M Sc ELECTRONICS

LOCF SYLLABUS 2023

Department of Electronics

School of Physical Sciences

St. Joseph's College (Autonomous)

Tiruchirappalli - 620002, Tamil Nadu, India

SCHOOLS OF EXCELLENCE WITH CHOICE BASED CREDIT SYSTEM (CBCS) POSTGRADUATE COURSES

St. Joseph's College (Autonomous), an esteemed institution in the realm of higher education in India, has embarked on a journey to uphold and perpetuate academic excellence. One of the pivotal initiatives in this pursuit is the establishment of five Schools of Excellence commencing from the academic year 2014-15. These schools are strategically designed to confront and surpass the challenges of the 21st century.

Each School amalgamates correlated disciplines under a unified umbrella, fostering synergy and coherence. This integrated approach fosters the optimal utilization of both human expertise and infrastructure. Moreover, it facilitates academic fluidity and augments employability by nurturing a dynamic environment conducive to learning and innovation. Importantly, while promoting collaboration and interdisciplinary study, the Schools of Excellence also uphold the individual identity, autonomy, and distinctiveness of every department within.

The overarching objectives of these five schools are as follows:

1. Optimal Resource Utilization: Ensuring the efficient use of both human and material resources to foster academic flexibility and attain excellence across disciplines.

2. Horizontal Mobility for Students: Providing students with the freedom to choose courses aligning with their interests and facilitating credit transfers, thereby enhancing their academic mobility and enriching their learning experience.

3. Credit-Transfer Across Disciplines (CTAD): The existing curricular structure, compliant with regulations from entities such as TANSCHE and other higher educational institutions, facilitates seamless credit transfers across diverse disciplines. This underscores the adaptability and uniqueness of the choice-based credit system.

4. Promotion of Human Excellence: Nurturing excellence in specialized areas through focused attention and resources, thus empowering individuals to excel in their respective fields.

5. Emphasis on Internships and Projects: Encouraging students to engage in internships and projects, serving as stepping stones toward research endeavors, thereby fostering a culture of inquiry and innovation.

6. Addressing Stakeholder Needs: The multi-disciplinary nature of the School System is tailored to meet the requirements of various stakeholders, particularly employers, by equipping students with versatile skills and competencies essential for success in the contemporary professional landscape.

In essence, the Schools of Excellence at St. Joseph's College (Autonomous) epitomize a holistic approach towards education, aiming not only to impart knowledge but also to cultivate critical thinking, creativity, and adaptability – qualities indispensable for thriving in the dynamic global arena of the 21st century.

Credit system

The credit system at St. Joseph's College (Autonomous) assigns weightage to courses based on the hours allocated to each course. Typically, one credit is equivalent to one hour of instruction per week. However, credits are awarded regardless of actual teaching hours to ensure consistency and adherence to guidelines.

The credits and hours allotted to each course within a programme are detailed in the Programme Pattern table. While the table provides a framework, there may be some flexibility due to practical sessions, field visits, tutorials, and the nature of project work.

For postgraduate (PG) courses, students are required to accumulate a minimum of 110 credits, as stipulated in the programme pattern table. The total minimum number of courses offered by the department is outlined in the Programme Structure.

OUTCOME-BASED EDUCATION (OBE)

OBE is an educational approach that revolves around clearly defined goals or outcomes for every aspect of the educational system. The primary aim is for each student to successfully achieve these predetermined outcomes by the culmination of their educational journey. Unlike traditional methods, OBE does not prescribe a singular teaching style or assessment format. Instead, classes, activities, and evaluations are structured to support students in attaining the specified outcomes effectively.

In OBE, the emphasis lies on measurable outcomes, allowing educational institutions to establish their own set of objectives tailored to their unique context and priorities. The overarching objective of OBE is to establish a direct link between education and employability, ensuring that students acquire the necessary skills and competencies sought after by employers.

OBE fosters a student-centric approach to teaching and learning, where the delivery of courses and assessments are meticulously planned to align with the predetermined objectives and outcomes. It places significant emphasis on evaluating student performance at various levels to gauge their progress and proficiency in meeting the desired outcomes.

Here are some key aspects of Outcome-Based Education:

Course: A course refers to a theory, practical, or a combination of both that is done within a semester.

Course Outcomes (COs): These are statements that delineate the significant and essential learning outcomes that learners should have achieved and can reliably demonstrate by the conclusion of a course. Typically, three or more course outcomes are specified for each course, depending on its importance.

Programme: This term pertains to the specialization or discipline of a degree programme.

Programme Outcomes (POs): POs are statements that articulate what students are expected to be capable of by the time they graduate. These outcomes are closely aligned with Graduate Attributes.

Programme Specific Outcomes (PSOs): PSOs outline the specific skills and abilities that students should possess upon graduation within a particular discipline or specialization.

Programme Educational Objectives (PEOs): PEOs encapsulate the expected accomplishments of graduates in their careers, particularly highlighting what they are expected to achieve and perform during the initial years postgraduation.

LEARNING OUTCOME-BASED CURRICULUM FRAMEWORK (LOCF)

The Learning Outcomes-Centric Framework (LOCF) places the learning outcomes at the forefront of curriculum design and execution. It underscores the importance of ensuring that these outcomes are clear, measurable, and relevant. LOCF orchestrates teaching methodologies, evaluations, and activities in direct correlation with these outcomes. Furthermore, LOCF adopts a backward design approach, focusing on defining precise and attainable learning objectives. The goal is to create a cohesive framework where every educational element is in harmony with these outcomes.

Assessment practices within LOCF are intricately linked to the established learning objectives. Evaluations are crafted to gauge students' achievement of these outcomes accurately. Emphasis is often placed on employing authentic assessment methods, allowing students to showcase their learning in real-life scenarios. Additionally, LOCF frameworks emphasize flexibility and adaptability, enabling educators to tailor curriculum and instructional approaches to suit the diverse needs of students while ensuring alignment with the defined learning outcomes.

Some important terminologies

Core Courses (CC): *These are compulsory courses that students must undertake as essential components of their curriculum, providing fundamental knowledge within their primary discipline. Including core courses is essential to maintain a standardized academic programme, ensuring recognition and consistency across institutions.*

Common Core (CC): *A common core course is a shared educational element encompassing fundamental topics across disciplines within a school. It promotes interdisciplinary comprehension and collaboration among students by providing a foundational understanding of key subjects essential for academic and professional success across diverse fields of study.*

Elective Courses (ES): *Elective courses are offered within the main discipline or subject of study. They allow students to select specialized or advanced options from a range of courses, offering in-depth exposure to their chosen area of study. Typically, ES are more applied in nature and provide a deeper understanding of specific topics.*

Generic Elective Courses (EG): *These elective courses are chosen from disciplines unrelated to the student's main area of study, aiming to broaden their exposure and knowledge base. As per the Choice Based Credit System (CBCS) policy, students may opt for generic elective courses offered by other disciplines within the college, enhancing the diversity of their learning experience.*

Ability Enhancement Course (AE): *AE is designed to enhance skills and proficiencies related to the student's main discipline. It aims to provide practical training and hands-on experience, contributing to the overall development of students pursuing academic programmes.*

Skill Enhancement Course (SE): *SE focus on developing specific skills or proficiencies relevant to students' academic pursuits. While it is open to students from any discipline, SE is particularly beneficial for those within the related academic programme.*

Self-paced Learning (SP): *This course promotes independent learning habits among students and they have to undergo the course outside the regular class hours within a specified timeframe.*

Comprehensive Examinations (CE): *These examinations cover detailed syllabi comprising select units from courses offered throughout the programme. They are designed to assess crucial knowledge and content that may not have been covered extensively in regular coursework.*

Extra Credit Courses: *To support students in acquiring knowledge and skills through online platforms such as Massive Open Online Courses (MOOCs), additional credits are granted upon verification of course completion. These extra credits can be availed across five semesters (2 - 6). In line with UGC guidelines, students are encouraged to enhance their learning by enrolling in MOOCs offered by portals like SWAYAM, NPTEL, and others. Additionally, certificate courses provided by the college are also considered for these extra credits.*

Outreach Programme (OR): *It is a compulsory course to create a sense of social concern among all the students and to inspire them to dedicated service to the needy.*

Course Coding

The following code system (10 alphanumeric characters) is adopted for Postgraduate courses:

23	**UXX**	**0**	**XX**	**00/X**
Year of Revision	PG Department Code	Semester Number	Course Specific Initials*	Running Number/with Choice

***Course Specific Initials**

CC - Core Course

CP - Core Practical

ES - Elective

AE - Ability Enhancement Course

SP - Self-paced Learning

EG - Generic Elective

PW - Project and Viva Voce

CE - Comprehensive Examination

OR - Outreach Programme

IS - Internship

EVALUATION PATTERN

Continuous Internal Assessment

Sl No	Component	Marks Alloted
1	Mid Semester Test	30
2	End Semester Test	30
3	*Three Components (15 + 10 + 10)	35
4	Library Referencing (30 hours)	5
	Total	**100**

Passing minimum: 50 marks

* *The first component is a compulsory online test (JosTEL platform) comprising 15 multiple choice questions (10 questions at K1 level and 5 questions at K2 level); The second and the third components are decided by the course in-charge.*

Question Paper Blueprint for Mid and End Semester Tests

<table>
<tr><td colspan="3">Duration: 2 Hours</td><td colspan="6">Maximum Marks: 60</td></tr>
<tr><td colspan="2" rowspan="2">Section</td><td colspan="6">K levels</td><td rowspan="2">Marks</td></tr>
<tr><td>K1</td><td>K2</td><td>K3</td><td>K4</td><td>K5</td><td>K6</td></tr>
<tr><td colspan="2">A (compulsory)</td><td>7</td><td></td><td></td><td></td><td></td><td></td><td>7 × 1 = 7</td></tr>
<tr><td colspan="2">B (compulsory)</td><td></td><td>5</td><td></td><td></td><td></td><td></td><td>5 × 3 = 15</td></tr>
<tr><td colspan="2">C (either…or type)</td><td></td><td></td><td>3</td><td></td><td></td><td></td><td>3 × 6 = 18</td></tr>
<tr><td rowspan="4">D (2 out of 3)</td><td>For courses with K5 as the highest cognitive level, one K4 and one K5 question is compulsory.
(Note: two questions on K4 and one question on K5)</td><td></td><td></td><td></td><td>1</td><td>1*</td><td></td><td rowspan="4">2 × 10 = 20</td></tr>
<tr><td rowspan="3">For courses with K6 as the highest cognitive level: Mid Sem: two questions on K4 and one question on K5; End Sem: two questions on K5 and one question on K6)</td><td></td><td></td><td></td><td colspan="2">Mid Sem</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="2">End Sem</td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>1</td><td>1*</td></tr>
<tr><td colspan="7">Total</td><td>60</td></tr>
</table>

***** *Compulsory*

Question Paper Blueprint for Semester Examination

Duration: 3 Hours						**Maximum Marks: 100**
UNIT	**Section A** *(Compulsory)*	**Section B** *(Compulsory)*	**Section C** *(Either…or type)*	**Section D** *(3 out of 5)*		
	K1	**K2**	**K3**	**K4**	**K5**	**K6**
UNIT I	2	2	2	2*	2*	1*
UNIT II	2	2	2			
UNIT III	2	2	2			
UNIT IV	2	2	2			
UNIT V	2	2	2			
Marks	**10 × 1 = 10**	**10 × 3 = 30**	**5 × 6 = 30**	**3 × 10 = 30**		

** For courses with K6 as the highest cognitive level wherein one question each on K4, K5 and K6 is compulsory.*
(Note: two questions each on K4 and K5 and one question on K6)

Evaluation Pattern for One/Two-credit Courses

Title of the Course	CIA	Semester Examination	Total Marks
• Ability Enhancement Course	20 + 10 + 20 = 50	50 *(A member from the Department other than the course instructors)*	100
• Self-paced Learning • Comprehensive Examination	25 + 25 = 50	50 *(CoE)*	100
• Internship	100	-	100
• Skill Enhancement Course: Soft Skills	100	-	100
• Project Work and Viva Voce	100	100	100

Grading System

The marks obtained in the CIA and semester for each course will be graded as per the scheme provided in Table - 1.

From the second semester onwards, the total performance within a semester and the continuous performance starting from the first semester are indicated by Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA), respectively. These two are calculated by the following formulae:

$$SGPA \ and \ CGPA = \frac{\sum_{i=1}^{n} C_i Gp_i}{\sum_{i=1}^{n} C_i}$$

$$WAM = \frac{\sum_{i=1}^{n} C_i M_i}{\sum_{i=1}^{n} C_i}$$

Where,

Ci - credit earned for the Course i

Gpi - Grade Point obtained for the Course i

Mi - Marks obtained for the Course i

*n - Number of Courses **passed** in that semester*

WAM - Weighted Average Marks

Table - 1: Grading of the Courses

Mark Range	Grade Point	Corresponding Grade
90 and above	10	O
80 and above and below 90	9	A+
70 and above and below 80	8	A
60 and above and below 70	7	B+
50 and above and below 60	6	B
Below 50	0	RA

Table - 2: Grading of the Final Performance

CGPA	Grade	Performance
9.00 and above	O	Outstanding*
8.00 to 8.99	A+	Excellent*
7.00 to 7.99	A	Very Good
6.00 to 6.99	B+	Good
5.00 to 5.99	B	Above Average
Below 5.00	RA	Re-appear

**The Candidates who have passed in the first appearance and within the prescribed duration of the PG programme are eligible. If the Candidates Grade is O/A+ with more than one attempt, the performance is considered "Very Good".*

Vision

Forming globally competent, committed, compassionate and holistic persons, to be men and women for others, promoting a just society.

Mission

- Fostering learning environment to students of diverse background, developing their inherent skills and competencies through reflection, creation of knowledge and service.
- Nurturing comprehensive learning and best practices through innovative and value- driven pedagogy.
- Contributing significantly to Higher Education through Teaching, Learning, Research and Extension.

Programme Educational Objectives (PEOs)

1. Graduates will be able to accomplish professional standards in the global environment.
2. Graduates will be able to uphold integrity and human values.
3. Graduates will be able to appreciate and promote pluralism and multiculturalism in working environment.

Programme Outcomes (POs)

1. Graduates will be able to apply assimilated knowledge to evolve tangible solution to emerging problems.
2. Graduates will be able to analyze and interpret data to create and design new knowledge.
3. Graduates will be able to engage in innovative and socially relevant research and effectively communicate the findings.
4. Graduates will become ethically committed professional and entrepreneurs upholding human values.
5. Graduates imbibed with ethical values and social concern will be able to understand and appreciate cultural diversity, social harmony and ensure sustainable environment.

Programme Specific Objectives (PSOs)

1. Critical and Analytical Thinking Skills
2. Focus on latest technology in Electronics
3. Hardware designing skills
4. Trouble shooting and programming skill
5. Digital design synthesis and simulation
6. Entrepreneurial Skills
7. Employability Enhancement
8. Research and industrial consultancy.

PROGRAMME STRUCTURE				
Semester	**Course Specification**	**Number of Courses**	**Hours**	**Credits**
1 - 4	Core Course	8	38	37
1 - 4	Core Practical	4	32	24
1, 2, 4	Elective	4	19	14
1	Ability Enhancement Course	1	2	1
2	Self-paced Learning	1	-	2
2	Skill Enhancement Course	1	4	3
2, 3	Generic Elective	2	8	6
3	Common Core	1	5	4
3	Internship	1	-	2
2 - 4	Extra Credit Course	3	-	(9)
4	Project Work and Viva Voce	1	12	11
4	Comprehensive Examination	1	-	2
2 - 4	Outreach Programme (SHEPHERD)	-	-	4
	Total	**28**	**120**	**110(9)**

M Sc ELECTRONICS							
Course Details					Scheme of Exams		
Sem	Course Code	Title of the Course	Hours	Credits	CIA	SE	Final
1	23PEL1CC01	**Core Course -1:** Embedded Systems Design with PIC	6	5	100	100	100
	23PEL1CC02	**Core Course - 2**: Digital Communication Systems	5	5	100	100	100
	23PEL1CP01	**Core Practical - 1:** Embedded systems -1	8	6	100	100	100
	23PEL1ES01	**Elective - 1:** Digital Signal Processing	5	3	100	100	100
	23PEL1ES02	**Elective - 2:** Instrumentation Control Techniques	4	3	100	100	100
	23PEL1AE01	**Ability Enhancement Course:** Electronics Research and Entrepreneurship	2	1	100	-	100
		Total	**30**	**23**			
2	23PEL2CC03	**Core Course - 3:** Mechatronics and Automotive Electronics	4	4	100	100	100
	23PEL2CC04	**Core Course - 4:** Embedded Systems Programming	5	5	100	100	100
	23PEL2CP02	**Core Practical - 2**: Signal Processing and Electronic Communication	8	6	100	100	100
	23PEL2SP01A	**Self-paced Learning:** Programmable Logic Controller*	-	2	50	50	50
	23PEL2SP01B	**Self-paced Learning:** Nanoelectronics*					
	23PEL2SP01C	**Self-paced Learning:** Medical Electronics*					
	23PEL2ES03A	**Elective - 3:** Electromagnetics and Antenna Design	5	4	100	100	100
	23PEL2ES03B	**Elective - 3:** Power Electronics and Solar PV Systems					
	23PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	3	100	-	100
	–	**Generic Elective - 1 (WS):** Refer ANNEXURE 1	4	3	100	100	100
	-	Extra Credit Courses (MOOC/Certificate Courses) - 1	-	(3)			
		Total	**30**	**27(3)**			
3	23PEL3CC05	**Core Course - 5:** VLSI Design and VERILOG Programming	4	4	100	100	100
	23PEL3CC06	**Core Course - 6:** Electronic Instrumentation and Virtual Instrumentation	5	5	100	100	100
	23PEL3CC07	**Core Course - 7:** Internet of Things with Single Board Computer	4	4	100	100	100
	23PEL3CP03	**Core Practical - 3**: Microcontroller Interfacing and FPGA	8	6	100	100	100
	23SPS3CC01	**Common Core:** Materials Science	5	4	100	100	100
	-	**Generic Elective - 2 (BS):** Refer ANNEXURE 2	4	3	100	100	100
	23PEL3IS01	Internship	-	2	100	-	100
	-	Extra Credit Courses (MOOC/Certificate Courses) - 2	-	(3)			
		Total	**30**	**28(3)**			
4	23PEL4CC08	**Core Course - 8:** Artificial Intelligence	5	5	100	100	100
	23PEL4CP04	**Core Practical - 4:** Internet of Things and Artificial Intelligence	8	6	100	100	100
	23PEL4ES04A	**Elective - 4:** Control System and Industrial Automation	5	4	100	100	100
	23PEL4ES04B	**Elective - 4:** Biomedical Signal and Image Processing					
	23PEL4PW01	Project Work and Viva Voce	12	11	100	100	100
	23PEL4CE01	Comprehensive Examination*	-	2	50	50	50
	-	Extra Credit Courses (MOOC/Certificate Courses) - 3	-	(3)			
		Total	**30**	**28(3)**			
2 - 4	23PCW4OR01	Outreach Programme (SHEPHERD)	-	4			
1 - 4		**Total (2 years)**	**120**	**110**			

*- for grade calculation 50 marks are converted into 100 in the mark statements

Passed by	***Board of Studies held on 18.12.2023***
Approved by	***48th Academic Council Meeting held on 27.03.2024***

ANNEXURE 1
Generic Elective - 1 (WS)*

Course Details		
School	**Course Code**	**Title of the Course**
SPS	23PCH2EG01A	Chemistry for Physical Sciences - 1
	23PCH2EG01B	Chemistry for Physical Sciences - 2
	23PPH2EG01A	Solar Energy and Utilization
	23PPH2EG01B	Renewable Energy Resources

**Offered to students from other Departments within School*

ANNEXURE 2
Generic Elective - 1 (BS)*

Course Details		
School	**Course Code**	**Title of the Course**
SBS	23PBI3EG02	First Aid Management
	23PBT3EG02	Food Technology
	23PBO3EG02	Horticulture and Landscaping
SCS	23PCA3EG02	Web Design
	23PCS3EG02	Advances in Computer Science
	23PDS3EG02	Information Security and Ethics
	23PMA3EG02	Operations Research
SLAC	23PEN3EG02	English for Effective Communication
SMS	23PCO3EG02	Basics of TallyPrime
	23PCC3EG02	Dynamics of Human Behaviour in Business
	23PCP3EG02	Social Psychology
	23PEC3EG02	Managerial Economics
	23PHR3EG02	Counselling and Guidance

**Offered to students from other Schools*

Semester	Course Code	Title of the Course	Hours/ Week	Credits
1	23PEL1CC01	**Core Course - 1**: Embedded Systems Design with PIC	6	5

Course Objectives
To study the architecture of the PIC -CPU, Memory and Micro C Programming Techniques
To understand Programming Parallel I/O Ports and Interface output devices
To understand Programming internal ADC, DAC and PWM
To understand how to handle Timers and interrupts
To understand Serial communication Protocols, programming various protocols, interface and communicate with GPS, Bluetooth Modules using serial communication protocols.

UNIT I: PIC 18 Architecture and Embedded C Programming: (18 Hours)

Architecture - WREG - File Register - Default Access Bank - Status Register - Program Counter - oscillator used in PIC - PIC Microcontroller Memory Types - Flash Program Memory, Data Memory (RAM) and EEPROM Data Memory - Program ROM Space - Embedded C Programming and data types in MikroC Pro for PIC - Variables - Conditional and Looping statements- arrays and user defined functions.

UNIT II: Programming Parallel I/O Ports: (18 Hours)

Port A, B, C, D, E and F - Reading and Writing Registers in PIC microcontroller - I/O Bit Manipulation Programming - LED Blinking Program - 16×2 LCD Interfacing with PIC - 7 Segment Display interfacing with PIC - Stepper Motor Interfacing with PIC

UNIT III: ADC, DAC and PWM: (18 Hours)

PIC18F ADC Module - PIC18F ADC Block Diagram - PIC18F ADC Registers - IC18F4550 Microcontroller ADC Programming - PIC Microcontroller Built-in DAC Modules - DAC Module Control Registers - DAC Module Programming - PWM using PIC Microcontroller - PWM Duty cycle - PWM Programming - PWM for DC Motor Speed Control

UNIT IV: Timers and Interrupts in PIC microcontroller: (18 Hours)

Types of timers in PIC microcontroller - Clock source of PIC microcontroller timers - Delay Calculation of timers - Timers Registers Configuration - Working of PIC microcontroller timers - Code to generate delay with timers - Counter Programming - PIC 18 Interrupts - Programming Timer Interrupts - Programming External Hardware Interrupts

UNIT V: PIC Communication Modules: (18 Hours)

UART Communication with PIC- Use UART Interrupt of PIC - PIC SPI Module - I2C Communication using PIC - USB interfacing with PIC - Serial Communication Using PIC - GPS module interfacing with PIC - GSM Module interfacing with PIC - PIC Bluetooth module interfacing with PIC

Teaching Methodology	Demo Videos, PPT, Handouts, circuit simulations and analysis

Book for Study

1. Mazidi, M. A., McKinlay, R., & Causey, D. (2013). *PIC microcontroller and embedded systems using assembly and C for pic 18.* Pearson.

Books for Reference

1. Peatman, J.B. (2009). *Design with PIC microcontroller.* Prentice Hall of India.
2. Predko & Myke. (2008). *PIC microcontroller.* Tata McGraw Hill Edition.

Websites and eLearning Sources

1. https://electronicsdesk.com/pic-microcontroller.html
2. https://ww1.microchip.com/downloads/en/devicedoc/39632e.pdf
3. https://www.microchip.com/wwwproducts/pic18f4550
4. https://www.dauniv.ac.in/public/frontassets/coursematerial/embeddedsystems/Chap_5 L01Emsys3EIOPortsSerial_Parallel.pdf
5. https://circuitdigest.com/microcontroller-projects/pic-to-pic-communication-using-rfmodule

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	describe the architecture, characteristics embedded systems	**K1**
CO2	outline and restate the embedded system design	**K2**
CO3	solve hardware and software issues and apply in embedded system	**K3**
CO4	analyze the embedded system in various applications	**K4**
CO5	assess and develop programming skill	**K5**
CO6	design their own Embedded System using PIC microcontroller	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
1	**23PEL1CC01**		**Core Course - 1**: Embedded Systems Design with PIC							**6**	**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	3	2	3	3	3	3	**2.5**
CO2	2	3	2	3	3	2	2	2	2	3	**2.4**
CO3	2	2	3	3	2	2	3	2	2	3	**2.4**
CO4	2	2	2	2	3	2	3	2	3	2	**2.3**
CO5	2	2	2	3	2	2	2	3	3	3	**2.4**
CO6	2	2	2	3	2	2	3	2	3	2	**2.3**
									Mean Overall Score		**2.38 (High)**

Semester	Course Code	Title of the Course	Hours /Week	Credits
1	23PEL1CC02	**Core Course - 2:** Digital Communication Systems	5	5

Course Objectives
To know the principles of Digital Communication System and Information theory
To study various waveform coding schemes
To learn various baseband transmission schemes
To understand various Digital Modulation Schemes
To learn various error control coding

UNIT I: Information Theory: **(15 Hours)**

Digital Communication System - Discrete Memory less source, Information, Entropy, Mutual Information - Discrete Memory less channels - Binary Symmetric Channel, Channel Capacity - Hartley - Shannon law - Source coding theorem - Shannon - Fano & Huffman codes.

UNIT II: Waveform Coding & Representation: **(15 Hours)**

Prediction filtering and DPCM - Delta Modulation - ADPCM & ADM principles-Linear Predictive Coding- Properties of Line codes- Power Spectral Density of Unipolar / Polar RZ & NRZ - Bipolar NRZ - Manchester

UNIT III: Baseband Transmission & Reception: **(15 Hours)**

ISI - Nyquist criterion for distortion less transmission - Pulse shaping - Correlative coding - Eye pattern - Receiving Filters - Matched Filter, Correlation receiver, Adaptive Equalization.

UNIT IV: Digital Modulation Scheme: **(15 Hours)**

Geometric Representation of signals - Generation, detection, PSD & BER of Coherent BPSK, BFSK & QPSK - QAM - Carrier Synchronization - Structure of Noncoherent Receivers - Principle of DPSK.

UNIT V: Error Control Coding: **(15 Hours)**

Channel coding theorem - Linear Block codes - Hamming codes - Cyclic codes - Convolutional codes - Viterbi Decoder.

Teaching Methodology	Demo Videos, PPT, Handouts, circuit simulations and analysis

Books for Study

1. Proakis, J. G., & Salehi, M. (2014). *Digital communication.* McGraw Hill Education Edition.
2. Bhattacharya, A. (2006). *Digital communication*. McGraw Hill Education (India) Pvt. Ltd.
3. Sklar, B.. & Ray, P. K. (2014). *Digital communications fundamentals and applications.* Pearson Education.
4. Haykin, S. (2005). *Digital communications.* John Wiley India.

Books for Reference

1. Shanmugam, K. S. (2012). *Digital and communication systems.* Wiley, India.
2. Nishanth, N. (2017). *Digital communication.* Cengage Learning India.
3. Rao, R. (2011). *Digital communication.* Tata McGraw Hill Education Pvt.
4. Haykin, S. (2012). *Communication systems,* (4th Ed.). Wiley, India.
5. Kundu, S. (2010). *Analog and digital communications*. Pearson.

Websites and eLearning Sources

1. https://www.sciencedirect.com/topics/engineering/digital-communication-system
2. https://www.tutorialspoint.com/digital_communication/digital_communication_quick _guide.htm
3. https://www.egr.msu.edu/~tongli/teaching/ece865/Introduction
4. https://www.electronicdesign.com/technologies/communications/article/21798737/ele ctronic-design-understanding-modern-digital-modulation-techniques
5. https://www.site.uottawa.ca/~yongacog/courses/elg3175/Lecture18-19-AYCoding.pdf

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	understand the basic of Digital communication systems	**K1**
CO2	illustrate various waveform coding	**K2**
CO3	sketch the signaling and transmission schemes	**K3**
CO4	analyze spectral characteristics of band pass signaling scheme and digital modulation	**K4**
CO5	assess and develop PCM systems	**K5**
CO6	design a digital communication scheme and error control coding schemes	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**23PEL1CC02**			**Core Course - 2:** Digital Communication Systems						**5**	**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	3	2	3	2	3	3	**2.4**
CO2	2	3	2	2	3	2	2	2	2	3	**2.3**
CO3	2	2	3	3	2	2	3	2	2	3	**2.4**
CO4	2	2	2	2	1	2	3	2	3	2	**2.2**
CO5	2	2	2	3	2	2	2	3	1	1	**2.2**
CO6	2	2	2	3	2	2	3	2	3	2	**2.3**
Mean Overall Score											**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PEL1CP01	**Core Practical -1**: Embedded Systems - 1	8	6

Course Objectives
To understand interfacing, I/O devices with PIC Parallel I/O and develop the embedded C programming in microC pro IDE / MPLAB IDE
To understand and develop timer, interrupt and Serial communication Programming
To study Digital communication Modulators and Demodulators
To develop MATLAB Programs to generate signals, Analyze the signal in Time and frequency domain
To develop MATLAB Programs to design FIR and IIR Filters

1. The DSP programs shall be implemented in software using MATLAB/C
2. BCD and ASCII Conversion
3. Testing PIC I/O Ports using LED and DIP switches
4. Interfacing Traffic Light Controller
5. Interfacing Seven Segment Display
6. Interfacing Relay and Buzzer
7. Interfacing LCD to PIC
8. ADC Programming in PIC
9. Interfacing Temperature Sensor to PIC
10. Interfacing Stepper Motor to PIC
11. Interfacing N x M Key Board to PIC
12. DAC Interfacing in PIC
13. Interfacing a DC Motor to PIC.
14. Timer Program
15. Event Counter Programmer
16. Interrupt Programming
17. PIC UART serial Interfacing
18. Study of ASK modulation and Demodulation
19. Study of FSK modulation and Demodulation
20. Study of BPSK modulation and Demodulation
21. Generation Of Basic Signals (unit impulse Signal, Step, Ramp, Exponential) Using Matlab
22. Generate Continuous Time and Discrete time sin/ cosine signal.
23. Compute Convolution of a given Sequence
24. Compute Correlation of a given Sequence
25. Compute Auto Correlation of a given Sequence
26. Compute Cross Correlation of a given sequence
27. Compute Correlation Coefficient of a given data
28. Find frequency response of a given system given in (Transfer Function/ Differential equation form).
29. Evaluate the impulse response of the system
30. Find the DFT / IDFT of given signal
31. Determination of Power Spectrum of a given signal(s).
32. Implementation of windows
33. Implementation of LP FIR filters for a given sequence.
34. Implementation of HP FIR filters for a given sequence.
35. Implementation of LP IIR filters for a given sequence.
36. Implementation of HP IIR filters for a given sequence.

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PEL1ES01	**Elective - 1**: Digital Signal Processing	5	3

Course Objectives
To Study the basics of Discrete Time signals and systems
To understand Discrete Fourier Transformation techniques to analyze the signals
To Learn Z Transformation along with Transfer functions
To Explain Digital filters and design of FIR and IIR filters
Explain Adaptive filters and design Adaptive filters using steepest decent, LMS algorithms

UNIT I: Discrete Time Signals and Systems: **(15 Hours)**

Sampling Theorem- Sampling of Analog Signals - Anti Aliasing Filter - Various Types of Signals - Standard Discrete Time Signals - Classification of Discrete Time Signals - Basic Operations on DTS - Discrete Time Systems - LTI invariant System (Discrete Convolution) - Classification of DT LTI systems - DT Deconvolution and Correlation.

UNIT II: Discrete Fourier Transformation: **(15 Hours**

Discrete Fourier Transform - Matrix Relation for Computing DFT and IDFT - Important Properties of DFT - Circular Convolution and its implementation - Linear Convolution from circular convolution - Decimation in Frequency FFT - Decimation in Time FFT - Radix -2 Inverse FFT - Frequency analysis of Known DT Signals - Power and Energy Spectral Density.

UNIT III: Z Transformation: **(15 Hours**

The Z Transform - Properties of Z-Transform - The Inverse Z-Transform - Elements of a Digital Filters - Transfer Functions of a Difference Equation - The z-Plane Pole-Zero Plot.

UNIT IV: Basics of Digital Filtering: **(15 Hours)**

FIR Filter Structure - Properties of Linear Phase FIR Filters -Window Design Techniques - Design of Linear Phase FIR Filter Using Window- Generic Equation for IIR Filter - Design of Low Pass IIR Butterworth Filter - Design of Low Pass Chebyshev Filter

UNIT V: Adptive Filters: **(15 Hours)**

Basic Adaptive Filter - System Identification - Noise Cancellation - Equalization - Adaptive Prediction - Computing the coefficients of an adaptive filter - The Steepest Decent Algorithm - LMS Adaptive Algorithm - Adaptive Noise Canceller - Adaptive System identification.

Teaching Methodology	Demo Videos, PPT, Handouts, circuit simulations and analysis

Books for Study

1. Oppenheim, A. V., & Schafer, R. W. (1975). *Digital signal processing*.
2. Reddy, D. C. (2009). *Biomedical signal processing principles and techniques.* The TataMcGraw Hill Publishing Company Ltd, New Delhi.
3. Apte, S. D. (2010). *Digital signal processing*. WILEY INDIA.
4. Proakis, J. G., & Monolakis, D. G. (2011). *Digital signal processing principals, algorithms and applications*. PEARSON.
5. Rao, K. D., & Swamy, M. N. S. (2012). *Digital signal processing.* JAICO Publishing House.

Books for Reference

1. Cristi, R. (2012). *Modern digital signal processing.* Cengage Learning.
2. Salivhanan, S. (2019). *Digital signal processing,* (4th Ed.). McGraw-Hill.
3. Ingle, V. K., &. Proakis, J. G. (2012). *Essentials of digital signal processing using MATLAB,* (3rd Ed.). Cengage Learning.
4. Tompkins, W. J. (2000). *Biomedical digital signal processing.* Prentice - Hall of India Pvt. Ltd.
5. Yong, W. Y. *et al*. (2001). *Signals and systems with MATLAB.* Springer International Edition.

Websites and eLearning Sources

1. https://www.analog.com/en/design-center/landing-pages/001/beginners-guide-to-dsp.html
2. https://www.tutorialspoint.com/digital_signal_processing/index.htm
3. https://www.geeksforgeeks.org/what-is-z-transform/
4. https://web.ece.ucsb.edu/~yoga/courses/DSP/P9_Intro_Digital_Filters.pdf
5. https://www.mathworks.com/help/dsp/ug/overview-of-adaptive-filters-and-applications.html

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	describe the discrete time signal and systems in time domain	**K1**
CO2	outline Digital Signal Processing	**K2**
CO3	solve the problem of discrete time signal and systems in time domain using convolution and correlation	**K3**
CO4	analyze the discrete time signal and systems in time domain using convolution and correlation	**K4**
CO5	assess and develop an algorithm to design adaptive filters for system identification, noise cancellation and Equalization	**K5**
CO6	design an algorithm to design and analyze the FIR and IIR filters using Z - transform	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**23PEL1ES01**			**Elective - 1**: Digital Signal Processing						**5**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	3	2	2	2	3	3	**2.3**
CO2	2	3	2	2	3	2	2	2	2	3	**2.3**
CO3	2	2	2	2	2	2	3	2	3	3	**2.3**
CO4	2	2	2	2	3	2	3	2	3	2	**2.3**
CO5	2	2	2	3	2	2	2	2	3	3	**2.3**
CO6	2	2	2	3	2	2	3	2	3	3	**2.4**
										Mean Overall Score	**2.32 (High)**

Semester	Course Code	Title of the Course	Hours /Week	Credits
1	23PEL1ES02	**Elective - 2**: Instrumentation Control Techniques	4	3

Course Objectives
To learn the concept of measurement and error estimation
To learn various industrial detection sensor and its interfacing
To learn to design data acquisition systems
To learn DC motor construction, operations and its drive
To know industrial control techniques

UNIT I: Measurement **(12 Hours)**

Performance characteristics of instruments- Static characteristics- Accuracy- Resolution Precision- Expected value- Error- Sensitivity- Errors in Measurement, Dynamic Characteristics- speed of response- Fidelity- Lag and Dynamic error.

UNIT II: Industrial Detection Sensors and Interfacing **(12 Hours)**

Proximity Detectors - Inductive Proximity Switches - Capacitive Proximity Switches - Hall Effect Sensor -IC Temperature Sensor - Optical Shaft Encoder Displacement Sensor - Photoelectric Sensor - Methods of Detection -Ultrasonic Sensors - Sensor Interfacing.

UNIT III: Data acquisition and Handling **(12 Hours)**

Systems: Introduction-signal conditioners-Instrumentation amplifiers-filters- Data conversion - multiplexers - A/D-D/A conversion - PC based telemetry System.

UNIT IV: DC Motor and Variable Speed Drive **(12 Hours)**

DC Motor: Principles of Operation - Practical DC Motor - Basic Motor Construction - Motor Classification - Coil terminal Identification - DC Servo Motor - Stepper Motor - Permanent Magnet Stepper Motor - Variable Reluctance Stepper Motor DC drive Fundamental - Variable Voltage DC drive - Motor Breaking.

UNIT V: Process Control- Techniques and Control Methods **(12 Hours)**

Pressure Control system - Temperature Control System- Flow Control System - Level Control System - Analytical Instrumentation - Non-Destructive Testing - Open Loop Control - Closed Loop Control - Single Variable Control - Selecting a Controller - On-Off Control - Case Study - Continuous Control - Tuning the Controller.

Teaching Methodology	Demo Videos, PPT, Handouts, circuit simulations and analysis

Books for Study

1. Nakra., & Chaudhry, K. K. (2004). *Instrumentation- measurement and analysis*, (2nd Edition). Tata McGraw Hill
2. Bartelt, T. L. (2006). *Industrial electronics: Circuits instruments and control techniques.* Cengage Learning.

Books for Reference

1. Bose, B. K. (2004). *Modern power electronics and AC drives*. Pearson Education.
2. Biswanath, P. (2005). *Industrial electronics and control.* Prentice Hall of India.
3. Nagrath, I. J., & Gopal, M. (1995), *Control systems engineering*. New Age International Pvt. Ltd.
4. Mathivanan, N. (2009). *PC based instrumentation concept and practice.* Prentice Hall of India.
5. Biswas, S. N. (2000). *Industrial electronics*. Dhanpat Rai & Co.

Websites and eLearning Sources

1. https://instrumentationtools.com/what-is-instrumentation-and-control-engineering/
2. https://www.britannica.com/technology/measurement#:~:text=measurement%2C%20the%20process%20of%20associating,to%20almost%20all%20everyday%20activities.

3. https://www.g2datasystems.co.uk/continuous-emissions-monitoring-software/dataacquisition-and-handling-system-
4. dahs/134/#:~:text=What%20is%20a%20Data%20Acquisition,can%20then%20be%20stored%20digitally
5. https://www.haroldbeck.com/processcontrol/#:~:text=Process%20control%20is%20the%20ability,a%20heater%20and%20 a%20thermostat.
6. https://www.sciencedirect.com/topics/engineering/process-control

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	remember the characteristics of instruments	**K1**
CO2	understand the basic techniques of instruments used in instrumentation control system	**K2**
CO3	explain the control techniques after measuring the signals	**K3**
CO4	select suitable instrument and control methods for different applications	**K4**
CO5	assess and develop the instruments for various applications	**K5**
CO6	design an instrument for a specific need	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
1	**23PEL1ES02**			**Elective - 2**: Instrumentation Control Techniques						**4**	**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	3	2	3	2	3	2	**2.3**
CO2	2	3	2	3	3	2	2	2	2	2	**2.3**
CO3	2	2	2	3	2	2	3	2	2	3	**2.3**
CO4	2	2	2	2	3	2	3	2	3	2	**2.3**
CO5	2	2	2	3	2	2	2	2	3	3	**2.3**
CO6	2	2	2	3	2	2	3	2	3	3	**2.3**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
1	23PEL1AE01	**Ability Enhancement Course**: Electronics Research and Entrepreneurship	2	1

Course Objectives
To learn the basic concept of Matrices and Vectors
To learn various industrial detection sensor and its interfacing
To learn to design data acquisition systems
To learn DC motor construction, operations and its drive
To know industrial control techniques

UNIT I: Mathematics I **(6 Hours)**

Matrices and Vectors-Eigenvalues and eigenvectors-Gradient-divergence and curl-Line and surface integrals- Stroke's Theorem

UNIT II: Mathematics II **(6 Hours)**

Second order Ordinary Differential Equations with variable coefficients - Cauchy-Euler equation - Bessel functions and their properties- Introduction to Partial Differential Equations + Definition of Laplace transform and its electronics applications

UNIT III: Logical Reasoning and Data Interpretation **(6 Hours)**

Understanding the structure of arguments: Venn diagram: Analogies - Data Interpretation Graphical representation

UNIT IV: Research Skills **(6 Hours)**

Meaning - types - characteristics - methods - research problem identification and formulation - Deductive and inductive theory - Hypothesis and quality of measure for the hypothesis - Thesis and article writing - Research ethics Introduction to reference management software (Mendeley) - Software for detection of plagiarism.

UNIT V: Troubleshooting skills **(6 Hours)**

Identification of problems - understanding the symptoms - causes for the problems - analysing the solutions - implementing the solutions - testing and validation - Troubleshooting by observing the signals (voltage measurement, current measurement, resistance measurement, waveform, …) - case study (troubleshooting an electronic device)

Teaching Methodology	Demo Videos, PPT, Handouts, Circuit Troubleshooting

Books for Study

1. Kreyszig, E. (2011). *Advanced engineering mathematics, (*10th Ed). Wiley Plus.
2. Sinha, N. K. (2019). *Logical reasoning and data interpretation for CAT,* (6th Ed).
3. Pearson Education.
4. Warburton, C., & Bookman, S. (2007). *Basic college research skills*, University Press of America.
5. Text prepared by the Department

Books for Reference

1. Bird, J. (2010). *Higher engineering mathematics,* (6th Ed). Elsevier.
2. Tomal, D. R. & Agajanian, A. S. (2014). *Electronic troubleshooting,* (4th Ed). Mc Graw Hill Education.
3. Kothari, C. R. & Garg, G. (2019). *Research methodology,* (4th Ed). New Age International Publishers.

Websites and eLearning Sources

1. https://www.niti.gov.in/innovation-and-entrepreneurship-sustainable-growth
2. http://www.untagsmd.ac.id/files/Perpustakaan_Digital_1/ENTREPRENEURSHIP%20Innovation%20a nd%20entrepreneurship.PDF

3. https://www.globalknowledge.com/us-en/resources/resource-library/articles/4-tips-tostrengthen-your-troubleshooting-skills/
4. https://cleverism.com/skills-and-tools/troubleshooting/
5. https://www.universityofgalway.ie/academicskills/readingandresearch/#:~:text=Research%20skills%20refer%20to%20the,relevant %20to%20a%20particular%20topic.

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	analyze the electronic circuits	**K4**
CO2	evaluate the symptoms	**K5**
CO3	trouble shoot the electronic circuits	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
1	**23PEL1AE01**	**Ability Enhancement Course**: Electronics Research and Entrepreneurship								**2**	**1**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	3	3	2	3	2	3	2	**2.4**
CO2	2	2	2	3	2	2	2	3	3	3	**2.4**
CO3	2	2	3	3	3	2	3	2	3	2	**2.5**
										Mean Overall Score	**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PEL2CC03	**Core Course - 3:** Mechatronics and Automotive Electronics	4	4

Course Objectives
To describe the components of automotive electronics
To understand the basics of automotive sensors, control systems and network protocols
To discover electronic circuits for automobile applications
To select suitable sensors and protocols for automobile applications
To decide and create new circuits for vehicles

UNIT I: Basics of Automotive Electronics **(12 Hours)**

Introduction to Electronic systems in Automotives - The Basics of Electronic Engine Control Concept of an Electronic Engine Control System - Definition of Engine Performance Terms (Torque, Power, Fuel Consumption, Engine Overall Efficiency, Calibration, Engine Mapping)- Electronic Fuel Control System- Analysis of Intake Manifold Pressure- Idle Speed Control - Electronic Ignition.

UNIT II: Sensors and Actuators **(12 Hours)**

Automotive Control System Applications of Sensors and Actuators- Airflow Rate Sensor - Pressure Measurement -Throttle Angle Sensor- Temperature Sensors- Typical Coolant Sensor Sensors for Feedback Control- Knock Sensors- Angular Rate Sensor- LIDAR- Digital Video Camera- Flex-Fuel Sensor- Automotive Engine Control Actuators- Variable Valve Timing Electric Motor Actuators- Stepper Motors- Ignition System.

UNIT III: Digital Powertrain Control Systems **(12 Hours)**

Control Modes for Fuel Control- Discrete Time Idle Speed Control- EGR Control Turbocharging- Integrated Engine Control System- Automatic System Adjustment- System Diagnosis- Summary of Control Modes.

UNIT IV: Vehicle Motion Controls and Automotive Instrumentation **(12 Hours)**

Cruise Control Electronics - Stepper Motor-based Actuator Electronics- Antilock Braking System - Electronic Suspension Control System- Electronic Steering Control- Modern Automotive Instrumentation- Input and Output Signal Conversion- Advantages of Computer Based Instrumentation- Measurement Examples- Fuel Quantity- Coolant Temperature- Oil Pressure- Vehicle Speed- Trip Information Function of the System

UNIT V: Motor vehicle Communications **(12 Hours)**

IVN- CAN- Local Interconnect Network (LIN)- FlexRay IVN- MOST IVN- Vehicle to Infrastructure Communication- Vehicle-to-Cellular Infrastructure- Quadrature Phase Shifter and Phase Modulation (QPSR)- Short-Range Wireless Communications- Satellite Vehicle Communication- GPS Navigation- Safety Aspects of Vehicle-to-Infrastructure Communication- Electronic Safety-Related Systems- Airbag Safety Device- Blind Spot Detection- Automatic Collision Avoidance System- Lane Departure Monitor - Advanced driver-assistance systems (ADAS).

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Books for Study

1. William, B.R. (2017). *Understanding Automotive Electronics*. (8th Ed.). Butterworth Heinemann Woburn.

Unit	Book	Chapter	Sections
I	1	4	all
II	1	5	all
III	1	6	all
IV	1	7, 8	all
V	1	9, 10	all

Books for Reference

1. James, L., & John, L. (2003). *Electric Vehicle Technology Explained.* John Wiley and Sons.
2. Robert, B. (2000). *Automotive Hand Book*, (5th Ed.). SAE.
3. Al Santini. (2013). *Automotive Electricity and Electronics*. Cengage Learning.

Websites and eLearning Sources*

1. https://www.tutorialspoint.com/difference-between-sensors-and-actuators
2. https://www.udemy.com/course/automotive-engineering-digital-powertrain-controlsystems/
3. https://www.speedgoat.com/products-services/i-o-connectivity/protocols/can-fd
4. https://www.elprocus.com/automotive-electronics-and-its-innovations/
5. https://www.techtarget.com/iotagenda/definition/vehicle-to-vehicle-communicationV2V-communication

(* subject to availability - not to be used for exam purpose)

Course Outcomes		
CO No.	**CO - Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K- level)**
CO1	acquire the basics of automotive sensors, controls and network protocols	**K1**
CO2	understand the concepts of Automotive Electronics	**K2**
CO3	apply various protocols for automotive control and communication networks	**K3**
CO4	analyze the Sensors and Actuators of Automotive Electronics Instrumentation	**K4**
CO5	evaluate Digital Powertrain Control Systems	**K5**
CO6	create next generation Electric Vehicle Technology System	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
2	**23PEL2CC03**	**Core Course - 3:** Mechatronics and Automotive Electronics								**4**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	2	2	2	3	2	2	3	**2.3**
CO2	2	3	2	3	2	2	2	3	2	3	**2.4**
CO3	3	3	3	2	2	3	3	3	2	2	**2.6**
CO4	2	2	3	2	1	3	3	3	3	3	**2.5**
CO5	2	2	3	2	1	3	3	3	3	3	**2.5**
CO6	2	3	2	2	2	3	3	2	3	3	**2.5**
										Mean Overall Score	**2.46 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PEL2CC04	**Core Course - 4:** Embedded Systems Programming	5	5

Course Objectives
To describe the features of microcontrollers
To understand the architecture of microcontrollers and embedded Linux
To solve domestic and industrial problems with embedded systems
To analyse the functions of embedded systems
To recommend the microcontroller, embedded systems and create an embedded systems for social needs

UNIT I: Arduino Embedded System **(15 Hours)**

AVR architecture - Atmega328p features - architecture - Arduino features - Arduino I/O - Arduino peripheral blocks - Arduino IDE - Arduino language - simple programs

UNIT II: CORTEX-M CORTEX-R Microcontrollers **(15 Hours)**

LPC2148 features - Architecture - Pinout and description - Development board - ARM Keil IDE - Simple applications - ARM Cortex M85 Architecture and features - ARM Cortex R82 Architecture and features

UNIT III: STM32F103C8 Embedded System **(15 Hours)**

Features - Architecture - Pinout and Pin description - memory mapping - Development board - STM32Cube - Architecture - Firmware package - Simple applications

UNIT IV: Embedded Linux **(15 Hours)**

Embedded Linux Fundamentals -Embedded Linux Commands - VI Editors -Kernel - Kernel Module Vs Application - Device Driver - The Role of Device Driver - Types of Device Driver - Character Driver - Block Driver and Network Driver

UNIT V: Embedded System Design **(15 Hours)**

Train controller - FIR filter - Data compressor - Audio player - Digital Still camera - Engine Control Unit - Air quality monitoring system

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Books for Study

1. Study Material prepared by the department
2. Marilyn, W. (2012). *Computers as Components Principles of Embedded Computing System Design* (3rd Ed.). Elsevier.

Unit	Book	Chapter	Sections
I	1	1	All
II	1	2	All
III	1	3	All
IV	1	4	All
V	2	1-6	E.g., 1.4, 2.1, 3.8, 4.9, 5.12, 6.11

Books for Reference

1. Data sheet - Atmega328p, LPC2148, Cortex M85, Cortex R82, STM32F103C8, stm32cubef1
2. www.arduino.cc
3. Yaghmour, K., Masters, J., Gilad Ben-Yossef and Philippe Gerum (2008), *Building Embedded Linux Systems* (2nd Edition), O'Reilly Media.

Websites and eLearning Sources*

1. https://www.arduino.cc/reference/en/
2. https://www.arm.com/products/silicon-ip-cpu/cortex-m/cortex-m85

3. https://www.st.com/
4. https://ubuntu.com/blog/what-is-embedded-linux
5. https://www.techopedia.com/definition/29946/embedded-linux

(* subject to availability - not to be used for exam purpose)

Course Outcomes		
CO No.	**CO - Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K- level)**
CO1	describe the architecture and different modes of operations of a microcontroller and Cortex-M processor	**K1**
CO2	outline and restate the microcontroller programs	**K2**
CO3	analyze the implementation of Microcontrollers in various applications	**K3**
CO4	identify requirements of RTOS and IoT in applications	**K4**
CO5	asses and develop programming skill for an embedded system	**K5**
CO6	design and construct embedded system with Arduino, Cortex-M Processor and IoT	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
2	**23PEL2CC04**			**Core Course - 4:** Embedded Systems Programming					**5**		**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	3	2	3	3	3	3	**2.5**
CO2	2	2	2	3	3	3	3	2	3	3	**2.6**
CO3	2	2	3	3	2	2	3	3	2	3	**2.5**
CO4	2	2	3	2	3	2	3	2	3	2	**2.4**
CO5	2	2	3	3	2	2	2	3	3	3	**2.5**
CO6	2	3	3	2	3	2	2	3	3	2	**2.5**
										Mean Overall Score	**2.5 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	**23PEL2CP02**	**Core Practical - 2:** Signal Processing and Electronic Communication	**8**	**6**

Any 16 Experiments

1. LM35, RTD, Thermistor, DS18S20 / DS18B20
2. Phototransistor and Opto TRIAC, TSOP 17 photo modules for PCM remote control system
3. MOC3041 zero cross opt isolators and TL173L linear hall effect sensor and KMZ51 magnetic field sensor
4. Pressure, Vibration and A1425 analog speed sensors
5. Sinewave generation using TMS320C54
6. Acoustic echo cancellation using TMS320C54
7. Study of DSP Toolbox in MATLAB.
8. Basic image processing using MATLAB
9. Design of buck boost regulator.
10. Study of PWM charge controller for solar.
11. PV system assembling for 12 V load.
12. Design of ASK and FSK generator
13. Design of CAN
14. I2C communication - Application
15. Multitasking algorithm - Application
16. Analysis and code optimization for an embedded system
17. CPU performance analysis
18. Characteristics of Antennas
19. DTFT signal - SCILAB
20. Automotive Sensors characteristics
21. Design of simple cruise control
22. GPS system
23. Design of IIR filter
24. Design of FIR filters
25. Delta modulation - MATLAB
26. Audio analysis - MATLAB
27. Design of transducer - light, sound and temperature
28. MEMS sensors performances - BP, Heartbeat, SpO_2
29. ASK, FSK and PSK - analysis
30. Process control - SCADA
31. Analysis of Pulse Code Modulation
32. Edge Detection using MATLAB
33. Basic CCS programming
34. PAM, PWM, PCM

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PEL2SP01A	**Self-paced Learning:** Programmable Logic Controller	-	2

Course Objectives
To define different types of PLC and basic I/O modules
To understand PLC programming of basic logics
To apply programming of basic logics in PLC
To analyse basic relay switching circuits in PLC
To implement timer and counter based programs in various applications and design a network control system with PLC and SCADA

UNIT I: PLC Overview

Programmable logic controllers- parts of PLC-principles of operation-modifying the operation the I/O Section-Discrete I/O modules- Analog I/O modules-I/O specifications-Memory design and types-programming terminal devices-Recording and retrieving data-human machine interfaces

UNIT II: PLC Programming

Number system and codes- Fundamentals of logic- AND, OR, NOT, XOR function-hardwired logic versus programmed logic-Producing the Boolean equation for a given logic circuit programming word level logic instructions.

PLC programming languages- Bit level logic instructions-instruction and branch instruction Internal relay instructions- programming examine if closed and examine if open instruction entering the ladder program-modes of operation-connecting with analog devices.

UNIT III: Developing Fundamental PLC Wiring Diagrams

Electromagnetic control relays-contactors-motor starters-manually operated switches mechanically operated switch-sensors-output control devices-Seal in circuits-electrical interlocking circuits-latching relays-converting relay schematics into ladder program-writing a ladder program from a narrative description-instrumentation

UNIT IV: Programming Timers, Counters and Other Instructions

Mechanical timing relays-timer instructions-on delay timer-off delay timer-retentive timer cascading timer-counter instructions-up counter-down counter-cascading counter-incremental encoder-counter application-combining counter and timer-high speed counters. Program control instruction-Master control reset instruction-jump and subroutine instruction-immediate input and output instructions-forcing external I/O addresses-selectable timed interrupt Temporary End and suspend instruction. Math instructions.

UNIT V: Process Control, Network Systems and SCADA

Structure of control systems-on/off control-PID control-motion control-Data Communications Data Highway - Serial communication - Device Net-ControlNet- Ether Net / IP-MODBUS Fieldbus - PROFIBUS - DP - Supervisory control and data acquisition (SCADA)

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Book for Study

1. Frank, D. P. (2017). *Programmable logic controllers*, (5th Ed.). McGraw Hill Education.

Unit	Book	Chapter	Sections
I	1	1,2	1.1-1.4,2.1-2.11
II	1	3,4,5	Overview of chapter 3,4.2-4.7,5.3-5.11
III	1	6	6.1-6.13,
IV	1	7	7.1-7.6,8.5-8.7,9.1
V	1	14	14.2-14.7

Books for Reference

1. William, B. (2015). *Programmable logic controllers*, (6th Ed.). newness publications.
2. Pradeeka, S. (2017). *Building Arduino PLCs: The essential techniques you need to develop Arduino-based PLCs*, Apress publishers.
3. Daniel, K. (2010). *Programmable automation technologies: an introduction to CNC robotics and PLCs*. Industrial press.

Websites and eLearning Sources*

1. https://instrumentationtools.com/ladder-diagram-programming/
2. https://control.com/technical-articles/ladder-logic-in-programmable-logic-controllersplcs/
3. https://www.automation.com/en-us/articles/2018/a-beginners-plc-overview-part-3-of- 4-plc-inputs-an
4. https://dipslab.com/plc-input-output-modules-2/
5. https://control.com/textbook/programmable-logic-controllers/inputoutput-iocapabilities/

(* subject to availability - not to be used for exam purpose)

Course Outcomes		
CO No.	**CO - Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K- level)**
CO1	acquire knowledge on different types of PLC and basic I/O modules	**K1**
CO2	understand the programming of basic logics	**K2**
CO3	apply programming of basic logics in PLC	**K3**
CO4	analyse basic relay switching circuits in PLC	**K4**
CO5	implement timer and counter based programs in various applications	**K5**
CO6	design a network control system with PLC and SCADA	**K6**

Relationship Matrix

Semester	**Course Code**	**Title of the Course**					**Hours**			**Credits**
2	**23PEL2SP01A**	**Self-paced Learning:** Programmable Logic Controller					**-**			**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	2	3	3	2	2	2	**2.4**
CO2	3	2	3	2	2	3	3	2	2	2	**2.4**
CO3	3	2	3	2	3	2	2	2	2	2	**2.3**
CO4	2	3	2	3	2	3	2	3	2	2	**2.4**
CO5	3	3	2	2	2	2	2	3	2	3	**2.4**
CO6	2	2	2	3	2	2	2	2	3	3	**2.3**
									Mean Overall Score		**2.36 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PEL2SP01B	**Self-paced Learning:** Nanoelectronics	-	2

Course Objectives
To describe the basics of nanoelectronics and devices
To understand the Quantum mechanics fundamentals, nanomaterials and fabrication techniques required to acquire knowledge on nanoelectronics
To apply the electron transition in nano electronic devices, operations and its characteristics
To analyse the inner behavior of electrons in nanomaterials
To evaluate nano structure and develop a new nanomaterial for electronic applications

UNIT I: Quantum Mechanics of Electronics

Introduction to Nano Electronics - Top -Down Approach - Bottom - Up approach General postulates of Quantum Mechanics - Operators for Quantum Mechanics - Eigen values and Eigen functions - Hermitian Operators -Time Independent Schrodinger's Equation - Electrons in a Potential Well

UNIT II: Materials for Nanoelectronics

Semiconductors - Crystal Lattices - Bonding in Crystals - Electron Energy Bands - Direct Band Gap and Indirect Band Gap Semiconductors - Band Structure of Semiconductor Alloys - Semiconductor Heterostructure - Organic Semiconductors -Carbon Nanomaterials.

UNIT III: Growth- and Fabrication for Nanostructures

Bulk Crystal and Heterostructure Growth - Single Crystal Growth - Epitaxial Growth - Molecular Beam Epitaxy - Clusters and Nanocrystals - Methods of Nanotube Growth - Arc-Discharge and Laser Ablation - Chemical Vapor Deposition - Directed Growth of Single Walled Nanotube - Self Assembly of Nanostructures

UNIT IV: Electron transport in Semiconductors

Time and Length Scales of the electrons in solids - Statistics of the electron in solids and Nanostructures - The Density of States of Electrons in Nanostructure - Electron transport in Nanostructures - Electrons in Quantum Well - Electrons in Quantum Wires - Electrons in Quantum Dots.

UNIT V: Nanoelectronics Devices

Resonant-tunneling Diodes - Field-effect Transistor - Single Electron Transistor - Potential-effect Transistor - LEDs and Lasers - Quantum-dot Cellular Automata - Nanoelectromechanical System Devices.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Books for Study

1. Daniel, B. (2012). *Quantum Mechanics: A Modern and Concise Introductory Course (Graduate Texts in Physics)* (3rd Ed.). Springer.
2. Anupama, B. K. (2013). *Microelectronics to Nanoelectronics Materials, Devices & Manufacturability* (1st Ed.). CRC Press, Taylor & Francis Group.
3. Georage, W. H. (2008). *Fundamentals of Nanoelectronics.* Pearson Education.

Unit	Book	Chapter	Sections
I	1		Relevant sections
II	2		Relevant sections
III	2		Relevant sections
IV	3		Relevant sections
V	3		Relevant sections

Books for Reference

1. Raza. (2019). *Nanoelectronics Fundamentals Materials Devices and Systems.* Springer.
2. Singh, K., & Singh, S. P. (2016). *Elements of Quantum Mechanics.* S. Chand & Company Pvt. Ltd.
3. Kar, A. (2017). *Nanoelectronics and Materials Development* (INTECH Ed.).
4. Loutfy, H., & Madkour. (2019). *Nano electronic Materials: Fundamentals and* Applications (1st Ed.). Springer (Advanced Structured Materials Book 116).
5. Robert, P., Livio B., Van de Voorde, M., Sebastiaan, E. & van Nooten. (2017). *Nanoelectronics: Materials, Devices, Applications,* 2 Volumes (Applications of Nanotechnology).
6. Valdimir, V., Mitin-Viatcheslav, A., Kochelap., & Michal, A. S. (2008). *Introduction to Nanoelectronics.* Cambridge University Press.

Websites and eLearning Sources

1. https://www.sciencedirect.com/topics/materials-science/nanoelectronics
2. https://www.nanowerk.com/nanoelectronics.php
3. https://www.azonano.com/article.aspx?ArticleID=6234
4. https://www.azom.com/article.aspx?ArticleID=18333
5. https://www.sigmaaldrich.com/IN/en/applications/materials-science-and-engineering/microelectronics-and-nanoelectronics
6. https://nano.stanford.edu/research/nanoelectronic-devices

(* subject to availability - not to be used for exam purpose)

Course Outcomes		
CO No.	**CO - Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K- level)**
CO1	identify nanoelectronics and devices	**K1**
CO2	explain the Quantum mechanics fundamentals, nanomaterials and fabrication techniques required to acquire knowledge on nanoelectronics	**K2**
CO3	apply the electron transition in nanoelectronics devices, operations and its characteristics	**K3**
CO4	analyze the inner behavior of electrons in nanomaterials	**K4**
CO5	evaluate the nano structure of a material	**K5**
CO6	develop a new nanomaterial for electronic applications	**K6**

Relationship Matrix

Semester	**Course Code**			**Title of the Course**				**Hours**		**Credits**
2	**23PEL2SP01B**			**Self-paced Learning:** Nanoelectronics				**-**		**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**				**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	2	3	2	2	2	2	**2.3**
CO2	3	2	3	2	2	2	3	2	2	2	**2.3**
CO3	3	2	3	2	3	2	2	2	2	2	**2.3**
CO4	2	3	2	3	2	3	2	3	2	1	**2.3**
CO5	3	2	2	2	2	2	2	3	2	3	**2.3**
CO6	2	2	2	3	2	2	2	2	3	3	**2.3**
									Mean Overall Score		**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PEL2SP01C	**Self-paced Learning:** Medical Electronics	-	2

Course Objectives
To recognize bio medical measurement and instruments
To understand bio medical signal measurements and the operations of bio medical instruments
To illustrate the bio medical instrumentation techniques
To categorize bio medical instruments
To compare different bio medical instrumentation techniques and choose the suitable instruments for bio medical needs

UNIT I: Introduction to Bio-Medical Instrumentation

Physiological Systems of Human body- Resting and Action Potential-Basic Medical Instrumentation System-Half Cell Potential- Silver-Silver Chloride Electrodes- Electrodes for ECG- Electrodes for EEG- Electrodes for EMG- Micro Electrodes-Classification of Transducers-Pressure Transducers-Transducers for body temperature measurement Biosensors-Smart sensors

UNIT II: Signal Conditioners and Bio-Medical Recording Systems

Signal Conditioners- Preamplifier- Bridge Amplifiers-Signal recovery and data acquisition-Bio signal Analysis- Electro Cardio Graph- Phono Cardio Graph- Electro Encephalo Graph- Electro Myo Graph-other Bio Medical Recorders

UNIT III: Blood Related Bio-Medical Measurement

Blood Pressure Measurement- Measurement of Heart Rate-Pulse Oximeters- Electromagnetic Blood Flowmeters- Ultrasonic Blood Flowmeters-Spirometry- Blood pH Measurement - Measurement of Blood pCO_2 and Blood pO_2 - Photometers and Colorimeters

UNIT IV: Human Assistive Bio-Medical Devices

Pace Makers- Defibrillators-Cardiac Monitor- Methods of Monitoring Foetal Heart Rate Heart-Lung Machine-Angiography-Pulmonary Function Analyzers- Ventilators-Lithotriptors Haemo -Dialysis Machine- Surgical Diathermy

UNIT V: Advanced Bio-Medical Applications

Bedside Patient Monitoring Systems- Elements of Bio-Telemetry-Design of Bio-Telemetry System-Computers in Medicine- laser in Medicine- Magnetic Resonance Imaging- Computer Tomography-Microwave Diathermy for Electrotherapy-Nerve Stimulators

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Books for Study

1. Khandpur, R. S. (2011). *Handbook of Biomedical Instrumentation* (2nd Ed.). Tata McGraw-Hill. (18th reprint)
2. Arumugam, M. (2011). *Biomedical Instrumentation* (2nd Ed.), Anuradha Publications.

Unit	Book	Chapter	Sections
I	1 2	1,2,31	1.2, 2.3-2.6,2.8,3.2,3.5,3.6,3.9,3.10 1.5,1.6
II	1 2	4,53	4.2,4.3,5.1,5.3-5.6 3.5,3.9,3.10
III	1 2	6,7,10,14,15	6.5,6.7,10.3,14.4,15.2 6.10,6.14,7.5
IV	1 2	6,8,13,315,6,7	6.2,8.2,13.5,31.2,31.3 5.2,5.5,5.7,5.8,6.2,6.8,7.12
V	1 2	2,6,8,9,10,20, 22	6.3,20.1-20.3,22.1-22.4,29.3,29.5,29.6 8.2,8.3,10.2,10.3

Books for Reference

1. Leslie, C. (2007). *Biomedical Instrumentation and Measurement* (2nd Ed.). Prentice Hall of India.
2. Myer, K. (2003). *Standard Handbook of Biomedical Engineering and Design* (1st Ed.).
3. McGraw-Hill.
4. Joseph, J., Carr.,, & John, M. B. (2004). *Introduction to Biomedical Equipment Technology* (4th Ed.). Pearson Education.

Websites and eLearning Sources*

1. https://www.udemy.com/course/electronics-with-applications-on-biomedicalengineering/
2. https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-ray
3. https://doi.org/10.1016/B978-0-323-85413-9.00005-0
4. https://link.springer.com/chapter/10.1007/978-3-540-36841-0_154
5. https://youtu.be/iK-6q4nnmtA

(* subject to availability - not to be used for exam purpose)

Course Outcomes		
CO No.	**CO - Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K- level)**
CO1	remember the Physiological systems and classify the types of electrodes and transducers	**K1**
CO2	interpret various Bio Medical Recorders	**K2**
CO3	categorize Blood related Measurements and Techniques	**K3**
CO4	appraise the performance of Bio Medical Instruments for major organs	**K4**
CO5	assess the need of modern society with professional ethics in Modern Bio Instruments and recommend solutions for the same	**K5**
CO6	plan a Bio Instruments for the need of modern society with professional ethics	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
2	**23PEL2SP01C**			**Self-paced Learning:** Medical Electronics						**-**	**2**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	1	2	1	2	2	1	1	2	3	3	**1.8**
CO2	2	2	2	3	3	1	2	2	3	3	**2.3**
CO3	2	3	3	2	3	1	1	2	3	3	**2.3**
CO4	2	3	2	3	3	2	2	2	3	3	**2.5**
CO5	3	3	2	3	3	2	2	2	3	3	**2.6**
CO6	2	2	2	2	1	2	2	2	1	2	**1.8**
										Mean Overall Score	**2.2 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PEL2ES03A	**Elective - 3:** Electromagnetics and Antenna Design	5	4

Course Objectives
To acquire Knowledge on fundamental concepts of Electro-Magnetic waves
To understand EM waves propagation and antennas
To Illustrate EM wave propagating devices and evaluate the modes of operation
To compare different type of Antennas
To assess and synthesis antennas for various requirements

UNIT I: Introduction to Electromagnetic Wave Theory **(15 Hours)**

Static Electric Field-Electro Magnetic waves- Divergence Theorem- Stroke's Theorem Coulomb's Law-Electric field due to charge distribution- Gauss Law-Equation of continuity Inconsistency of Ampere Law- Boundary conditions for Electric field- Static magnetic field Biot-Savart's Law-Magnetic field intensity due to finite and infinite conductor- Boundary conditions for Magnetic field

UNIT II: EM Wave Equations and Transmission Lines **(15 Hours)**

Maxwell's Equations- Electromagnetic wave equation for free space- EM wave equation for conducting medium-Uniform Plane waves-Poynting Theorem- Transmission Lines-Types of Transmission lines-Transmission line parameters-Properties of Symmetrical Networks Current and Voltage along an infinite line - SWR- Applications of the Smith chart.

UNIT III: Waveguides and Antennas **(15 Hours)**

Introduction to Waveguides- Transverse Electric waves- Transverse Magnetic waves characteristics of TE and TM waves-Transverse Electro-Magnetic waves- velocities of propagation-Introduction to Antenna-Types of Antennas- Radiation Mechanism- Antenna parameters

UNIT IV: Design of Antenna **(15 Hours)**

Design and performance study of finite length Dipole- Halfwave Dipole Antenna- Loop Antenna-Design and study of small Circular Loop Antenna- Folded Dipole Antenna Broadband Antennas- Design of Frequency dependent Log Periodic Antennas-Antenna Array Two Element Array- Design Procedure

UNIT V: Advanced Antenna Design **(15 Hours)**

Aperture Antennas- Design considerations- Horn Antennas- Types of Horn Antennas Microstrip and Mobile Communication Antennas- Reflector Antennas- Smart Antennas-Smart Antenna system design and simulation.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Books for Study

1. Edward, C. J., Keith. G. B. (2002). *Electromagnetic Waves and Radiating Systems* (2nd Ed.). Prentice Hall Of India,15th reprint.
2. Bakshi, U. A., & Bakshi, A. V. (2009). *Electromagnetic waves and Transmission lines* (2nd Ed.). Technical Publications.
3. Constantine, A. B. (2016). *Antenna Theory Analysis and Design* (4th Ed.). Wiley.

Unit	Book	Chapter	Sections
I	1	1,2,3,4	1.01,1.05,2.03,2.05,2.11,3.02,3.03 4.01,4.02, 4.04
II	1 2	4,5,611,12	4.03,5.01-5.05,6.01 11.1,11.2,11.3,11.4,11.7, 12.5,12.11
III	2 3	131,2,9,10,11	13.1-13.71.1-1.3, 2,9.6,10.3,11.4
IV	3	4,5,6	4.5, 4.6, 5.1,5.2,6.1,6.2,6.5
V	3	12,13,14,15,16	12.1,12.7,13.1,13.2,13.3, 14.1-14.4,15.1-15.4,16.1,16.2,16.10,16.11

Books for Reference

1. Dhananjayan, P. (2013). *Electromagnetic Fields.* Laksmi publications.
2. Prasad, K. D. (2009). *Antenna and Wave Propagation* (2nd Ed.) Sathya Prahashan.
3. Ishimaru, A. (2017). *Electromagnetic Wave Propagation, Radiation and Scattering from Fundamentals to Applications,* IEEE press.

Websites and eLearning Sources*

1. https://www.allaboutcircuits.com/textbook/alternating-current/chpt-14/waveguides/
2. https://ocw.mit.edu/courses/8-311-electromagnetic-theory-spring-2004/
3. https://edurev.in/courses/23240_Electromagnetic-Fields-Theory
4. https://examsdaily.in/antenna-pdf-download
5. https://www.sathyabama.ac.in/course-materials/antenna-and-wave-propagation
6. (* subject to availability - not to be used for exam purpose)

Course Outcomes		
CO No.	**CO - Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K- level)**
CO1	acquire knowledge on fundamental concepts of Electro-Magnetic waves	**K1**
CO2	explain EM waves propagation	**K2**
CO3	illustrate EM wave propagating devices and evaluate the modes of operation	**K3**
CO4	compare different type of Antennas	**K4**
CO5	recommend antennas for various requirements	**K5**
CO6	design antennas for various requirements	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
2	**23PEL2ES03A**		**Elective - 3:** Electromagnetics and Antenna Design						**5**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	1	2	1	2	1	1	**1.6**
CO2	1	3	2	3	3	2	3	2	2	2	**2.3**
CO3	2	3	2	2	2	2	3	2	3	3	**2.4**
CO4	2	3	2	3	3	2	3	2	3	3	**2.6**
CO5	1	3	2	3	3	2	3	2	3	3	**2.5**
CO6	1	2	2	3	1	3	3	3	2	3	**2.3**
										Mean Overall Score	**2.3 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PEL2ES03B	**Elective - 3:** Power Electronics and Solar PV Systems	5	4

Course Objectives
To identify suitable semiconductor devices for power control applications
To understand the working of high-power rectifiers and solar power systems
To calculate the energy requirement for the system requirements
To evaluate different power handling devices
To decide and develop a solar power system for the needs and become an entrepreneur

UNIT I: Power Semiconductor Devices **(15 Hours)**

Introduction - Difference between linear and power devices - Power diodes - types - series connected and parallel connected diodes - BJT - steady state characteristics - switching characteristics - Power MOSFET-characteristics - COOLMOS - SIT - IGBTs, -switching characteristics - Thyristors - control characteristics - Advanced Silicon devices - Silicon HV thyristors, MCT, BRT & EST- SiC devices - diodes, thyristors, JFETs & IGBTs- Gallium nitrate devices - Diodes, MOSFETs.

UNIT II: Rectifiers and DC-DC Converters **(15 Hours)**

Single phase half - wave rectifiers - single phase full - wave rectifiers with RL load- -three phase bridge rectifiers- DC-DC converters- step-down operation- Generation of duty cycle - with RL load - Principle of step-up operation -with resistive load - performance parameters - converter classification - switching mode regulators buck regulators - boost regulators - Buck boost regulators - comparison of regulators - chopper circuit design

UNIT III: Inverters and Charge Controllers **(15 Hours)**

Full bridge converter - square wave inverter - Fourier series analysis -harmonic distortion - amplitude and harmonic control - half bridge inverter -multilevel inverters - PWM inverters - PWM harmonics - three phase inverters- induction motor speed control - PWM charge controller.

UNIT IV: Solar PV Systems and PSIM Programming **(15 Hours)**

Photovoltaic systems overview - electricity generation with PV cells - Basic of Solar PV systems -blocks of solar PV system - PV modules - solar array (roof top panel connection) - function of inverter - energy storage - charge controllers - calculation of solar panel - battery - types of battery - MPPT -MPPT algorithm - MPPT charge controller. grids. PSIM- Introduction -programming - power computation - instantaneous power - energy and average power - inductors and capacitors - RMS values of sinusoids - apparent power and power factor - Fourier analysis.

UNIT V: Smart Grids **(15 Hours)**

Definitions and Need for Smart Grid - Smart grid drivers - Functions -opportunities - Challenges and benefits - Difference between conventional& smart Grid - Concept of Resilient &Self-Healing Grid - off grid and on-grid - Introduction to Smart Meters - Advanced Metering infrastructure (AMI) drivers and benefits- Phasor Measurement Unit-(PMU) - Intelligent Electronic Devices (IED) &their application for monitoring & protection.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Books for Study

1. Muhammad, H. R (2009). *Power electronics,* (3rd Ed.). Pearson.
2. Smets, A.H., Jäger, K., Isabella, O., Swaaij, R.A. & Zeman, M. (2015). *Solar Energy: The physics and engineering of photovoltaic conversion, technologies and systems*, UIT Cambridge. (2017), *PSIM User Manual*.
3. Stuart, B. (2012), *Smart Grid: Infrastructure Technology and Solutions*, CRC Press.

Unit	Book	Chapter	Sections
I	1	1	1.1, 2.1-2.4,2.6, 3.1-3.5, 4.4, 5.2-5.4, 6.1- 6.4,6.6,8.1,8.2, 9.8, lecture notes
II	1	11,12,13	11.2, 12.2.4, 13.1-13.5
III	1	15,17	15.2,15.3,15.7, 17.2,17.3
IV	2 3	1, 3, 12,13,15, 17,19, 20,2,4,8	1.3,3, 3, 12.2,13.3, 15.1-15.4, 17.1-17.3, 19.1-19.4, 20.1,20.22.1, 4.1.1-4.1.3, 8.1.3, 8.1.4
V	4	2,3	2.1,2.2, 2.4.4,2.4.5, 3.1,3.3.1, 3.10.1-3.10.3, lecture notes

Books for Reference

1. Ned, M. (2003). *First Course on Power Electronics and Drives* (1st Ed.). MNPERE.
2. Robert, W. E., & Dragan, M. (2004). *Fundamentals of Power Electronics*, (2nd Ed.). Kluwer Academic Publisher.
3. Parimita, M. Tariq, M., & Mohan, K. (2016). *Solar Photovoltaic System Applications*. Springer International Publishing, Switzerland.

Websites and eLearning Sources*

1. https://www.tutorialspoint.com/power_electronics/index.htm
2. https://www.electrical4u.com/concept-of-power-electronics/
3. https://electronicscoach.com/power-electronics.html
4. https://www.energy.gov/eere/solar/solar-photovoltaic-technology-basics
5. http://www.ews-solarpower.co.uk/24-how-does-the-system-work

(* subject to availability - not to be used for exam purpose)

Course Outcomes		
CO No.	**CO - Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K- level)**
CO1	identify suitable semiconductor devices for power control applications	**K1**
CO2	illustrate the working of high-power rectifiers and solar power systems	**K2**
CO3	calculate the energy requirement for the system requirements	**K3**
CO4	evaluate different power handling devices	**K4**
CO5	recommend a solar power system for a requirement and become an entrepreneur	**K5**
CO6	plan a solar power system for a specific need	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**						**Hours**		**Credits**
2	**23PEL2ES03B**		**Elective - 3:** Power Electronics and Solar PV Systems						**5**		**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	3	3	3	3	3	2	2	**2.5**
CO2	3	3	2	2	3	2	2	3	2	1	**2.3**
CO3	1	2	3	2	3	1	3	3	3	2	**2.3**
CO4	3	2	2	2	3	3	2	3	2	3	**2.5**
CO5	3	3	3	2	1	3	2	3	2	3	**2.5**
CO6	3	3	3	2	2	2	2	2	3	1	**2.3**
										Mean Overall Score	**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
2	23PSS2SE01	**Skill Enhancement Course:** Soft Skills	4	3

Course Objectives
To provide a focused training on soft skills for students in colleges for better job prospects
To communicate effectively and professionally
To help the students take active part in group dynamics
To familiarize students with numeracy skills for quick problem solving
To make the students appraise themselves and assess others

UNIT I: Effective Communication & Professional Communication (12 Hours)

Definition of communication, Barriers of Communication, Non-verbal Communication; Effective Communication - Conversation Techniques, Good manners and Etiquettes; Speech Preparations & Presentations; Professional Communication.

UNIT II: Resume Writing & Interview Skills (12 Hours)

Resume Writing: What is a résumé? Types of résumés, - Chronological, Functional and Mixed Resume, Purpose and Structure of a Resume, Model Resume.

Interview Skills: Types of Interviews, Preparation for an interview, Attire, Body Language, Common interview questions, Mock interviews & Practicum

UNIT III: Group Discussion & Personal effectiveness (12 Hours)

Basics of Group Discussion, Parameters of GD, Topics for Practice, Mock GD & Practicum & Team Building.

Personal Effectiveness: Self Discovery; Goal Setting with questionnaires & Exercises

UNIT IV: Numerical Ability (12 Hours)

Introducing concepts Average, Percentage; Profit and Loss, Simple Interest, Compound Interest; Time and Work, Pipes and Cisterns.

UNIT V: Test of Reasoning (12 Hours)

Introducing Verbal Reasoning: Series Completion, Analogy; Data Sufficiency, Assertion and Reasoning; and Logical Deduction. Non-Verbal Reasoning: Series; and Classification

Teaching Methodology	Chalk and talk, Lectures, Demonstrations, PPT.

Book for Study

1. Melchias G., Balaiah, J. & Joy, J. L. (Eds). (2018). *Winner in the Making: A Primer on soft Skills.* Trichy, India: St. Joseph's College.

Books for Reference

1. Aggarwal, R. S. (2010). *A Modern Approach to Verbal and Non-Verbal Reasoning.* S. Chand.
2. Covey, S. (2004). *7 Habits of Highly effective people.* Free Press.
3. Gerard, E. (1994). *The Skilled Helper* (5th Ed.). Brooks/Cole.
4. Khera, S. (2003). *You Can Win.* Macmillan Books.
5. Murphy, R. (1998). *Essential English Grammar,* (2nd Ed.). Cambridge University Press.
6. Sankaran, K., & Kumar, M. (2010). *Group Discussion and Public Speaking* (5th Ed.). M.I. Publications.
7. Trishna, K. S. (2012). *How to do well in GDs & Interview*s? (3rd Ed.). Pearson Education.
8. Yate, M. (2005). *Hiring the Best: A Manager's Guide to Effective Interviewing and Recruiting*

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K - Level)**
CO1	recall various soft skill sets	**K1**
CO2	understand personal effectiveness in any managerial positions	**K2**
CO3	apply verbal and non-verbal reasoning skills to solve problems	**K3**
CO4	differentiate problems at work and home; and design solutions to maintain work-life balance	**K4**
CO5	assess growth and sustainability and infuse creativity in employment that increases professional productivity	**K5**
CO6	construct plans and strategies to work for better human society	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**					**Hours**		**Credits**
2	**23PSS2SE01**			**Skill Enhancement Course:** Soft Skills					**4**		**3**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	3	2	3	2	3	2	3	**2.7**
CO2	3	3	3	2	3	3	3	3	3	3	**2.9**
CO3	3	2	2	3	3	3	3	3	3	3	**2.8**
CO4	3	3	2	2	3	3	3	3	3	3	**2.8**
CO5	3	3	3	2	2	3	3	3	3	3	**2.8**
CO6	3	3	3	2	2	3	3	3	3	3	**2.8**
										Mean Overall Score	**2.8 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PEL3CC05	**Core Course - 5:** VLSI Design and VERILOG Programming	4	4

Course Objectives
To familiarize with different Semiconductor Devices used in VLSI
To enrich the knowledge on low power VLSI technology and Verilog programming.
To apply the fundamental concepts of FPGA for various applications
To explore various idea about Scaling Factors and Testing Supply Voltage Scaling for Low Power.
To design and build simple circuits, simulate using Xilinx IDE and testing digital circuits using Verilog AMS

UNIT I: Low Power VLSI Technology **(12 Hours)**

Introduction - Low-Power Design Methodologies - MOS Fabrication Technology - Basic Fabrication Processes - NMOS Fabrication Steps- CMOS Fabrication Steps- Latch-Up Problem and Its Prevention- Short-Channel Effects - Design rules and layout diagram - Lambda based design rules.

UNIT II: MOS Transistors and Inverters **(12 Hours)**

Introduction- MOS Transistors- the Structure of MOS Transistors- The Fluid Model- Modes of Operation of MOS Transistors-Electrical Characteristics of MOS Transistors- MOS Transistors as a Switch -MOS Inverters- Inverter and Its Characteristics- MOS Inverter Configurations- Switching Characteristics- Delay Parameters- Driving Large Capacitive Loads.

UNIT III: Supply Voltage Scaling for Low Power **(12 Hours)**

Introduction- Device Feature Size Scaling- Architectural-Level Approaches- Voltage Scaling Using High-Level Transformations - Multilevel Voltage Scaling- Challenges in MVS Dynamic Voltage and Frequency Scaling- Adaptive Voltage Scaling- Subthreshold Logic Circuits

UNIT IV: Basic Concepts of FPGA **(12 Hours)**

INTRODUCTION TO FPGAs: Evolution of programmable devices- FPGA Design flow Applications of FPGA - FPGA boards and Software tools - FPGA building blocks -digital system Design Examples: Design of Universal block - Memory- Floating point multiplier Barrel shifter.

UNIT V: Circuit Design and Simulation Using VIVADO Design Suite **(12 Hours)**

Xilinx - Vivado Design Suite - Verilog: Verilog fundamental -Design Flows & EDA Tools Code Structure- Data types -Operators and Attributes- overloading -Concurrent Code: Concurrent versus Sequential- Using Operators- WHEN, Generate and Block- Sequential Code: Process- Signals and Variables - IF, WAIT- CASE -Using Sequential- Code to Design Combinational Circuits. System Verilog: Verilog + - Coverage - Randomization - Assertion functional coverage- Object oriented programming, define - parameter-Verilog-AMS: Verilog Family of Languages-Mixed Signal Simulators- Applications of Verilog-AMS- Analog Modeling

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials.

Books for Study

1. Pal, A. (2015). *Low-Power VLSI Circuits and Systems*.
2. Palnitkar, S. (2003). *Verilog HDL*, (2nd Ed.). Pearson Education.

Unit	Book	Chapter	Sections
I	1	1, 2	All
II	1	3, 4	All
III	1	7	All
IV	2	1, 2, 3	All
V	2	8	All

Books for Reference

1. Peter Van Zant. (1997). *Microchip fabrication*. McGraw Hill.
2. Plummer, J. D., Deal, M. D. & Griffin, P. B. (2000). *Silicon VLSI Technology: Fundamentals*, (3rd Ed.). Practice and Modeling.
3. Justin Rajewski. (2017). *Leaning FPGAs*, (1st Ed.). O'Reilly Media. Inc.

Websites and eLearning Sources

1. https://www.tutorialspoint.com/vlsi_design/index.htm
2. http://www.eeherald.com/section/design-guide/Low-Power-VLSI-Design.html
3. https://www.nandland.com/articles/fpga-101-fpgas-for-beginners.html
4. https://docs.xilinx.com/v/u/hvSo8dqbS1aQfQu8EocbwA
5. https://www.electronicshub.org/introduction-to-fpga/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	identify various Semiconductor Devices used in VLSI	**K1**
CO2	understand the basics of low power VLSI technology and Verilog programming	**K2**
CO3	apply the basic concepts of FPGA for different applications	**K3**
CO4	analyse Scaling Factors and Testing Supply Voltage Scaling for Low Power.	**K4**
CO5	test various digital circuits using Verilog AMS	**K5**
CO6	develop circuits and simulate using Xilinx IDE using Verilog AMS	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
3	**23PEL3CC05**	**Core Course - 5:** VLSI Design and VERILOG Programming								**4**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	2	2	2	2	2	2	**2.0**
CO2	2	2	2	2	2	2	2	2	2	3	**2.1**
CO3	2	3	3	2	2	2	2	3	2	2	**2.3**
CO4	2	2	2	3	3	2	2	3	3	3	**2.5**
CO5	2	3	2	3	3	3	2	3	3	3	**2.7**
CO6	2	2	3	3	2	3	2	3	2	2	**2.4**
										Mean Overall Score	**2.33 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PEL3CC06	**Core Course - 6:** Electronic Instrumentation and Virtual Instrumentation	5	5

Course Objectives
To explain basic concepts and definitions in measurement and describe the bridge configurations and their applications.
To elaborate discussion about the importance of signal generators and analysers in Measurement.
To provide knowledge on design of process control by using virtual instrumentation techniques.
To provide knowledge in process analysis by VI tools.
To give basic knowledge in describing function analysis and to get adequate knowledge VI tool sets.

UNIT I: Introduction to Instrumentation (15 Hours)

Introduction- Functions and Characteristics of instruments- Electrical Units -Measurement Standards- Error in Measurement- Statistical Analysis of Error in Measurement -Limiting Errors-Elements of Electronic Instruments-Selection ‹Care, and Use of Instruments- Static and Dynamic Characteristics of Instrumentation.

UNIT II: Bridges and Basic Electronic Instruments (15 Hours)

Bridge circuits - D.C. bridge (Wheatstone bridge) -Deflection-type D.C. bridge-Error analysis -A.C. bridges- Transistors Voltmeters (TVM)-Dual Slope Integrating type DVM -Ammeter - Multimeter - Resistance measurement: D.C. bridge circuit -Voltmeter-ammeter method - Resistance-substitution method- Use of the digital voltmeter to measure resistance -The ohmmeter - Inductance measurement- Capacitance measurement - Current measurement Cathode ray oscilloscope -Frequency measurement- Phase-locked loop - The Wien bridge Phase measurement.

UNIT III: Digital Instruments (15 Hours)

Digital Storage Oscilloscope- Vector Scope-Digital Phase meter- Digital capacitance meter Digital pH meter- Microprocessor based instruments-Function Generators- Spectrum Analyzer- Single channel and multichannel Data Acquisition Systems- Data Loggers environmental Monitoring Systems: Water quality and Air quality Measurement Systems Pollution Monitoring.

UNIT IV: Virtual Instrumentation (15 Hours)

Introduction- Graphical system design (GSD) model - Design flow with GSD -Virtual instrumentation - Virtual instrument and traditional instrument- Hardware and Software in virtual instrumentation- Virtual instrumentation for test, control and design -Virtual instrumentation in the engineering process- Virtual Instruments Beyond Personal Computer Graphical System Design Using LabVIEW -Graphical Programming And Textual Programming- Software Environment- Creating and Saving a VI-Front Panel Toolbar- Block Diagram-Data Types- Data Flow Program.

UNIT V: Modular Programming and Motor Control on LabVIEW (15 Hours)

Introduction-Modular Programming in LABVIEW -Icon and Connector Panel-Creating an Icon - Building A Connector Panel- Displaying Sub VI s And Express VIs as Icons or Expandable Nodes- Creating SubVI from Sections of A VI- Opening and Editing Sub VIs - Placing SubVIs on Block Diagrams- Saving SubVIs-Creating A Stand-Alone Application Components of a Motion Control System - Software for Configuration, Prototyping and Development - Motion Controller- Move Types- Motor Amplifiers and Drives.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials.

Books for Study

1. Larry, D. J. *Electronic Instruments and Measurements,* (2nd Ed.). Prentice-Hall International Ed.
2. Alan, S. M. (2001). *Measurement and Instrumentation Principles,* (3rd Ed.).
3. Kalsi, H.S. (2006). *Electronic Instrumentation,* (2nd Ed.). (Sixth reprint). McGraw hill Companies.
4. Jerome, J. (2010). *Virtual Instrumentation using LabVIEW*. PHI Learning PVT. Limited.

Unit	Book	Chapter	Sections
I	1	1	1.1-1.10
II	2	7	7.1 to 7.7
III	3	6, 9, 17	6.10, 6.14, 8.8, 9.6, 17.4, 17.5, 17.8.
IV	4	1,2	1.1 to 1.11, 2.1 to 2.15
V	4	3	3.1 to 3.12

Books for Reference

1. Gregory, B. A. (1981). *An introduction to Electrical Instrumentation and measurement System,* (2nd Ed.). Palgrave HE UK.
2. Alan, S. M., & Reza Langari. (2012). *Measurement and Instrumentation Theory and Application*. Elseiver.
3. Travis, J., & Kring, J. (2007). *LabVIEW for Everyone*. Prentice Hall Edition.

Websites and eLearning Sources

1. https://ocw.tudelft.nl/wpcontent/uploads/Reader_ET8017_Electronic_Instrumentation__Chapter1.pdf
2. https://www.tutorialspoint.com/electronic_measuring_instruments/index.htm
3. https://www.electronics-notes.com/articles/test-methods/labview/vis-virtual-instruments.php
4. https://mindmajix.com/labview-tutorial
5. https://www.ni.com/getting-started/labview-basics/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	understand the errors in measurement and characteristics of instrumentation, used to solve the problems in instruments.	**K1**
CO2	distinguish an AC and DC bridges and apply the same in various basic electronic instruments for real time problems	**K2**
CO3	create the program by applying SubVIs and empower to integrate real-world signals for earlier error detection.	**K3**
CO4	analyze the principles of virtual instrumentation	**K4**
CO5	evaluate the virtual instrumentation for various industrial applications	**K5**
CO6	develop and analyze modern and digital instruments for laboratorial, clinical and environmental applications	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
3	**23PEL3CC06**	**Core Course - 6:** Electronic Instrumentation and Virtual Instrumentation								**5**	**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	2	3	3	2	2	2	**2.4**
CO2	3	2	3	2	2	2	2	3	3	2	**2.4**
CO3	2	2	3	3	2	2	2	2	3	2	**2.3**
CO4	3	2	2	2	2	2	2	3	3	3	**2.4**
CO5	3	2	2	3	3	3	2	2	2	3	**2.5**
CO6	3	3	3	2	2	2	3	3	2	2	**2.3**
										Mean Overall Score	**2.38 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PEL3CC07	**Core Course - 7:** Internet of Things with Single Board Computer	4	4

Course Objectives
To describe IoT and IIoT
To understand the concepts of IoT and IIoT
To apply IoT techniques in real time applications using single board computer
To analyse the working of IoT devices
To evaluate and design IoT and IIoT systems for a specific need

UNIT I: IoT Basics **(12 Hours)**

Introduction - Architectures- Wireless Networks-- Devices-Security and Privacy-Event-Driven Systems - IoT System Architectures: Protocols Concepts - IoT - Oriented Protocols -Databases - Time Bases-Security - IoT Devices: The IoT Device Design Space-Cost of Ownership and Power Consumption - Cost per Transistor and Chip Size - Duty Cycle and Power Consumption - Platform Design

UNIT II: IoT Network Model **(12 Hours)**

Event-Driven System Analysis: Introduction -IoT Network Model-Events-Networks-Devices and Hubs-Single-Hub Networks-Multi-hub Networks-Network Models and Physical Networks-IoT Event Analysis: Event Populations-Stochastic Event - Environmental Interaction Modeling-Event Transport and Migration

UNIT III: IIoT and Security and Safety **(12 Hours)**

Industrial Internet of Things: Industry 4.0-Industrial Internet of Things (IIoT) - IIoT Architecture-Basic Technologies-Applications and Challenges-Security and Safety: Systems Security-Network Security-Generic Application Security-Application Process Security and Safety-Reliable, Secure design IoT Applications-Run Time Monitoring- ARMET Approach Privacy and Dependability-Security Testing IoT Systems.

UNIT IV: Introduction to Single Board Computer **(12 Hours)**

Introduction - Architecture - applications - Overview on Raspberry Pi - GPIO - Comparison of different Raspberry Pi boards-shields - overview of Beagle bone - features - NVIDIA Jetson Nano Special Features - NVIDIA Jetson Xavier nx - special features.

Installing and preparing Raspberry Pi - flashing SD Card - Booting up - Configuring Pi - Troubleshooting - Using Command Line interface - root user commands - configuring network connection - remote desktop access using Putty software- Raspberry Pi4 Architecture Specifications

UNIT V: Hardware Interface with Raspberry Pi **(12 Hours)**

Installing RPI. GPIO- setting up I2C and SPI- Connecting and controlling LED-Switching a high-power DC device using a Transistor-making a user interface to turn ON and OFF a device controlling servo motors-controlling the speed of DC motor-using resistive sensors with Raspberry Pi.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials

Books for Study

1. Serpanos, D. *Internet-of-Things (IoT) Systems, Architectures, Algorithms, Methodologies.* Springer International Publishing.
2. Material prepared by department.
3. Monk, S. (2014). *Raspberry Pi cookbook*. O'Reilly Media Inc.

Unit	Book	Chapter	Sections
I	1	1, 2, 3	All
II	1	4	All
III	1	5, 6	All
IV	2		All
V	3	8, 9, 10, 12	8.3,8.4,8.6, 9.1,9.2, 9.4,9.7, 10.1,10.3, 12.1

Books for Reference

1. Tripathy, B. K., & Anuradha, J. *Internet of Things (IoT) Technologies, Applications, Challenges, and Solutions.* Taylor & Francis Group.
2. Constandinos, X., Mastorakis, M.G., & Batalla, J.M. (2016). *Internet of Things (IoT) in 5G Mobile Technologies.* Springer International Publishing.
3. Mukherjee, A., & Roy, A. (2022). *Introduction to IoT,* (1st Ed.). Cambridge University Press.

Websites and eLearning Sources

1. https://www.oracle.com/in/internet-of-things/what-is
2. iot/#:~:text=The%20Internet%20of%20Things%20(IoT)%20describes%20the%20network%20of
3. 20physical,and%20systems%20over%20the%20internet.
4. https://www.techtarget.com/whatis/feature/IoT-basics-A-guide-for-beginners
5. https://www.javatpoint.com/iot-internet-of-things
6. https://www.iberdrola.com/innovation/what-is-iiot#:~:text=The%20Industrial%20Internet%20of%20Things%20(IIoT)%20is%20the%20collection%20of,the%20internet%20to%20industrial%20applications.
7. https://www.raspberrypi.org/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	recall and describe IoT and IIoT	**K1**
CO2	understand the concepts of IoT and IIoT	**K2**
CO3	apply IoT techniques in real time applications using single board computer	**K3**
CO4	analyze the working of IoT devices	**K4**
CO5	evaluate IoT and IIoT systems in applications	**K5**
CO6	design IoT and IIoT systems for a specific need	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
3	**23PEL3CC07**	**Core Course - 7:** Internet of Things with Single Board Computer								**4**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	2	2	3	3	2	2	**2.4**
CO2	2	2	3	2	3	2	2	3	2	2	**2.3**
CO3	2	3	2	2	2	2	2	2	3	3	**2.3**
CO4	2	2	2	2	3	2	2	2	3	2	**2.2**
CO5	2	3	3	2	3	2	2	3	2	2	**2.4**
CO6	2	3	3	2	3	2	3	3	2	2	**2.5**
										Mean Overall Score	**2.25(High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23PEL3CP03	**Core Practical - 3:** Microcontroller Interfacing and FPGA	8	6

Any 16 Experiments

1. I/O programming in Arduino board
2. Design of data logger using Arduino and microSD card for temperature measurement.
3. ESP 8266 -01 interfacing with Arduino
4. ADXL335 interfacing with Arduino.
5. Bluetooth module interfacing with Arduino.
6. GSM and GPS module interfacing with Arduino.
7. Multiplexer and demultiplexer with Quartus II
8. Developing Data Visualization Interfaces in Python with Dash
9. Adder subtractor with Quartus II
10. Study of loading OS and GPIO (DHT11) with Raspberry Pi
11. Web hosting with Raspberry Pi
12. GLCD interfacing with Arduino
13. PCF8591 interfacing with Raspberry Pi for ADC and DAC study.
14. Node MCU for IoT node configuration (4 nodes)
15. Machine Vision: Recognizing objects and scenes using Python
16. Pick and place robot
17. Developing MUX and DEMUX and verifying the same in Vivado IDE
18. Implementing Full adder, Full subtractor, Multiplexer, divider and ALU in FPGA
19. Implementing Decoder, priority encoder, 8-bit comparator and 8-bit latch in FPGA
20. Implementing D flip-flop with synchronous and asynchronous inputs,4-bit up / down
21. Counter with control input in FPGA (clock source to be switch)
22. Implementing clock divider, pulse counter (for delay program) shift registers and barrel
23. shifter in FPGA
24. Interfacing FPGA with PC through DB9 by implementing UART
25. Interfacing keypad with FPGA.
26. Interfacing LCD with FPGA.
27. Study of different types of network cables and Connections
28. OS installation, server command and network configuration
29. Data analysis - LabView
30. ADC, DAC, RTC and PWM - STM32F103
31. Interrupt and Timer in LPC2148 - Stratify OS
32. Design of computer network - LAN
33. Multi-function gates - Verilog
34. Design of encoder and decoder in Verilog
35. Testbench for multiplexer and demultiplexer in Verilog.
36. Design of PH meter
37. Data logger for environment monitoring
38. Pollution monitoring

Semester	Course Code	Title of the Course	Hours/Week	Credits
3	23SPS3CC01	**Common Core:** Materials Science	5	4

Course Objectives
To know the basic concepts in materials science and characterization of materials
To understand the structure and properties of various materials and the working of characterization techniques.
To choose materials based on characterization of properties for appropriate applications
To analyze and evaluate various properties of materials
To develop and suggest materials design for practical problems and applications.

UNIT I: Metal Alloys **(15 Hours)**

Elastic deformation- Stress-Strain Behavior- Anelasticity- Elastic properties- tensile properties- Hardness- Mechanism of strengthening in metals- Binary Phase diagrams- Phase transformation- microstructural and property changes in Iron-carbon alloy- types of metal alloys- fabrication - thermal processing of metals- Applications

UNIT II: Ceramics **(15 Hours)**

Ceramic structure- crystal structure-silicate ceramics- Carbon-Ceramic Phase diagrams-mechanical properties- Stress-Strain Behavior -mechanics of Plastic deformation- types of ceramic-fabrication and processing of ceramics- glasses and glass-ceramics- clay- powder pressing-tape casting- 3D printing- Applications of ceramics

UNIT III: Polymers Science **(15 Hours)**

Introduction to polymers- monomers- polymerization- types of polymerizations methods- Addition polymerization and condensation polymerization - Thermoplastics and thermos settings- classification of polymers - properties of polymers - molecular weight- viscosity-mechanical property - molecular weight relationships - number average and weight average molecular weight - optical property-Glass transition temperature - Applications of polymers.

UNIT IV: Material Characterization **(15 Hours)**

Principle and Instrumentation: X Ray Photoelectron spectroscopy and Auger Electron spectroscopy- - Scanning Tunneling Microscopy and Atomic Force Spectroscopy- X Ray Diffraction- Transmission Electron Microscopy- Scanning Electron Microscopy - Infrared Spectroscopy and UV/ Vis Spectroscopy -Macro and Micro Thermal Analyses

UNIT V: Smart Materials **(15 Hours)**

Overview of Smart Materials - Structures and Products Technologies - Electrical properties - Piezoelectric Materials - Electro strictive Materials - Magneto strictive Materials - Magneto electric Materials - Magnetorheological Fluids - Electrorheological Fluids - Shape Memory Materials - Fiber-Optic Sensors - Smart Sensors: Accelerometers - Force Sensors - Load Cells - Torque Sensors - Pressure Sensors - Microphones - Impact Hammers - MEMS Sensors - Sensor Arrays Smart Actuators - Displacement Actuators - Force Actuators - Power Actuators - Vibration Dampers - Ultrasonic Transducers.

Teaching Methodology	Lectures, Demonstrations, Presentations and Videos.

Books for Study

1. Callister, Jr. W. D., & Rethwisch, D.G. (2018). *Materials Science and Engineering an Introduction*, (10th Ed.). Wiley.
2. Zhang, S., Li L., & Kumar, A. (2008). *Materials Characterization Techniques*. CRC Press.

3. Gowariker, V. R., Viswanathan, N. V., & Sreedhar, J. (2005). *Polymer Science*. New Age International (P) Ltd.
4. Gandhi, M. V., & Thompson, B. S. (1992). *Smart Materials and Structures*. Chapman & Hall.

Unit	Book	Chapters	Sections
I	1	6, 7, 9, 10, 11	6.3-6.10, 7.8-7.10, 9.7, 10.2-10.9, 11.1-11.10
II	1	12, 13	12.2-12.10, 13.2-13.10,13.11-13.15
III	2	1,2,3 &6	1.1-1.4, 2.1 - 2.5, 3.1 - 3.7, 6.1 - 6.10
IV	3	3,4,5,7,9 & 10	3.3,3.4,4.2,4.3,5.1 -5.6 ,7.1,7.2,7.2,9.1.4,9.2,10.1,10.3
V	4	1,2,13	1.1-1.10,2.1-2.12,13.8 - 13.15

Books for Reference

1. Billmeyer, F.W. (1994). *Textbook of polymer science,* (3rd Ed.). John Wiley.
2. Lee, J. D. (2008). *Concise Inorganic chemistry*, (5th Ed.). Wiley Blackwell publications.
3. Sze, S. M. (2007). *Physics of Semiconductor Devices*. Wiley-Inter science.

Websites and eLearning Sources

1. https://www.britannica.com/technology/materialsscience#:~:text=materials%20science%2C%20the%20study%20of,a%20material's%20composition%20and%20structure.
2. https://www.annualreviews.org/doi/pdf/10.1146/annurev.ms.24.080194.000245#:~:text=This%20is%20the%20same%20set,composition%2C%20properties%2C%20and%20performance.
3. https://www.coursera.org/learn/materials-science

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	know the various types of materials, their applications and characterization techniques	**K1**
CO2	understand the structure and properties of various materials and the working of various characterization methods	**K2**
CO3	identify and choose materials based on properties characterized by various methods	**K3**
CO4	analyze and investigate the properties and characteristics of materials using various techniques	**K4**
CO5	evaluate and interpret the features of the materials for appropriate applications	**K5**
CO6	develop and modify materials design to address various problems	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**				**Hours**			**Credits**
3	**23SPS3CC01**			**Common Core:** Materials Science				**5**			**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	2	2	3	2	3	2	3	2	1	**2.3**
CO2	2	3	2	2	3	3	2	2	2	1	**2.2**
CO3	3	3	2	3	3	2	3	2	2	1	**2.4**
CO4	3	2	2	3	3	2	2	3	2	1	**2.3**
CO5	3	3	2	2	2	2	2	2	2	1	**2.1**
CO6	2	2	2	2	3	3	2	3	2	1	**2.2**
										Mean Overall Score	**2.25 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PEL4CC08	**Core Course - 8:** Artificial Intelligence	5	5

Course Objectives
To observe AI and Machine Learning Basics
To understand AI logics and types of Machine learning and its applications
To solve problems using AI
To analyse deep learning and neural networks
To evaluate AI applications and create AI solutions

UNIT I: AI Logic **(15 Hours)**

Introduction - Propositional Logic - First-order Predicate Logic - Limitations of Logic

UNIT II: Search, Games and Problem Solving **(15 Hours)**

Uninformed Search - Heuristic Search - Games with Opponents - Heuristic Evaluation Functions - State of the Art - Problems

UNIT III: Reasoning with Uncertainty **(15 Hours)**

Computing with Probabilities - Principle of Maximum Entropy - LEXMED, an Expert System for Diagnosing Appendicitis - Reasoning with Bayesian Networks

UNIT IV: Machine Learning and Data Mining **(15 Hours)**

Data Analysis - Perceptron, a Linear Classifier - Nearest Neighbor Method - Decision Tree Learning - Learning of Bayesian Networks - Naive Bayes Classifier - Clustering - Data Mining in Practice

UNIT V: Neural Networks **(15 Hours)**

From Biology to Simulation - Hopfield Networks - Neural Associative Memory - Linear Networks with Minimal Errors - Backpropagation Algorithm - Applications

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials.

Book for Study

1. Ertel, W. (2011). *Introduction to Artificial Intelligence*, Springer-Verlag.

Unit	Book	Chapter	Sections
I	1	1	All
II	1	2	All
III	1	4, 5	All
IV	1	10, 11	All
V	1	17, 18	All

Book for Reference

1. Russell, S., & Norvig, P. (2016). *Artificial Intelligence a Modern Approach*, (3rd Ed.). Pearson Education Limited.

Websites and eLearning Sources

1. https://www.simplilearn.com/tutorials/artificial-intelligence-tutorial/what-is-artificial-intelligence
2. https://www.ibm.com/topics/artificial-intelligence
3. https://builtin.com/artificial-intelligence
4. https://cloud.google.com/learn/what-is-artificial-intelligence
5. https://www.oracle.com/in/artificial-intelligence/what-is-ai/
6. https://www.mygreatlearning.com/blog/what-is-artificial-intelligence/

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	describe Artificial Intelligence in various stages	**K1**
CO2	express AI and machine learning	**K2**
CO3	apply various machine learning for data analytic	**K3**
CO4	analyse deep learning and neural networks to find the accuracy of the system design	**K4**
CO5	recommend AI solutions to a social need	**K5**
CO6	collect data and to develop an AI system	**K6**

Relationship Matrix											
Semester	**Course Code**			**Title of the Course**						**Hours**	**Credits**
4	**23PEL4CC08**			**Core Course - 8:** Artificial Intelligence						**5**	**5**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	3	2	2	3	2	2	2	2	**2.3**
CO2	2	3	3	3	2	3	2	2	2	2	**2.4**
CO3	2	3	3	3	2	3	2	2	3	2	**2.5**
CO4	2	3	3	3	2	2	2	2	3	3	**2.5**
CO5	3	2	3	2	2	3	2	2	2	2	**2.3**
CO6	3	1	3	2	3	2	3	3	2	2	**2.4**
Mean Overall Score											**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PEL4CP04	**Core Practical - 4:** Internet of Things and Artificial Intelligence	8	6

Any 16 Experiments

1. PID algorithm implementation for temperature control
2. Thermal printer interfacing with microcontroller
3. Study of Heart beat sensor and interfacing with microcontroller.
4. ICM105A VGA CMOS sensor
5. MPU 6050 IMU Sensor interfacing with microcontroller
6. AC bridge for signal conditioning
7. Design of Smart lighting system
8. Battery management system - RTOS
9. RTOS- Arduino (Blink-AnalogRead, IntegerQueue, StructQueue and Interrupts)
10. IOT - warning light connected to an MQTT server
11. IOT - design of WiFi gateway
12. Fiber optic characteristics
13. Data communication
14. Design and analysis of MAC protocol
15. Optical communication - 1
16. Data encryption and decryption using microcontroller.
17. Text and sound data transfer - LASER
18. Brushless motor interfacing with microcontroller
19. Design of RPM counter
20. Design of accelerometer and application
21. Wireless data transfer.
22. RF communication for Drone.
23. Design of wireless sensor network with two sensors
24. Design of vehicle tracking system
25. FPGA - VivadoHLx Software - Verilog
26. 3-bit binary adder - Verilog
27. Design of accelerometer and application
28. Weather data collection using Python
29. Digital Read, ADC, Interrupt and PWM using Python
30. Embedded Linux Programming
31. Simulation of WSN with LEACH Protocol using Mannasim Simulator
32. Pick and place Robot system,
33. Fingerprint Sensor interfacing,
34. Image processing

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PEL4ES04A	**Elective - 4:** Control System and Industrial Automation	5	4

Course Objectives
To acquire knowledge on fundamentals of control system and industrial automation
To explain the time-domain and frequency-domain analyses a control system
To explain various controllers in industrial automation
To understand various performance parameters of control systems
To understand various Standards of industrial automation

UNIT I: Introduction **(15 Hours)**

Control System - open loop and closed loop systems- Mathematical models: mechanical system- electrical system -Transfer function- Laplace transforms- Block diagram Algebra signal flow graphs- feedback characteristics of control system.

UNIT II: Time and frequency domain Analysis **(15 Hours)**

Time response: type and order of control system- test signals- Time response of first and second order systems to unit step input. Time Domain specifications and their formulae-frequency response- correlation between time and frequency response-bode plots-Nyquist plot-Nyquist stability criterion- determination of closed loop response from open loop response.

UNIT III: Error analysis and Controllers **(15 Hours)**

The role of feedback system, error analysis- Response of 2nd order system with P, PI and PID controllers- Ziegler Nichols rules for tuning PID controllers- Design of PID controllers with frequency response approach - comparison of the controller response- Design concepts of modified PID controller- two degrees of freedom control- zero placement approach to improve response characteristics.

UNIT IV: Introduction to automation **(15 Hours)**

Automation- basic concept: Definition-positioning concept- components and application of automation system: automation system application -function of automation system- levels of automation- important concepts- Analog and digital- input and output types- numbering system- electrical power - processes- Documentation and file formats.

UNIT V: Automation system **(15 Hours)**

Components and hardware- power control- actuators, sensors and movement- Ac and DC motors- control devices-machine system- process control system and automated machinery machine and system design-safety- application.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials.

Books for Study

1. Ogata, K.. (2010). *Modern control engineering*, (5th Ed). Upper Saddle River, NJ: Prentice Hall.
2. Nagrath, I.J., & Gopal, M. (2006). *Control Systems Engineering*, (4th Ed). New Age International (P) Ltd., Publishers.
3. Dickson, P.P. (2013). *Industrial Automation: An Engineering Approach*.
4. Lamb, F. (2013). *Industrial automation: hands-on*. McGraw-Hill Education.

Unit	Book	Chapter	Sections
I	1, 2	12, 3	1.1,1.2,1.32.4,2.5, 2.6, 2.7, 3.1- 3.7
II	2, 1	5, 7	5.1, 5.2,5.3, 5.4, 8.2-8.45.8, 7.2, 7.3,7.5, 7.6, 7.8, 7.10
III	1, 2	8, 3	8.1-8.73.1 -3.6
IV	3, 2	1, 22	1.1, 1.2, 1.3, 2.1-2.4, 2.1-2.7
V	4	3, 4, 9, 10	3.1-3.6, 4.1, 9.1-9.6, 10

Books for Reference

1. Levine, W. S. (2011). *Control system fundamentals*, (2nd Ed). CRC press.
2. Manesis, S., & Nikolakopoulos, G. (2018). *Introduction to industrial automation*. CRC Press.
3. Norman, S., & Nise. (2015). *Control System Engineering*, (7th Ed). Courier Kendallville.

Websites and eLearning Sources

1. https://sites.google.com/view/vivekmohan/control-system-lecture-notes.
2. https://www.princeton.edu/~cuff/ele201/kulkarni_text/frequency.pdf.
3. https://learnemc.com/time-frequency-domain
4. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0242428.
5. https://www.msec.be/verboten/seminaries/ICS_archs_and_sec_essentials/ICS_Overview.pdf

Course Outcomes		
CO No.	**CO-Statements**	**Cognitive Levels (K-Level)**
	On successful completion of this course, students will be able to	
CO1	acquire knowledge on basic concepts of control system and industrial automation	**K1**
CO2	explain the time-domain and frequency-domain analyses of the model to predict the system's behaviour.	**K2**
CO3	apply various controllers in industrial automation	**K3**
CO4	analyze the performance of control systems	**K4**
CO5	conclude the control system for an application	**K5**
CO6	standardize and compose industrial automation	**K6**

Relationship Matrix											
Semester	**Course Code**	**Title of the Course**								**Hours**	**Credits**
4	**23PEL4ES04A**	**Elective - 4:** Control System and Industrial Automation								**5**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	2	2	3	3	2	2	**2.4**
CO2	2	2	3	2	3	2	2	3	2	2	**2.3**
CO3	2	3	2	2	2	2	2	2	3	3	**2.3**
CO4	2	3	2	2	3	2	2	2	3	2	**2.3**
CO5	2	2	3	3	3	2	2	2	3	3	**2.5**
CO6	3	3	3	2	3	2	2	2	3	3	**2.6**
										Mean Overall Score	**2.4 (High)**

Semester	Course Code	Title of the Course	Hours/Week	Credits
4	23PEL4ES04B	**Elective - 4:** Biomedical Signal and Image Processing	5	4

Course Objectives
To study bio signals from organs and wavelet transformation
To understand Brain CT, ECG and EEG signal processing using various algorithms
To apply signal and image processing in bio medical applications
To analyse and compare the signal processing techniques in bio medical applications
To develop suitable algorithm for bio signal processing

UNIT I: ECG Signal Processing **(15 Hours)**

Origin of ECG Signal - ECG Electrode Placement - Model ing and Representation of ECG - Heart Rate - Processing and Feature Extraction of ECG: Time Domain Analysis - Frequency Domain Analysis - Wavelet Domain Analysis.

UNIT II: EEG Signal Processing **(15 Hours)**

The Brain Wave - Characteristics of EEG Signal - Basic Principle of EEG Signal Analysis - Brain Computer Interface (BCI) EEG signal Processing System Block Diagram - EEG signal Acquisition - Signal Preprocessing using Adaptive Filtering - Signal Extraction using FFT and Wavelet Transformation.

UNIT III: Brain CT-scan image processing **(15 Hours)**

CT Scanner and Detector - Pre- Processing using Image Restoration - Edge Detection Using Canny and Prewitt Methods - Gobar Filter to Detect Region of Interest - Detect the Features Using BLOB (binary large object) Analysis.

UNIT IV: MRI Image Processing **(15 Hours)**

Preprocessing using Gaussian Filter - Image Enhancement using Threshold Based Anisotropic Diffusion Filter - Threshold model on bounding box method - Parameters used to define a bounding box - Threshold with bounding box approach to detect tumor - Image Segmentation - Morphological Dilation and Erosion.

UNIT V: Fingerprint Biometrics **(15 Hours)**

Finger Print Sensors - Useful Features of the Fingerprint - Fingerprint Recognition Systems - Histogram Equalization - Fingerprint Image Enhancement Using Fourier Transform - Binarization - Image Segmentation - Minutiae Extraction - Finger Print Indexing - Advantages and Disadvantages.

Teaching Methodology	Demo Videos, PPT, Handouts, Study materials.

Books for Study

1. Najarian, K., & Splinter, R. (2012). Biomedical Signal and Image Processing. CRC Press. Taylor & Francis Group
2. Sinha, G. R., & Sandeep, B. P. (2013). Biometrics: Concepts and Applications, Wiley.

Unit	Book	Chapter	Sections
I	1		Relevant sections
II	1		Relevant sections
III	1		Relevant sections
IV	1		Relevant sections
V	2		Relevant sections

Books for Reference

1. Rathinam, M. "*Enhanced Image Filtration using Threshold based Anisotropic Filter for Brain*

Tumor Image Segmentation ", Proceedings of the Third International Conference on Intelligent Sustainable Systems
2. Kamarainen, J.K. *"Gabor Features in Image Analysis", Machine Vision and Pattern Recognition Laboratory*, Lappeenranta University of Technology (LUT Kouvola
3. Nilesh Bhaskarrao Bahadure, Arun Kumar Ray and Har Pal Thethi, *"Image Analysis for MRI Based Brain Tumor Detection and Feature Extraction Using Biologically Inspired BWT and SVM",*
4. *International Journal of Biomedical Imaging*, Volume 2017, Article ID 9749108, 12 pages,
5. Rupavathy. Na, & Dr. M. J. Carmel Mary Belindab," *Anisotrophic Filter Based Detection of Brain Tumor* ", Turkish Journal of Computer and Mathematics Education Vol.12 No.9 (2021), 172-181.
6. Sonka, Hlavac & Boyle, Reprint 2011"*Digital Image Processing and Computer Vision*", CENGAGE

Websites and eLearning Sources

1. http://taylorandfrancis.com Learning, Sixth Indian.
2. https://ieeexplore.ieee.org/document/5783430
3. https://library.oapen.org/handle/20.500.12657/41663
4. https://www.sciencedirect.com/journal/biomedical-signal-processing-and-control
5. https://www.southampton.ac.uk/courses/modules/isvr6138

Course Outcomes		
CO No.	**CO-Statements** On successful completion of this course, students will be able to	**Cognitive Levels (K-Level)**
CO1	recognize bio signals from organs and wavelet transformation	**K1**
CO2	understand Brain CT, ECG and EEG signal processing using various algorithms	**K2**
CO3	apply signal and image processing in bio medical applications	**K3**
CO4	analyse the signal processing techniques in bio medical applications	**K4**
CO5	compare and recommend suitable algorithm for bio signal processing	**K5**
CO6	develop algorithm to design an ECG, EEG arrhythmia detection system detect brain tumor and fingerprint biometric system	**K6**

Relationship Matrix											
Semester	**Course Code**		**Title of the Course**							**Hours**	**Credits**
4	**23PEL4ES04B**		**Elective - 4:** Biomedical Signal and Image Processing							**5**	**4**
Course Outcomes	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	3	2	3	2	2	3	3	2	2	**2.4**
CO2	2	2	3	2	3	2	2	3	2	2	**2.3**
CO3	2	3	2	2	2	2	2	2	3	3	**2.3**
CO4	2	2	2	2	3	2	2	2	3	2	**2.2**
CO5	2	2	2	2	3	2	2	2	2	2	**2.1**
CO6	2	2	2	2	3	2	2	2	2	2	**2.1**
										Mean Overall Score	**2.33 (High)**