Anekant Education Society's

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

(Autonomous)

Academic Year 2023-2024

2022 Pattern

Course Structure for M.Sc. - II: Electronic Science

Semester	Paper Code	Title of Paper	No. of Credits
III	PSEL231	Advanced Communication Electronics	4
	PSEL232	Advanced Embedded Systems	4
	PSEL233	Digital Signal Processing	4
	PSEL234	Programmable Logic Controllers and Supervisory Control & Data Acquisition	4
	PSEL235	Practical Course –V	4
	PSEL236	Practical Course –VI	4

PSEL231: Advanced Communication Techniques (4 Credits)

Objectives:

1. To learn analog modulation techniques
2. Study the noise and source.
3. To learn various digital modulation techniques.
4. To study basic digital communication system and digital codes.
5. To learn error detection and correction codes.
6. To study various digital data communication systems
7. To understand the advanced communication system.

Course Outcome:

CO1. Learn the power distribution in AM.
CO2. Student will be able to learn digital modulation techniques.
CO3. Student will be able to learn Analog modulation techniques
CO4. Develop ability to Detection and Error Correction.
CO5. To know the working principle of advanced digital communication systems
CO6. Student will be able to explain the frequency spectrum band.
CO7. Student will be able to learn advanced communication technology.

Unit 1: Analog Communication [15]

Analog communication systems, Modulation, Bandwidth requirements, External and Internal noise, Theory of Amplitude modulation, Power distribution, Generation of AM, Suppression of carrier, suppression of unwanted side Bands, Extensions of SSB. Theory of frequency and Phase modulation, sidebands and modulation index, Noise and Frequency modulation, Analog base band Transmission.

Unit 2: Digital Communication [15]

Digital Communication Pulse modulation, Pulse amplitude modulation, pulse width modulation, pulse position modulation, Delta modulation, Adaptive delta modulation, Digital modulation techniques- ASK, FSK, PSK, QAM, M-ary digital modulation techniques. Digital base band transmission. Coding Techniques- Introduction to the Coding, Alpha - Numeric coding, Parity Check Coding, Hamming Code, Concept of Systematic Code, RZ, NRZ, Manchester code, AMI, Error Detection and Error Correction.

Unit 3: Advanced Digital Communication Systems [15]

Satellite Communication, Satellite for Television applications: Direct-To-Home (DTH) and Cable TV. Voice and Data communication, Earth observation (Remote Sensing) applications, Military applications. Principle of digital telephony. 1G, 2G, 2.5G, 3G, 4G cellular networks, Cellular Phones concept, Frequency reuse, Capacity expansion techniques- Cell splitting and cell sectoring, working of a typical cellular system. Telephone, Dual Tone Multi Frequency (DTMF) dialing.

Unit 4: Communication Technologies [15]

Integrated Services Digital Network (ISDN), spread spectrum techniques, OFDM, 3G wireless, IP telephony, IrDA, CDMA Local Loop, PSTN, digital exchanges, Principles of Telemetry, VSAT, GSM,

Wireless communication: Bluetooth, Bluetooth-Components, Stack, Links and channels, Bluetooth networking, Applications. Features and applications of Wi-Fi, Hot-spot. ZIGBEE- Zigbee Applications.

Text / Reference Books

1. Electronic Communication Systems, George Kennedy and Bernard Davis Publ. Tata McGraw Hill.
2. Electronic communications, Dennis Roddy and John Coolen, Pearson Publ.
3. Communication Electronics Principles and applications, Louis E. Frenzel, Tata McGraw Hill.
4. Digital data communication, Miller Tomasi, Advanced Electronic Communication Systems, 6/e, Pearson, 2015.
5. W.C.Y.Lee, Mobile Cellular Telecommunication, McGraw Hill, 2010.

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

Justification for the mapping

PO1: Disciplinary Knowledge

The course outcomes (COs) contribute to the development of students' disciplinary knowledge in communication engineering. For example, CO1, CO2, CO3, CO5 and CO6 require students to analog and digital modulation fundamental concept in communication engineering. CO4 and CO7 require students to apply these concepts to error detection in communicated signal and learn advance communication technology.

PO2: Critical Thinking and Problem Solving

All of the COs contributes to the development of students' critical thinking and problem-solving skills. For example, CO1, CO2, CO3, CO5 and CO6 require students to think critically about analog and digital communication techniques, spectrum band requirement. CO4 required for detection and error correction involve critical thinking to identify and solve problems in communication systems. how to apply different transformation method to solve problems. CO7 require students to use their knowledge for advanced communication technology.

PO3: Social competence

CO4, CO5 and CO6: It is required for explaining the frequency spectrum band involves effective communication, contributing to social competence in conveying technical information to diverse audiences.

.PO4: Research-related skills and Scientific temper

The entire COs contributes to the development of students' research-related skills and scientific temper. CO2, CO3 and CO7 require students to Understanding power distribution in AM involves a scientific approach and research skills in exploring the principles of analog and digital modulation as well as advance communication technology.

PO5: Trans-disciplinary knowledge

All the COs contribute to the development of students' trans-disciplinary knowledge. CO2, CO3 and CO4 require students to understanding advanced digital and analog communication systems requires knowledge that spans multiple disciplines within the broader field of communication engineering.

PO6: Personal and professional competence

CO32, CO3, CO5, CO7 all contribute to the development of students' personal and professional competence. For example, learning advanced communication technology enhances personal and professional competence in keeping up with technological advancements in the field.

PO8: Environment and Sustainability

CO2, CO3, CO7: required for understanding the environmental impact of communication systems is crucial for promoting sustainability in the field.

PO9: Self-directed and Life-long learning

CO2, CO3, CO4, CO6 and CO7 all contribute to the development of students' ability to engage in self-directed and life-long learning. For example, the entire COs is essential for staying updated in the rapidly evolving field of communication engineering.

PSEL 232: Advanced Embedded Systems (Credit-4)

Course Objectives:

1. To study 32-bit Processor and Controller.
2. To learn ARM Cortex-M3.
3. To get familiar with real time operating system (RTOS)
4. To get acquainted to fundamentals of operating system
5. To Understand basic programming of RTOS
6. To introduce Raspberry pi.
7. To understand raspberry pi Programming

Course Outcomes:

CO1. Design embedded applications with operating system support.
CO2. Instruction set of ARM Cortex-M3.
CO3. Design 32-bit system.
CO4. Basic programming of RTOS
CO5. Interfacing of ARM Cortex-M3. to Various Sensor
CO6. Concept of Raspberry pi.
CO7. Programming of raspberry pi to real world.

Unit -1: ARM Cortex-M3 Processor Architecture [18]

Introduction: What Is the ARM Cortex-M3 Processor, Background of ARM and ARM Architecture,Cortex-M3 Processor Applications, Registers, Operation Modes, Memory Maps, The Pipeline, Bus Interfaces on the Cortex-M3, Other Interfaces on the Cortex-M3, Exceptions, Built-In Nested Vectored Interrupt Controller, Interrupt Behavior, Cortex-M3 Programming, Exception Programming, Advanced Programming Features and System Behavior, The Memory Protection Unit, Other Cortex-M3 Features, Debug Architecture, Debugging Components, Choosing a Cortex-M3 Product, Development Tools, Development Using the GNU Tool Chain.

Unit-2 : ARM Cortex-M3 Processor Implementation [15]

LPC176XIntroduction, Features, Applications, Device, information, Architectural overview, ARM Cortex-M3 processor, Block diagram, Memory maps, Clocking and Power control functions, Nested Vectored Interrupt Controller, Pin configuration, Pin connect block, GPIO, Ethernet, UART, CAN, SPI, I2C, Timer, Repetitive Interrupt Timer, System Tick Timer, PWM, Motor control PWM, ADC, DAC, RTC, WDT.
Programming: GPIO, UART, Timer, PWM, ADC, DAC, RTC.

Unit-3: Real Time Operating Systems (RTOS) [12]

Operating System basics, Types of Operating Systems, Tasks, Process, Threads, Multiprocessing and Multi tasking, Task Scheduling, Threads-Processes-Scheduling putting them together, Task Communication, Task Synchronization, Device Drivers, How to choose an RTOS.

Unit-4: Raspberry Pi with Python [15]

Basic functionality of the Raspberry Pi board and its processor, setting and configuring the board, differentiating Raspberry pi from other platform like arduino, asus thinker etc., overlocking Component overview. Communication facilities on Raspberry pi(I2C,SPI,UART)working with RPil. GPIO library, interfacing of Sensors and Actuators.

Text / Reference Books:

1. The Definitive Guide to the ARM CORTEX-M3 *2nd edition, by Joseph Yiu.*
2. Using the Free RTOS Real Time Kernel ARM Cortex-M3 Edition, *by Richard Barry*
3. UM10360 LPC176x/5x User manual.
4. Operating Systems Concept, Galvin, John Willey and Sons
5. Raspberry Pi for Python Programmers Cookbook - Second Edition 2nd Edition,Kindle Edition
6. Raspberry Pi® User Guide, 4Eben Upton Gareth Halfacree
7. Operating Systems Concept, Galvin, John Willey and Sons

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

Justification for the mapping

PO1:Disciplinary Knowledge

CO1: Designing embedded applications with operating system support contributes to disciplinary knowledge in embedded systems and software engineering.

CO2:Designing a 32-bit system enhances disciplinary knowledge in computer architecture and embedded systems.

CO3: Designing Raspberry Pi Python code contributes to disciplinary knowledge in embedded systems and programming.

CO5: Interfacing ARM to various sensors enhances disciplinary knowledge in embedded systems and sensor integration.

CO7: Programming Raspberry Pi for real-world applications contributes to disciplinary knowledge in embedded systems and practical programming.

PO2:Critical Thinking and Problem solving

CO1: Designing embedded applications requires critical thinking and problem-solving skills, especially in managing system resources and ensuring optimal performance**.**

CO2: Designing a 32-bit system enhances critical thinking and problem-solving in computer architecture and embedded systems.

CO3: Developing Python code for Raspberry Pi involves critical thinking and problem-solving skills in programming.

CO5 : Interfacing ARM to various sensors enhances critical thinking and problem-solving in embedded systems and sensor integration.

CO6: Raspberry Pi knowledge may involve critical thinking and problem-solving with computing and electronics.

CO7: Implementing real-world applications with Raspberry Pi requires considerations of critical thinking and problem-solving.

PO3 :Social competence

CO1: Designing embedded applications requires Social competence, especially in managing system resources and ensuring optimal performance.

CO2: Designing a 32-bit system develops Social competence in advanced system design.

CO5: Interfacing ARM to sensors develops Social competence in hardware-software integration.

PO4: Research-related Skills and Scientific Temper

CO1 to CO6: All provide Research-related Skills and Scientific Temper.

P05: Trans-disciplinary knowledge

CO1: Designing embedded applications with operating system support contributes to Trans-disciplinary knowledge in embedded systems and software engineering**.**

CO2: Interfacing ARM to sensors develops Trans-disciplinary knowledge in hardware-software integration.

CO4: Understanding RTOS involves develops Trans-disciplinary knowledge to real-time system design.

CO6: Raspberry Pi knowledge may involve trans-disciplinary connections with computing and electronics.

P06: Personal and professional competence

CO1: Designing embedded applications with operating system support contributes to Personal and professional competence in embedded systems and software engineering.

CO3: Developing Python code for Raspberry Pi involves Personal and professional competence - solving programming.
CO5: Interfacing ARM to sensors develops personal and professional competence in hardware-software integration.

P07: Effective Citizenship and Ethics

CO1: his outcome involves developing applications that operate within an embedded system, which may have ethical implications related to data security, privacy, and responsible use. Students engaging in this course outcome learn to be ethically conscious citizens by considering the impact of their embedded applications on users and society.

CO2: Students learn to make responsible decisions in system design, promoting effective citizenship in the technological domain.

CO4: Understanding the ethical implications of RTOS programming is essential for effective citizenship, especially in safety-critical systems.

CO6: Students learn to approach technology with ethical awareness, promoting effective citizenship.

PO8: Environment and Sustainability

CO2: Optimizing these factors contributes to creating more energy-efficient systems, aligning with principles of environmental sustainability**.**

CO4: Optimizing the use of resources in RTOS programming contributes to energy efficiency and sustainability.

PO9: Self-directed and Life-long learning

CO1: Students engaging in this outcome cultivate self-directed learning by keeping themselves informed about advancements in embedded systems and operating systems throughout their careers.

CO2: Students pursuing this outcome develop the ability for self-directed learning, staying informed about evolving technologies in system design and architecture.

CO4: Basic programming of Real-Time Operating Systems (RTOS) necessitates understanding real-time computing principles and staying informed about the latest developments in this domain.

PSEL233: Digital Signal Processing (Credits : 4)

Objectives:

1. To understand the sampling, aliasing and block schematic of digital signal processing.
2. To learn design of digital filters and implementation on digital Signal Processor
3. To understand DFT, FFT transforms for analysis of DT signals.
4. To make the students able to apply digital filters according to known filter specifications
5. To provide the knowledge about the principles behind the discrete Fourier transform (DFT) and its fast computation
6. To be able to apply the MATLAB Programme to digital processing problems and Presentations
7. To become familiar with digital image fundamentals.

Course Outcomes: On completion of the course, students will be able to –

CO1. Interpret and process discrete/ digital signals and represent DSP system.
CO2. Implement efficient transform/ algorithm and its application to analyze DT signals.
CO3. Analyze DFT transform for DT signals.
CO4. Solve the problems on DFT and IDFT.
CO5. Know FFT algorithms of DT signals.
CO6. Design and implement IIR filters and FIR filters.
CO7. Apply knowledge of mathematics for image understanding and analysis.

Unit-1: Signals and Systems [12]

Overview: Classification of Signals and Systems, DSP system and interfacing A-D conversion process, sampling, quantization and encoding, oversampling and antialiasing, Nyquist rate & aliasing problem, anti aliasing,
Basic elements of DSP and its requirements, advantages of Digital over Analog signal processing, Introduction to DSP processor. types of DSP processors and architecture, general purpose DSP processors.

Unit-2: DFT and FFT [15]

Introduction to Fourier series, Fourier series Representation of periodic signals, Dirichlet Conditions, Evaluation of Fourier coefficients, Properties of Fourier Transform (FT), Discrete Fourier Transform (DFT) and its inverse DFT, Existence of DFT, properties of DFT, Circular convolution, linear convolution, Fast Fourier Transform (FFT), DIT, DIF algorithm. Inverse FFT.

Unit-3: Digital Filter Design [18]

Digital filters and analog filters. FIR filter: Windowing techniques: Gibbs phenomenon, characteristics and comparison of different window functions, Design of linear phase FIR filter using windows: Rect, Hanning, Hamming, Blackmann & Kaiser, Magnitude and Phase response of Digital filters, Frequency response of Linear phase FIR filters, FIR filter realization using Direct Form, Cascade and linear phase structure.
IIR Filter: IIR filter design by approximation of backward derivatives, IIR filter design by impulse invariance method, Bilinear transformation method, warping effect.IIR filter realization using direct form, cascade form and parallel form, Finite word length effect in IIR filter design.

Unit-4: Fundamentals of DIP **[15]**

Introduction, application fields of DIP, image sensing and acquisition, overview of image representation and modelling techniques. Elements of visual perception: luminance, brightness, contrast, hue, saturation and Mach band effect. Color image fundamentals: RGB and HIS models. DIP Techniques: Image Enhancement: point and spatial operation techniques. Image Segmentation: fundamentals, point, line and edge detection. Image Restoration. Boundary detection.

Text /Reference Books:

1. Digital Signal Processing: A Practical Approach, Emmanuel Ifeachor, Barrie Jervis, Prentice Hall.
2. S. Salivahanan, C. Gnanapriya , "Digital Signal Processing", McGraw Hill, 2nd Edition.
3. Digital Signal Processing: A Hands on Approach: Charles Schuller, Mahesh Chugani, Tata McGraw Hill Pub. Co. Ltd. Edn. 2006.
4. Digital Signal Processing: - Principles, Algorithms and Applications: John G Proakis, Dimitris G Monolkis, and Pub. Person 2005.
5. Digital Signal Processing and Applications with the C6713 and C6416 DSK, Rulph Chassaing, a John Wiley & Sons, Inc.
6. S Sridhar, "Digital Image Processing", Oxford University Press, 2nd Edition.
7. Jain Anil K., "Fundamentals Digital Image Processing", Prentice Hall India, 4th Edition.

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

Justification for the mapping

PO1 Disciplinary Knowledge:

CO1: Understanding and interpreting discrete signals and systems is fundamental to disciplinary knowledge in Digital Signal Processing (DSP).
CO2: Implementing efficient transforms and algorithms for analyzing discrete-time signals is a crucial aspect of disciplinary knowledge in DSP.
CO3,CO4: Analyzing and solving problems related to the Discrete Fourier Transform (DFT) contribute to a deep understanding of DSP, aligning with disciplinary knowledge.
CO5: Knowing Fast Fourier Transform (FFT) algorithms for discrete-time signals is an integral part of disciplinary knowledge in DSP.
CO6: Designing and implementing Infinite Impulse Response (IIR) and Finite Impulse Response (FIR) filters is a direct application of disciplinary knowledge in DSP.
CO7: Demonstrates a profound understanding of disciplinary knowledge by applying mathematical concepts to image understanding and analysis.

PO2 Critical Thinking and Problem solving

CO1: Critical thinking is applied in interpreting and processing digital signals, solving problems related to signal representation, and understanding DSP systems.

CO2: Critical thinking is employed in implementing efficient transforms and algorithms for the analysis of discrete-time signals.
CO3,CO4: Analyzing and solving problems related to the Discrete Fourier Transform (DFT) requires critical thinking skills.
CO5: Understanding and applying Fast Fourier Transform (FFT) algorithms involve critical thinking in dealing with complex signal processing tasks.
CO6: The design and implementation of Infinite Impulse Response (IIR) and Finite Impulse Response (FIR) filters require critical thinking in solving engineering challenges.
CO7: Utilizes mathematical reasoning to engage in critical thinking and problem-solving in the context of image understanding, enhancing analytical skills.

PO4 Research-related skills and Scientific temper

CO1: Engaging in signal interpretation and processing involves research-related skills and a scientific temper to explore, analyze, and understand the principles of digital signal processing.
CO2: Implementation of efficient transforms and algorithms requires research skills to stay updated on advancements and a scientific temper to assess their applications in analyzing discrete-time signals.
CO3,CO4: Analyzing and solving problems related to the Discrete Fourier Transform (DFT) necessitate research-related skills and a scientific temper to delve into the theoretical foundations and practical applications.
CO5: Acquiring knowledge of Fast Fourier Transform (FFT) algorithms involves research skills to understand their development and scientific temper for critical evaluation and application.
CO6: Designing and implementing Infinite Impulse Response (IIR) and Finite Impulse Response (FIR) filters require research-related skills and a scientific temper to explore various design approaches and evaluate their effectiveness.
CO7: Applies mathematical techniques in research activities, displaying scientific temper and research-related skills essential for image analysis.

PO6 Personal and professional competence:

CO1: Developing competence in interpreting and processing signals reflects personal and professional growth, showcasing an individual's capability to handle complex tasks in the field of digital signal processing.
CO2: Implementing efficient transforms and algorithms demonstrates personal and professional competence, indicating the ability to apply theoretical knowledge to practical problem-solving.
CO3,CO4: Analyzing and solving problems related to the Discrete Fourier Transform (DFT) reflects personal and professional competence in dealing with mathematical and theoretical aspects of digital signal processing.
CO5: Acquiring knowledge of Fast Fourier Transform (FFT) algorithms showcases personal and professional competence in staying updated with technological advancements and applying them in signal analysis.
CO6: Designing and implementing IIR and FIR filters demonstrates personal and professional competence in applying signal processing concepts to real-world scenarios and engineering solutions.
CO7: Integrates mathematical knowledge into personal and professional competence, emphasizing the practical application of skills for effective image analysis.

PO9 Self-directed and Life-long learning:

CO1: Mastering the interpretation and processing of signals reflects a commitment to continuous learning, showcasing the ability to adapt and acquire new skills throughout one's professional journey.
CO2: Implementing efficient transforms and algorithms requires ongoing learning to stay abreast of advancements in the field, aligning with the self-directed and life-long learning aspect.

CO3,CO4: Analyzing and solving problems related to DFT and IDFT demonstrates a commitment to self-directed learning, as individuals strive to deepen their understanding and proficiency in solving complex mathematical challenges.
CO5: Acquiring knowledge of FFT algorithms signifies a commitment to self-directed learning, as individuals engage in continuous education to understand and apply advanced algorithms for signal analysis.
CO6: Designing and implementing IIR and FIR filters involves ongoing learning to explore innovative approaches and adapt to evolving technologies, aligning with the ethos of self-directed and life-long learning.
CO7: Exhibits a commitment to continuous learning, using mathematical expertise for ongoing self-directed development in image understanding and analysis.

PSEL234- Programmable Logic Controllers and Supervisory Control & Data Acquisition

Objectives:

1. To make awareness of programmable logic controller hardware.
2. To familiarize with timers, counters and programming in PLC.
3. To learn different modes of PLC programming.
4. To study some case studies using PLC.
5. To develop applications of PLC.
6. To introduce SCADA.
7. To know the difference between PLC and SCADA.

Course Outcomes:

1. Identify different components of PLC and functions of PLC components.
2. Develop PLC ladder programs for different applications.
3. Study of different cases using PLCs.
4. Develop logic gate circuits from Boolean expressions and convert it to programming.
5. Describe switching elements on input/output modules.
6. Describe functions of programmable logic controller components.
7. Test the simple SCADA application.

Unit 1: Introduction to PLC [15]

Need and benefits of Automation, Tools of Automation – PLC, PLC Architecture Block diagram, Working, CPU – Function, scanning cycle, Speed of execution, Memory Organization and function, sink and source concept in PLC, Input/output module with reference to sink or source, output module relay, transistor, triac, Signal conditioning, PLC Characteristics, PLC types – Fixed and Modular, PLC applications, PC v/s PLC.

Unit 2: PLC Programming [15]

Programming methods- Logic control elements (NOT, AND, OR, NAND, NOR etc.),ladder diagrams, function blocks, statement list, programming a PLC, programming terminals, ladder relay instructions, ladder relay programming (digital gates, Boolean expression, mux-demux, flip flop), **Timers, Counters and Registers -** Types of timers, programming timers, off-delay timers, pulse timers, programming examples, forms of counter, programming, up and down counting, timers with counters, sequencer, data handling: registers and bits, data handling, arithmetic functions, closed loop control shift registers, ladder programs, Concept of smart PLC,HMI using smart PLC.

Unit 3: Case studies of PLC [15]

Program development, Documentation programs- temperature control, valve sequencing, conveyor belt control, control of a process, traffic lights controller, bottle filling control, alarm monitor program, car parking, vending machine, automatic stacking program, AC motor drive interface, elevator, water level controller.

Unit 4: SCADA **[15]**

Introduction to SCADA, Applications of SCADA, SCADA Architecture (block diagram), Benefits of SCADA, Types of SCADA – Single Master Single Remote, Single Master Multiple Remote, Multiple Master Multiple Remote, SCADA System Hardware - Remote Terminal Units (RTUs), Master Terminal units (MTUs), Communication System. Difference between PLC and SCADA.

Text /Reference Books:

1. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers Principles and Applications", Fifth Edition, Prentice Hall Publication, New Delhi, 2002.
2. L.A. Bryan, E.A. Bryan, "Programmable controller theory and Implementations" second edition, An Industrial Text Company Publication.
3. W. Bolton, "Programmable Logic Controllers", Fifth Edition, Elsevier Publication
4. Dunning G., "Introduction to Programmable Logic Controllers", Thomson/ Delmar learning, 2005, ISBN – 13: 9781401884260.
5. Bailey David, Wright Edwin, "Supervisory Control and Data Acquisition", Newnes (an imprint of Elsevier), 2003. ISBN – 0750658053.

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

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Students will demonstrate knowledge about understanding theoretical and practical Programmable Logic Controller and its components over other microcontrollers and supervisory control systems.

CO2: Students will develop the ladder diagram programs using programmable logic controllers for various logic circuits and its applications.

CO3: Students will demonstrate their knowledge of programmable logic controller and its comparison with other microcontrollers.

CO4: Students will be able to demonstrate the knowledge of developing a logic gate circuit from the Boolean equation and convert them into any of programming language.

CO5: Students will be able to describe and execute the theoretical and practical switching elements for PLC as input and output modules.

CO6: Students will be able to know and demonstrate the each and every component and its function to execute strong theoretical as well as practical understanding.

CO7: Students will be able to know and demonstrate simple supervisory control and data acquisition system with its application.

PO2: Critical Thinking and Problem Solving:

CO2: Students will be able to develop PLC ladder diagram programming after critical thinking of various applications.
CO3: Students will be able to exhibit the skill of understanding the scientific approach and skill of critical thinking by doing various case studies using programmable logic controller.
CO4: Students will be able to do critical thinking of different logic gate circuits and after that it is to be converted into the programming for further process.
CO6: Students will be able to describe each and every component of PLC by identifying its functions and thus apply analytical skills to design solution oriented systems.
CO7: Students will be able test the simple supervisory control and data acquisition system to solve system situation scientifically.

PO3: Social Competence

CO3: Students will be able to exhibit their thoughts regarding some real life applications in the society by communicating with the people around them to find case studies and to design the related systems.
CO4: Students will be able to write the Boolean equation and draw logic diagrams and also do programming on that and can present any complex case study in a clear and proper way which can help to reach the final output or conclusion of the system.
CO7: Students will be able to exhibit the thoughts and ideas of SCADA system in writing as well as orally by presenting its complex information into a clear and concise way.

PO4: Research-related skills and scientific temper

CO2: Developing PLC ladder programs for different applications is moderately related to research-related skills, as it involves practical application but may not directly engage in scientific literature review or hypothesis testing.
CO3: Studying different cases using PLCs is moderately related to research-related skills, as it involves gaining practical knowledge but may not explicitly involve hypothesis formulation or scientific literature review.
CO4: Developing logic gate circuits from Boolean expressions and converting them to programming is partially related to research-related skills, as it emphasizes technical skills but may not involve extensive literature review or hypothesis testing.

PO5: Trans-disciplinary knowledge:

CO1: Identifying different components of PLCs and understanding their functions is partially related to trans-disciplinary knowledge, as it primarily involves technical knowledge within the specific domain of PLCs without explicitly transcending beyond discipline-specific approaches.
CO3: Studying different cases using PLCs is partially related to trans-disciplinary knowledge, as it involves gaining practical knowledge within the domain of PLCs without explicitly transcending beyond discipline-specific approaches.
CO5: Describing switching elements on input/output modules is partially related to trans-disciplinary knowledge, as it provides technical information within the field of PLCs without explicitly addressing interdisciplinary perspectives.

PO9: Self-directed and Life-long learning

CO3: Studying different cases using PLCs is moderately related to self-directed and lifelong learning, as it involves applying knowledge in various contexts, fostering adaptability and continuous learning.
CO5: Describing switching elements on input/output modules is moderately related to self-directed and lifelong learning, as it involves understanding and adapting to changes in hardware components over time.

PSEL235: Practical course V

Objectives:

1. To learn analog modulation techniques
2. To learn various digital modulation techniques.
3. To learn different control system.
4. To make students aware of various actuators
5. To learn various power Electronics Circuit.
6. To study different types of Motor.
7. To know the Multiplexing.

Course Outcomes: On completion of the course, students will be able to

CO1. Design different analog Modulation Techniques.
CO2. Design Various control system Application.
CO3. Design Various Power Electronic Circuit.
CO4. Designing different motor controlling techniques.
CO5. Student will able to design digital Modulation and demodulation system
CO6. Student will able to design ON-OFF Controller system
CO7. Understand the operation of various power supplies.

Laboratory Practical: Any 10 Practicals from following sections

Advanced Communication Electronics

1. Design of AM/FM transmitter and receiver
2. Delta modulation
3. Design PCM encoder/ decoder system
4. Design of FSK transmitter and receiver
5. Time division Multiplexing
6. Telemetry Applications
7. Varactor diode characteristics and its application in FM
8. Design of FSK transmitter and receiver
9. Design of Binary Phase Shift Keying

Control Systems and Process Instrumentation

1. Signal conditioning circuits for analog controller
2. Design and implement ON-OFF Controller
3. Design and implement P / PI / PID controller
4. To study the position / velocity control of dc servo motor
5. Flow control using solenoid valve
6. Study of optical position encoder

Advanced Power Electronics

1. DC motor speed /AC motor speed control/ Stepper motor control
2. Practical based on Inverter.
3. Design single phase on-off controller.
4. Study of thyristor its characteristics.
5. Study of Commutation method of SCR.
6. Design Dual Power supply using Transformer.
7. Design Variable Power supply.

Mechatronics

1. Study of DC servo motor/BLDC motor.
2. Study of PMDC motor toque speed characteristics
3. Study of AC servo motor, its speed control/position control
4. Set up a flow control system using suitable flow sensor and actuator
5. study of actuators and their driving circuit (solenoids, motors etc.)
6. Study digital sensor

Activity: Industrial Visit / Hobby project (equivalent to practical experiments)

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

Justification for the mapping

PO1: Disciplinary Knowledge

The course outcomes (COs) contribute to the development of students' disciplinary knowledge in electrical and electronics engineering. For example, CO1, CO5 require to know the modulation techniques and design the necessary circuit. CO2, CO4 and CO6 required getting knowledge of controlling techniques. CO3 and CO7 require students to understand concepts of power supply.

PO2: Critical Thinking and Problem Solving

The entire COs contributes to the development of students' critical thinking and problem-solving skills. For example, CO1 and CO5 require students to think critically about operation of analog and digital modulation circuit. CO2, CO4 and CO6 require students to think critically about how to design analog or digital circuit for controlling dedicated application and its response. CO3 and CO7 require students to think critically about the power supply design.

PO3: Social competence

CO2, CO3, CO4, CO6 and CO7: contributes to the development of students' for problem-solving skills. They think the solution and design circuit for social need in automation, controlling and power supply design.

.PO4: Research-related skills and Scientific temper

The entire COs contributes to the development of students' research-related skills and scientific temper. CO1, CO2, CO3, CO4, CO5 CO6 and CO7 require for students to think to design circuit for problem solving and formulate the hypothesis.

PO5: Trans-disciplinary knowledge

CO2, CO3, CO4, CO6 and CO7 contribute to the development of students' trans-disciplinary knowledge. Student will able to design system for practical problems solve interdisciplinary field.

PO6: Personal and professional competence

CO3, CO4, CO5 and CO6 all contribute to the development of students' personal and professional competence. Students to develop their ability to work independently or as a team to solve real-world problems. Students develop their skills for starting own start-up in electronics design. Students use their knowledge to develop suitable solution for interdisciplinary field such as physics, chemistry, agriculture, industrial, botany etc.

PO7: Effective Citizenship and Ethics

CO3 and CO6 contribute to the development of automation system; controlling or security system design for understanding the ethical considerations in technology aligns for effective citizenship.

PO8: Environment and Sustainability

CO2, CO3, CO4, CO6 and CO7 required to student for thinking development of analog or digital circuit for simplified practical problems for soil, water or environment parameter monitoring and easy handling laboratory instruments.

PO9: Self-directed and Life-long learning

CO2, CO4 and CO6 all contribute to the development of students' ability to engage in self-directed and life-long learning. For example, the entire COs requires students to develop their ability to learn new concepts of designing and apply them to new problems. It is lifelong learning due to hands on practical.

PSEL236: Practical course VI

Objectives:

1. To learn ARM Cortex-M3.
2. To introduce Raspberry pi.
3. To make the students aware of programmable logic controller hardware
4. Identify different components of PLC.
5. To be able to apply the MATLAB Program to digital processing problems and Presentations.
6. To learn interfacing with microcontroller.
7. To understand the programming in MATLAB.

Course Outcomes: On completion of the course, students will be able to

CO1: Design embedded applications with operating system support
CO2: Design Raspberry pi python code.
CO3: Develop PLC ladder programs for different applications.
CO4: Design and implement IIR filters and FIR filters
CO5: Develop MATLAB code for FSK, PSK etc.
CO6: Design code for different interfacing with microcontroller.
CO7: Design program for SCADA.

Laboratory Practical: Any 10 Practicals from following sections
Advanced Embedded System

1. Interfacing Alphanumeric LCD to 32-bit microcontroller.
2. Interfacing matrix keyboard to 32-bit microcontroller.
3. Programming ADC of 32-bit microcontroller.
4. Programming DAC of 32-bit microcontroller.
5. Programming UART of 32-bit microcontroller.
6. Implementation of Multitasking using RTOS.
7. Implementation of Semaphore using RTOS.
8. LED, SSD, Stepper Motor, Switch interface to Raspberry Pi.
9. Camera Control using Raspberry Pi

Programmable Logic Controllers and Supervisory Control & Data Acquisition

1. Relay programming (all logic gates, boolean equation like multiplexer, demultiplexer, encoder, decoder, latch etc.)
2. Temperature controller
3. Conveyor belt control
4. Alarm monitor program
5. Vending machine
6. Water level controller

Digital Signal Processing

1. Generation of signals- Impulse, Step, Exponential and Ramp functions
2. Design of FIR filter, Design of IIR filter
3. Find DFT and IFT of given Example
4. Linear and circular convolution

5. To design low pass/ band pass filter using MATLAB.
6. To generate rectangular, hamming, hanning, blackman and kaiserwindow using MATLAB.
7. Implementation of Decimation Process / Interpolation Process
8. Implementation of image enhancement techniques in MATLAB.
9. Study and implementation of a segmentation techniques in MATLAB.
10. Study image restoration application using filtering techniques in MATLAB.
11. Implementation of boundary detection in MATLAB.

Communication:- Experiments using MATLAB

1. Phase shift keying (PSK)
2. Generation and reception of BPSK
3. Generation and reception of FSK
4. Generation and reception of QPSK

Activity: Industrial Visit / Hobby project (equivalent to practical experiments)

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

Justification for the mapping

PO1: Disciplinary Knowledge

CO1: Designing embedded applications with operating system support requires a deep understanding of both embedded systems and operating systems, contributing to disciplinary knowledge.

CO2: The design process involves critical thinking and problem-solving skills to address the complexities of embedded applications with OS support.

CO4: Developing expertise in designing embedded systems enhances Disciplinary Knowledge

CO5: Designing embedded applications with operating system support requires a deep understanding of both embedded systems and operating systems, contributing Disciplinary Knowledge

CO7: use of various software include Disciplinary Knowledge

PO2:Critical Thinking and Problem solving

CO1 to CO7(Expect CO6):All include critical thinking and problem solving.

PO3 Social competence

CO1: Developing PLC ladder programs involves knowledge of industrial automation and PLC programming, contributing to disciplinary knowledge.

CO2: Crafting Python code for Raspberry Pi requires disciplinary knowledge.

PO4: Research-related Skills and Scientific Temper

CO1 to CO6:All include Research-related Skills and Scientific Temper.

PO5: Trans-disciplinary knowledge

CO1: Designing embedded applications with operating system support requires an understanding of both hardware and software aspects.

CO2: Designing Raspberry Pi Python code involves combining knowledge in embedded systems, programming, and the specific capabilities of Raspberry Pi.

CO6: This trans-disciplinary understanding spans multiple areas in electrical engineering and computer science.

P06: Personal and professional competence

CO1: Designing embedded applications with operating system support requires students to develop technical skills and the ability to work professionally.

CO3: Developing PLC ladder programs requires a combination of control system knowledge and programming skills.

P07: Effective Citizenship and Ethics

CO1: Designing embedded applications with operating system support requires considerations of ethical implications such as data security, privacy, and responsible use of technology**.**

CO2: Designing Python code for Raspberry Pi involves considerations of ethical coding practices, including ensuring data integrity, security, and user privacy**.**

CO4: Designing and implementing IIR and FIR filters involves considerations of ethical data processing, especially in applications with societal impact.

CO7: Using various software tools involves considerations of ethical software usage and responsible handling of data.

PO8: Environment and Sustainability

CO1: Designing embedded applications with operating system support involves optimizing resource usage, which contributes to energy efficiency and sustainability.

CO4: This outcome encourages students to consider the sustainability aspects of signal processing.

PO9: Self-directed and Life-long learning

CO1: Designing embedded applications with operating system support requires continuous learning to keep abreast of evolving technologies and updates in operating systems.

CO4: This outcome encourages students to embrace self-directed learning to keep abreast of developments in signal processing.

CO7: Using various software tools necessitates continuous learning to adapt to new technologies and tools. This outcome encourages students to be self-directed learners capable of mastering a variety of software applications.