors, evaluate their suitability for communication and radar applications, integrating interdisciplinary understanding of wave–matter interaction.

| Unit | Course Content | Learning Pedagogies * | CLO(s) |
|---|---|---|---|
| 1. | Electromagnetic Field Theory and Wave Propagation: Introduction of Electromagnetics, Pancha Mahabhuta : Concept of Space (Akasha) and Energy Fields, Electrostatics – Review of Laws of Electrostatics – Coulomb's Law, Proof of Gauss law on arbitrary surface, Poison and Laplace equations, Green's Theorem, Potential energy and energy density. Magnetostatics – Biot-Savart law, Ampere's law, Energy density in magnetic field, Maxwell's equations : Integral and Differential Forms, Time - varying fields and Displacement current, Scalar and Vector Potential, Applications of Gauge transformations, Poynting's theorem and Energy flow, Plane wave propagation in Free space, Conducting medium and Dielectric medium | 1,2,3,10,12, 14,15 | CLO1, CLO2 |

| | | | |
|---|---|---|---|
| 2. | Transmission Lines and RF Structures: Transmission line theory and Telegrapher's Equations, Nāda : Vibration and Wave Theory, Standing wave ,Reflection coefficient, VSWR, Smith Chart and its applications Types of Transmission lines : Coaxial Cable, Twin wire line, Strip and Microstrip line, Impedance matching : Quarter and Half wavelength lines, Stubs and Baluns, RF passive components: Couplers, Filters, Attenuators , Introduction to RF design and PCB considerations | 2,3,4,5,6,12, 16 | CLO3 |
| 3. | Waveguides and Microwave Engineering: Wave guides : Rectangular and Circular, Surya Siddhanta : Ancient Indian Insights on Light and Wave Propagation, Wave propagation in Rectangular and Circular waveguides, Wave-guide modes : Transverse Electric (TE) Mode, Transverse Magnetic (TM) Mode, Cutoff frequency, Waveguides components - Junctions, couplers, Cavity Resonators : Isolators and circulators, Matching and attenuations, Types of Microwave sources: Klystron, Magnetron, Traveling Wave Tube , Microwave Detectors : Gunn diode, PIN diode, Schottky diode, Introduction to RF MEMS and microwave subsystems. | 2,3,5,6,8,10, 17 | CLO4, CLO6 |
| 4. | Antenna Technology and Modern Applications: Radiation mechanism and antenna parameters, Resonance and Structural Response in Sthapatya Veda, Basic antennas: Dipole, Monopole, Loop, Antenna arrays and beamforming , Yagi-Uda, Log-periodic, Horn and Reflector antennas , Microstrip patch antenna (design concepts), MIMO and smart antennas, Antennas for 5G, IoT, RFID and wearable devices, Antenna measurement techniques, Applications of different antennas | 3,4,6,7,9,11, 17 | CLO5 |

- **(*) Learning Pedagogies/Methods**
  1. Concept-Based Teaching with Visualization
     (Use of diagrams, field visualization and animation tools for EM)
  2. Problem-Based Learning (PBL)
     ( Numerical problem solving for Maxwell equations, transmission lines, waveguides
  3. Simulation-Based Learning
     ( Use of MATLAB, HFSS, CST for antenna and EM analysis
  4. Design-Oriented Learning
     (Antenna design (dipole, microstrip, arrays) and matching networks)
  5. Experimental & Laboratory Learning
     ( Hands-on exposure to transmission lines, antennas, and RF measurements)
  6. Project-Based Learning
     (Micro-projects/Mini research Tasks on IoT/5G antenna systems and RF applications)
  7. Collaborative & Active Learning
     (Group discussions, seminars, and technical presentations: Student-led and Faculty-moderated)
  8. Case-Based Learning (CBL)

9. Industrial Visit/Field Visit/Institutional Visit
10. Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
11. Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
12. ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
13. Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
14. Flipped Classroom Approach
15. Inquiry-Based Learning
16. Self-Directed Learning (Guided Readings, Concept Exploration Tasks)
17. Guest lectures from industry experts

- **Assessment Methodologies**

**(A) Internal Assessment (50%)**

**a. Internal Formative assessment (20%)**

(a) Assignments/Problem Sets
(b) Seminar/Presentation
(c) Simulation/ Design Exercises
(d) Attendance and Class Participation

**b. Internal Summative Assessment (30%)**

(a) Mid-term examination

**(B) External Assessment (50%)**

| Unit | Aligned CLOs | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) | | | Total Marks |
|---|---|---|---|---|---|---|
| | | | Remember (R) | Understanding (U) | Application/ Analyse & above (A) | |
| 1 | CLO1,CLO2 | 30 | 2 | 4 | 8 | 14 |
| 2 | CLO3 | 30 | 2 | 4 | 6 | 12 |
| 3 | CLO4,CLO6 | 30 | 2 | 4 | 6 | 12 |
| 4 | CLO5 | 30 | 2 | 4 | 8 | 14 |
| | | 120 | 04 | 08 | 38 | 50 |

- **Assessment and Evaluation**

| Sr. No. | Assessment/Evaluation | Component | Weightage (%) |
|---|---|---|---|
| 1 | Continuous Internal Evaluation | 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** | **PLO11** |
| **CLO1** | 3 | 2 | 1 | 2 | 2 | 1 | – | 1 | – | – | 1 |
| **CLO2** | 3 | 3 | 1 | 3 | 3 | 3 | – | 2 | – | – | 1 |
| **CLO3** | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | – | – | 1 |
| **CLO4** | 2 | 3 | 2 | 3 | 3 | 2 | 1 | 1 | – | – | 1 |
| **CLO5** | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 2 |
| **CLO6** | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 1 | 1 | 2 |

(D) 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 | Engineering Electromagnetics | Nathan Ida | 4th, 2021 | Springer |
| 2 | Advanced Engineering Electromagnetics | Constantine A.Balanis | 3rd, 2024 | Wiely |
| 3 | Electromagnetic Field Theory Fundamentals | Bhag Singh Guru,Huseyin Hiziroglu | Latest Indian Reprint | Cambridge Publications |
| 4 | Elements of Electromagnetics | Matthew N.O.Sadiku | 7th, 2018 | Oxford Publication |
| 5 | Electromagnetic Field theory and Transmission Lines | G.S.N.Raju | 1st, 2005 | Pearson Education, South Asia |
| 6 | Introduction to Electrodynamics | David J. Griffith | 4th, 2013 | Prentice Hall of India Pvt. Ltd., New Delhi, INDIA |
| 7 | Antenna Theory: Analysis and Design | Constantine A.Balanis | 4th 2024 | Wiely |
| 8 | Antennas and Propagation for 5G and Beyond | Qammer H.Abbasi et.al. | 1st, 2020 | IET |
| 9 | Electronics Communications Systems | George Kennedy | 4th,1999 | McGraw Hill International,N.Y., USA |
| 9 | Electromagnetism (Theory and Applications) | Ashutosh Pramanik | 2nd, 2009 | Prentice Hall of India Pvt. Ltd. ,New Delhi, INDIA |

| | | | | |
|---|---|---|---|---|
| 10 | Traditional Knowledge System in India | Jha, A | 1st, 2009 | Atlantic Publishers & Distributors, New Delhi. |

**Online Resources (Open Source)**

| Sr. No. | Description of Resource(s) | Weblink |
|---|---|---|
| 1. | NPTEL – Electromagnetic Theory | https://onlinecourses.nptel.ac.in/noc25_ee149/preview?utm_source |
| 2. | NPTEL – Analysis and Design of Microwave Antennas | https://onlinecourses.nptel.ac.in/noc24_ee150/preview?utm_source |
| 3. | Software Tools | Software Tools: MATLAB, Smith Chart tools, HFSS/CST Microwave Studio |
| 4. | specialized academic book focusing on electromagnetic and antenna-related theory. | https://www.worldscientific.com/worldscibooks/10.1142/2599 |
| 5. | standard reference textbook in antenna theory | http://onlinelibrary.wiley.com/doi/10.1002/9781119079699.refs/pdf |
| 6. | Industry-oriented article | https://interferencetechnology.com/antenna-fundamentals/ |
| 7. | Course on Indian Knowledge System (IKS): Concepts and Applications in Science | https://iksindia.org/course-list.php?utm_source=chatgpt.com |

## M.Sc. Electronics Semester-II

| Course Type | Course Code | Course Title | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| | | | L-P-T | | |
| DSC | P2S02NCELE02 | Microprocessors and Systems on Chip (SoC) | 3-0-1 | 120 | 04 |

**Course Learning Outcomes (CLOs)**

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

**CLO1**: Explain the architecture and functioning of Intel 8086 microprocessor. Identify registers, flags, memory organization, and instruction formats.

**CLO2:** Write and debug assembly language programs for 16-bit processors. Use different addressing modes and instruction types effectively.

**CLO3**: Design and analyse interfacing of memory and peripheral devices (e.g., keyboards, displays, ADC/DAC). Understand interrupt handling and DMA operations.

**CLO4:** Interpret timing diagrams and control signals. Analyse bus cycles and system performance.

**CLO5**: Explain characteristics of real-time systems (hard vs soft real-time). Understand scheduling policies. Understand structure and services of RTOS. Implement basic real-time tasks.

**CLO6:** Develop simple embedded systems integrating microprocessors and real-time concepts, Apply real-time constraints in practical applications (e.g., automation, robotics, control systems).

| Unit | Course Content | Learning Pedagogies* | CLO(s) |
|---|---|---|---|
| I | Software Architecture of the 8086 microprocessor, Combinatorics and Binary Logic, Enumeration Methods, Binary patterns in Sanskrit prosody, Memory address space & data organization, Segment registers & memory segmentation, Dedicated & general use of memory, Instruction Pointer, Data Registers, Status Registers, Generating a memory address, The Stack, I/O address space, Addressing modes of 8086, Debug Program & Debug Commands. The 8086 Instruction set, Data Transfer, Arithmetic, Logic, Shift, Rotate, Flag Control, Compare & Jump Instructions, Subroutine & Subroutine handling Instructions, Loop & The Loop handling Instructions, String & The String handling Instructions, Examples | 1,2,3,12 | CLO1<br>CLO2 |
| II | The 8086 Microprocessor Pin-out Diagram, Minimum & Maximum mode systems, Minimum system mode interface, Maximum mode system interface, System clock, BUS cycle, Memory interface, hardware organization of the memory address space, Memory bus status code, Memory control signals, Read & Write bus cycles, Demultiplexing the address/data bus, Program & Data storage memory circuits | 1,4,8,9,14 | CLO1<br>CLO3<br>CLO4 |

| | | | |
|---|---|---|---|
| III | Input & Output interface, I/O data transfers, Input & Output Instructions, Input & output bus cycles, Eight byte wide output Ports, Interfacing 8255A parallel ports at even & odd boundaries, Types of interrupts, Interrupt address pointer table, Masking of interrupts, External hardware interrupt interface & sequence, Software interrupts, Non-maskable interrupts, Reset, Internal interrupt functions | 1, 4,10 | CLO3<br>CLO4 |
| IV | Real Time OS, Rule based systems in Nyāya and Vyākarana structured logic, Fundamentals of RTOS, RTOS Vs General OS, Task Scheduling, Fixed Time Switching, Inter-task Communication & Synchronization, Dynamic Memory Allocation, Application of RTOS, Architecture of Embedded Systems, RTOS Architecture. Programmable System on Chip (PSoC), Characteristics of PSoC, System Overview, PSoC CPU, Frequency Generator, Microcontroller Power Consumption, Reset, Digital & Analog I/O, Accessing Programmable Digital Blocks, PWM-LED–LCD-ADC interface using PSoC | 1,5,6,7,11,12,13,14 | CLO5<br>CLO6 |

**(*) Learning Pedagogies/Methods**

(a) Classroom Lecture (CL)
(b) Assembly Language Practice: Learning-by-doing (hands-on coding)
(c) Simulation-Based Learning: Interactive simulation learning
(d) Hardware Exposure: Experiential learning
(e) Hands-On with RTOS APIs: API-driven practical learning
(f) Project-Based Learning: Small PSoC Practical & Projects
(g) Seminars (Student-led and Faculty-moderated)
(h) Case-Based Learning (CBL)
(i) Industrial Visit/Field Visit/Institutional Visit
(j) Problem-Based Learning (PBL)
(k) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
(l) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
(m) Experiential Learning (Internship-linked Activities, Practice-based Tasks)
(n) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)

- **Assessment Methodologies**

**(A) Internal Assessment**

**a. Internal Formative assessment**

(a) MCQ and Objective question Quiz
(b) Seminar/Presentation and Group Discussion
(c) Assignments
(d) Attendance and Class Participation

**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** | CLO1,2 | 30 | 3 | 3 | 8 | **14** |
| **II** | CLO1,3,4 | 30 | 3 | 3 | 8 | **14** |
| **III** | CLO3,4 | 30 | 2 | 2 | 7 | **11** |
| **IV** | CLO5,6 | 30 | 2 | 2 | 7 | **11** |
| | | **120** | **10** | **10** | **30** | **50** |

- **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 |
| **CLO2** | 2 | 3 | 2 | 3 | 1 | – | – | 2 | – | – | 1 |
| **CLO3** | 2 | 3 | 3 | 2 | 2 | 2 | – | 1 | – | – | 1 |
| **CLO4** | 2 | 2 | 2 | 3 | 2 | 2 | – | 1 | – | – | 1 |
| **CLO5** | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 2 |
| **CLO6** | 2 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 1 | 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 | 16-bit and 32-bit Microprocessors Architecture, Software and Interfacing Techniques | Avtar Singh and Walter A. Trible | First, 1991 | Printice Hall, Englewood Cliff, N.J.,USA |
| 2 | The 8088 Microprocessor Programming, Interfacing, Software, Hardware & Applications | Avtar Singh and Walter A. Trible | First, 1989 | Printice Hall, Englewood Cliff, N.J.,USA |
| 3 | The 8086 and 8088 Microprocessors Programming, Interfacing, Software, Hardware & Applications | Walter A. Trible and Avtar Singh | Fourth, 2003 | Printice Hall of India Pvt. Ltd., New Delhi, INDIA |
| 4 | Microprocessor & Microcomputer based system design | Mohamed Rafiquzzaman | Second, 1995 | Universal Book Stall, New Delhi, INDIA |
| 5 | Real-Time Concepts for Embedded Systems, | Qing Li and Carolyn Yao | First, 2003 | CMP Books, USA |
| 6 | Designer Guide to the Cypress PSoC | Robert Ashby | First, 2005 | Newnes, USA |

- **Online Resources (Open Source)**

| Sr. No. | Description of Resource(s) | Weblink |
|---|---|---|
| 1 | Greeks for Greeks | https://www.geeksforgeeks.org/search/?gq=8086%20Microprocessor |
| 2 | Intel | https://www.intel.com/content/www/us/en/search.html#q=8086%20Microprocessor&cf-tabfilter=Developers |
| 3 | You tube | https://www.youtube.com/watch?v=A9ajXMwsuI0&list=PLgwJf8NK-2e5QRoJek5ApkZEkMgTIYLu7&index=1 to 54 |
| 3 | Free RTOS | https://freertos.org/ |
| 4 | Infineon | https://www.infineon.com/ |

## M.Sc. Electronics Semester-II

| Course Type | Course Code | Course Title | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| | | | L-P-T | | |
| DSE | **P2S02NEELE01** | **C++ for Microcontrollers and Firmware** | 3-0-1 | **120** | 04 |

- **Course Learning Outcomes (CLOs)**

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

**CLO1:** Demonstrate a comprehensive understanding of quantum mechanical principles and their application to band theory and semiconductor physics

**CLO2:** Analyze charge carrier transport phenomena and evaluate electrical properties of semiconductor materials using appropriate measurement techniques

**CLO3:** Examine and interpret the behavior of semiconductor junctions, interfaces, and device structures

**CLO4:** Apply the principles of semiconductor devices to optoelectronic and photovoltaic systems, including solar energy applications

**CLO5:** Design, model, and critically evaluate semiconductor devices and their performance for practical electronic and photonic applications

| Unit | Course Content | Learning Pedagogies* | CLO(s) |
|---|---|---|---|
| I | Algorithmic Traditions in Ancient Indian Mathematics : Introduces programming fundamentals through C++ as the first high-level language. Covers algorithms, flowcharts, pseudocode, data types, variables, operators, and control structures. Functions, arrays, strings, and pointers are taught with emphasis on problem-solving and structured coding practices | Classroom Lecture (CL), Problem-Based Learning (PBL), ICT-Enabled Learning, Self-Directed Learning | **CLO1** |
| II | Panini's Grammar and Modern Programming Syntax : Focuses on object-oriented concepts such as classes, objects, constructors, destructors, inheritance, polymorphism, and encapsulation. Includes memory management techniques (dynamic allocation, references) and exception handling for reliability. Students practice writing reusable libraries for microcontroller projects | Classroom Lecture (CL), Case-Based Learning (CBL), Collaborative Learning, Simulation and Role-Play | **CLO2, CLO5** |
| III | Provides an overview of microcontroller architectures (ARM Cortex, AVR, PIC), registers, memory mapping, and GPIO programming. Introduces firmware concepts including bootloaders, startup code, and initialization routines. Covers peripheral interfacing (digital I/O, timers, interrupts, ADC/DAC) and embedded C++ coding standards with optimization techniques | Classroom Lecture (CL), ICT-Enabled Learning, Experiential Learning, Inquiry-Based Learning | **CLO3, CLO4, CLO5** |

| | | | |
|---|---|---|---|
| IV | Consolidates learning through applied projects and a case study such as designing a smart sensor system. Students work through problem definition, peripheral configuration, data acquisition, debugging, and testing. Mini-projects include LED blinking with timers, UART communication, and simple data logging. Concludes with documentation, performance evaluation, and ethical considerations in firmware design | Micro-Projects/Mini Research Tasks, Problem-Based Learning (PBL), Collaborative Learning, Reflective Practices | **CLO4, CLO6** |

- **Assessment Methodologies**

**(A) Internal Assessment**

**a. Internal Formative assessment**

(a) MCQ and Objective question Quiz
(b) Seminar/Presentation and Group Discussion
(c) Assignments
(d) Attendance and Class Participation

**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** | | 30 | 3 | 3 | 8 | **14** |
| **II** | | 30 | 3 | 3 | 8 | **14** |
| **III** | | 30 | 2 | 2 | 7 | **11** |
| **IV** | | 30 | 2 | 2 | 7 | **11** |
| | | **120** | **10** | **10** | **30** | **50** |

- **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 |
| **CLO2** | 2 | 3 | 2 | 2 | 2 | - | - | 2 | - | - | 1 |
| **CLO3** | 2 | 2 | 3 | 3 | 2 | 1 | - | 2 | - | - | 1 |
| **CLO4** | 1 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | - | 1 |
| **CLO5** | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 |
| **CLO6** | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 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 | Programming with C++ | D. Ravichandran | – | Tata McGraw-Hill Education, ISBN: 9780070616677 |
| 2 | Object-Oriented Programming with C++ | E. Balagurusamy | – | McGraw-Hill Education (India), ISBN: 9789353162344 |
| 3 | Microcontrollers: Architecture, Programming, Interfacing and System Design (2nd Edition) | Raj Kamal | 2nd Edition | Pearson Education India, ISBN: 9788131759905 |
| 4 | Modern C++ Embedded Systems Programming: Build Real-Time, Safe, and Scalable Firmware | Maya Posch | – | Packt Publishing (Indian Edition), ISBN: 9781800201201 |
| 5 | DIY Microcontroller Projects for Hobbyists | Miguel Angel Garcia-Ruiz | – | Packt Publishing, ISBN: 9781800564138 |
| 6 | The C++ Programming Language (Special Indian Edition) | Bjarne Stroustrup | Special Indian Edition | Addison-Wesley / Pearson India, ISBN: 9788131705216 |

- **Online Resources (Open Source)**

| Sr. No. | Description of Resource(s) | Weblink |
|---|---|---|
| 1 | NPTEL – Programming in C++ (Prof. Sudhanshu Shekhar; English, Indian accent; basics of C++ programming, step-by-step lectures) | YouTube Playlist |
| 2 | NPTEL – Microprocessors and Microcontrollers (Prof. Ajit Pal, IIT Kharagpur; English, Indian accent; microcontroller architecture, assembly, interfacing) | NPTEL Course Page |
| 3 | Udemy – STM32 Embedded Systems in Hindi (Omkar Bhagat; Hindi; ARM Cortex-M4, STM32Cube IDE, GPIO, UART, ADC) | Udemy Course |
| 4 | YouTube – STM32 Series in Hindi (Hardware_Programming Channel; Hindi; practical tutorials: LED blinking, UART, ADC, LCD) | YouTube Playlist |
| 5 | E&ICT Academy IIT Kanpur – Embedded Systems & IoT (IIT Kanpur Faculty; English, Indian accent; certification course: Embedded C, peripherals, IoT) | E&ICT Academy Website (ict.iitk.ac.in in Bing) |
| 6 | Computation in Ancient India | https://www.youtube.com/watch?v=pscROPdITjA |
| 7 | Panini's Language Philosophy | https://www.youtube.com/watch?v=TTpMvGHu46Q |

## M.Sc. Electronics Semester-II

| Course Type | Course Code | Course Title | Teaching-Learning Scheme L-P-T | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| DSE | **P2S02NEELE02** | **Power Electronics and Industrial Automation** | **3-0-1 = 4** | **120** | **04** |

**Course Learning Outcomes (CLOs)**

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

**CLO1:** Explain and analyze the characteristics, operation, and selection criteria of various power semiconductor devices such as diodes, SCR, MOSFET, IGBT, and GTO for industrial applications, with understanding of controlled energy flow and transformation (Shakti) from Indian Knowledge Systems.

**CLO2:** Design and evaluate different power electronic converter topologies including AC–DC, DC–DC, DC–AC, and AC–AC converters for efficient energy conversion and control, incorporating cyclic energy transformation concepts analogous to traditional systems.

**CLO3:** Apply the principles of electric drives to design and analyze the performance and control of electric drives (DC, induction, stepper, and servo motors) for various industrial applications, with interpretation of controlled motion (Gati) and dynamic balance.

**CLO4:** Develop PLC-based control programs using ladder logic, timers, counters and registers and evaluate their suitability for sequential process control in industrial automation systems, relating structured logic to classical reasoning frameworks (Nyāya).

**CLO5:** Interpret and utilize sensors, actuators, industrial communication protocols, and SCADA systems in automation and control environments, with understanding of systematic interaction and coordinated system behavior.

**CLO6:** Design and propose integrated industrial automation solutions using power electronics, drives, PLC and IoT concepts for real-world applications, incorporating holistic and system-level thinking.

| Unit | Course Content | Learning Pedagogies* | CLO(s) |
|---|---|---|---|
| 1. | Power Semiconductor Devices and Characteristics: Concept of Energy (Shakti) and Transformation, Power Semiconductor Switches – Characteristics, Power diodes: characteristics and applications, Thyristors (SCR): operation, triggering, commutation techniques, Advanced devices: GTO, IGBT, Power MOSFET, MCT, comparison of power semiconductor devices, Switching characteristics and protection circuits, Thermal management and heat sinks. | 1, 2, 3, 4, 5, 6, 13, 17 | CLO1 |
| 2. | Power Electronic Converters: Cyclic Energy Transformation : concept of Yajna, Introduction to SMPS, SMPS Converters, AC–DC converters: single-phase and three-phase rectifiers (controlled & uncontrolled), DC–DC converters: Buck, Boost, Buck-Boost converters, DC–AC converters: Inverters (single-phase & three-phase), AC–AC converters: Cycloconverters, Synch-Servo Control | 1, 2, 5, 6, 7, 13, 17 | CLO2 |

| | | | |
|---|---|---|---|
| | mechanism | | |
| 3. | Electric Drives and Industrial Applications: Concept of Motion (Gati) and Dynamics, AC voltage controllers, Basics of electric drives and load characteristics, DC motor drives and speed control, AC motor drives: induction motor drives (V/f control), Stepper motor and servo motor: operation and control, excitation modes, damping modes, Industrial applications : Induction heating and dielectric heating , Automated material handling systems, Industrial motor control applications | 1, 2, 3, 5, 6, 7, 8, 12, 13, 17 | CLO3 |
| 4. | Industrial Automation and PLC: Nyāya Logic and Structured Decision-Making, Introduction to Industrial Automation systems, Sensors and Transducers (temperature, pressure, flow, proximity), Actuators and final control elements, Relay logic and sequential control , Programmable Logic Controllers (PLC): Architecture and operation, PLC programming languages (Ladder, FBD, SFC), Ladder programming, Address and register organization, Timers, counters, registers , Introduction to SCADA and basics of industrial IoT , Case studies of automated systems, SCADA and HMI fundamentals, Industrial communication protocols (RS-485, Modbus, Profibus) | 1, 3, 5, 7, 9, 10, 11, 13, 14, 15, 16, 17 | CLO4, CLO5, CLO6 |

- **(*) Learning Pedagogies/Methods**

1. Lecture-Based Conceptual Teaching
2. Concept mapping with visual aids
3. Demonstration-based lab (bench experiment)
4. Flipped classroom with pre-read datasheets
5. Simulation-based learning (MATLAB/PSIM)
6. Problem Solving and Tutorial Sessions
7. Case study method with industry data
8. Industrial / virtual visit
9. Laboratory/ Experiential learning with PLC trainer kit
10. Project-based learning (PjBL) — mini automation project
11. Collaborative and Active learning — SCADA dashboard design activity
12. Think-pair-share
13. ICT-Enhanced learning
14. Peer instruction & seminars
15. PLC Programming practice
16. Industrial Visit/Field Visit/Institutional Visit
17. Assignment and Self-Learning

**Assessment Methodologies**

**(A) Internal Assessment (50%)**

**a. Internal Formative assessment (20%)**

(a) Assignments/Problem Sets
(b) Seminar/Presentation
(c) Simulation/ Design Exercises

(d) Attendance and Class Participation

**b. Internal Summative Assessment (30%)**

(a) Mid-term examination

**(B) External Assessment (50%)**

| 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 | 4 | 08 | 14 |
| II | CLO2 | 30 | 2 | 4 | 06 | 12 |
| III | CLO3 | 30 | 2 | 4 | 06 | 12 |
| IV | CLO4,CLO5, CLO6 | 30 | 2 | 4 | 08 | 14 |
| | | 120 | 08 | 16 | 28 | 50 |

- **Assessment and Evaluation**

| Sr. No. | Assessment/Evaluation | Component | Weightage (%) |
|---|---|---|---|
| 1 | Continuous Internal Evaluation | 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 | PLO11 |
| CLO1 | 3 | 2 | 1 | 2 | 2 | 2 | – | 1 | – | – | 2 |
| CLO2 | 3 | 3 | 2 | 3 | 3 | 2 | – | 1 | – | – | 2 |
| CLO3 | 3 | 3 | 3 | 3 | 2 | 3 | 1 | 1 | 2 | – | 2 |
| CLO4 | 2 | 3 | 2 | 3 | 3 | 1 | 2 | 1 | – | 2 | 2 |
| CLO5 | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 3 |
| CLO6 | 2 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 |

(D) 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 | Power Electronics: Converters, Applications, and Design | Ned Mohan | 4th Ed. (2022) | John Wiley & Sons |

| | | | | |
|---|---|---|---|---|
| 2 | Power Electronics Handbook | Muhammad H. Rashid | 4th Ed., 2023 | Elsevier |
| 3 | Fundamentals of Power Electronics | Robert W. Erickson, Dragan Maksimović | 3rd Ed., 2020 | Springer |
| 4 | Modern Power Electronics and AC Drives | B. K. Bose | Reprint 2021 | Pearson Education |
| 5 | Industrial Automation and Process Control | Stamatios Manesis, George Nikolakopoulos | 2020 | Academic Press (Elsevier) |
| 6 | Programmable Logic Controllers | Frank D. Petruzella | 5th Ed., 2021 | McGraw-Hill |
| 7 | Industrial Communication Systems | Bogdan M. Wilamowski, J. David Irwin | 2021 | CRC Press |
| 8 | Smart Grid and Industrial IoT | Sudip Misra et al. | 2022 | Cambridge / Springer |
| 9 | Power Electronics: Circuits, Devices and Applications | Muhammad H. Rashid | 3rd Ed. (Reprint) | Prentice Hall of India |
| 10 | Programmable Logic Controllers: Principles and Applications | John W. Webb, Ronald A. Reis | Latest Edition | Prentice Hall of India |

- **Online Resources (Open Source)**

| Sr. No. | Description of Resource(s) | Weblink |
|---|---|---|
| 1. | Industrial Electronics Tutorials | https://www.industrial-electronics.com/ |
| 2. | Industrial Electronics PPT | https://www.powershow.com/view4/7b170d-NDQ1N/Introduction_to_Industrial_Electronics_powerpoint_ppt_presentation |
| 3. | Industrial Electronics Lecture Notes | https://pinoybix.org/2013/11/industrial-electronics-lecture-1.html |
| 4. | Lecture Slides (RPI) | http://hibp.ecse.rpi.edu/~connor/edw-ecse.ppt |
| 5. | NPTEL Video Lectures on Power Electronics | https://elearn.nptel.ac.in/shop/nptel/power-electronics/?utm_source=chatgpt.com&v=13b5bfe96f3e |

## M.Sc. Electronics Semester-II

| | | |
|---|---|---|
| 6 | Books related to IKS | https://books.google.com/books/about/Indian_Knowledge_Systems.html?id=Ovk-PgAACAAJ&utm_source=chatgpt.com |

| Course Type | Course Code | Course Title | Teaching-Learning Scheme L-P-T | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| DSE | **P2S02NEELE03** | **Advanced Electronic Devices, Microwave and Quantum Systems with IKS Perspectives** | 3-0-1 | **120** | 04 |

- **Course Learning Outcomes (CLOs)**

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

**CLO1:** Analyze semiconductor devices using carrier transport theories and relate them to fundamental concepts of matter, including Kanada's atomic theory and Panchamahabhuta.

**CLO2:** Evaluate microwave and high-frequency devices (IMPATT, TRAPATT, BARITT) and analyze their operation in microwave generation, amplification, and communication systems.

**CLO3:** Explain superconductivity and analyze superconducting devices such as Josephson junctions, SQUIDs, and their applications in advanced systems.

**CLO4:** Analyze magnetic materials and devices, including ferromagnetic and ferrimagnetic systems, and evaluate their role in electronic applications such as memory, sensors, and MRI.

**CLO5:** Interpret quantum phenomena including quantum size effects, entanglement (EPR), observer effect, and qubits in the context of modern electronic and nanoscale systems.

**CLO6:** Integrate modern electronic concepts with interdisciplinary perspectives, including insights from the Kena Upanishad, to develop a holistic understanding of measurement, systems, and knowledge frameworks

| Unit | Course Content | Learning Pedagogies* | CLO(s) |
|---|---|---|---|
| I | Semiconductor Physics and Foundational Concepts- Carrier transport and scattering mechanisms, High-field effects and breakdown, Boltzmann transport equation, Advanced MOSFETs and scaling<br>Kanada's atomic theory (*Anu, Paramanu*) → discrete nature of matter, Panchamahabhuta → material, energy, and field analogies | Classroom Lecture (CL), Seminars (Student-led and Faculty-moderated), Inquiry-Based Learning | CLO1 |
| II | Microwave and High-Frequency Devices and Systems-Microwave frequency characteristics, Transit-time devices: IMPATT diode, TRAPATT diode, BARITT diode,<br>Negative resistance and oscillations,<br>Microwave generation and amplification,<br>Microwave systems: radar and communication | CL, PBL, ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual | CLO2 |

| | | | |
|---|---|---|---|
| | | Labs/Webinars) | |
| III | Magnetic Properties and Devices - Ferromagnetism and Ferrimagnetism, Magnetic domains and hysteresis, Magnetic materials and devices (memory, sensors, cores), MRI as a quantum–magnetic system<br>Superconductivity and Superconducting Devices - Superconductivity fundamentals (Meissner effect, zero resistance), Type I and Type II superconductors, BCS theory (introductory)<br>Devices: Josephson junctions, SQUID, Superconducting magnets<br>Concept of Akasha (field continuity and interactions), Equilibrium and coherence in physical systems | CL, ICT Enabled Learning, CBL | CLO3, CLO4 |
| IV | Quantum and Nanoscale Effects - Quantum size effect, Introduction to nanostructures<br>Quantum Physics Concepts in Electronics- Einstein-Podolsky-Rosen paradox and quantum entanglement, Observer effect in measurement systems,<br>Introduction to qubits and quantum information- Concept of qubit vs classical bit- Superposition and quantum states- Physical realization (overview): Superconducting qubits, Spin-based qubits, Basic idea of quantum information processing<br>Insights from the Kena Upanishad: Distinction between instrument (device) and observer (knower), Limits of measurement and perception, "That which enables perception but is beyond the instrument". | 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
(d) Attendance and Class Participation

**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 | 30 | 3 | 3 | 8 | **14** |
| **II** | CLO2 | 30 | 3 | 3 | 8 | **14** |
| **III** | CLO3, CLO4 | 30 | 2 | 2 | 7 | **11** |
| **IV** | CLO5, | 30 | 2 | 2 | 7 | **11** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | CLO6 | | | | | |
| | | **120** | **10** | **10** | **30** | **50** |

- **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 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 |
| **CLO2** | 3 | 3 | 1 | 2 | 1 | 3 | 3 | 2 | 1 | 1 | 2 |
| **CLO3** | 3 | 2 | 1 | 2 | 2 | 1 | 3 | 1 | 1 | 1 | 2 |
| **CLO4** | 3 | 2 | 1 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 |
| **CLO5** | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CLO6** | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 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 | Physics of Semiconductor Devices | S. M. Sze, Yiming Li, Kwok K. Ng | 4th Edition, 2021 | John Wiley & Sons (Wiley-VCH) |
| 2 | Semiconductor Devices: Physics and Technology | S. M. Sze, Ming-Kwei Lee | 3rd Edition, 2012 | John Wiley & Sons (Barnes & Noble) |
| 3 | High-Speed Semiconductor Devices | S. M. Sze | 1st Edition, 1991 | John Wiley & Sons (eBay) |
| 4 | Microwave Devices and Circuits | Samuel Y. Liao | 3rd Edition, 2003 | Pearson Education |
| 5 | Introduction to Superconductivity | Michael Tinkham | 2nd Edition, 1996 | McGraw-Hill |
| 6 | Introduction to Magnetic | B. D. Cullity, C. D. | 2nd Edition, 2008 | Wiley-IEEE Press |

## M.Sc. Electronics Semester-II

| Sr. No. | Title | Author(s) | Edition / Year | Publisher |
|---|---|---|---|---|
| | Materials | Graham | | |
| 7 | Quantum Computation and Quantum Information | Michael A. Nielsen, Isaac L. Chuang | 10th Anniversary Edition, 2010 | Cambridge University Press |
| 8 | Solid State Electronic Devices | Streetman, B. G., & Banerjee, S. | 7th Edition, 2014 | Pearson Education |
| 9 | The Kena Upanishad (Introductory Commentary) | Kireet Joshi | 1st Edition, 2004 | DK Printworld |

- **Online Resources (Open Source)**

| Sr. No. | Description of Resource(s) | Weblink |
|---|---|---|
| 1 | NPTEL: Semiconductor Devices | https://nptel.ac.in |
| 2 | NPTEL: Microwave Engineering | https://nptel.ac.in |
| 3 | NPTEL: Solid State Physics | https://nptel.ac.in |
| 4 | NPTEL: Nanotechnology | https://nptel.ac.in |
| 5 | MIT OpenCourseWare: Quantum Physics | https://ocw.mit.edu |
| 6 | LTspice Simulation Tool | https://www.analog.com/ltspice |

## M.Sc. Electronics Semester-II

| Course Type | Course Code | Course Title | Teaching-Learning Scheme L-P-T | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| DSC | **P2S02NCELE03** | **Practicals** | 0-8-1 | **120** | 04 |

- **Course Learning Outcomes (CLOs)**

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

**CLO1**: Design, analyze, and simulate second and higher order active and passive filter circuits (low-pass, high-pass, band-pass, and band-stop) using SPICE/EDA tools, and evaluate their frequency response, quality factor, and phase characteristics. Design Antenna and study its parameters.

**CLO2**: Analyze the working principles and performance parameters of Analog-to-Digital Converters (ADC) and Digital-to-Analog Converters (DAC), and validate conversion accuracy, resolution, and sampling characteristics through laboratory experiments.

**CLO3**: Design and verify digital logic systems by implementing combinational and sequential circuits, and assess their functional correctness, timing behavior, and practical interfacing using standard digital design tools and hardware.

**CLO4**: Study and characterize the V-I characteristics, switching behavior, and thermal ratings of power semiconductor devices such as diodes, SCRs, MOSFETs, IGBTs, and TRIACs under controlled experimental conditions, and evaluate their suitability for power electronics applications.

**CLO5**: Develop and execute 8086 Assembly Language Programs for arithmetic, logical, data transfer, and string operations, demonstrating an understanding of microprocessor architecture, register organization, addressing modes, and instruction set execution.

**CLO6**: Apply DEBUG commands and utilities to trace, examine, and interpret 8086 program execution at the machine level, analyze register and memory states, and document observations through structured technical reports that communicate findings with clarity and precision.

| Unit | List of Suggested Practicals | Learning Pedagogies* | CLO(s) |
|---|---|---|---|
| I | Experiments based on the Second and Higher order filter design and simulation, Antenna design and simulation and study of its parameters. | Suggested as follows: PBL, ICT-Enabled Learning, Simulation, Inquiry-Based Learning Self-Directed Learning | CLO1 |
| II | Experiments based on Analog and Digital Converters, Digital Systems. | | CLO2, CLO3 |
| III | Experiments based on Study characteristics of various power semiconductor devices. | | CLO4 |
| IV | Experiments based on 8086 Assembly level Programming, study of DEBUG Programs and Commands | | CLO5, CLO6 |

- **Assessment Methodologies**

**(A) Internal Assessment**

**a. Internal Formative assessment**

(a) Performance of Experiment and Execution
(b) Writing of Laboratory Journal and Technical Documentation
(c) Viva Voce Assessment

**b. Internal Summative Assessment**

(a) 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 | **30** | **2** | **3** | **7** | 12 |
| **II** | CLO2,3 | **30** | **3** | **3** | **7** | 13 |
| **III** | CLO4 | **30** | **2** | **3** | **7** | 12 |
| **IV** | 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 | • Experimental Performance and Execution<br>• Results Reporting and Technical Documentation<br>• Viva Voce Assessment<br>• Laboratory Conduct and Practices<br>• Regularity and Active Participation<br>• Group Discussion and Collaborative Learning | 50 % |
| 2 | End-Semester Examination | Experimental Performance, Analysis, Reporting of Readings, and Conceptual Understanding | 50 % |

**(C) CLOs – PLOs Matrix**

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

- **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

## M.Sc. Electronics Semester-II

| Course Type | Course Code | Course Title | Teaching-Learning Scheme L-P-T | Total Notional Hours | Course credits |
|---|---|---|---|---|---|
| DSC | **P2S02NCELE04** | **Project Work** | 0-2-0 | **60** | 02 |

- **Course Learning Outcomes (CLOs)**

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

**CLO1:** Apply structured C/C++ programming practices to configure and operate microcontroller boards, demonstrating confidence in coding fundamentals and laboratory safety protocols.

**CLO2:** Implement basic embedded system tasks such as GPIO control, timers, and interrupts, while practicing debugging and documentation discipline.

**CLO3:** Design and optimize firmware routines, including bootloaders and initialization sequences, and create reusable libraries for peripheral modules.

**CLO4:** Integrate sensors and devices using UART, SPI, and I2C protocols, applying error handling and memory management strategies for reliable system performance.

**CLO5:** Plan, develop, and evaluate small-scale embedded projects, applying iterative debugging, optimization, and ethical considerations in firmware design.

**CLO6:** Document project processes, prepare technical reports, and deliver oral presentations, demonstrating collaborative problem-solving and professional communication skills.

| Phase | Suggested Flow of Project Work | Learning Pedagogies* | CLO(s) |
|---|---|---|---|
| I | Foundations<br>1. Orientation to laboratory environment, tools, and safety protocols<br>2. Introduction to C/C++ programming for embedded systems<br>3. Microcontroller board familiarization (ARM Cortex/AVR/PIC)<br>4. Basic coding tasks: LED blinking, GPIO control, timers, interrupts<br>5. Structured coding practices, debugging basics, and documentation discipline | Suggested as follows:<br><br>PBL, Collaborative Learning, Experiential Learning, Simulation, ICT-Enabled Learning, Reflective Practices, Reflective writing, Inquiry-Based Learning, Self-Directed Learning | CLO1, CLO2 |
| II | Development & Integration<br>1. Firmware development: bootloaders, startup routines, initialization<br>2. Writing reusable libraries for peripheral modules<br>3. Memory management, optimization techniques, and exception handling<br>4. Communication protocols: UART, SPI, $I^2C$ for device interfacing<br>5. Data logging, sensor integration, and error handling strategies<br>6. Collaborative coding exercises to simulate modular design and teamwork | | CLO3, CLO4 |

| | | | |
|---|---|---|---|
| III | Project Execution & Evaluation<br>1. Project planning: problem definition, peripheral configuration, and design documentation<br>2. Development of small in-house mini projects (e.g., smart sensor systems, data acquisition modules)<br>3. Debugging, iterative testing, and performance evaluation<br>4. Ethical considerations in firmware design (reliability, safety, sustainability)<br>5. Final integration, validation, and optimization of project systems<br>6. Preparation of project reports, oral presentations, and prototype demonstrations<br>**7.** Peer review and collaborative refinement of solutions | | CLO5, CLO6 |

- **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 | **20** | **1** | **2** | **4** | **07** |
| **II** | CLO3, CLO4 | **20** | **2** | **2** | **4** | **08** |
| **III** | CLO5, CLO6 | **20** | **2** | **3** | **5** | **10** |
| | | **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 |
| 2 | End-Semester Examination | Final Project Evaluation (Design, Implementation, Testing, and Performance)<br>Project Report and Technical Documentation<br>Viva Voce Examination | 25 |

**(e) CLOs – PLOs Matrix**

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

- **Suggested Learning Materials/ Books:**

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