Anekant Education Society's

Tuljaram Chaturchand College, Baramati

(Autonomous)

Four Year B. Sc. Degree Program in Electronics

(Faculty of Science & Technology)

CBCS Syllabus

T.Y.B. Sc. (Electronics) Semester -V

For Department of Electronics

Tuljaram Chaturchand College, Baramati

Choice Based Credit System Syllabus (2023 Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2025-2026

Course & Credit Structure for T. Y. B. Sc. Electronics (2023 Pattern as per NEP-2020)

Sem	Course Type	Course Code	Course Title	Theory/ Practical	Credits
V	Major Mandatory	ELE-301-MJM	Digital Logic Design with Verilog HDL	Theory	02
	Major Mandatory	ELE-302-MJM	8051 Microcontroller	Theory	02
	Major Mandatory	ELE-303-MJM	Analog Circuit Design and Applications	Theory	02
	Major Mandatory	ELE-304-MJM	Foundation of Semiconductor Devices	Theory	02
	Major Mandatory	ELE-305-MJM	Hardware Practicals	Practical	02
	Major Elective (MJE)	ELE-306MJE(A)	JAVA Progamming	Theory (Any two)	04
	Major Elective (MJE)	ELE-306-MJE(B)	Optical Fiber Communication		
	Major Elective (MJE)	ELE-306-MJE(C)	Single Board Computers		
	Minor	ELE-311-MN	Progamming in C	Theory	02
	Minor	ELE-312-MN	C Program Practicals	Practical	02
	Vocational Skill Course (VSC)	ELE-321-VSC	Software Practicals	Practical	02
	Field Project(FP)	ELE-335-FP	Field Project(FP)	Practical	02
	Total Credits Semester-V				**22**
VI	Major Mandatory	ELE-351-MJM	Advanced Communication Techniques	Theory	02
	Major Mandatory	ELE-352-MJM	Embedded System Design	Theory	02
	Major Mandatory	ELE-353-MJM	Power Electronics	Theory	02
	Major Mandatory	ELE-354-MJM	Nano Electronics	Theory	02
	Major Mandatory	ELE-355-MJM	Ele. Practical 4	Practical	02
	Major Elective(MJE)	ELE-356MJE(A)	MATLAB and Simulink for Electronics	Theory (Any two)	04
	Major Elective(MJE)	ELE-356-MJE(B)	Electronic Instrumentation		
	Major Elective(MJE)	ELE-356-MJE(C)	Electric Vehicals		
	Minor	ELE-361-MN	Arduino	Theory	02
	Minor	ELE-362-MN	Arduino Practicals	Practical	02
	On Job Training(OJT)	ELE-385-OJT	On Job Training(OJT)	Practical	04
	Total Credits Semester-VI				**22**
				Total Credits Semester-V+ VI	**44**

CBCS Syllabus as per NEP 2020 for T. Y. B. Sc. Electronics (SEM V) (2023Pattern)

Name of the Programme	: B.Sc. Electronics
Programme Code	: USEL
Class	: T. Y. B.Sc.
Semester	: V
Course Type	: Major Mandatory (Theory)
Course Code	: ELE-301-MJM
Course Title	: Digital Logic Design with Verilog HDL
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. To introduce VERILOG
2. To know the architectural features of programmable logic devices
3. To know the behavioral modeling of combinational and simple sequential circuits
4. To understand sequential and combinational logic design techniques
5. To learn various digital circuits using VERILOG
6. To know the behavioral modeling of algorithmic state machines
7. To learn VLSI devices

Course Outcomes:

By the end of the course, students will be able to:

CO1.To know the basic language features of Verilog HDL and the role of HDL in digital logic design

CO2. To know the various modeling of combinational and simple sequential circuits

CO3. To know the architectural features of programmable logic devices

CO4. Construct the combinational circuits, using discrete gates and programmable logic devices.

CO5.Describe Verilog model for sequential circuits and test pattern generation.

CO6. Understand the language constructs and programming fundamentals of Verilog HDL.

CO7. Analyze and verify the functionality of digital circuits/systems using test benches

CO8.Synthesize different types of processor and I/O controllers that are used in embedded system.

Unit 1: Digital System Design **[10]**

Design flow for logic circuits, Mealy & Moore sequential machine models, state machine notation, state equivalence, state reduction, Equivalence classes, Implication charts, state reduction of incompletely specified state tables, Merger graphs, ASM symbols

Unit 2: Introduction to Verilog Hardware Description Language **[08]**

Importance of HDL's, features of Verilog HDL, Overview of Digital Design with Verilog HDL, Hierarchical modeling concepts, Basic concepts of Verilog- Operators, comments, Number specifications, strings, Identifiers& keywords, Data types, system tasks & Compiler Directives, Modules & ports.

Unit 3: Modeling of Digital systems **[12]**

Gate level Modeling- Introduction, Gate types, Gate delays

Data flow modeling- Introduction, Delays expression, operators & operands

Behavioral Modeling- Structured Procedures, Assignments, Timing Controls, Conditional statements, Loops

Verilog-Based Design Examples:

- Combinational Circuits: Multiplexer, Demultiplexer, Encoder, Decoder, Adder, Subtractor
- Sequential Circuits: Flip-Flops, Counters, Shift Registers
- Practical Design Implementations: Traffic light controller, Stepper motor sequence generator

Recommended Books:

1. Digital logic: Applications & design by John M. Yarbrough, cengage Learning India(Thompson)
2. Verilog HDL A guide to digital design & synthesis By Samir Palnitkar, Pearson Second Edition
3. A VHDL Synthesis Primer J. Bhaskar BS Publications Hyderabad
4. Fundamental of digital logic with Verilog By Stephen Brown, Zvonko Vranesic, Tata McGrawHill
5. Digital fundamentals By Floyd, Thoms, Jain R.P.,Pearson

Mapping of Program Outcomes with Course Outcomes

Weightage: 1=Weak or low relation, 2=Moderate or partial relation, 3=Strong or direct relation

Course Outcome	Program Outcomes								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	-	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-
CO3	2	-	-	-	-	-	-	-	-
CO4	-	-	-	3	-	-	-	-	-
CO5	-	-	-	-	-	-	-	-	1
CO6	-	-	-	1	-	-	-	-	-
CO7	-	3	-	-	-	-	-	-	-

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Students focuses on the fundamental understanding of Verilog HDL, which is a key aspect of the discipline.

CO2: Students will involve in understanding and modeling circuits, a fundamental aspect of the discipline.

CO3: Students will involve in understanding the architecture of programmable logic devices, a critical aspect within the discipline.

PO2: Critical thinking and problem solving
CO7: Students will involve in the critical skills of analyzing and verifying the functionality of digital circuits/systems.
PO4: Research-related skills and scientific temper
CO4: Students will involve in the practical application of constructing circuits using both discrete gates and programmable logic devices.
CO6: Students will involve in understanding the language constructs and programming fundamentals, a key aspect of research-related skills.
PO5: Trans-disciplinary knowledge
CO8: Students will involve in synthesizing components used in embedded systems, demonstrating knowledge that spans multiple disciplines.
PO9: Self-directed and lifelong learning:
CO5: Students will involve in ability to describe Verilog models and generate test patterns, reflecting self-directed learning in a specific technological domain.

CBCS Syllabus as per NEP 2020 for T. Y. B. Sc. Electronics (SEM V) (2023Pattern)

Name of the Programme : B.Sc. Electronics
Programme Code : USEL
Class : T. Y. B.Sc.
Semester : V
Course Type : Major Mandatory (Theory)
Course Code : ELE-302-MJM
Course Title : 8051 Microcontroller
No. of Credits : 02
No. of Teaching Hours : 30

Course Objectives:

1. To study the basics of 8051 microcontroller.
2. To study the architecture of 8051 microcontroller.
3. To study the addressing modes of 8051 microcontroller.
4. To learn the 8051 programming.
5. To apply knowledge of 8051 to design different application circuits.
6. To introduce the basic concepts of advanced Microcontrollers.
7. To introduce advance microcontrollers.

Course Outcomes:

By the end of the course, students will be able to:

CO1. Get familiar with general microcontroller and their working.

CO2. Knowledge about architecture and programming syntaxes of microcontroller.

CO3. Run the programmes on the Compiler "Keil".

CO4. Interfacing of input output peripherals to the 8051 microcontrollers.

CO5. Designing microcontroller based hobby projects.

CO6. Comparing the microcontrollers.

CO7. Comparing Assembly Language and Embedded C language.

Unit 1: Microcontroller architecture **[15]**

Introduction to microcontroller, 8051 microcontroller block diagram, 8051 Oscillator and clock, Program counter, Data pointer, A and B CPU registers, Flags and PSW, Internal RAM and ROM, Stack and stack pointer, SFRs, I/O ports, Clock and reset circuitry, External memory , Counters and timers , Serial Data I/O, Interrupts.

Unit 2: Instruction set **[15]**

Addressing modes, Different groups of instructions- Data transfer instructions, Logical instructions, Arithmetic instructions, Jump and call instructions. Programs based on data transfer, logical, arithmetic, Jump and call instructions.

Recommended Books :

1. The 8051 Microcontroller Architecture, Programming and application [Second Edition] Kenneth J. Ayala, Penram International (1999)
2. The 8051 Microcontroller and Embedded Systems using Assembly and C
   M.A.Mazidi, J.G.Mazidi, R.D.Mckinlay. Pearson Education Second Edition 2009
3. The 8051 Microcontroller and Embedded Systems using Assembly and C, Kenneth J. Ayala, Dhananjay V. Gadre. Cengage Learning
4. Microcontrollers [Theory and Applications] Deshmukh Ajay V. TMH

Mapping of Program Outcomes with Course Outcomes

5. **Weightage: 1=Weak or low relation, 2=Moderate or partial relation, 3=Strong or direct relation**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	-	-	-	-	-	1	1
CO2	-	-	-	-	-	-	1
CO3	2	1	1	-	-	-	2
CO4	2	2	2	-	-	-	-
CO5	2	2	2	2	-	1	-
CO6	-	-	-	-	1	1	1
CO7	-	-	-	-	-	-	1

Justification for the mapping

PO1: Computer Knowledge

CO3: Students will be running programs on the Keil compiler is a specific skill that supports the broader application of computer fundamentals and programming knowledge.
CO4: Students will be able to interfacing input/output peripherals with microcontrollers requires the application of mathematics, statistics, and computer fundamentals.
CO5: Students will be capable of designing microcontroller-based hobby projects involves applying knowledge of microcontroller architecture and programming syntaxes.
CO3: Students will be able to run programs on the Keil compiler is a specific skill that is not directly linked to designing solutions with the latest technologies.
CO4: Students will interface different peripherals with microcontrollers are a skill that contributes to solution design, but the focus is on microcontroller technology rather than the latest IT application technologies.

CO5: Students will be capable for designing microcontroller-based hobby projects involves skills that can contribute to solution design but may not necessarily involve the latest technologies.

PO2: Design/ Development of Solution

PO3: Modern tool usage

CO3: Students will be able to running programs on the Keil compiler involves the direct use of a modern IT tool, aligning with the objective of modern tool usage in IT applications.

CO4: Students will be interfacing peripherals involves a skill set that contributes to modern tool usage, but the specific use of modern engineering and IT tools is not explicitly emphasized.

CO5: Students will design microcontroller-based hobby projects contributes to technical skills but may not explicitly involve the application of modern engineering and IT tools.

PO4: Environment and Sustainability

CO5: Students will be designing microcontroller-based hobby projects which involves technical skills, but the connection to societal and environmental impacts is not explicitly emphasized.

PO5: Ethics

CO6: Students will compare microcontrollers, which is more focused on technical aspects and less on explicit consideration of professional ethics.

PO6: individual and Team work

CO1: Students will be familiar with general microcontrollers contributes to individual effectiveness but may not explicitly address teamwork and leadership skills.

CO5: Students will be designing microcontroller-based hobby projects involves both individual and potentially team-based efforts, fostering teamwork and leadership skills.

CO6: Students will study as comparing microcontrollers involves technical analysis but may not directly address teamwork or leadership skills.

PO7: Innovation, employability and Entrepreneurial skills

CO1: Students will be in familiarity with general microcontrollers provides a foundation for innovation and entrepreneurial skills but may not explicitly address value creation and wealth generation.

CO2: Students will get knowledge of microcontroller architecture contributes to innovation and entrepreneurial skills but may not directly address wealth creation or employability.

CO3: Students will be running programs on the Keil compiler involves technical skills but may not explicitly contribute to entrepreneurial skills or employment transition.

CO6: Students will study as comparing microcontrollers involves technical analysis but may not directly address innovation, employability, or entrepreneurial skills.

CO7: Students will be comparing Assembly Language and Embedded C language is more focused on technical aspects and may not directly contribute to innovation, employability, or entrepreneurial skills.

CBCS Syllabus as per NEP 2020 for T. Y. B. Sc. Electronics (SEM V) (2023Pattern)

Name of the Programme	: B.Sc. Electronics
Programme Code	: USEL
Class	: T. Y. B.Sc.
Semester	: V
Course Type	: Major Mandatory (Theory)
Course Code	: ELE-303-MJM
Course Title	: Analog Circuit Design and Applications
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. To study the practical design aspects while using Op- amps
2. To study the basic application circuits of Op -amps
3. To Learn the specifications and selection criterion for linear ICs
4. To obtain information about different special purpose ICs and their applications
5. To refer and understand data manuals.
6. To study the voltage regulators for power supply.
7. To understand the basics of PLL and its practical applications

Course Outcomes:

By the end of the course, students will be able to:

CO1: Learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve engineering problems
CO2 : Develop skills to design simple circuits using OP-AMP.
CO3 : Gain knowledge about various filters and rectifiers.
CO4 : Gain knowledge about PLL.
CO5: Learn about various techniques to develop multivibrators.
CO6 : Develop skills to develop simple filter circuits and various amplifiers and can solve problems related to it.
CO7 : Develop skills to design power supply

Unit 1: Basic Application Circuits using Op-amp **[14]**

Selecting Op-amps for dc, low frequency and high frequency applications, offset compensation / balancing techniques, Design of basic and practical integrator and differentiator circuits, Active filters: 2nd and higher order, Design of LP, HP and BP filters Log and antilog amplifiers, Precision half wave rectifier, precise full wave rectifiers, peak detectors, sample and hold circuits.

Unit 2: Basic Application Circuits using Linear ICs **[8]**

Voltage comparators using op-amp as well as comparator IC (LM311), Astable and mono stable multivibrators using op-amp. Single power supply Op-amp. Timer IC555: Block diagram, astable and mono stable multivibrators Function generators: LM 566, ICL8038

Unit 3: Voltage Regulators and Phase Lock Loops **[8]**

Fixed three terminal regulators ICs-78XX, 79XX; Adjustable Three terminal regulators ICs LM317, LM337, PWM controller IC3524 Phase lock loop (PLL): Monolithic IC LM565, operating principle, block diagram, PLL characteristics.

Recommended Books:

1. George Clayton and Steve Winder, "Operational Amplifiers," 5th Edition NewnesAn Imprint of Elsevier.
2. Sergio Franco, "Design With operational Amplifiers and analog integrated circuits,"TMH
3. Ramakant A. Gayakwad, "Op-Amps and Linear Integrated Circuits," 4th EditionPHI
4. R.F. Coughlin, F.F. Driscoll, "Operational Amplifiers and Linear Integrated Circuits," PrenticeHall.
5. James M Fiore, "Operational Amplifiers and Linear Integrated Circuits," JaicoPublishinghouse

Mapping of Program Outcomes with Course Outcomes

Weightage: 1=Weak or low relation, 2=Moderate or partial relation, 3=Strong or direct relation

Course Outcome	Program Outcomes								
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9
CO1	-	1	-	-	-	-	-	-	-
CO2	2	-	-	-	-	-	-	-	-
CO3	-	-	-	-	2	-	-	-	-
CO4	2	-	-	-	-	-	-	-	2
CO5	-	3	-	-	-	-	-	-	2
CO6	2	-	-	-	-	-	-	-	-
CO7	-	-	-	-	-	1	-	-	-

Justification For The Mapping

PO1: Disciplinary Knowledge:

CO2: It focuses on the development of skills in designing circuits using operational amplifiers (OP-AMP), a fundamental aspect of electrical engineering.

CO4: Learning about Phase-Locked Loops (PLL) contributes to disciplinary knowledge in electronics and also involves trans-disciplinary knowledge, as PLL is utilized in various engineering domains.

CO6: This CO involves disciplinary knowledge in the design of filter circuits and amplifiers, contributing to personal and professional competence in the field of electronics.

PO2: Critical thinking and problem-solving:

CO1: It involves understanding basic concepts and applying them to solve engineering problems related to linear integrated circuits.

CO5: Studying various techniques for developing multivibrators requires critical thinking skills and expands knowledge as multivibrators are used in different electronic systems.

PO5: Trans-disciplinary knowledge:

CO3: Understanding various filters and rectifiers involves gaining knowledge through research and applying scientific temper in the study and analysis of these components.

PO6: Personal and professional competence:

CO7: The design of power supplies requires a combination of technical expertise, creativity, and problem-solving skills. This process develops the students' personal and professional competence by enhancing their ability to analyze, design, and implement complex systems.

PO9: self-directed and life-long learning

CO4: Understanding Phase-Locked Loops (PLL) and various techniques for developing multivibrators requires students to delve into specialized knowledge within the field of electronics. These topics often extend beyond basic curriculum requirements, encouraging students to engage in self-directed learning to fully grasp these advanced concepts.

CO5: Students develop the ability to adapt to new technologies and continue their education independently for designing of various multivibrator techniques,. This aligns with the spirit of self-directed and life-long learning, preparing students for a dynamic and ever-evolving field like electronics.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Electronics (SEM V)
(2024 Pattern)

Name of the Programme : B.Sc. Electronics
Programme Code : USEL
Class : T. Y. B.Sc.
Semester : V
Course Type : Theory
Course Code : ELE-304-MJM
Course Title : Foundation of Semiconductor Devices
No. of Credits : 02
No. of Teaching Hours : 30

Course Objectives:

1. To introduce the fundamental concepts of crystal structures and semiconductor materials.
2. To explain the growth techniques of bulk and epitaxial semiconductors.
3. To develop an understanding of the electrical behavior of semiconductor junctions.
4. To study the characteristics and operation of Bipolar Junction Transistors (BJTs).
5. To analyze switching behavior and secondary effects in BJTs.
6. To understand the structure and working principles of different Field Effect Transistors (FETs).
7. To compare the performance and characteristics of various semiconductor devices.

Course Outcomes:

By the end of the course, students will be able to:

CO1:Understand crystal structures and semiconductor types.
CO2:Identify growth methods of semiconductors.
CO3:Analyze junction properties under biasing.
CO4:Explain BJT structure and characteristics.
CO5:Illustrate switching actions and effects in BJTs.
CO6:Understand working of JFET, MOSFET, and MESFET.
CO7:Compare current-voltage behavior of different FETs.

Unit 1 : Fundamentals of Semiconductors [8L]

Crystal structure: Basic Lattice Types, Basic Crystal Structures, bulk semiconductor growth and epitaxial growth. metal semiconductors and insulators, direct and indirect semiconductors, Fermi level and temperature dependence Majority and minority charge carriers.

Unit 2 : Junctions [6L]

Equilibrium conditions: contact potential, space charge at junction. Forward and reverse bias Junctions. Reverse bias breakdown: Zener and avalanche breakdown mechanism
Metal Semiconductor Junction: Schottky barriers, rectifying contacts, Ohmic Contacts.

Unit 3 : Bipolar Junction Transistors [8L]

BJT structure and operation, BJT Characteristics, Minority carrier distributions and terminal currents, current transfer ratio. Coupled diode model (Ebers-Moll Model).
Switching: cutoff, saturation, switching cycle. Effects: Drift in the Base region, Avalanche Breakdown.

Unit 4 : Field Effect Transistors (FETs) [8L]

Junction FETs (JFETs),MOSFET, Metal Semiconductor FETs (MESFETs):

The Ohmic Region,Pinchoff and saturation, GaAs MESFET, Current-Voltage Characteristics.

Text / Reference Books:

1. Solid State Electronics Devices, Ben G. Streetman and Sanjay Kumar Banerjee, PHI, 6thEdition.
2. Semiconductor Physics and Devices Basic Principles, Donald A. Neamen, TMH, 3rdEdition.
3. Semiconductor Device Physics and Design, Umesh K. Mishra and Jasprit Singh,Springer.
4. Semiconductor Device fundamentals, Robert F. Pierret, Pearson Education.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1=Weak or low relation, 2=Moderate or partial relation, 3=Strong or direct relation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	-	3	3	-	-	-	-	-	3	-	-
CO2	3	3	-	1	1	-	3	-	2	-	-	-	-
CO3	3	3	-	3	3	-	1	-	-	-	-	3	-
CO4	3	3	-	3	3	2	-	-	-	-	2	3	-
CO5	3	3	-	3	3	3	-	-	-	-	-	1	-
CO6	3	3	-	2	2	3	-	-	3	-	-	-	-
CO7	3	3	-	3	3	-	-	-	3	-	-	-	-

Justification of Mapping

PO1: Comprehensive Knowledge and Understanding

CO1: Builds strong conceptual understanding of semiconductor types and crystal structures.
CO2: Enhances theoretical understanding of semiconductor fabrication techniques.
CO3: Deepens understanding of junction theory under different electrical conditions.
CO4: Reinforces knowledge of internal structure and function of BJTs.
CO5: Provides comprehensive understanding of BJT as a switch.
CO6: Offers strong conceptual base on different types of FETs.
CO7: Strengthens theoretical understanding of I-V characteristics of FETs.

PO2: Practical, Professional, and Procedural Knowledge

CO1: Provides knowledge applicable to lab and industry procedures in semiconductor analysis.
CO2: Imparts procedural knowledge useful in research labs and fabrication industries.
CO3: Applies practical knowledge to real-world biasing of PN junctions.
CO4: Provides practical understanding applicable to lab experiments and real devices.
CO5: Offers professional insight into switching in electronic applications.
CO6: Supports procedural knowledge in analyzing FET performance.
CO7: Enhances lab-based skills through comparative analysis.

PO4: Specialized Skills and Competencies

CO1: Develops specialized knowledge in the domain of solid-state electronics.

CO2: Builds competencies in advanced crystal growth and doping technologies.
CO3: Enhances skills in analyzing electronic component behavior.
CO4: Develops technical competencies in BJT behavior and analysis.
CO5: Builds skills in high-speed switching circuit design.
CO6: Develops expertise in modern device operations.
CO7: Develops device comparison skills vital for design applications.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning
CO1: Encourages analytical reasoning while studying different materials and their properties.
CO2: Encourages problem-solving through analysis of different growth methods.
CO3: Strengthens analytical ability to solve biasing and circuit problems.
CO4: Supports analytical and problem-solving abilities in transistor-based circuits.
CO5: Improves logical thinking and analysis in switching operations.
CO6: Encourages reasoning in comparing FET characteristics.
CO7: Promotes analytical reasoning through I-V plotting and interpretation.

PO6: Communication Skills and Collaboration
CO4: Enhances ability to explain technical concepts in group discussions or presentations.
CO5: Boosts teamwork and communication in practical sessions.
CO6: Promotes collaborative discussion during lab activities.

PO7: Research-related Skills
CO2: Fosters research aptitude by exploring advanced growth processes.
CO3: Encourages critical thinking needed for device-level research.

PO9: Digital and Technological Skills
CO2: Provides insight into modern technological processes in semiconductor industry.
CO6: Builds digital skills for advanced electronics and VLSI concepts.
CO7: Builds competence in handling digital and analog device data.

PO11: Value Inculcation and Environmental Awareness
CO1: Promotes awareness of eco-friendly and hazardous materials used in semiconductors.
CO4: Informs students of materials and sustainable design aspects in BJT usage.

PO12: Autonomy, Responsibility, and Accountability
CO3: Builds accountability through precise biasing techniques in practical applications.
CO4: Promotes responsibility in handling and testing of BJT circuits.
CO5: Reinforces responsibility in precise timing and operation of switching circuits.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Electronics (SEM V)

(2024 Pattern)

Name of the Programme : B.Sc. Electronics
Programme Code :
Class : T. Y. B.Sc.
Semester : V
Course Type : Theory
Course Code : ELE-305-MJM
Course Title : Electronics Practical –I
No. of Credits : 02
No. of Teaching Hours : 60

Course Objectives:

1. To refer the various datasheets of the electronic devices and integrated circuits
2. To learn how to select the devices, sensors, actuators and ICs for a particular application
3. To develop the basic skills required to handle the various instruments
4. To learn the designing aspects of circuits/ systems
5. To learn basic of semiconductor.
6. To understand concept of OFC
7. To design transmitter and Receiver for OFC.

Course Outcomes:

By the end of the course, students will be able to

CO1:- Design of integrated circuit
CO2: Concept of sensor
CO3:handleling different Sensor.
CO4: Basic of design circuit
CO5:Basic of semiconductor.
CO6: Working of OFC
CO7:Design of OFC circuit.

List of Practical's

- The practical course consists of **10** experiments. (08 experiment +01 Activity).
- Any one of the following activities with proper documentation will be considered as equivalent of 2 experiments weightage in term work.

Group 1: Total 4 Experiments

Analog Circuit Design and Applications

1. Wave shaping circuits (Integrator / differentiator circuit)
2. Op-amp based clipper and clampers
3. Log amplifier using opamp
4. Regulated power supply using IC 723 (Low and High Voltage,1A Current)
5. Function generator using 8038/2206 or any equivalent IC
6. Astable and monostable multivibrator using IC555.

Group 2: Total 2 Experiments

Foundation of Semiconductor Devices

1. Measurement of Efficiency and fill factor of solar cell.
2. Energy band gap measurement
3. Reverse recovery time measurement of diodes (any two).
4. Transfer characteristic of phototransistor/ Photodiode

Group 3: Total 2 Experiments

Optical fiber Communication

1. Design of fiber optic Transmitter
2. Design of fiber optic Receiver
3. Study of propagation loss in optical fibers.

Activities

1. To learn PCB Software.
2. Study tour
3. Internet survey on Electronics.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1=Weak or low relation, 2=Moderate or partial relation, 3=Strong or direct Relation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	2	3	3	-	-	-	3	-	-	-	-
CO2	3	3	-	2	2	-	-	-	2	-	-	-	-
CO3	2	3	-	3	3	-	-	-	2	-	-		-
CO4	3	3	-	3	3	-	-	-	3	-	-	-	-
CO5	3	2	-	2	2	-	-	-	2	-	-	-	-
CO6	3	3	-	2	2	-	-	-	3	-	-	-	-
CO7	3	3	-	3	3	-	-	-	3	-	-	-	-

Justification of Mapping

PO1: Comprehensive Knowledge and Understanding

- **CO1**: Introduces concepts of integrated circuit design.
- **CO2**: Builds foundational knowledge about sensors.
- **CO4**: Covers basic principles of circuit design.
- **CO5**: Provides semiconductor fundamentals.
- **CO6**: Offers conceptual understanding of Optical Fiber Communication.
- **CO7**: Advances understanding of OFC circuit design.

PO2: Practical, Professional, and Procedural Knowledge

- **CO1**: Applies theory to circuit designing.
- **CO2**: Encourages practical identification and use of sensors.
- **CO3**: Hands-on handling of various sensor types.
- **CO4**: Basic level design implementation of circuits.

CO6: Applies practical knowledge to fiber optic systems.
CO7: Real-world OFC circuit design.

PO3: Entrepreneurial Mindset and Knowledge
CO1: Inspires innovation in IC design.
CO7: Encourages self-driven development of OFC systems.

PO4: Specialized Skills and Competencies
CO1–CO7: All course outcomes contribute to acquiring design, development, and system-level skills in electronics.

PO5: Application, Problem-Solving, and Analytical Reasoning
CO1: Requires problem-solving in IC circuit design.
CO3: Sensor handling demands practical issue resolution.
CO4–CO7: All outcomes involve analytical design and application of electronics principles.

PO7: Research-related Skills
Not explicitly targeted, though CO7 can involve exploration of OFC advancements.

PO9: Digital and Technological Skills
CO1: Involves IC design using digital tools.
CO2–CO3: Enhances understanding of digital interfacing of sensors.
CO4–CO7: Requires software tools and circuit simulation skills.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Electronics (SEM V) (2023 Pattern)

Name of the Program	: B.Sc. Electronics
Program Code	: USEL
Class	: T. Y. B.Sc.
Semester	: V
Course Type	: Major Elective (Theory)
Course Code	: ELE -306- MJE (A)
Course Title	: Java Programming
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives

1. Understand the fundamentals of computer languages.
2. Explore Object-Oriented Programming (OOP) concepts.
3. Develop Java programming skills.
4. Implement control structures.
5. Work with advanced Java concepts.
6. Handle strings efficiently.
7. Develop modular programs using user-defined methods.

Course Outcomes

After completing this course, students will be able to:

CO1: Differentiate between low-level and high-level programming languages and explain the roles of compilers and interpreters.

CO2: Apply Object-Oriented Programming (OOP) concepts like abstraction, inheritance, polymorphism, and encapsulation in Java applications.

CO3: Develop and execute Java programs using appropriate syntax, keywords, data types, variables, operators, and error-handling mechanisms.

CO4: Implement control structures such as if-else, switch-case, loops, and nested loops to design logical program flows.

CO5: Utilize advanced Java features, including wrapper classes, arrays, and array operations such as searching and sorting.

CO6: Perform string manipulations using predefined Java string functions to enhance program efficiency.

CO7: Create modular and reusable Java programs using user-defined methods, method overloading, and function calls.

Topics and Learning Points

Unit 1: Fundamentals of Java and OOP Concepts (10L)

- **Introduction to Computer Languages**: Low-level and high-level languages, Compiler vs. Interpreter

- **Object-Oriented Programming (OOP) Concepts**: Data Abstraction, Inheritance, Polymorphism, Encapsulation
- **Introduction to Java**: Features and applications of Java, JDK and JVM, Difference between C and Java, Structure of Java programming, Objects and Classes

Unit 2: Java Programming Essentials (10L)

- **Java Language Basics**: Character set, tokens, literals, keywords. Data types, variables, and operators. Input and output handling in Java. Types of errors in Java. Mathematical library methods
- **Control Flow in Java**: Conditional statements (if-else, switch). Iterative constructs (for, while, do-while loops). Nested loops
- **Programming Examples**

Unit 3: Advanced Java Concepts and Data Handling (10L)

- **Library Classes and Wrapper Classes**: Wrapper class and its methods. Character-oriented functions
- **Arrays in Java**: Single and double-dimensional arrays, Creating arrays. Basic operations: searching, sorting
- **String Handling**: String class, string variables, string functions (length, to Lowercase, to Uppercase, replace, equals, etc.)
- **User-Defined Methods in Java**: Syntax, definition, declaration. Calling methods, method overloading. Ways to invoke methods, returning values
- **Programming Examples**

Reference Books :

1. Programming with Java A Primer, E. Balaguruswamy Tata McGraw Hill Companies.
2. Java Programming John P. Flynt Thomson 2nd .
3. Java Programming Language Ken Arnold Pearson.
4. The complete reference JAVA2, Hervert schildt. TMH.
5. Big Java, Cay Horstmann 2nd edition, Wiley India Edition.

Mapping Table:

Course Outcomes	Program Outcomes												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	-	-	1	-	-	1	2	-	-	-	-
CO2	1	2	-	3	2	-	-	1	2	-	-	-	-
CO3	2	3	-	2	3	1	-	1	3	-	-	1	-
CO4	1	2	-	2	3	1	-	2	2	-	-	-	-

CO5	1	3	-	2	3	1	-	1	2	-	-	-	-
CO6	1	2	-	2	2	3	-	1	2	-	-	-	-
CO7	1	2	-	2	2	1	-	1	2	-	-	3	-

Justification For The Mapping :-

PO1 : Comprehensive Knowledge and Understanding

CO1 to CO7: Ensures a fundamental understanding of programming concepts, OOP principles, syntax, control structures, and Java features.

PO2 : Practical, Professional, and Procedural Knowledge

CO1 to CO7: Develops hands-on programming skills and proficiency in Java.

PO3 : Entrepreneurial Mindset and Knowledge

Not directly mapped, as the focus is more on software development rather than entrepreneurship.

PO4 : Specialized Skills and Competencies

CO2 to CO7: Builds specialized skills in object-oriented programming, control structures, and Java functionalities.

PO5 : Capacity for Application, Problem-Solving, and Analytical Reasoning

CO1 to CO7: Enhances logical and analytical thinking in programming and software development.

PO6 : Communication Skills and Collaboration

CO3 to CO7: Encourages clear, structured, and documented coding for effective teamwork and communication.

PO7 : Research-related Skills

Not directly mapped, as the course focuses on implementation rather than research.

PO8 : Learning How to Learn Skills

CO1 to CO7: Promotes self-learning, adaptability, and exploration of Java programming concepts.

PO9 : Digital and Technological Skills

CO1 to CO7: Strengthens digital literacy and technological proficiency in software development.

PO10 : Community Engagement and Service

Not directly mapped, as the course focuses on technical programming skills.

PO11 : Value Inculcation and Environmental Awareness

Not applicable to the Java programming course.

PO12 : Autonomy, Responsibility, and Accountability

CO3, CO7: Encourages responsibility in writing structured, reusable, and maintainable code.

PO13 : Multicultural Competence, Inclusive Spirit, and Empathy

Not directly mapped, as the course primarily focuses on programming skills.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Electronics

(2023 Pattern)

Name of the Programme:	**B.Sc. Electronics**
Programme Code:	**ELE**
Class:	**T. Y. B.Sc.**
Semester:	**V**
Course Type:	**Major Elective (Theory)**
Course Code:	**ELE -306-MJE (C)**
Course Title:	**Single Block Computers**
No. of Credits:	**02**
No. of Teaching Hours:	**30**

Course Objectives:

1. To introduce basic blocks of single board computers.
2. To know the use of input and output devices in SBCs.
3. Learn to use SBCs in various applications.
4. Apply skills to conduct interfacing SBC to different peripherals.
5. Apply the knowledge in real world applications using Arduino board.
6. Understand programming basics of python programming language.
7. Write code/program using open-source programming language (Arduino) for basic identified applications

Course Outcomes:

CO1. Acquire a basic knowledge about single board computers.

CO2. Acquire a basic knowledge about SBC's input and output devices.

CO3. Acquire knowledge about devices SBCs in embedded systems.

CO4. Develop programming skills in embedded systems for various applications.

CO5. Knowledge of various SBCs in the market and their comparison.

CO6. Familiar to Arduino microcontroller board.

CO7. Learn Arduino IDE and python programming.

Unit 1: Single Board Computers (SBC) in Embedded System **[15]**

SBC Block diagram, Types, Comparison of SBC models, Specifications, I/O devices (Storage, Display, Keyboard, Mouse), Network Access Devices. Arduino Microcontroller Board: Introduction to Arduino and Raspberry pi models, Comparison of different SBC models, Microcontrollers used in Arduino, Pin configuration and architecture, Concept of digital and analog ports. Arduino 6 programming: Introduction to Arduino IDE, variables and data types, Comparison operators (arithmetic, logical and relational, modulo and assignment) Statements: If Else Statement, Switch statement Control structures: While and For Loop Writing Arduino programs: LED blinking and Push button Serial Port Communication Function blocks: analogRead (), digitalRead () functions Intensity control of LED with Pulse Width Modulation using analogWrite ( ).

Unit 2: Introduction to Python **[15]**

Basic Python programming (Script programming), Python variables & data types, Data type conversion, Flow control structures, Functions: I/O function (GPIO, Digital), Time functions, Library functions, Basic arithmetic programs: Addition, Subtraction, Multiplication, and Division. Python codes using functions, Basic arithmetic programs by using functions.

Recommended Books:

1. Prof. Dr. P.B. Buchade, Microcontroller and python programming, First edition(2021), Nirali Publication.
2. Carr, Joseph J. Single-board computer applications. Blue Ridge Summit, PA: TAB Books, 1986.
3. G.K. Kanagachidambaresan, Role of Single Board Computers (SBCs) in Rapid IoT Prototyping, First edition (2021), Springer publication.
4. Dr. Charles Russell Severance, Python for everybody, First edition (2016).
5. Allen B. Downey , Think Python: How to Think Like a Computer Scientist, second edition (2015), O'Reilly publication.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1=Weak or low relation, 2=Moderate or partial relation, 3=Strong or direct relation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3								3	1			
CO2		3		2					3				
CO3			3		3		3	3					2
CO4			3		3		3	3				3	2
CO5	3							3			3		
CO6		3				2				2			
CO7				3		2	3		3				

PO1: Comprehensive Knowledge and Understanding:

CO1: Provides strong foundational understanding of SBCs, directly aligned with comprehensive knowledge.

CO5: Provides strong foundational understanding of SBCs, directly aligned with comprehensive knowledge.

PO2: Practical, Professional, and Procedural Knowledge:

CO2: Directly relates to procedural handling and integration of I/O devices in real-world projects.

CO6: Strong hands-on knowledge critical for practical implementation and prototyping.

PO3: Entrepreneurial Mindset and Knowledge:

CO3: Strongly relevant for creating innovative embedded system applications and products.

CO4: Vital skill for prototyping, building, and launching entrepreneurial tech solutions.

PO4: Specialized Skills and Competencies:

CO2: Essential for mastering hardware interfacing, a core specialized skill in embedded systems.

CO7: Strongly develops domain-specific programming abilities crucial for embedded projects.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning:

CO3: Enables critical analysis of device integration and problem-solving in embedded systems.

CO4: Strongly enhances the ability to apply knowledge and troubleshoot real-time embedded problems.

PO6: Communication Skills and Collaboration:

CO6: Supports collaboration during hardware setup, especially in group projects.

CO7: Enables peer collaboration in coding, debugging, and presenting projects.

PO7: Research-related Skills:

CO3: Directly supports innovation in embedded applications through system-level understanding.
CO4: Core skill required to implement, test, and validate research ideas through code.
CO7: Provides essential tools for experimental coding, simulations, and data collection in research.

PO8: Learning How to Learn Skills:

CO3: Fosters an independent approach to learning new technologies in embedded systems.
CO4: Strengthens continuous learning through hands-on coding and debugging experiences.
CO5: Promotes lifelong learning by analyzing and evaluating new technologies.

PO9: Digital and Technological Skills:

CO1: Understanding SBCs builds core digital competency essential in modern technology-driven environments.
CO2: Directly contributes to skills needed to interface with and control digital devices.
CO7: Encourages strong digital skills through the use of modern development environments and languages.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy:

CO1: Provides foundational knowledge but does not directly engage with multicultural or inclusive aspects.
CO6: Use of globally recognized platforms can foster appreciation of international standards and diverse educational tools.

PO11: Value Inculcation and Environmental Awareness:

CO5: Encourages selection of energy-efficient, cost-effective, and sustainable platforms.

PO12: Autonomy, Responsibility, and Accountability:

CO4: Programming encourages self-driven learning, responsibility for debugging, and system behavior.

PO13: Community Engagement and Service:

CO3: Can be moderately related if applied in real-world service projects like smart energy or community sensors.
CO4: Can be used to design community-focused solutions such as automation in public services or health monitoring.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Electronics

(2023 Pattern)

Name of the Programme:	**B.Sc. Electronics**
Programme Code:	**ELE**
Class:	**T. Y. B.Sc.**
Semester:	**V**
Course Type:	**Major Elective (Theory)**
Course Code:	**ELE -306-MJE (B)**
Course Title:	**Optical Fiber Communication Technology**
No. of Credits:	**02**
No. of Teaching Hours:	**30**

Course Objectives:

1. To learn optical characteristics.
2. To understand the principles of fiber optic communication system.
3. To learn different parameter of optical fibers.
4. To understand essential optical components of Fiber Optic Communication.
5. To study measuring equipment.
6. To get knowledge about optical sources and their working principles.
7. To calculate different optical parameters

Course Outcomes:

CO1: Understand concepts of fiber optics, its types, different optical sources and detectors.
CO2: Know the concepts of attenuation and losses in fiber used in optical communication.
CO3: Demonstrate an understanding of optical fiber communication link, structure, propagation and transmission properties of an optical fiber.
CO4: Describe the principles of optical sources and power launching-coupling methods.
CO5: To learn the various optical sources, materials and fiber splicing.
CO6: Learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.
CO7: Knowledge about optical fiber transmitter and receiver system.

Unit 1: Overview and Transmission characteristics **(12)**

Introduction, Historical development, general system, advantages, disadvantages, and applications of optical fiber communication, optical fiber waveguides, Ray theory, cylindrical fiber, single mode and multimode fiber, cutoff wave length, and mode filed diameter. Optical Fibers: fiber materials, photonic crystal, fiber optic cables specialty fibers, Introduction to transmission characteristics, Attenuation, absorption, scattering losses, bending loss, dispersion, Intra modal dispersion, Inter modal dispersion.

Unit 2: Optical Sources and Detectors **(8)**

Coherent and non-coherent sources, LEDs: Working principle, structure and characteristics, Laser diodes: Working principle, structure and characteristics, PIN and APD: Working principle and characteristics of detectors, noise analysis in detectors. Comparison of photo diodes.

Unit 3: Fiber optic losses and communication technology **(10)**

Fiber splices, fiber connectors and fiber couplers, Dispersion, Intra model dispersion, Inter model dispersion. Attenuation in optical fibers, material or impurity losses, scattering losses, absorption losses, bending losses. Fiber optic link structure and link losses, connector and splicing losses. OPTICAL NETWORKS: Introduction, SONET. OTDR Working Principle and characteristics,

Reference Books:

1. G. Kaiser Optical fiber communication McGraw Hill

2. Subirkumar Sarkar Optical fibers and fiber optic communication systems S.Chand and Company

3. R. P. Khare Fiber optics and optoelectronics oxford University Press

4. John M. Senior Optical fiber communications Principles and Practice, (2nd edition) PHI

5. Ajoy Ghatak and K. Thyagarajan Introduction to fiber optics Cambridge University Press

6. Fiber Optic Communications – Joseph C. Palais, 4th Edition, Pearson Education, 2004.

7. Fiber Optic Communications – D.K. Mynbaev , S.C. Gupta and Lowell L. Scheiner, Pearson Education, 2005.

Mapping of Program Outcomes with Course Outcomes

Weightage: 1=Weak or low relation, 2=Moderate or partial relation, 3=Strong or direct relation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	2	2		2								1
CO2	3	2			3		3						
CO3	2	3		3		3	3			2		3	
CO4				3					2		1		
CO5			3			3				2		3	
CO6	3							3					2
CO7		3						2	3		2		

PO1: Comprehensive Knowledge and Understanding:
CO1: Strong theoretical understanding of fiber optics is fundamental to comprehensive knowledge.
CO2: In-depth knowledge of signal losses contributes directly to understanding system limitations.
CO3: This CO reflects the understanding of system-level properties, aligning strongly with PO1.
CO6: Strong alignment as it involves structural and conceptual understanding.

PO2: Practical, Professional, and Procedural Knowledge:
CO1: Theoretical understanding is necessary before applying it practically. Moderate relevance.
CO2: Important for analyzing and troubleshooting practical communication systems.
CO3: Directly supports practical application and system design. Strong procedural relevance.
CO7: Critical for practical understanding of communication systems. Strong alignment.

PO3: Entrepreneurial Mindset and Knowledge:
CO1: Provides foundational knowledge that supports innovation in optical technology ventures.
CO5: Strong link—hands-on skills are essential for launching a fiber optic service or hardware business.

PO4: Specialized Skills and Competencies:
CO3: In-depth understanding of fiber link properties is essential for specialized system configuration and analysis.
CO4: Coupling and launching methods are key skills in advanced optical communication setups.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning:
CO1: Basic understanding supports the identification and interpretation of optical system problems. CO2: Analyzing attenuation and loss involves strong analytical reasoning and practical application.

PO6: Communication Skills and Collaboration:

CO3: Communicating link structures and behaviors is essential in collaborative design and analysis tasks.
CO5: Fiber splicing and material selection often require hands-on collaboration and clear communication during lab work.

PO7: Research-related Skills:
CO2: Loss analysis and attenuation modeling are commonly explored in experimental optical communication research.
CO3: In-depth knowledge of fiber link properties is critical for formulating and validating research hypotheses.

PO8: Learning How to Learn Skills:
CO6: Studying transmission structures promotes independent inquiry and deeper conceptual learning.
CO7: Familiarity with transmitter-receiver systems encourages learners to explore further technologies and upgrades.
PO9: Digital and Technological Skills:
CO4: Learning coupling methods enhances understanding of technical setups and digital signal interfacing.
CO7: Transmitter and receiver knowledge is fundamental to working with modern fiber-optic and digital communication systems.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy:
CO3: Working on communication systems may involve collaboration with diverse teams, promoting inclusivity.
CO5: Hands-on skills like fiber splicing may involve teamwork and inclusive lab environments.

PO11: Value Inculcation and Environmental Awareness:
CO4: Launching and coupling methods are technical and have limited direct environmental context.
CO7: Understanding transmitter and receiver systems helps in developing low-power, environmentally conscious technologies.

PO12: Autonomy, Responsibility, and Accountability:
CO3: Designing and managing communication links requires independent judgment and technical responsibility.
CO5: Performing splicing and material selection independently reinforces both accountability and skill ownership.

PO13: Community Engagement and Service:
CO1: Basic knowledge of fiber optics has limited direct connection to community service activities.
CO6: Fiber transmission systems can aid in building infrastructure for education, healthcare, or disaster management.

CBCS Syllabus as per NEP 2020 for T. Y. B. Sc. Electronics (SEM V) (2023Pattern)

Name of the Programme : B.Sc. Electronics

Programme Code : USEL

Class : T. Y. B.Sc.

Semester : V

Course Type : Major Mandatory (Practical)

Course Code : ELE-321-VSC

Course Title : Software Practicals

No. of Credits : 02

No. of Teaching Hours : 60

Course Objectives:

1. To learn the basic embedded C-Programming.
2. To learn Verilog HDL to design basic combinational and sequential circuits
3. To get familiar with structural, data flow and behavioral modeling
4. To learn assembly level language of 8051 microcontroller
5. To Understand assembly language for programming
6. To develop 8051 microcontroller based systems.

Course Outcomes:

After completing the course, the students will be able to

CO1: Develop and simulate design digital systems using Verilog.
CO2: Design and develop AVR microcontroller based systems.
CO3: Understand c language programming.
CO4: Increase problem-solving skills, creativity, algorithmic etc.
CO5: sequential and computational thinking skills.
CO6: Understand assembly language for programming
CO7: inculcate basic skills required for design and development of embedded Systems.

Total 15 practical's are compulsory including activities.

<u>List of experiments</u>

Digital System Design using Verilog HDL

1. Design logic gates using gate level/data flow/Structural/Behavioral style of modeling
2. Design 4 to 1 line MUX/ 1 to 4 DEMUX
   Use a) gate level b) data flow c) Structural d) Behavioral style of modeling
3. Arithmetic circuits: Half adder, Full adder (using gate level , Data flow modeling) and Parallel adder using structural modeling
4. Four bit ALU design.
5. Design of flip-flops : R-S, J-K, D and T using behavioral modeling
6. Code converters
7. Binary Adder
8. Counters. (Up counter/down counter, ring counter)

9. Shift Registers (SIPO/SISO/PISO/PIPO)
10. Sequence generator for stepper motor

Basic 8051 Microcontroller programming

1. Program to find Largest/smallest from a series.
2. Arithmetic, logical problems using C programming
3. Code conversion problems using C programming
1. Factorial Calculation
2. Sum of First N Natural Numbers
3. Swapping Two Numbers
4. Fibonacci Sequence (First 10 Numbers)
5. Checking Prime Number
4. Interfacing LED array to Microcontroller
5. Interfacing the thumbwheel & seven segment display.
6. Traffic light controller using microcontroller.
7. Interfacing LCD to Microcontroller.
8. Waveform generation using DAC Interface.
9. Interfacing Stepper motor to Microcontroller

Activity

Any one of the following activities will be considered as equivalent to 2 experiments

1. PCB Making using simulator
2. Internet browsing
3. Industrial /field Visit
4. Hands on training workshop
5. Do it Yourself Open ended Project

Mapping of Program Outcomes with Course Outcomes

Weightage: 1=Weak or low relation, 2=Moderate or partial relation, 3=Strong or direct relation

Course Outcome	Program Outcome								
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	-	1	1	2	-	-	3
CO2	3	3	-	1	1	2	-	-	3
CO3	3	3	2	3	2	2	-	-	3
CO4	3	3	2	3	1	2	-	-	3
CO5	3	3	2	3	1	2	-	-	3
CO6	3	3	2	3	1	2	-	-	3
CO7	3	3	2	3	2	2	-	-	3

Justification For The Mapping

PO1: Disciplinary Knowledge

CO1,CO6,CO7: Providing essential foundations for effective programming within the C language.

CO2,CO4,CO5: Fostering basic skills for embedded systems align with disciplinary knowledge, laying the foundation for effective understanding and application within the field of embedded systems.

CO3: Providing essential skills for effective design and implementation within the field of digital systems

PO2: Critical Thinking and Problem solving

CO1,CO6,CO7: Fostering analytical reasoning and practical application in programming challenges.

CO2,CO4,CO5: Enhancing analytical reasoning and practical application in the field of embedded systems.

CO3:Developing analytical reasoning and practical application, enabling effective design and implementation within the realm of digital systems.

PO3: Social competence

CO3: Encouraging collaborative problem-solving and effective communication in the context of designing and implementing digital systems.

CO4,CO5: Encouraging collaboration, effective communication, and shared problem-solving experiences within the realm of embedded systems development.

CO6,CO7: Fostering collaborative learning, effective communication, and shared problem-solving experiences within the programming community.

PO4: Research-related skills and Scientific temper

CO1: Proficiency in C language software enhances research-related skills by providing a versatile programming tool for developing and analyzing algorithms in scientific investigations.

CO2: Mastery of microcontroller programming tools cultivates a scientific temper by enabling the exploration and development of advanced embedded systems, crucial for research and technological innovation.

CO3: Verilog skills contribute to research-related proficiency by empowering the design and simulation of digital systems, fostering a scientific approach in exploring complex hardware implementations.

CO4: Designing 8051 microcontroller-based systems develops a scientific temper through hands-on experience, allowing for practical application of theoretical knowledge in research-oriented embedded system projects.

CO5: Acquiring basic skills in embedded systems design promotes a research-oriented mindset, laying the foundation for exploring innovative solutions in scientific and technological domains.

CO6: Gaining basic programming skills in C language fosters research-related capabilities by providing a fundamental tool for implementing algorithms and conducting computational analyses in scientific research.

CO7: Developing and simulating C programs using Turbo C++ enhances research-related skills, as it equips individuals with the ability to efficiently implement and analyze algorithms in a research context.

PO5: Trans-disciplinary knowledge

CO1: Proficiency in C language software contributes to trans-disciplinary knowledge, offering a versatile programming tool applicable across various domains and facilitating interdisciplinary collaboration.

CO2:Understanding microcontroller programming software promotes trans-disciplinary knowledge by providing a foundation for diverse applications, from embedded systems in healthcare to automation in industrial sectors.

CO3: Verilog skills for digital system design and simulation transcend disciplinary boundaries, enabling the application of digital systems in fields such as communication, signal processing, and control systems.

CO4: Designing 8051 microcontroller-based systems imparts trans-disciplinary knowledge by offering a platform applicable in various domains, from consumer electronics to automotive and medical devices.
CO5: Basic skills in embedded systems design foster trans-disciplinary knowledge, as they are essential for creating innovative solutions that bridge the gap between hardware and software in diverse application domains.
CO6: Basic programming skills in C language contribute to trans-disciplinary knowledge, as C is widely used in fields ranging from data science to game development, facilitating communication and collaboration across disciplines.
CO7: Developing and simulating C programs using Turbo C++ enhances trans-disciplinary knowledge, providing a foundational skill applicable in diverse fields and facilitating collaboration through the use of a widely recognized programming environment.

PO6: Personal and professional competence
CO1: Proficiency in C language software contributes to personal and professional competence by equipping individuals with a fundamental programming skill widely used in the industry, enhancing their employability and adaptability.
CO2: Knowledge of microcontroller programming software enhances personal and professional competence, providing individuals with the skills needed to work on a variety of embedded systems projects, from IoT devices to robotics.
CO3: Developing and simulating digital systems using Verilog enhances personal and professional competence by imparting advanced skills crucial for working on complex projects in digital design and hardware development.
CO4: Designing and developing 8051 microcontroller-based systems contributes to personal and professional competence by providing hands-on experience in embedded systems, reinforcing practical skills essential for engineering professionals.
CO5: Inculcating basic skills in embedded systems design nurtures personal and professional competence, preparing individuals to contribute effectively to the development of innovative solutions in diverse industries.
CO6: Acquiring basic programming skills in C language is foundational for personal and professional competence, enabling individuals to comprehend and contribute to a wide range of software projects across various domains.
CO7: Developing and simulating C programs using Turbo C++ enhances personal and professional competence by providing skills that are applicable in legacy systems and fostering adaptability in diverse programming environments.

PO9: Self-directed and Life-long learning
CO1: Knowing the C language software fosters self-directed and life-long learning by providing a foundational programming skill that encourages continuous exploration and adaptation to evolving software development practices.
CO2: Knowledge of microcontroller programming software promotes self-directed and life-long learning, as it empowers individuals to stay current with advancements in embedded systems and microcontroller technologies through ongoing self-education.
CO3: Developing and simulating digital systems using Verilog encourages self-directed and life-long learning by exposing individuals to the complexities of hardware design, motivating ongoing exploration and improvement of digital system design skills.
CO4: Designing and developing 8051 microcontroller-based systems instills a self-directed and life-long learning mindset by requiring continuous skill enhancement to adapt to emerging challenges in the field of embedded systems and microcontroller applications.

CO5: Inculcating basic skills in embedded systems design supports self-directed and life-long learning by laying the groundwork for individuals to independently explore and advance their knowledge in this dynamic and evolving field.

CO6: Acquiring basic programming skills in C language promotes self-directed and life-long learning by providing a solid foundation for individuals to continuously enhance their programming abilities and adapt to new programming languages and paradigms.

CO7: Developing and simulating C programs using Turbo C++ encourages self-directed and life-long learning by exposing individuals to different programming environments, fostering adaptability and a proactive approach to staying current with diverse programming tools.

CBCS Syllabus as per NEP 2020 for T. Y. B.Sc. Electronics (SEM V)

Name of the Programme : BSc. Electronics
Programme Code : ELE-311-MN
Class : T.Y.B.Sc (MN)
Semester V
Course Type : Minor (Theory)
Course Code : ELE-311-MN
Course Title : Programming in C
No. of Credits. : 02
No. of Teaching Hours. : 30

Course Objectives

1. To express algorithms and draw flowcharts in a language independent manner.
2. To teach how to write modular, efficient and readable C programs.
3. To understand different data types and operators.
4. To study decision making statements and control structures in C.
5. To design programs using if else , nested if and loops.
6. To impart knowledge in creating and using Arrays of the C data types.
7. To design C programs based on arrays while solving problems.

Course Outcomes

Upon completion of the course, the students will be able to:

CO1. Describe the fundamentals of C programming Language.
CO 2. Write, compile and debug programs in C language.
CO 3. Use different data types in a computer programs.
CO 4. Design programs involving decision structures, loops.
CO 5. Apply appropriate Control structures to solve problems.
CO 6. Describe the concept of Arrays.
CO 7. Use and implement data structures like arrays to obtain solutions.

Topics and Learning Points

Unit 1: Introduction to C Programming [10 L]

Introduction, History and importance of C, Art of Programming through Algorithms and Flowcharts, Basic structure of C program, executing a C program.

Constants, Variable and Data Types: Character Set, C Tokens, Keywords and Identifiers, Constants, Variables, Data Types, Declaration of Variables, Assigning Values to Variables, Defining Symbolic Constants. Reading a Character, Writing a Character, Formatted Input, Formatted Output.

Operators and Expressions: Introduction, Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Increment and Decrement Operators, Conditional Operator, Bitwise Operators, Special Operators, Arithmetic Expressions, Evaluation of Expressions, Precedence of Arithmetic Operators, Expressions.

Unit 2: Control Statements [10 L]

Decision Making and Branching: Introduction, Decision Making with if Statement, Simple if statement, the if-else statement, Nesting of if-else statements, else if ladder, switch statement, goto statement, Program examples Decision Making and Looping: Introduction, The while Statement, The

do while statement, The for statement, nested for loop, Jump statements in loops. Program examples.

Unit 3: Fundamentals of Arrays [10 L]

Arrays: One-dimensional Arrays, Declaration of One-dimensional Arrays, Initialization of One-dimensional Arrays, Read and display 1D array. Example programs.

Two-dimensional Arrays, Declaration of Two-dimensional Arrays, Initialization of Two- dimensional Arrays, Example programs-Matrix addition, subtraction, multiplication, Transpose of a matrix Programs.

Reference Books:

1. J. JayasriThe 'C Language Trainer with C Graphics and C++ WILEY
2. Byron. S. Gottfried Schaum's Outline of Programming with C TMH
3. E Balaguruswamy Programming in ANSI C The McGraw Hill publication
4. Stephens Cochan Programming in C Prentice hall of India Ltd
5. V. Rajaraman Computer Programming in C Prentice hall of India Ltd.
6. MadhusudanMothe C for Beginner

Mapping:

Course Outcome	Program Outcome												
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	3	3	-	1	2	1	-	-	-	-	-	-	-
CO2	3	3	1	-	2	1	-	-	-	-	-	-	-
CO3	3	3	-	2	2	-	-	-	-	-	-	2	-
CO4	3	3	-	-	2	2	2	-	1	1	-	2	-
CO5	3	3	1	2	2	2	2	1	1	1	-	2	-
CO6	3	3	-	1	2	2	-	-	-	-	-	-	-
CO7	3	3	1	2	2	-	2	1	-	-	-	2	-

Justification:

PO1: Comprehensive Knowledge and Understanding

CO1:Students get a deep understanding of the key concepts and principles of the C programming language.

CO2: Students will be able to write, compile, and debug programs in the C programming language confidently.

CO3: Students will have a comprehensive understanding of various data types available in the C programming language and will be able to use them effectively in their programs.

CO4: Students will be able to design and implement programs that involve decision structures (such as if-else statements) and loops (such as for and while loops) to achieve desired outcomes.

CO5: Students will be able to apply appropriate control structures in their programs to solve complex problems efficiently.

CO6: Students will have a clear understanding of the concept of arrays in C programming and their usage in storing and manipulating multiple values of the same data type.

CO7: Students will be able to effectively use and implement data structures like arrays to solve real-world problems and obtain optimal solutions.

PO2: Practical, Professional, and Procedural Knowledge

CO1: Students will have practical and professional knowledge of the C programming language and its fundamentals.

CO2: Students will be proficient in writing, compiling, and debugging programs in the C programming language.

CO3: Students will have procedural knowledge of using different data types in the C programming language and will be able to use them effectively in their programs.

CO4: Students will be able to design programs using decision structures and loops to achieve expected outcomes and will be proficient in executing them.

CO5: Students will be able to apply appropriate control structures to solve complex problems in a professional and procedural manner.

CO6: Students will have practical knowledge of the concept of arrays in the C programming language and their application in solving real-world problems.

CO7: Students will be proficient in implementing data structures like arrays to obtain solutions to complex programming problems in a professional and procedural manner.

PO3: Entrepreneurial Mindset and Knowledge

CO2: Students will be able to effectively utilize the C programming language in developing innovative solutions and will be capable of debugging and optimizing code to create value in the marketplace.

CO5: Students will be able to apply appropriate control structures in their programs to solve complex problems effectively and innovatively.

CO7: Students will be capable of using and implementing data structures like arrays to develop innovative solutions to complex real-world problems in a competitive marketplace.

PO4: Specialized Skills and Competencies.

CO1: Students will have specialized skills and competencies in the fundamentals of the C programming language, enabling them to effectively communicate and collaborate with professionals in the field.

CO3: Students will demonstrate specialized skills and competencies by effectively utilizing different data types in their computer programs, showcasing their ability to leverage the full potential of the C programming language.

CO5: Students will exhibit specialized skills and competencies by effectively applying appropriate control structures to solve various problems, highlighting their ability to optimize code and enhance program efficiency.

CO6: Students will showcase their specialized skills and competencies by demonstrating a comprehensive understanding of the concept of arrays in the C programming language, emphasizing their ability to utilize this data structure effectively.

CO7: Students will develop specialized skills and competencies in using and implementing data structures like arrays to obtain solutions for complex programming challenges, demonstrating their ability to produce efficient and effective code.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

CO1: Students will be able to apply their understanding of the fundamentals of C programming language to solve real-world problems, showcasing their capacity for practical application and analytical reasoning.

CO2: Students will demonstrate their capacity for practical application and problem-solving by effectively writing, compiling, and debugging programs in the C programming language, showcasing their ability to analyze and solve programming challenges.

CO3: Students will exhibit their capacity for application and problem-solving by using different data types effectively in computer programs, demonstrating their ability to select and utilize appropriate data types for specific scenarios.

CO4: Students will showcase their capacity for problem-solving and analytical reasoning by designing programs that incorporate decision structures and loops, demonstrating their ability to implement logical solutions to complex programming problems.

CO5: Students will demonstrate their capacity for problem-solving by effectively applying appropriate control structures to solve various programming problems, showcasing their ability to analyze problems and devise efficient solutions.

CO6: Students will exhibit their capacity for application and analytical reasoning by describing the concept of arrays in the C programming language, showcasing their ability to understand and explain fundamental data structures.

CO7: Students will apply their capacity for application, problem-solving, and analytical reasoning by effectively using and implementing data structures like arrays to obtain solutions for complex programming challenges, showcasing their ability to analyze problems and devise efficient solutions using appropriate data structures.

PO6: Communication Skills and Collaboration

CO1: Students will demonstrate effective communication skills by describing the fundamentals of the C programming language, facilitating collaboration and understanding with peers and professionals in the field.

CO2: Students will showcase their communication skills and ability to collaborate by effectively writing, compiling, and debugging programs in the C programming language, enabling efficient communication and teamwork in programming projects.

CO4: Students will demonstrate their ability to communicate and collaborate by designing programs that incorporate decision structures and loops, facilitating effective communication and collaboration with peers and stakeholders in the programming process.

CO5: Students will showcase their communication skills and ability to collaborate by effectively applying appropriate control structures to solve programming problems, promoting effective communication and collaboration in solving complex programming challenges.

CO6: Students will exhibit their communication skills by describing the concept of arrays in the C programming language, facilitating clear communication and collaboration with peers and stakeholders in programming projects involving arrays.

PO7: Research-related Skills

CO4: The various decision structures and loops and their usage in C programming language to design effective programs.

CO5: Various control structures and their usage in C programming language to solve problems effectively.

CO7: Various data structures and their usage in C programming language to efficiently implement them in programs to obtain solutions.

PO8: Learning How to Learn Skills

CO5: Learner will acquire the skills to learn and apply various control structures in the C programming language to effectively solve problems, enhancing their ability to learn and adapt to new programming challenges.

CO7: Learner will gain the knowledge and skills required to learn and implement data structures such as arrays through self-directed learning, enabling them to leverage these structures efficiently to obtain solutions.

PO9: Digital and Technological Skills

CO4: Learners to design programs with decision structures (like if-else statements) and loops (like for and while loops). It helps them create more robust and efficient software solutions.

CO5: Learners to apply suitable control structures (like loops and conditional statements) to tackle problems in computer programming. It enhances their problem-solving capabilities in real-world

PO10: Community Engagement and Service

CO4: Enables developers to create more efficient and effective software solutions that can have a positive impact on communities.

CO5: Allows developers to create software solutions that can help solve real-world problems faced by communities.

PO12: Autonomy, Responsibility, and Accountability

CO3: Demonstrates an understanding of the importance of selecting appropriate data representation and taking responsibility for accurate and efficient data management.

CO4: Designing efficient and logical program flow and being accountable for the outcomes produced.

CO5: Reflects autonomy in problem-solving, taking responsibility for developing efficient and effective solutions, and being accountable for the results.

CO7: Obtain solutions demonstrates autonomy in leveraging appropriate data structures, taking responsibility for efficient algorithm design, and being accountable for delivering effective solutions.

CBCS Syllabus as per NEP 2020 for T.Y. B.Sc. Electronics (SEM V)

Name of the Programme : B.Sc. Electronics
Programme Code : ELE-312-MN
Class : T. Y. B.Sc.(MN)

Semester	: V
Course Type	: Minor Mandatory (Practical)
Course Code	: ELE-312-MN
Course Title	: C Program Practical's
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Objectives:

1. To make use different basic concepts for building different applications
2. To understand design procedures of different electronic circuit as per requirement
3. To build experimental setup and test the circuits.
4. To develop skills of analyzing test results of given experiments.
5. To Design and test combinational circuits.
6. This course gives students deep knowledge in digital communication systems
7. To Understand Basic knowledge of Digital electronics.

Course Outcomes

After achieving the above objectives, students should be able to

1. Design any operational amp. Based application circuit and test it.
2. Design any instrumentation based application circuit and test it.
3. To Understand basic parameters in electronics.
4. Students we Know operation of different instruments used in the laboratory.
5. Students we Connect circuit and do required performance analysis.
6. The course will help in design and analysis of the digital circuit and system.
7. At the end of the course, the students will be able to.

List of Practicals

The practical course consists of **15** experiments.

List of Practical's :(C programming):

1. Basic programs using different operators.
2. To swap value of two variables.
3. To find the maximum number out of the three numbers.
4. To check given number is Armstrong number or not.
5. To reverse digits of the given number.
6. To calculate average of all elements of an array.
7. Program to calculate average of an array
8. Finding the length of string using pointers.
9. Sin and COS by Taylor series using C.
10. Prime number using C.
11. To print the sum of digits of a number using for loop.
12. To find the largest of three numbers using ternary operators.
13. Write Program to print an Array.
14. Program to print an array in reverse order.
15. To add two square matrices.
16. Swapping two numbers using pointer.

Activity: (Any one Activity equivalent to two experiments)

1. PCB Making
2. Internet browsing
3. Industrial /field Visit
4. Hands on training workshop
5. Do it Yourself Open ended Project

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	-	3	1	3	2	-	-	3	1	2	2	-	3
CO2	3	2	-	1	-	2	2	-	-	-	1	-	-
CO3	-	-	2	-	1	-	-	-	-	2	1	-	2
CO4	3	-	-	2	-	-	1	2	2	-		-	
CO5	-	1		-	3	3	2	2	-	-	-	-	-
CO6	-	-	-	-	-	-	-	-	-	2	3	-	
CO7	1	3	-	-	3	-	-	-	-	-	-	-	1

Mapping Justification:-

PO1:- Comprehensive Knowledge and Understanding:

CO2:- Students acquire practical skills in designing and testing instrumentation-based circuits. Through this, students get understanding of the theoretical concepts and practical applications of instrumentation, thereby enhancing their overall knowledge and understanding.

CO4:- Understanding the operation of various instruments in a laboratory setting is fundamental to gaining comprehensive knowledge in the field of instrumentation.

CO7: It enables students to demonstrate their ability to apply theoretical knowledge to practical scenarios by designing and testing instrumentation-based circuits.

PO2:- Practical, Professional, and Procedural Knowledge:

CO1:- Students practical knowledge and skills in designing operational amplifier-based circuits.

CO2:- Design and testing process, students acquire professional-level competence in applying instrumentation principles to real-world applications.

PO7:-Research-related Skills:

CO2:- When designing and testing instrumentation-based circuits, students may need to conduct research to explore new techniques, components.

CO4:- students develop their capacity for application, problem-solving, and analytical reasoning in the field of electronics.

CO5:- To Understanding the operation of various instruments used in the various circuits.

PO8:-Learning How to Learn Skills:

CO1:- students are encouraged to engage in research, seek out resources, and apply critical thinking to solve problems.

CO4:- Understanding the operation of various instruments in the laboratory requires students to engage in active learning processes

CO5:- The design and testing process, students encounter challenges that require them to analyze problems, develop solutions, and evaluate the performance of their designs.

PO9:-Digital and Technological Skills:

CO1:- Electronic circuit design, digital components and technologies are often integrated with analog circuits.

CO4:- Understanding the operation of various instruments in the laboratory, including digital instruments.

PO10:-Multicultural Competence, Inclusive Spirit, and Empathy:

CO2:- Collaborating on projects such as designing and testing instrumentation-based circuits encourages interaction and mutual respect among students, fostering an inclusive atmosphere where different viewpoints are valued.

CO3:- Understanding basic parameters in electronics is essential for effective communication and collaboration, specially in multicultural settings.

CO6:- When working on digital circuit and system design, students may encounter diverse requirements and constraints that require them to consider the needs this circuits .

PO11:-Value Inculcation and Environmental Awareness:

CO1:- The importance of designing operational amplifier-based circuits with optimal performance and minimal waste, students learn to value efficiency and environmental consciousness in their practical.

CO5:- Connecting circuits and performing performance analysis are essential procedural skills. And students develop the ability to effectively connect circuits and analyze their performance, which is crucial for professional practice in the field of instrumentation.

CO7:- Students to demonstrate their ability to apply practical knowledge and skills in designing and testing operational amplifier-based circuits

PO3:- Entrepreneurial Mindset and Knowledge:

CO1:- Designing and testing operational amplifier-based circuits, students not only gain technical skills but also learn to innovate and create solutions to real-world problems.

CO3:- Understanding basic parameters in electronics is essential for developing an as it provides students with foundational knowledge about electronic components and systems.

PO4:-Specialized Skills and Competencies:

CO1:- To design and testing process, students acquire specific competencies relevant to their field of study.

CO2:- Design and testing of such circuits equips students with specialized competencies required for working with instrumentation systems.

CO4:- Understanding the operation of various instruments used in laboratory settings is a fundamental specialized skill.

PO5:-Capacity for Application, Problem-Solving, and Analytical Reasoning:

CO1:- Students to apply their theoretical knowledge of operational amplifiers and circuit design principles to real-world applications. By designing and testing circuits.

CO3:- Understanding basic parameters in electronics is crucial for applying theoretical knowledge to practical Skill.

CO5:-Students get performing performance analysis requires students to apply their knowledge of circuit theory and measurement techniques.

CO7:- Developing students' capacity for application, problem-solving, and analytical reasoning throughout the course.

PO6:-Communication Skills and Collaboration:

CO2:-Students will get the communication skills through group projects or lab work. In many cases, students may need to work in teams to design and test instrumentation-based circuits.

CO5:-In the process of designing circuits, students encounter various challenges that require them to analyze problems and develop the own skill in electronics projects.

CO2:- students to design instrumentation-based circuits that are energy-efficient and environmentally sustainable.

CO3:- Understanding basic parameters in electronics, such as power consumption, voltage levels, and signal etc.

CO6:- Students develop a deeper understanding of the importance of environmental awareness in electronic Project practices.

PO13: Community Engagement and Service:

CO1:- Students to independently design operational amplifier-based circuits and test them. By taking ownership of their design projects, students learn to make decisions, solve problems, and manage tasks autonomously.

CO3:- Understanding basic parameters in electronics is essential for students to take responsibility for their designs and ensure their effectiveness

CO7:- Students develop autonomy in problem-solving and decision-making, take responsibility for their design choices, and are held accountable for the performance of their digital circuits and systems.