VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
(VJTI)
MATUNGA, MUMBAI 400 019

(Autonomous Institute affiliated to University of Mumbai)

Curriculum
(Scheme of Instruction & Evaluation and Course contents)

For
Third Year Undergraduate Programme Leading to
Bachelor of Technology (B. Tech.) Degree
in
Electronics Engineering

Implemented from the batch admitted in Academic Year 2023-2024

[NEP 2020 Based Syllabus]

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

(Autonomous Institute affiliated to University of Mumbai)

Curriculum

(Scheme of Instruction & Evaluation and Course contents)

For

Third Year Undergraduate Programme Leading to
Bachelor of Technology (B. Tech.)

In

Electronics Engineering

(106)

Implemented from the batch admitted in Academic Year 2023-2024

Institute Vision

- To establish global leadership in the field of Technology and develop competent human resources for providing service to society

Institute Mission

- To provide students with comprehensive knowledge of principles of engineering with a multi-disciplinary approach that is challenging
- To create an intellectually stimulating environment for research, scholarship, creativity, innovation, and professional activity.
- To foster relationship with other leading institutes of learning and research, alumni, and industries in order to contribute to National and International development.

Department Vision

- To establish global leadership in the field of Electrical, Electronics & Communication Engineering and to develop competent human resources for providing service to society.

Department Mission

- To provide student with comprehensive knowledge for taking up challenges in the field of Electrical Engineering with a multi-disciplinary approach.
- To create an intellectually stimulating environment for research, industry interaction, creativity, innovation and professional activity.
- To foster relationship with renowned institutes of learning and research, alumni and industries in order to contribute to National and International development.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

Electronics Engineering Graduates will have ability to

1. Apply analysis, design, optimization and implementation skills in order to formulate and solve Electronics Engineering and multidisciplinary problems.
2. Take up higher studies, innovation, research & development and other such creative efforts in technology.
3. Use their skills in professional manner to raise the satisfaction level of stake holders.

PROGRAMME OUTCOMES

Engineering Graduate will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOS)

Electronics and Telecommunication Engineering Graduate will be able to:

1. Design, develop and test electronic systems in the areas related to analog and digital electronics, electronic instrumentation, signal processing and VLSI design.
2. Analyze, design and implement electronic systems to strive balance between increasing complexity, robustness and performance of systems.
3. Design electronic software and hardware systems, components or process to meet desired needs within realistic constraints.

Credit Framework for Multidisciplinary UG Programme in Electronics Engineering (Level 5.5)

Semester - V

Sr.	Course Type	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %			Ownership
									TA	MST	ESE	
1	PCC	R5EL3001T	Electromagnetic Fields	3	0	0	3	3	20	30	50	Electronics
2	PCC	R5EL3002T	Principles of VLSI	3	0	0	3	3	20	30	50	Electronics
3	PCC	R5EL3003T	Digital Signal Processing	3	0	0	3	3	20	30	50	Electronics
4	PCC	R5EL3004T	Control System	3	0	0	3	3	20	30	50	Electronics
5	PCC	R5EL3005T	Microprocessor systems	2	0	0	2	2	20	30	50	Electronics
6	PEC	R5EL31XXT	Program Elective –I	3	0	0	3	3	20	30	50	Electronics
7	MDM	R5XX32XXT	Multi-Disciplinary Minor-III	3	0	0	3	3	20	30	50	Respective Department
8	PCC	R5EL3002L	Principles of VLSI Lab	0	0	2	2	1	ISCE:60		40	Electronics
9	PCC	R5EL3003L	Digital Signal Processing Lab	0	0	2	2	1	ISCE:60		40	Electronics
10	PCC	R5EL3005L	Microprocessor systems Lab	0	0	2	2	1	ISCE: 60		40	Electronics
11	PEC	R5EL31XXL	Program Elective-I Laboratory	0	0	2	2	1	ISCE:60		40	Electronics
			Total	20	0	8	28	24				

Semester - VI

Sr.	Course Type	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %			Ownership
									TA	MST	ESE	
1	PCC	R5EL3006T	Power Electronics	2	0	0	2	2	20	30	50	Electronics
2	PCC	R5EL3007T	Embedded Systems	2	0	0	2	2	20	30	50	Electronics
3	PCC	R5EL3008T	Computer Communication Network	3	0	0	3	3	20	30	50	Electronics
4	OE	R5XX33XXT	Open Elective-I	3	1	0	4	4	20	30	50	Respective Departments
5	PEC	R5EL31XXT	Program Elective –II	3	0	0	3	3	20	30	50	Electronics
6	MDM	R5XX32XXT	Multi-disciplinary Minor-IV	3	0	0	3	3	20	30	50	Respective Departments
7	HSSM	R5EL3401T	Financial Planning / Taxation / Management	2	0	0	2	2	20	30	50	Electronics
8	VEC	R5EL3402T	Electronics in Service to Society	1	0	2	3	2	ISCE:60		40	Electronics
9	PCC	R5EL3007L	Embedded Systems Lab	0	0	2	2	1	ISCE:60		40	Electronics
10	PCC	R5EL3008L	Computer Communication Network Lab	0	0	2	2	1	ISCE:60		40	Electronics
11	PEC	R5EL31XXL	Program Elective –II Lab	0	0	2	2	1	ISCE:60		40	Electronics
			Total	19	1	8	28	24				

MDM Course Code offered by Electronics Engineering

Sr. No.	Course code	Name of MDM	Name of the MDM Course	Semester
1	R5EL3201T	Internet of things	Sensors and transducers	V
2	R5EL3202T	Signal and Image Processing	Digital Image Processing	V
3	R5EL3203T	Internet of things	Principles of IoT	VI
4	R5EL3204T	Signal and Image Processing	Pattern Recognition	VI

Abbreviations: **L** Lecture, **T** Tutorial, **P** Practical, **TA** Teacher Assessment / Term work Assessment, **MST** Mid Semester Test, **ESE** End Semester Written Examination, **ISCE** In-semester Continuous Evaluation, **PCC** Program Core course, **PEC** Program Elective Course, **MDM** Multi-Disciplinary Minor **VSEC** Vocational and Skill Enhancement Course, **OE** Open Elective, **VEC** Value Education Course. **EC** Exit Course.

Program Elective Offered by Electronics Engineering

		Course code	Name of the Course	Semester
Elective-I	1	R5EL3101T	Digital VLSI Design	V
		R5EL3101L	Digital VLSI Design Lab	V
	2	R5EL3102T	Data Compression and Encryption	V
		R5EL3102L	Data Compression and Encryption Lab	V
	3	R5EL3103T	Image Processing	V
		R5EL3103L	Image Processing Lab	V
	4	R5EL3104T	Introduction to Artificial Intelligence	V
		R5EL3104L	Introduction to Artificial Intelligence Lab	V
	5	R5EL3105T	Basics of IoT	V
		R5EL3105L	Basics of IoT Lab	V
Elective-II	1	R5EL3106T	Introduction to microfabrication	VI
		R5EL3106L	Introduction to microfabrication Lab	VI
	2	R5EL3107T	Error-correcting codes	VI
		R5EL3107L	Error-correcting codes Lab	VI
	3	R5EL3108T	Advanced Digital Signal Processing	VI
		R5EL3108L	Advanced Digital Signal Processing Lab	VI
	4	R5EL3109T	Data Science	VI
		R5EL3109L	Data Science Lab	VI
	5	R5EL3110T	Wireless Sensor networks	VI
		R5EL3110L	Wireless Sensor networks Lab	VI

List of Exit Courses after completion of Semester V and VI

1. The exit option is available for students who have earned a total of 132 credits at the End of the Second Semester.
2. Students who want to avail of the exit option after the Third year has to earn additional 6-8 credits from the list of courses shown below.
3. These courses students have to complete within summer vacation after the Third Year.
4. After fulfillment as mentioned in 1 to 3 above, Students can earn B. Voc. or B. Sc. (Tech.) and the same will be issued by the Institute.

List of Exit Courses after completion of Semester V and VI: Electronics Engineering											
Sr.	Course Type	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %		
									TA	MST	ESE
1	EC	R5EL3901T	Industrial Automation	2	0	0	2	2	20	30	50
2	EC	R5EL3902T	Virtual Instrumentation	2	0	0	2	2	20	30	50
3	EC	R5EL3901L	Industrial Automation Lab	0	0	2	2	1	ISCE: 60		40
4	EC	R5EL3902L	Virtual Instrumentation Lab	0	0	2	2	1	ISCE: 60		40
5	EC	R5EL3901I	Internship (6-8 weeks)					6	ISCE: 60		40
6	EC	R5EL3901P	Mini-Project	0	0	12	12	6	ISCE: 60		40
			Total								

T. Y. B. Tech. Electronics Engineering

Course code	R5EL3001T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	ELECTROMAGNETIC FIELDS						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Represent a vector in different coordinate systems and compute area, volume, divergence and curl.
2. State the Coulomb's and Gauss' laws and the Maxwell's equation.
3. Describe conduction and convection current in conductors, boundary conditions and polarization effect in dielectrics.
4. Describe electromagnetic wave propagation and define various terms related to it.
5. Design transmission lines; Impedance matching network for microwave systems and cut-off frequencies of waveguides and TEM mode.

Module	Content	Hrs.
1	**Vector calculus, coordinate systems and transformations:** Cartesian coordinates, Cylindrical coordinates, Spherical coordinates, Differential length, Area and volume, Line surface and volume integral, Del operator and gradient of scalar, Divergence of vector, Curl of vector.	5
2	**Electrostatics and Magnetostatics:** Review of Coulomb's law and field intensity, Electric flux density, Applications of Gauss's law, Relation between E and V Maxwell's equation, Applications of Ampere's law, Magnetic flux density - Maxwell's equation, Maxwell's equation for static fields, Magnetic scalar and vector potentials	7
3	**Maxwell's equations:** Faraday's law, Transformer and motional electromotive forces, Displacement current, Inconsistency of Ampere's law, Maxwell's equation in time varying and harmonic form, Analogies between electric and magnetic fields.	6
4	**Electric fields in Material's space and Boundary value problems:** Properties and materials, Convection and conduction current, Current density, Conductors, Polarization in dielectrics, Dielectric constant and strength, Continuity equation and boundary condition, Poisson's and Laplace equation, Uniqueness theorem, Resistance, capacitance and super conductance, The Earth capacitor : an automatic electrostatic pilot.	8
5	**Electromagnetic wave propagation:** Waves in general, Comparison and relation between permittivity & permeability, Propagation in lossy dielectric, Plane wave in lossless dielectrics, Plane waves in free space, Plane waves in good conductors, Power and Poynting vector, Propagation based on frequency variation, Reflection of plane wave at normal incidence.	8

6	**Transmission Lines & Waveguides:** Introduction, Concept of Distributed Elements, Equations of Voltage and Current, Standing Waves and Impedance Transformation, Lossless and Low Loss transmission Lines, Power Transfer on a Transmission Lines, Graphical Representation of a Transmission Lines with Impedance Smith Chart, Application of Transmission Lines, Impedance Matching with Single and Double Stub matching networks, Wave Equations, Transverse Magnetic (TM) Mode, Transverse Electric (TE) Mode, Rectangular Waveguides, Circular Waveguides, Transverse Electro-Magnetic (TEM)Mode.	8

Text Book:

1. William Hayt, *Engineering Electromagnetics*, McGraw Hill, Eight edition, 2017
2. R K Shevgaonkar, *Electromagnetic Waves*, McGraw-Hill Education (India) Pvt Limited, 2005.

Reference:

1. Edminister, *Schaum's series in Electromagnetic*s, McGraw Hill, third edition, 1986.
2. Edward C. Jordan, Keith G. Balmain, *Electromagnetic Waves and Radiating Systems*, Second edition, Prentice-Hall,1968l.
3. Devid J. Griffiths, *Introduction to Electrodynamics,*4th edition, Cambridge University press,2017.

Course code	R5EL3002T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	PRINCIPLES OF VLSI						**Category**: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Describe VLSI design principles and evaluate different design styles and quality metrics.
2. Model and analyze MOSFET behavior, including scaling effects, resistance, and capacitance considerations.
3. Design and optimize CMOS inverters and static logic circuits, considering power, speed, and noise margins.
4. Implement and analyze advanced CMOS logic techniques, including transmission gates, dynamic CMOS, and memory cells.

Module	Content	Hrs.
1	**Introduction** Moore's law; VLSI Design flow; design hierarchy; concepts of regularity, modularity and locality; VLSI design styles; design quality.	8
2	**Physics and Modeling of MOSFETs** Energy band diagram view of MOS system under external bias; MOSFET structure and operation; first order V-I characteristics of MOSFET; channel length modulation; MOSFET modelling–drain-source resistance, MOSFET capacitance, MOSFET scaling; Short channel effects.	8
3	**CMOS inverter: Analysis and Design** Voltage Transfer Curve (VTC) of ideal inverter; noise margin; CMOS digital logic inverter – different regions of operation, calculation of critical voltage points on VTC; CMOS inverter switching characteristics; design of CMOS inverter; power dissipation in CMOS inverter and layout designs and stick diagrams.	10
4	**Static CMOS Logic Design and Semiconductor Memory Basics** Static Logic Circuits CMOS-based gates and complex logic circuits; transistor sizing for gates; Pseudo-nmos logic; Schmitt trigger and tri-state output circuits; ROM array, NAND and NOR flash memory, 6T-SRAM, and operation of 1T and 3T DRAM Cell	8
5	**Transmission Gate & Dynamic Logic Circuits** nMOS and pMOS pass transistors; CMOS transmission gate; dynamic CMOS logic; high-performance dynamic CMOS circuits such as domino CMOS logic, NORA logic	8

Text Book:

1. Sung-Mo Kang & Yusuf Leblebici, *CMOS Digital Integrated Circuits-Analysis and Design*, 3rd edition, McGraw Hill,2002.

Reference:

1. Jan M. Rabaey, Anantha Chandrakasan & Borivoje NIkolic, *Digital Integrated Circuits-A Design Perspective,* 2nd edition, PHI.
2. Neil H E Weste & Kamran Eshragian, *Principles of CMOS VLSI Design- A systems perspective*, Addison- Wesley.
3. John P. Uyemura, *CMOS Logic Circuit Design*, Springer International Edition.
4. Adel S. Sedra & Kenneth C. Smith, *Microelectronic Circuits*, 5th edition, Oxford University Press, 2003.

Course code	R5EL3002L	Semester	V	Credits	1	Scheme	0L:0T:2P
Course	PRINCIPLES OF VLSI LAB						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Plot and analyze MOSFET I-V characteristics to understand transistor behavior.
2. Simulate and interpret CMOS inverter voltage transfer and switching characteristics for circuit optimization.
3. Design CMOS-based logic gates and complex logic circuits, ensuring functional correctness.
4. Evaluate the performance of CMOS transmission gates in digital design applications.
5. Develop and implement schematic and layout designs for CMOS circuits, including arithmetic and logic modules.

Sr.No.	Topics	
1	To plot the output characteristics and the transfer characteristics of an n-channel and p-channel MOSFET	
2	To design a CMOS inverter and simulate the circuit for transient analysis and voltage transfer characteristics, and calculate noise margins.	
3	To design Schematic of CMOS based logic gates.	
4	To design Schematic of CMOS based complex logic circuits.	
5	To study CMOS Transmission Gate Characteristics.	
6	To design Schematic and Layout of CMOS complex gates	
7	To design Schematic and Layout of CMOS adders.	
8	To draw the layout of a 6T SRAM cell and plot the read and write waveforms.	
9	To design the schematic and layout of a 4-bit ripple carry adder and verify its functionality.	
10	To design a domino logic OR/NAND gate and verify its functionality	
11	To design a CMOS-based full adder circuit and plot the carry and sum waveforms	

Course code	R5EL3003T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	DIGITAL SIGNAL PROCESSING						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Analyze DT systems in the frequency domain, using analytical and graphical techniques.
2. Design linear phase systems to meet the desired specifications..
3. Compute DFT using FFT algorithms
4. Design FIR and IIR filters to meet the given specifications.
5. Determine the quantization effects due to finite processor word length.

Module	Content	Hrs.
1	**Frequency Domain Analysis of Discrete Time Systems** Pole-zero diagram, Frequency domain analysis using Analytical & graphical techniques, System classification based on pass-band as low pass, high pass, Band pass & band reject, System classification based on phase response as Minimum phase , maximum phase , mixed phase or linear phase systems, Finite word-length effect on system poles.	8
2	**Linear Phase FIR Systems** Need for linear phase, concept of phase delay & group delay, Condition for Linear Phase, Magnitude & phase response for Four types of Linear Phase systems, Location of zeros.	6
3	**Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT)** DFT and its Properties, Relation between DFT and Z-Transform, FFT: Decimation in Time (DIT) and Decimation in Frequency (DIF), 8-point DFT using Radix-2 DIT FFT and Radix-2 DIF FFT, Computation of Inverse DFT using FFT.	8
4	**FIR Filter Design** FIR versus IIR filters, Design of FIR filters by windowing technique: (Gibb's phenomenon, Use of different windows: rectangular, triangular, Hamming, Hanning, Kaiser), Design of FIR filters using Frequency sampling techniques, Design of optimal linear phase FIR filters, Structures for implementation: canonic and lattice	8
5	**Design of IIR filters** The design process Methodology, Different types of analog approximations: Butterworth, chebyshev, inverse chebyshev, elliptical, Bessel etc., Spectral transformations, Conversion techniques like bilinear transformation, impulse invariance, matched Z-transform, Intuitive approaches .	7
6	**Quantization Effects** Quantization methods, Limit cycle oscillations due to Quantization, Errors in frequency response due to coefficient Quantization.	5

Text Book:

1. J. G. Proakis, D. G. Manolakis, *Digital Signal Processing : Principles, Algorithms and Applications*, Prentice Hall of India, third edition, 1995.
2. A. Nagoor Kani, *Digital Signal Processing*, McGraw-Hill Education Second edition 2013.

Reference:

1. Oppenheim and Schafer with Buck, Discrete- Time Signal Processing, Prentice Hall of India, 2000.
2. A. Antoniou, Digital Filters: Analysis Design and Applications, Tata McGraw-Hill, .2001.
3. Ashok Ambardar, Analog and Digital Signal Processing, Thomson Learning, second edition, 2001.

Course code	R5EL3003L	Semester	V	Credits	1	Scheme	0L:0T:2P
Course	DIGITAL SIGNAL PROCESSING LAB						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Implement and plot frequency response of FIR and IIR systems and obtain their transfer functions
2. Implement DIT-FFT and DIF-FFT
3. Design FIR & IIR filter.
4. Implement simple programs on DSP processors

Sr.No.	Topics	
1	Frequency response of FIR and IIR system	
2	Transfer function and pole-zero plots of FIR and IIR systems	
3	Implementation Decimation In Time -FFT and Decimation In Frequency-FFT	
4	Magnitude & phase response for Four types of Linear Phase systems	
5	Design of FIR filters by windowing technique. [rectangular, triangular, Hamming, Hanning and Kaiser]	
6	Design of FIR filters using frequency sampling techniques.	
7	Design of IIR filters (a) Different types of analog approximations: Butterworth, Chebyshev, Inverse Chebyshev (b) Conversion techniques like bilinear transformation, impulse invariance, matched Z-transform	
8	Implementation of simple programs on DSP processors	

Reference:

1. V.K. Ingle, John G. proakis, Digital Signal processing , 4th Edition,2015, Cengage learning Press.

Course code	R5EL3004T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	CONTROL SYSTEMS						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Model various control system problems.
2. Improve performance and stability of the control system.
3. Improve stability of the system through frequency compensation.
4. Analyze and design state variable systems and various industrial controllers.

Module	Content	Hrs.
1	**Control system terminology & Mathematical Models of Physical Systems** Control system Terminology, classification of control system, Open loop and closed loop systems, examples. Modeling of Electric systems and mechanical systems, Block diagram reduction Techniques and Signal flow graph.	10
2	**Time and Frequency domain Stability Analysis** Standard test signals, Time response of first order system and second order system.Transient specifications of second order system. Steady state specifications of the second order system. Stability analysis – Routh-Hurwitz criterion .Root locus technique: applications, concept, construction of root loci. Bode Plot technique: applications, concept, construction of Bode plot	12
3	**Compensator Design** Introduction to Compensator: Derivative and integral error compensation. Analysis of the basic approaches to compensation, cascade compensation, feedback compensation. Electrical Lag, Lead, Lag-Lead.Design Lag, Lead, Lag-Lead compensator using Root-locus. Design Lag, Lead, Lag-Lead compensator using Bode plot. PID Design	13
4	**State Variable Analysis** Concept of state, state variables and state model. State space representation of Continuous Time systems. Transfer function from State Variable Representation, Solutions of the state Equations. Concepts of Controllability and Observability	7

Text Book:

1. Noman S. Nise, *Control system Engineering*, Wiley, 8th Edition, 2024.
2. I. G. Nagarath, *Control System Engineering,* New age International Pvt. Ltd., 8th Edition, 2024.
3. Katsuhiko Ogata, *Modern Control engineering,* Pearson Edu. India, 5th Edition, 2015.
4. Karl J. Astrom, *PID controller: Theory, Design and tuning,* ISA, 2nd Edition, 1995.

Reference:

1. Graham C. Goodwin, Stefan F. Graebe, Mario E. Salgado, *Control System Design*, Pearson Edu. India, 1st Edition, 2015.
2. Loan Dore Landau, *Digital control Systems: Design, Identification and implementation*, Springer, 2006 .

Course code	R5EL3005T	Semester	V	Credits	2	Scheme	2L:0T:0P
Course	MICROPROCESSOR SYSTEMS						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Describe architecture of 16-bit microprocessors.
2. Design microprocessor systems consisting of a 16-bit microprocessor/microcontroller, memory , I/O and other relevant devices.
3. Design and implement assembly language programs for 8086/ARM 7 microprocessors.
4. Design and implement I/O data transfer techniques.

Module	Content	Hrs.
1	**Intel 8086/8088/8087 microprocessor family** Architecture and organisation of 8086/8088 microprocessor family. Study of its Instruction set. Assembly language programming, 8086 family minimum and maximum mode operation. Timing diagram for 8086 family, detailed study of maximum mode connection: study of 8288 bus controller. 8086 interrupt structure. Architecture and basic instructions of 8087 Math co-processor.	7
2	**8086 Memory & I/O design:** Memory system design for 8086 family, timing considerations for memory interfacing. Connection of I/O Controllers 8255AH programmable peripheral Interface, Programmable Interrupt Controller 8259A, programmable D.M.A. Controller 8237	10
3	**ARM7 TDMI Architecture** Architectural Block diagram and Features of ARM 7 TDMI, processor operating states, Memory formats, Data types, Operating modes, registers , Pipelining, Program status registers, exceptions, interrupt latencies. Memory system design.	4
4	**ARM7 TDMI Assembly Language Programming** 8,16,32 bit and floating point numbers processing, Conversions between Hexadecimal, BCD, ASCII, Data movement/copy operations, block transfer of data, data swap/exchange Arithmetic, Logical, and Stack operation, loops, condition evaluation and decision making based on flags, control transfers (Call, Return, Jumps), processor state changing between ARM and THUMB, Exceptions, interrupts and its handling.	7

Text Book:

1. John Uffenback, *8086 / 8088 Design, Programming and Interfacing*, second edition, ninth Indian reprint, Prentice Hall of India, 2001.
2. Sloss, Symes, Wright, *ARM System Developers Guide*, Elsevier Morgan Kaufman, first edition, 2004.

Reference:

1. Douglas Hall, M*icroprocessors Interfacing and Programming*, Tata McGraw Hill, third edition, 2002.
2. William Hohl, *ARM Assembly Language: Fundamentals and Techniques*, CRC press, 2009.

Course code	R5EL3005L	Semester	V	Credits	1	Scheme	0L:0T:2P
Course	MICROPROCESSOR SYSTEMS LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Write programs for data transfer, arithmetic and logic operations for 8086 microprocessors.
2. Write programs for data transfer, arithmetic and floating point operations for 8087 microprocessors.
3. Write programs for data transfer, arithmetic and logic operations and floating point operations for ARM 7 microprocessor.

Sr.No.	Topics	
1	**Module 1:** Any five programs on data transfer operations, Arithmetic & logic operations for 8086. 1.1 Data transfer for 8086. 1.2 Addition of two numbers. 1.3 Subtraction of two numbers. 1.4 Multiplication of two numbers 1.5 Division of two numbers 1.6 BCD Subtraction of 8 bit & 16 bit numbers. 1.7 Sorting of an array.	
2	**Module 2:** Any three programs on floating point operations involving 8087 2.1 Arithmetic operation on two single-precision floating-point numbers. 2.2 Find square root, trigonometric functions , absolute value, negation of a floating point number. 2.3 Multiply two 2×2 matrices with floating-point values using 8087. 2.4 Verify $\sin^2(x) + \cos^2(x) = 1.0$ for $x = 45°$	
3	**Module 3:** Any three programs on data transfer operations, arithmetic & logic operations and I/O involving ARM 7 3.1 Data transfer for ARM 7. 3.2 Arithmetic operation on two numbers. 3.3 Conditional execution program. 3.4 Sorting of an array. 3.5 Multiply two 3×3 matrices.	

Text Book:

1. John Uffenback, "8086 / 8088 Design"*, Programming and Interfacing,* second edition, ninth Indian reprint, Prentice Hall of India, 2001.
2. William Hohl, A*RM Assembly Language: Fundamentals and Techniques*, CRC press, 2009.

Program Elective-I [3(Th)+1(L) CREDIT]

Course code	R5EL3101T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	DIGITAL VLSI DESIGN						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Design of combinational and sequential circuits using MOS logic techniques, and assess their performance and reliability.
2. Write and simulate Verilog code for digital circuit implementation, using concurrent and Sequential constructs and synthesizable coding practices.
3. Apply digital system design principles, including FSMs, metastability, synchronization, and pipelining techniques.
4. Design FPGA-based systems by utilizing logic blocks, routing architecture, special resources, and timing constraints.
5. Perform testing and verification of digital circuits using fault modeling, DC/AC parametric tests, and other validation techniques

Module	Content	Hrs.
1	**Fundamentals of Digital VLSI Circuit Design** Introduction to MOS transistor theory, combinational circuit design, theory of logical efforts and interconnect delay, sequential circuit design, timing issues and power optimization, datapath subsystems, array subsystems	8
2	**Digital System Design** Introduction to Digital design; Hierarchical design, controller (FSM), FSM issues, timing issues, pipelining, resource sharing, metastability, synchronization, MTBF Analysis, setup/hold time of various types of flip-flops, synchronization between multiple clock domains, reset recovery, proper resets.	8
3	**HDL Basics** Introduction to Verilog and digital IC design CAD tools, Verilog operators, variables, and signal types, Structural, Data-flow, and Behavioral styles of hardware description, Concurrent and sequential constructs, loops, delay models, functions, coding for synthesis, test bench	10
4	**FPGA** Logic block and routing architecture, design methodology, special resources, Xilinx Spartan-6, Altera and Actel FPGAs, programming FPGA, constraints, STA, timing closure.	8
5	**Testing and Verification** Basics of testing and fault modelling: Introduction- Principle of testing - types of testing - DC and AC parametric tests - fault modelling	8

Text Book:

1. CMOS VLSI Design: A Circuits and Systems Perspective" by Neil Weste & David Harris
2. Samir Palnitkar, Verilog HDL: A Guide To Digital Design And Synthesis, Second Edition

Reference:

3. J. M Rabaey, A. Chandrakasan, B.Nikolic, Digital Integrated Circuits: A Design Perspective, Pearson, 2012
4. J Bhasker, A Verilog Primer, Star Galaxy Publishing
5. N. Weste and K. Eshraghian, *Principles of CMOS VLSI Design*, Addison Wesley, 1993

Course code	R5EL3101L	Semester	V	Credits	1	Scheme	0L:0T:2P

Course	DIGITAL VLSI DESIGN LAB	Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Design and simulate arithmetic circuits (adders, multipliers) using HDL.
2. Implement and analyze combinational and sequential circuits, including multiplexers, decoders, flip-flops, and counters.
3. Develop and simulate FSMs for real-time digital logic applications.
4. Utilize HDL-based design methodologies for efficient digital circuit implementation.
5. Synthesize and deploy digital circuits on FPGA hardware, verifying their performance.

Sr.No.	Topics	
1	To design and simulate half and full adder using HDL code.	
2	To design and simulate ripple carry adder using HDL code.	
3	To design and simulate multipliers using HDL code.	
4	To design and simulate multiplexers, de-multiplexers, encoders and decoders using HDL code.	
5	To design and simulate different flip flops using HDL code.	
6	To design and simulate different synchronous counters using HDL code.	
7	To design and simulate different asynchronous counters using HDL code.	
8	To design and simulate different shift registers using HDL code.	
9	To design and simulate a Finite state machine using HDL code.	
10	To implement a digital circuit HDL code on an FPGA using HDL code.	
11	To design synchronous RAM with write Enable and Clock	
12	To design dual-port RAM using behavioral modelling for a 4-bit data width and a 3-bit address.	

Course code	R5EL3102T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	DATA COMPRESSION AND ENCRYPTION						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Implement and evaluate various lossless and lossy compression methods.
2. Develop codes for text compression and estimate audio compressions
3. Develop and estimate image and video compressions
4. Analyze various quantization methods.
5. Describe different algorithms for encryption and decryption.

Module	Content	Hrs
1	**Data Compression Techniques** Loss less compression, Lossy compression, Entropy Measures of performance, Modeling and Coding Text Compression: Minimum variance Huffman coding, Extended Huffman coding, Adaptive Huffman coding, Shannon Fano Coding, Arithmetic coding Dictionary coding techniques, LZ 77, LZ 78, LZW ,File compression	8
2	**Audio Compression** High quality digital audio, Frequency, Spectral and Temporal masking, Lossy sound compression, Format of Compressed Data ,M-law and A-law companding, MPEG audio standard ,DPCM and ADPCM audio compression, Frequency Domain coding	9
3	**Image and Video Compression** Two D Image Transforms, Lossless Image compression techniques, PCM, DPCM, JPEG, JPEG –LS and JPEG 2000 standards ,Video Compression, Intra frame coding, motion estimation and compensation, Introduction to MPEG - 2 H-264 encoder and decoder, MPEG Industry Standards	8
4	**Quantization** Problems in quantization Uniform, adaptive, forward adaptive, backward adaptive, nonuniform quantization,Vector quantization and algorithms (Linde Buzo Gray algorithm, tree, pyramid, polar, lattice spherical quantization	9
5	**Encryption:** Different types of attacks, network security mechanism,substitution and transposition techniques, symmetric and asymmetric keys, DES, AES algorithm, RSA, Diffie Hellman key exchange,Key management.	8

Text Book:

1. David Salomon, *Data Compression: The Complete Reference* ,4th edition , Springer Publication,2007.
2. Khalid Sayood, *Introduction to Data Compression*, Morgan Kaufmann Series ,3rd Edition 2006.
3. Behrouz Forouzan, *Introduction to Cryptography and Network Security* ,McGraw-Hill Higher Education,1st edition,2008

Reference Book:

1. Mark Nelson, *The Data Compression Book* ,BPB publication 2nd Edition,1996.
2. Salomon, David, Motta, Glovanni., *Handbook of Data Compression* , Springer, Publications, 2010.

Course code	R5EL3102L	Semester	V	Credits	1	Scheme	0L:0T:2P
Course	DATA COMPRESSION AND ENCRYPTION LAB						Category: PEC

Course Outcomes:

After the completion of the course, the student should be able to

1. Implement Lossless and Lossy compression algorithms and estimate parameters.
2. Implement text compression algorithms and estimate parameters.
3. Implement audio compression algorithm and estimate parameters.
4. Implement Image and video compression algorithms and estimate parameters.
5. Measure parameters of various quantization.

Lab Instructions: At least 2 experiments should be conducted on each module

Sr.No.	Topics	
1	**Data Compression Techniques** 1.1 Loss less compression and Lossy compression Implementation 1.2 Entropy Measures of Performance Simulation 1.3 Modeling and Coding Simulation 1.4 Text Compression Coding	
2	**Audio Compression** 2.1 Frequency, Spectral and Temporal masking Coding 2.2 M-law and A-law companding coding, 2.3 DPCM and ADPCM Implementation 2.4 Audio compression Implementation 2.5 Frequency Domain coding	
3	**Image and Video Compression** 3.1 Image Compression Implementation 3.2 Video Compression Implementation 3.3 MPEG encoder and decoder Simulation	
4	**Quantization** 4.1 LBG algorithm 4.2 Estimation of parameters in quantization	
5	**Data Encryption:** 5.1 To implement the DES and AES algorithm. 5.2 To implement the RSA algorithm.	

Course code	R5EL3103T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	IMAGE PROCESSING						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Understand theory and models in Image Processing.
2. Interpret and analyze 2D signals in frequency domain through image transforms.
3. Apply quantitative models of image processing for various engineering applications.
4. Develop innovative designs for practical applications of image processing in various fields.

Module	Content	Hrs
1	**Introduction: Image Fundamentals** Image acquisition, Image Digitization, sampling and quantization, image resolution, basic relationship between pixels, Image Formation Model, Geometrical transformation, Camera Modelling, Stereo vision, Colour images, RGB, HSI and other models, Different Imaging Modalities.	8
2	**Image Transforms** Discrete Fourier Transform, Discrete Cosine Transform, Walsh and Hadamard Transform, Haar Transform, Discrete Wavelet Transform, and its applications, slant transform.	9
3	**Image Enhancement** Point Processing: Digital Negative, contrast stretching, thresholding, gray level slicing, bit plane slicing, log transform and power law transform, Histogram Equalization and Specification, Neighbourhood Processing: Averaging filters, order statistics filters, high pass filters and high boost filters, Frequency domain filtering.	8
4	**Image Segmentation** Point, line and edge detection, edge linking using Hough transform and graph theoretic approach, thresholding, and region-based segmentation Clustering Algorithms. Dilation, erosion, opening, closing, hit or miss transform, thinning and thickening, and boundary extraction on binary images.	9
5	**Image Compression** Image Compression Fundamentals, Image compression Model, Image Formats, Containers and Compression Standards, Huffman Coding, Arithmetic Coding, LZW Compression, Run Length Coding, Run-Length Coding, Bit-Plane Coding, Difference between Lossless Compression and Lossy Compression, Block Transform Coding, JPEG Compression, JPEG 2000.	8

Text Book:

1. Gonzalez and Woods, *Digital Image Processing* , Third Edition, Pearson Education, India, 2009.
2. Anil K.Jain, *Fundamentals of Image Processing* , First Edition,Prentice Hall of India, 1989.

Reference Book:

1. Murat Tekalp, *Digital Video Processing* , Pearson, 2010.
2. John W. Woods, *Multidimensional Signal, Image and Video Processing* , Academic Press 2012.
3. J.R.Ohm , *Multimedia Communication Technology* , Springer Publication,2003.
4. A.I.Bovik, *Handbook on Image and Video Processing* , Academic Press, 2000.

Course code	R5EL3103L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	IMAGE PROCESSING LAB						Category: PEC

Course Outcomes:

After the completion of the course, the student should be able to

1. Implement different Image transform algorithms in Image Processing.
2. Implement different filtering algorithms used to enhance or restore images.
3. Implement different edge detection algorithms to study intensity progression in images.
4. Implement and study the morphological operations on images.
5. Implement algorithms to extract higher level features from images.

Sr. No.	Topics	
1	Implement the convolution operation on images	
2	Implement geometric transformations on images	
3	Implementation of Histogram based Techniques	
4	Implement Discrete Fourier Transform (DFT) and Inverse DFT on images.	
5	Generate the basis images of order N for Discrete Cosine Transform (DCT) and Walsh Transform. Also plot the basis images.	
6	Implement different filtering operations on images.	
7	Implement different edge detection techniques on images.	
8	Implement morphological operations on images.	
9	Implementation of feature extraction techniques on images.	

Text Book:

1. Gonzalez and Woods, *Digital Image Processing* , Pearson Education, India, Third Edition.
2. Anil K.Jain, *Fundamentals of Image Processing* , Prentice Hall of India, First Edition, 1989.

Reference Book:

1. Murat Tekalp, *Digital Video Processing* , Pearson, 2010.
2. John W. Woods, *Multidimensional Signal, Image and Video Processing* , Academic Press 2012.
3. J.R.Ohm , *Multimedia Communication Technology* , Springer Publication,2003.
4. A.I.Bovik, *Handbook on Image and Video Processing* , Academic Press, 2000.

Course code	R5EL3104T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	INTRODUCTION TO ARTIFICIAL INTELLIGENCE						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Explain core AI concepts, including intelligent agents, search algorithms, knowledge representation, and machine learning paradigms.
2. Implement and compare different search algorithms for problem-solving.
3. Apply machine learning techniques to build and train models for prediction and pattern recognition.
4. Evaluate the performance of AI systems and discuss their limitations.

Module	Content	Hrs.
1	**Introduction to Artificial Intelligence** What is AI? Definitions, history, and applications of AI. Intelligent Agents: Rationality, types of agents, and agent architectures. Problem Solving: Problem formulation, search space, and search strategies.	8
2	**Search Techniques** Uninformed Search: Breadth-first search, depth-first search, uniform cost search. Informed Search: Heuristic search, A search, greedy best-first search. Local Search: Hill climbing simulated annealing, genetic algorithms. Constraint Satisfaction Problems: CSPs, backtracking, constraint propagation.	8
3	**Knowledge Representation and Reasoning** Propositional Logic: Syntax, semantics, inference rules, resolution. Predicate Logic: First-order logic, quantifiers, unification, and resolution. Semantic Networks: Representing relationships and concepts. Ontologies: Knowledge representation frameworks, description logic. Reasoning under Uncertainty: Probabilistic reasoning, Bayesian networks.	9
4	**Machine Learning** Introduction to Machine Learning: Supervised, unsupervised, and reinforcement learning. Supervised Learning: Classification (KNN, decision trees, support vector machines), regression (linear regression, polynomial regression). Unsupervised Learning: Clustering (k-means, hierarchical clustering), dimensionality reduction (PCA). Reinforcement Learning: Markov decision processes, Q-learning.	9
5	**Applications of AI in Electronics** AI in Communication Systems: Channel modelling, signal detection, network routing. AI in Signal Processing: Speech recognition, image processing, pattern recognition. AI in Robotics: Robot control, path planning, computer vision. AI in IoT: Smart devices, data analytics, predictive maintenance.	8

Text Book:

1. Russell, Stuart J., and Peter Norvig, *Artificial intelligence: a modern approach*, pearson, 2016.
2. Knight, Kevin, and Elaine Rich B. Nair, *Artificial Intelligence,* 2017.

Reference:

1. Ertel, Wolfgang. *Introduction to artificial intelligence*. Springer Nature, 2024.
2. Nilsson, Nils J. *Principles of artificial intelligence*. Morgan Kaufmann, 2014.

Course code	R5EL3104L	Semester	V	Credits	1	Scheme	0L:0T:2P
Course	INTRODUCTION TO ARTIFICIAL INTELLIGENCE LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Implement fundamental AI algorithms such as search techniques, heuristic methods, and optimization algorithms.
2. Apply machine learning models for classification, clustering, and prediction using real-world datasets.
3. Analyze and evaluate AI models based on accuracy, efficiency, and computational complexity.
4. Utilize AI frameworks and tools like Python (NumPy, Pandas), TensorFlow, and OpenCV for practical implementations.

Sr.No.	Topics	
1	Python Programming for AI: Introduction to Python and essential libraries like NumPy ,Pandas, pyTorch , Tensor flow etc.	
2	Search Algorithm Implementation: Coding and testing BFS and DFS algorithms.	
3	An Algorithm Application: Solving shortest path problems using the A* algorithm.	
4	Constraint Satisfaction Solver: Developing solutions for Sudoku or similar puzzles.	
5	Bayesian Network Modelling: Constructing and inferring Bayesian networks.	
6	Supervised Learning Models: Implementing linear regression and classification tasks.	
7	Clustering Techniques: Applying K-Means clustering to group data sets.	
8	Reinforcement Learning Simulation: Creating simple game simulations to apply reinforcement learning.	
9	AI in Signal Processing: Using AI for noise filtering in audio signals.	
10	Network Traffic Prediction: Applying machine learning to forecast network usage patterns.	
11	AI-Driven Embedded Application: Developing a smart IoT prototype with embedded AI capabilities.	
12	Ethical Case Study Analysis: Evaluating real-world AI applications and their ethical considerations.	

Text Book:

1. Russell, Stuart J., and Peter Norvig. *Artificial intelligence: a modern approach*. pearson, 2016.
2. Knight, Kevin, and Elaine Rich B. Nair *Artificial Intelligence,* 2017.

Reference:

1. Ertel, Wolfgang. *Introduction to artificial intelligence*. Springer Nature, 2024.
2. Nilsson, Nils J. *Principles of artificial intelligence*. Morgan Kaufmann, 2014.

Course code	R5EL3105T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	BASICS OF IOT						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Define the Internet of Things and its components.
2. Perform IoT Systems management
3. Design IoT systems
4. Analyse the system through Data Analytics tools.

Module	Content	Hrs.
1	**Introduction to IoT** Background and Vision; IoT as a Disruptive Technology; Standardization; Thing in the context of IoT; Needs of an IoT; Commonly used smart Things; Machine to Machine (M2M) Technology	6
2	**IoT Standards and Protocols** An overview of Internet Principles; IPv6 and Its Role in IoT; Low Power Wide Area Network (LPWAN); Wireless Technologies supporting IoT applications	6
3	**Wireless Sensor Networks in IoT** Types of WSN and Their Architecture; Characteristics of Wireless Sensor Network; Network Topologies in Wireless Sensor Network; WSN Communication Protocols; Security in WSN; Distributed Sensor Network; Wireless Sensor Network Data Aggregation Approaches; Real World WSN Applications	8
4	**Sensors, Actuators and Open Hardware in IoT:** Introduction of sensors for different IoT applications, Perception Layer of IoT; Active sensors vs Passive Sensors; Understanding Various Commonly Used Sensors eg.: Light sensor, accelerometer, gyroscope, magnetometer, proximity, RFID; Environment Measuring Sensors; Flow and Fluid Measuring Sensors; Range and Motion Capture Sensors; Actuators; IoT Examples IoT Hardware; Prototyping Boards/Kits for IOT - Arduino and Raspberry-pi; Hardware for Cellular IoT	8
5	**IoT Middleware and Software Platforms** Introduction to Middleware; Functional and Non-functional Requirements of IoTMiddleware; Architectures of IoT Middleware; State-of-the-art IoTMiddleware - OpenIoT, Node-RED, Google Cloud IoT. Introduction to IoT Software Platforms; Need and characteristics of IoT Platform, Commercial IoT Software Platforms - AWS, IBM Watson IoT Platform, Microsoft Azure IoT suite; Open IoT Software Platforms- things board and things.io; Important considerations for selection of IoT Platform.	7
6	Arduino Programming Building Blocks – Basics, Internet Connectivity, Communication Protocols. IoT Patterns: Real-time Clients, Remote control, On-demand Clients, Web Apps: Machine to Human, Machine to Machine, Platforms	7

Text Book:

1. Surya Durbha and Jyoti Joglekar, *Internet of Things*, Oxford University press, 2021

Reference:

1. Cuno Pfister, *Getting Started with the Internet of Things*, O'Reilly Media,2011.

2. Arshdeep Baga and Vijay Madisetti, *Internet of things, A hands-on approach*, Orient Blackswan Private Limited - New Delhi, 2015.

Course code	R5EL3105L	**Semester**	V	**Credits**	1	Scheme	0L:0T:2P
Course	BASICS OF IOT LAB						**Category**: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Design and implement circuits to interface sensors, actuators, and communication modules with IOT based embedded platforms
2. Implement wireless communication protocols for IOT platforms
3. Design and prototype basic IoT applications
4. Implement cloud based IOT applications

Sr.No.	**Topics**	
1	Interfacing LED and Switch with Arduino and Raspberry pi.	
2	Interfacing Light dependent Resistor (LDR), Infrared Sensor with Arduino Uno/ raspberry pi.	
3	Interfacing ultrasonic, GPS, DHT22 sensor using ESP32.	
4	Interfacing of water sensor, Air quality sensor,collision sensor using arduino UNO/ Raspberry pi.	
5	Interfacing of thumb joystick using arduino uno.	
6	Study of zigbee and BLUEtooth protocol using Arduino/ ESP 32.	
7	Implementation of a home automation system raspberry pi.	
8	Implementation of a weather monitoring system using raspberry pi.	
9	To interface a temperature and humidity sensor and acquire data using Node-RED and display it on a real-time dashboard.	
10	To securely publish environmental sensor data from ESP32 to Cloud Platform (such as Google cloud, microsoft azure ,Amazon aws) using MQTT	

Reference:

1. Schwartz, Marco, *Internet of Things with Arduino Cookbook*, United Kingdom: Packt Publishing, 2016.
2. Michael Margolis, *Arduino Cookbook,* O'Reilly Media, Inc. , 2011

MDM-III: Minor in Signal Processing and Imaging

Course code	R5EL3202T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	DIGITAL IMAGE PROCESSING						Category: MDM

Course Outcomes:

After the completion of course, the student should be able to

1. Students will be able to understand theory and models in Image Processing.
2. Students will be able to interpret and analyze 2D signals in frequency domain through image transforms.
3. Students will be able to apply quantitative models of image processing for various engineering applications.
4. Students will be able to develop innovative designs for practical applications of image processing in various fields.

Module	Content	Hrs
1	**Introduction: Image Fundamentals** Image acquisition, Image Digitization, sampling and quantization, image resolution, basic relationship between pixels, Image Formation Model, Geometrical transformation, Camera Modelling, Stereo vision, Colour images, RGB, HSI and other models, Different Imaging Modalities.	8
2	**Image Transforms** Discrete Fourier Transform, Discrete Cosine Transform, Walsh and Hadamard Transform, Haar Transform, Discrete Wavelet Transform, and its applications, slant transform.	9
3	**Image Enhancement** Point Processing: Digital Negative, contrast stretching, thresholding, gray level slicing, bit plane slicing, log transform and power law transform, Histogram Equalization and Specification, Neighbourhood Processing: Averaging filters, order statistics filters, high pass filters and high boost filters, Frequency domain filtering.	8
4	**Image Segmentation** Point, line and edge detection, edge linking using Hough transform and graph theoretic approach, thresholding, and region-based segmentation Clustering Algorithms. Dilation, erosion, opening, closing, hit or miss transform, thinning and thickening, and boundary extraction on binary images.	9
5	**Image Compression** Image Compression Fundamentals, Image compression Model, Image Formats, Containers and Compression Standards, Huffman Coding, Arithmetic Coding, LZW Compression, Run Length Coding, Run-Length Coding, Bit-Plane Coding, Difference between Lossless Compression and Lossy Compression, Block Transform Coding, JPEG Compression, JPEG 2000.	8

Text Book:

1. Gonzalez and Woods, *Digital Image Processing* , Pearson Education, India, Third Edition, 2007.
2. Anil K.Jain, *Fundamentals of Image Processing* , Prentice Hall of India, First Edition, 1989.

Reference Book:

1. Murat Tekalp, *Digital Video Processing* , Pearson, 2010.
2. John W. Woods, *Multidimensional Signal, Image and Video Processing* , Academic Press 2012.
3. J.R.Ohm , *Multimedia Communication Technology* , Springer Publication, 2012.
4. A.I.Bovik, *Handbook on Image and Video Processing* , Academic Press,2000.
5. Frank Y. Shih, Digital Watermarking and Steganography, Fundamentals and Techniques, 2nd Edition, CRC Press, 2017.

MDM-III: Minor in Internet of Things

Course code	R5EL3201T	Semester	V	Credits	3	Scheme	3L:0T:0P
Course	SENSORS AND TRANSDUCERS						Category: MDM

Course Outcomes:

After the completion of course, the student should be able to

1. Classify and characterize different types of transducers and sensors.
2. Identify transducers and sensors for measurement of various quantities.
3. Analyze the use of transducers and sensors for various applications in electronics engineering.
4. Design schematic diagrams and circuits using transducers and sensors for various applications

Module	Content	Hrs
1	**Introduction** Measurement systems, Basic electronic measuring system, Classification of transducers, General transducer characteristics, Criteria for transducer and sensor selection.	7
2	**Resistive, Capacitive and Inductive Transducers** Resistance Potentiometers-Principles of operation, construction, theory, advantages and disadvantages, applications of Potentiometers, Strain gauges: metallic and semiconductor type. Resistance Thermometer and Thermistors. Types of Inductive transducer: Principles of operation, construction. Advantages & disadvantages and applications. Various variable Inductive Transducers, LVDT (Linear variable differential transformer).Capacitive transducer: Types, Principles of operation, construction, advantages, disadvantages and applications of capacitive transducers .	10
3	**Elastic and Active Transducer** Principle of operation, construction, theory, advantages and disadvantages and applications of following transducers: Thermocouple, Piezo-electric transducer. Spring bellows, diaphragm, bourdon tube – their special features and application	8
4	**Conventional Sensors** Capacitive Sensors: variable distance-parallel plate type, variable area parallel plate, serrated plate/teeth type and cylindrical type variable dielectric constant type,Stretched diaphragm type: microphone. proximity sensors. Thermal Sensors: Various types and applications . Magnetic Sensor: Sensors based on Villari effect.Wiedemann effect , Thomson effect, Hall effect and applications Radiation sensors.	10
5	**Smart Sensors** Introduction, Components of smart sensors, Architecture and evolutions of smart sensors . Advantages and disadvantages . Industrial applications	7

Text Book:

1. Sensor & transducers, D. Patranabis, 2nd edition, PHI 2009.
2. D. V. S. Murthy, T*ransducers and Instrumentation* , 2 edition, Prentice Hall India Learning Private Limited,2008.

Reference:

1. H. K. P. Neubert, *Instrument transducers*, 2nd edition , Oxford University press 1999.
2. E. A. Doebelin, *Measurement systems: application & design*, Tata McGraw Hill Education, 5th edition, 2006.
3. Sawhney A K, *Electrical and Electronics Measurements and Instrumentation*, Dhanpat Rai & Co. (P) Limited, New Delhi,2015.
4. Kalsi H S, *Electronic Instrumentation* , 4th Ed,Tata McGraw Hill, New Delhi, 2010.

SEMESTER -VI

Course code	R5EL3006T	Semester	VI	Credits	2	Scheme	2L:0T:0P
Course	POWER ELECTRONICS						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Make a comparative study of performance of various devices on the basis of the circuit requirement including its rating and specifications.
2. Analyse single phase and three phase converters with different loads and solve problems related to it.
3. Comprehend the inverters with different loads and configurations and solve related problems.
4. Describe the concept of chopper with its types and solve the problems

Module	Content	Hrs
1	**Switching devices** SCR: Principle of operation, Static, dynamic and gate characteristics, Methods of turning on , firing circuits, commutation circuits, Protection of SCR Other power switches –(TRIAC, DIAC, GTO, MOSFET, IGBT, power BJT etc.): Principle of operation, Characteristics (v-I, switching), Rating, specifications and applications, Driver circuits including MOSFET drivers.	8
2	**Converters – Controlled rectifiers** Half wave controlled rectifier with R and R-L load, Full wave controlled rectifiers(half controlled and fully controlled) with R, R-L Load, Single phase dual converter, Three phase half controlled and fully controlled rectifier, Numerical analysis essential Converters – Cyclo converters: Introduction, Single phase and three phase cycloconverters,Concept of SMPS,Applications.	8
3	**Inverters** Introduction to VSI and CSI, Single phase half / full bridge VSI with R and R-L load, Three phase bridge inverters with R and R-L load (120 and 180), Voltage control of single phase inverter using PWM techniques, Numerical analysis essential, Introduction to multilevel inverters.	7
4	**Choppers** Introduction to DC-DC switching mode regulators, Buck, Boost, Buck-Boost, Cuk,SEPIC, Flyback, forward, push-pull regulators, Numericals essential	5

Text Book:

1. M. H. Rashid, *Power Electronic*s , Academic Press,2001 Pearson Education India, 2009

Reference:

1. P. C. Sen, *Power Electronics* , Tata McGraw-Hill Education, 1987.
2. N. Mohan, T.M. Undeland, W.P Robbins, *Power Electronics, Converters, Applications & Design*, Wiley India Pvt. Ltd. 2002

Course code	R5EL3007T	Semester	Vi	Credits	2	Scheme	2L:0T:0P
Course	EMBEDDED SYSTEMS						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Describe the software architecture of embedded system.
2. Identify the necessary communication Interface for the embedded system.
3. Implement systems softwares and application software related to real-time systems.
4. Design and develop the small-scale embedded systems.

Module	Content	Hrs
1	**Introduction to Embedded system** Introduction To Embedded Systems , Classification, Major Application Areas, Purpose Of Embedded Systems, Characteristics And Quality Attributes Of Embedded Systems.	2
2	**Software Architecture of Embedded System** Software Architecture: Services Provided By OS, Architecture Of Embedded OS, Categories Of Embedded OS, Application Software, Communication Software, Development And Testing Tools.	3
3	**Communication Interfaces** Need For Communication Interfaces, OSI Reference Model, Basic Of Networks, Network Topology, RS232/UART,RS422/RS485, USB,Infrared, Ethernet, IEEE 802.11, Bluetooth, SPI, I2C, CAN, Wifi, Flex Ray, LIN Bus, Zigbee. Galvanic Isolation and its importance.	6
4	**Embedded Software** Software Developments Tools, Cross Platform Development, Programming Languages Like Embedded C, Embedded C++ And J2ME , Device Drivers, Debuggers, Profilers, Code Optimization, Overview Of RTOS, Architecture Of Kernel, Task & Task Scheduler, ISR, Semaphore, Mutex, Mailbox, Message Queues, Event Registers, Pipes, Signals, Timers, Memory Management, Priority Inversion Problem.	6
5	**Embedded System Development & Testing** Different Embedded System Development Models, Requirement Engineering, Design Tradeoff, Co-Design, Hardware Design, Software Design, Implementation, Integration & Testing, Packaging, Configuration Management, Managing Embedded System Development Projects, Embedded System Failures.	6
6	**Design Examples & Case Studies of Embedded System** Digital Thermometer, Navigation Systems, Smart Card, RF Tag	5

Text Book:

1. Raj Kamal , *Embedded system ,* Third edition, Tata McGraw Hill, 2017.
2. Prasad , *Embedded Real time systems*,1st edition Dream tech press.2003

Reference:

1. David Simon, *An embedded Software Primer*, Pearson Publication, 2002.
2. Frank Vahid, *Embedded system- A unified Hardware Software Introduction*, John Wiley and Sons, 2002.

Course code	R5EL3007L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	EMBEDDED SYSTEMS LAB						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Design and implement programs on 8051 microcontroller and its derivatives
2. Connect sensors and implement programs using them
3. Using RTOS in embedded projects
4. Design build and test an embedded product

Lab Instructions: At least 1-2 experiments should be conducted on each topic

Sr.No.	Topics	
1	**Embedded Software Development Tools:** 1.1 Use Keil µVision 4/5 to create, compile, and flash a simple LED blink program on an 8051 derivative. 1.2 Enhance the blink project by using Timer 0 (in auto-reload mode) and interrupts to toggle the LED. 1.3 Build a visual flowchart-based application in Flowcode. 1.4 Develop, compile, and upload a basic Arduino sketch using the Arduino IDE.	
2	**Embedded sensors and peripheral modules:** Test several sensors and peripherals modules with 8051 and Arduino UNO boards.	
3	**Deployment of embedded system:** Deployment of software into hardware and testing hardware, software and hardware with software and measure design parameters	
4	**RTOS:** Study of Various Commands of RTOS like RTX51 tiny, Free RTOS, RTLinux and programming and develop multitasking software applications.	
5	**Embedded system design and implementation :** Design, build and test embedded product for various embedded applications using development systems and open source platforms.	

Text Book:

1. Raj Kamal , *Embedded system ,* Third edition, Tata McGraw Hill, 2017.
2. Prasad , *Embedded Real time systems*,1st edition Dream tech press.2003

Reference:

1. Mazidi, *8051 microcontroller and embedded system*, 2nd Edition, Pearson,2007.
2. Cornel Amariei, *Arduino Development Cookbook,*standard edition, Packt publishing, 2015.

Course code	R5EL3008T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	COMPUTER COMMUNICATION NETWORKS						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Define the network models, layered tasks and protocols for data transmission.
2. Estimate various parameters of Data Link Layer.
3. Analyze various parameters of Network Layer .
4. Describe the concept of Transport Layer and Application Layer.

Module	Content	Hrs
1	**Data Communication:** Components, Direction of Data flow, Networks, Types of connections, Topologies (Bus, Star, Ring, Mesh). Transmission Media – Twisted-Pair Cable, Coaxial Cable, Fibre Optics, Line Coding. Physical layer standards Basics of Message switching, Packet switching, Circuit switching and cell switching. Introduction to LAN, MAN, WAN.	07
2	**Protocols And Standards:Standards –** ISO/OSI reference model, Overview of TCP/IP architecture, TCP/IP model, Structured cabling and specification: Standard CAT5, 5ERS232 Interfacing Standard. **Networking Devices:**Internetworking device- hub, repeater, bridge- spanning tree algorithm, switch, router Interfaces and connectors.Performance factors – Throughput, Bandwidth and Latency, High speed networks, Application performance needs.	10
3	**Data Link Layer and Logical Link Control (LLC) sub-layer**: Framing; Error control including Bit-parity, CRC and Hamming Codes; Reliable transmission and Automatic Repeat Request (ARQ) protocols including Stop-and-Wait, Go-back-N, and Selective Repeat. Performance analysis of ARQ protocols. Example protocols such as HDLC and PPP. **Medium Access Control (MAC) sub-layer**: Random Access Protocols: CSMA, CSMA/CD,CSMA/CA IEEE 802.3; IEEE 802.11; Related protocols such as ICMP, NAT, ARP and RARP,VLAN	10
4	**Network Layer:Internet Protocol (IP) suite**; Hierarchical network architectures; IPv4 and IPv6 addressing and headers; Routing protocols including distance-vector and link-state approaches; Interior and Exterior Gateway Protocol concepts; Routing Algorithms including Dijkstra's algorithm and distributed Bellman-Ford algorithm; Example protocols: OSPF, RIP, BGP	08
5	**Transport Layer:** Reliable end-to-end transmission protocols; UDP header; TCP and congestion control; Window mechanisms in TCP. TCP and UDP services. **Application Layer**: DHCP introduction ,DHCP configuration,DNS, Need for DNS, SMTP, FTP, and HTTP.,Web server,	07

Text Books:

1. Andrew Tanenbaum, A. Forouzan, *Computer Networks* , Fifth Edition ,Person, 2010.
2. A. Forouzan, *Data Communication and networking* Fifth Edition, Mc Graw Hill., 2013.
3. Behrouz A. Forouzan, *TCP/IP Protocol Suite*, Fourth Edition , Tata Mc Graw Hill., 2010.

References:

1. Alberto Leon Garcia Indra Widjaja, *Communication networks Fundamental concepts and Key Architecture* , Second Edition, Tata Mc Graw Hill, 2004.
2. Darren L Spohn, *Data Network Design* , Third Edition , Tata Mc Graw Hill., 2002.
3. Derrick Rountree, Ileana Castrillo , *The Basics of Cloud Computing* , Syngress, 2013.

Course code	R5EL3008L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	COMPUTER COMMUNICATION NETWORK LAB						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Expertise in computer network simulation software.
2. Simulate and estimate parameters of the Ethernet network.
3. Simulate and estimate parameters in the Token ring network and Implement routing algorithm.
4. Design and test TCP/IP networks.

Sr.No.	Topics	
1	To study configuration of different network connecting devices.	
2	To perform the basic networking commands.	
3	To implement and simulate different network topology by using Computer network simulator.	
4	To implement bit stuffing and Destuffing at the data link layer.	
5	To implement and simulate Token Ring by using a Computer network simulator.	
6	To implement and simulate collision detection by using a Computer network simulator.	
7	To implement and examine performance of designed network via VLAN topology by using Computer network simulator.	
8	To implement and simulate Static Routing configuration by using Computer network simulator.	
9	To implement Routing Information Protocol by using a Computer network simulator.	
10	To simulate Open Short Path First by using a Computer network simulator.	
11	To simulate TCP and UDP Protocols by using Computer network simulator.	
12	To study about packet sniffers and see how they capture and analyze network traffic by using Wireshark.	

Text Books:

1. Andrew Tanenbaum A. Forouzan,, *Computer Networks* , Fifth Edition ,Person, 2010.
2. A. Forouzan, *Data Communication and networking* Fifth Edition, Mc Graw Hill., 2013.
3. Behrouz A. Forouzan, *TCP/IP Protocol Suite*, Fourth Edition , Tata Mc Graw Hill., 2010.

References:

1. Alberto Leon Garcia Indra Widjaja, *Communication networks Fundamental concepts and Key Architecture* , Second Edition, Tata Ma Graw Hill, 2004.
2. Darren L Spohn, *Data Network Design* , Third Edition , Tata Mc Graw Hill., 2002.
3. Derrick Rountree, Ileana Castrillo , *The Basics of Cloud Computing* , Syngress, 2013.

Course code	R5EL3402T	Semester	VI	Credits	2	Scheme	1L:0T:2P
Course	ELECTRONICS IN SERVICE TO SOCIETY						Category: PCC

Course Outcomes:

After the completion of course, the student should be able to

1. Analyze the needs of various sections of society who can benefit from Electronic interventions.
2. Translate the need into an idea of electronic systems.
3. Design and implement electronic systems using analog and digital components and sensors / transducers.

Module	Content	Hrs
1	**Analysis of an electronic aid / instrument / system** Requirements analysis to gather inputs to understand needs of various sections of society. Understand Government of India Schemes like - Make in India, Digital India,Start up India, Stand up India, Smart cities mission, Electronic manufacturing mission,Software parks, hardware parks, Facilities and support provided by various government agencies for these schemes.	7
2	**Design, fabricate and test an electronic system** Understand UN sustainable development goals. Design, fabricate, implement and test an electronic system with both analog and digital electronic components which will be a prototype of a product useful to society and confirming to UN sustainable development goals.	7

Program Elective-II [3(Th)+1(L) CREDIT]

Course code	R5EL3106T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	INTRODUCTION TO MICROFABRICATION						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Explain the process of crystal growth and wafer preparation, including cleanroom requirements and wafer cleaning techniques.
2. Describe the principles and mechanisms of oxidation, lithography and etching in semiconductor manufacturing processes and their impact on device performance.
3. Demonstrate an understanding of thin-film deposition methods and diffusion techniques used in IC fabrication.
4. Evaluate the significance of metallization and interconnects in semiconductor device performance and reliability.

Module	Content	Hrs.
1	**Crystal Growth & Wafer Preparation** History of IC's; Operation & Models for Devices of Interest: CMOS and MEMS.Crystal Growth, Wafer Preparation, Clean room and Wafer Cleaning: Definition, Need of Clean Room.	10
2	**Oxidation** Dry and Wet Oxidation, Oxidation Rate Constants, Dopant Redistribution, LOCOS, Oxidation System	9
3	**Lithography & Etching** Lithography: Overview of Lithography, Radiation Sources, Masks, Photoresist, Depth of Focus, Advanced Lithography. Etching: Wet Etching, Plasma Etching, Reactive Ion Etching. Overview of Interconnects, Contacts, Metallization	11
4	**Deposition & Diffusion** Thin Film Deposition: Physical Vapor Deposition: Thermal evaporation, Sputtering, Chemical Vapor Deposition, Plasma Enhanced CVD, Atomic layer deposition (ALD). Diffusion: Dose, 2-Step Diffusions, Junction Depth, Diffusion System. Ion Implantation, Applications in ICs, Annealing.	12

Text Book:

1. James D. Plummer, Michael D. Deal, Peter B. Griffin, *Silicon VLSI Technology-Fundamentals*, Practice, and Modeling, Prentice Hall Electronics and VLSI Series, 2000.

Reference:

1. Sorab K Gandhi, *VLSI Fabrication Principles: Silicon and Gallium ArsenideI*, 2nd Edition, Wiley,2008.
2. S. M. Sze, M. K. Lee, *Semiconductor Devices: Physics & Technology*, 3rd edition, John Wiley & Sons Inc, 2012.

Course code	R5EL3106L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	INTRODUCTION TO MICROFABRICATION LAB						Category: PEC

Course Outcomes:

After the completion of the course, the student should be able to

1. Simulate the process of Photo-lithography in CMOS fabrication and understand its impact on pattern transfer and device scaling.
2. Analyze and simulate oxidation processes in both dry and wet conditions to understand oxidation kinetics and its role in device insulation.
3. Model and simulate etching techniques (both dry and wet) and evaluate their effects on feature size and material selectivity.
4. Simulate the deposition processes used in CMOS fabrication, including Physical Vapor Deposition (PVD) and Chemical Vapor Deposition (CVD).
5. Implement diffusion processes and ion implantation techniques in CMOS fabrication, including junction depth and impurity profiles.

Sr.No.	Topics	
1	To simulate the process of Photo-lithography in CMOS Fabrication.	
2	To understand and simulate the Oxidation process in both dry and wet states.	
3	To simulate the process of Etching (Dry and Wet) in CMOS Fabrication.	
4	To simulate the Deposition process in CMOS Fabrication.	
5	To simulate the Diffusion process in CMOS Fabrication.	
6	To simulate the Ion Implantation process in CMOS Fabrication.	
7	To simulate the Annealing process in CMOS Fabrication.	
8	To simulate a MOS capacitor using a virtual fabrication process.	

Course code	R5EL3107T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	ERROR CORRECTING CODES						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Apply algebraic structures to construct Galois fields and cyclic codes.
2. Design and analyze error-correcting codes for reliable communication.
3. Implement compression and cryptographic coding for secure data transmission

Module	Content	Hrs
1	**Linear Abstract Algebra and Finite Fields** Groups, Fields, Rings, Vector spaces, subspaces, Galois field, Extension fields, Primitive element, primitive polynomial, GCD of polynomial, LCM of polynomial, minimal polynomial, cyclotomic cosets, factorization of (Xn-1) over a Galois field, construction of generator polynomial & parity check polynomial primitive nth root of unity.	8
2	**Linear Block Codes, Cyclic Codes** : Properties, Various methods of generation and detection of cyclic codes, error detecting capability, cyclic Hamming code.	6
3	**BCH codes** Binary primitive BCH codes, decoding, iterative algorithm for finding the error location polynomial, error location numbers and error correction, implementation of error correction, primitive BCH codes, RS codes, decoding of BCH and RS codes.	8
4	**Convolutional Codes** Encoder and decoder, structural properties, optimum decoding of Convolutional codes, Viterbi, soft output Viterbi, BCJR algorithm.	6
5	**Turbo codes and Low Density Parity Check Codes** Encoding, decoding scheme for Turbo code, Turbo code's application Encoding ,decoding scheme for LDPC , LDPC's application	6
6	**Compression Techniques and security coding techniques** Text compression, image compression and video compression techniques, Public key cryptography, coded based cryptosystem	8

Text Book:

1. Shu Lin, Daniel J.Costello, *Error Control Coding,* 2nd, Edition, Pearson-prentice Hall, Reprint, 2012.
2. K. Deergha Rao, *Channel Coding Techniques for Wireless Communications*, 2nd Edition, Springer, India, Private Ltd, 2016.

Reference:

1. G.Kabatiansky,E.Krouk,S.Semenov, *Error Control Coding and security for data network, Analysis of super channel concept* , John Wiley & Sons Ltd., 2005.
2. W. C. Huffman & Vera Pless, *Fundamentals of Error-Correcting Code* , Cambridge University Press; 1st edition (18 February 2010).
3. Stephen B. Wicker, *Error control systems for Digital communication & storage* , Prentice Hall,1995.
4. Ze-Nian Li,Mark S Drew and Jiangchuan Liu , *Fundamentals of Multimedia Video Compression* ,2nd Edition,Springer ,2014.
5. Richard E. Blahut, Th*eory and Practice of Error Control Codes* , Addison, Wesley Longman Publishing Co, 1983.

Course code	R5EL3107L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	ERROR CORRECTING CODES LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Implement the construction of GF(2^m), conjugacy classes, and minimal polynomials.
2. Develop and apply linear block, cyclic, convolutional, and Hamming codes for encoding and decoding.
3. Perform error detection and correction using specified generator polynomials and trellis structures.

Sr.No.	Topics	
1	Construction of GF(2^m)	
2	Construction of Conjugacy Classes	
3	Construction of Minimal Polynomials	
4	Encoding and Decoding using linear Block code	
5	Implementation of Cyclic Code	
6	Perform Convolutional encoding and decoding on a message sequence using the specified generator polynomial and trellis structure	
7	Implementation of Hamming Encoder and decoder	
8	Implementation of Turbo codes	

Course code	R5EL3108T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	ADVANCED DIGITAL SIGNAL PROCESSING						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Apply concept of linear algebra and Eigen analysis
2. Design and implement ARMA, AR and MA processes.
3. Apply MRA concepts.
4. Design wavelet based MRA for 1D 2D processing.

Module	Content	Hrs
1	**Multirate Digital Signal Processing** Decimation Interpolation Filter design and implementation Sampling rate conversion Application of multirate signal processing	7
2	**Review of Linear Algebra** Linear Algebra-Research part, abstractness, real life examples, Introduction to Random processes, numerical approach.	6
3	**Filtering Discrete Time random processes** Spectral Estimation, Levinson Durbin, evolution of Tukey, MUSIC..	7
4	**Spectral Factorization** Minimum phase signals & systems Partial energy & minimum delay Minimum phase & minimum delay property Spectral factorization theorem.	8
5	**Spectral Estimation by Classical methods** The periodogram The modified periodogram Barlett, Welch & BlackmanTuckey, approach	6
6	**Multiresolution Analysis using Wavelets** Introduction to time frequency analysis Short-time Fourier transform WignerVille transform Continuous time wavelet transform Discrete wavelet transform Tiling of the time-frequency plane and wavepacket analysis, Construction of wavelets, orthogonal, biorthogonal basis	8

Text Book:

1. S.M. Kay, *Modern Spectral Estimation*, Prentice hall, 1988.
2. J. G. Proakis, D.G. Manolakis, and D. Sharma, *Digital Time Signal Processing: principles, algorithms, and applications*, Pearson Education, 2006.
3. DaFatta, D. J., Lucas, J. G., and Hodgkiss, W. S,*Digital Signal Processing: A system design approach*, Wiley publications, 1988.
4. S.K. Mitra, *Digital Signal Processing: A Computer - Based Approach*, 4th edition, McGraw Hill Education,July 2013.

Reference:

1. R. M. Rao, and A.S. Bopardikar, *Wavelet Transforms*, Pearson Education, 2001.
2. C. S. Burrus, R. A. Gopinath, and H. Guo,. *Introduction to Wavelets and Wavelets Transforms*, PrenticeHall, 1998.
3. P. P. Vaidyanathan, *Multirate Systems and Filter Banks*, Prentice Hall, 1993.

Course code	R5EL3108L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	ADVANCED DIGITAL SIGNAL PROCESSING LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Apply and implement the concept of linear algebra and Eigen analysis.
2. Implement ARMA, AR and MA processes.
3. Apply MRA concepts.
4. Implement wavelet based MRA for speech and image signals.

Lab Instructions: At least 1-2 experiments should be conducted on each topic

Sr.No.	Topics	
1	**Multirate Digital Signal Processing:** Multirate sampling	
2	**Spectral Filtering** 2.1 Auto Regressive process 2.2 Moving average process 2.3 ARMA process	
3	**Filtering Discrete Time random processes** 3.1 Levinson Durbin, 3.2 Schur algorithm 3.3 Tukey algorithm 3.4 MUSIC algorithm	
4	**Spectral Estimation** Design and implementation of periodogram method, modified periodogram, Barlett, Welch & Blackman-Tuckey algorithms approach.	
5	**Multiresolution Analysis using Wavelets** MRA using filter banks	

Text Book:

1. S.M. Kay, *Modern Spectral Estimation*, Prentice hall, 1988.
2. J. G. Proakis, D.G. Manolakis, and D. Sharma, *Digital Time Signal Processing: principles, algorithms, and applications*, Pearson Education, 2006.

Reference:

1. R. M. Rao, and A.S. Bopardikar, *Introduction to Wavelets and Wavelets Transforms* ,Wiley publications , 1988.
2. C. S. Burrus, R. A. Gopinath, and H. Guo, *Introduction to Wavelets and Wavelets Transforms,* PrenticeHall, 1998.
3. P. P. Vaidyanathan, *Multirate Systems and Filter Banks*, Prentice Hall, 1993

Course code	R5EL3109T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	DATA SCIENCE						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Utilize sophisticated mathematical, statistical, and machine learning methods to extract meaningful insights and build predictive models from complex datasets.
2. Design and implement efficient data acquisition, cleaning, transformation, and storage processes using industry-standard tools and programming languages.
3. Articulate complex data findings and recommendations clearly and persuasively to both technical and non-technical audiences through compelling visualizations and narratives.
4. Analyze data science problems from diverse domains, select appropriate methodologies, and develop ethical and impactful solutions.

Module	Content	Hrs
1	**Foundational Mathematics and Statistics:** Linear Algebra: Vectors, matrices, matrix operations, systems of linear equations, eigenvalues and eigenvectors, dimensionality reduction techniques (e.g., Principal Component Analysis – PCA) Calculus: Differentiation, integration, optimization techniques (e.g., gradient descent). Probability and Statistics: Descriptive statistics: Measures of central tendency, dispersion, and shape. Probability theory: Basic concepts, conditional probability, Bayes' theorem. Probability distributions: Discrete (e.g., binomial, Poisson) and continuous (e.g., normal, exponential) distributions. Inferential statistics: Hypothesis testing, confidence intervals, p-values. Statistical modeling: Linear regression, logistic regression, analysis of variance (ANOVA)	9
2	**Programming and Data Handling** Programming Languages: Python: Fundamentals, data structures (lists, dictionaries, etc.), libraries for data manipulation (Pandas), numerical computation (NumPy), and visualization (Matplotlib, Seaborn). R: Fundamentals, data structures, statistical analysis capabilities, and visualization libraries. Database Management Systems: Relational databases (SQL): Database design, querying, data manipulation. NoSQL databases: Understanding different types (e.g., document, key-value) and their applications. Data Wrangling and Pre-processing: Data cleaning, Data transformation, Data integration.	9
3	**Core Data Science Concepts and Techniques** Exploratory Data Analysis (EDA): Techniques for visualizing and summarizing data to gain insights. Machine Learning: Supervised learning: Classification (e.g., decision trees, support vector machines, naive Bayes), regression (e.g., linear regression, polynomial regression). Unsupervised learning: Clustering (e.g., k-means, hierarchical clustering), dimensionality reduction (e.g., PCA, t-SNE), association rule mining. Model evaluation and selection: Metrics for classification and regression, cross-validation, hyperparameter tuning.	10

	Deep Learning: Neural networks: Fundamentals, activation functions, backpropagation. Convolutional Neural Networks (CNNs): Image recognition and processing. Recurrent Neural Networks (RNNs): Sequence data analysis (e.g., time series, natural language). Big Data Technologies: Distributed computing frameworks (e.g., Hadoop, Spark). Cloud computing platforms for data science (e.g., AWS, Azure and GCP). Data Visualization: Principles of effective data visualization, using tools and libraries to create informative charts and graphs (e.g., Tableau, Power BI, Python libraries).	
4	**Cutting-Edge Data Science Techniques** Natural Language Processing (NLP): Text analysis, sentiment analysis, topic modeling, language modeling. Computer Vision: Image analysis, object detection, image segmentation. Time Series Analysis: Forecasting, modeling time-dependent data. Big Data Analytics: Advanced techniques for analyzing large and complex datasets. Cloud Computing for Data Science: Utilizing cloud services for data storage, processing, and machine learning. Data Mining: Knowledge discovery from large datasets. Business Intelligence: Using data analysis to support business decision-making. Data Ethics and Privacy: Understanding ethical considerations and legal frameworks related to data collection and use. Domain-Specific Applications: Applying data science techniques to specific fields (e.g., healthcare, finance, marketing, environmental science).	8
5	**Research and Project Work** Research Methodology: Principles of scientific research, formulating research questions, designing experiments. Data Science Project: A significant hands-on project where students apply their knowledge and skills to solve a real-world problem. This often includes data collection, cleaning, analysis, modeling, and presentation of results.	6

Text Book:

1. Guttag, John. *Introduction to Computation and Programming UsinG Python: With Application to Understanding Data*. 2nd ed. MIT Press, 2016. ISBN: 9780262529624.
2. Gelman, Andrew, et al. *Bayesian Data Analysis*. 2nd ed. Chapman and Hall/CRC, 2003. ISBN: 9781584883883.

Reference:

1. Hastie, Trevor, Robert Tibshirani, and Jerome Friedman. The Elements of Statistical Learning: Data Mining, *Inference, and Prediction: with 200 full-color illustrations*. New York, NY: Springer, c2001. ISBN:0387952845.
2. Duda, Richard O., Peter E. Hart, and David G. Stork. *Pattern Classification*. New York, NY: John Wiley & Sons, 2000. ISBN: 9780471056690.
3. “Deep learning” by goodfellow, bengio and courville.
4. “Hands on Machine learning with scikit -learn, Keras & Tensor flow” by Aureleien Geron

Course code	R5EL3109L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	DATA SCIENCE LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Process and transform raw data into suitable formats
2. Implement Bayesian techniques for data analysis
3. Implement regularization techniques with interpretation
4. Implement clustering methods
5. Implement Monte Carlo simulation

Sr.No.	Topics	
1	Fundamentals of Python programming for data science	
2	Implement data visualization and wrangling (ggplot)	
3	Implement linear regression with different regularization techniques	
4	Implement Bayesian classifier with different densities	
5	Implement SVM classifier with feature kernel techniques	
6	Implement clustering using different methods	
7	Implement monte carlo simulation for complex problems	
8	Implement Machine learning algorithm on a distributed computing frameworks.	
9	Implement Machine learning algorithm on Cloud computing platforms.	

Course code	R5EL3110T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	WIRELESS SENSOR NETWORKS						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Describe the concepts, network architectures and applications of ad hoc and wireless sensor networks.
2. Analyze the protocol design issues of ad hoc and sensor networks.
3. Describe the concepts of communication, MAC, routing protocols and also study about the naming and addressing in WSN.
4. Simulate routing protocols for ad hoc and wireless sensor networks with respect to some protocol design issues.

Module	Content	Hrs
1	**Overview Of Wireless Sensor Networks** Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless Sensor Networks, Advantages of sensor networks- energy advantage, detection advantage, Sensor network applications- Habitat Monitoring, Tracking chemical plumes- Smart transportation.	8
2	**Architectures** Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, Network Architecture -Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts	9
3	**Networking Sensors** Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts- S-MAC, The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.	9
4	**Infrastructure Establishment** Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.	8
5	**Sensor Network Platforms And Tools** Sensor Node Hardware- Berkeley Motes, Programming Challenges, Node Level software platforms, Node-level Simulators, State-centric programming. Wireless Sensor Network Security	8

Text Book:

1. Holger Karl & Andreas Willig, *Protocols And Architectures for Wireless Sensor Networks* , John Wiley, 2005.
2. Feng Zhao & Leonidas J. Guibas, *Wireless Sensor Networks- An Information Processing Approach* , Elsevier, 2007.

Reference:

1. Kazem Sohraby, Daniel Minoli, & Taieb Znati, *Wireless Sensor Networks- Technology, Protocols, And Applications* , John Wiley, 2007.
2. Anna Hac, *Wireless Sensor Network Designs* , John Wiley, 2003
3. K. Akkaya and M. Younis, *A survey of routing protocols in wireless sensor networks* , Elsevier Ad Hoc Network Journal, Vol. 3, no. 3, pp. 325—349.
4. Philip Levis, T*inyOS Programming* .
5. Anna Ha'c, *Wireless Sensor Network Designs* , John Wiley & Sons Ltd,2003.

Course code	R5EL3110L	Semester	VI	Credits	1	Scheme	0L:0T:2P
Course	WIRELESS SENSOR NETWORKS LAB						Category: PEC

Course Outcomes:

After the completion of course, the student should be able to

1. Describe the concepts, network architectures and applications of ad hoc and wireless sensor networks.
2. Analyze the protocol design issues of ad hoc and sensor networks.
3. Describe the concepts of communication, MAC, routing protocols and also study about the naming and addressing in WSN.
4. Simulate routing protocols for ad hoc and wireless sensor networks with respect to some protocol design issues.

Sr. No.	Topics	
1	To study various wireless sensor network architectures	
2	To simulate adhoc sensor network and compute performance metrics	
3	To implement and compare various MAC layer protocols.	
4	To implement and compare AODV and DSR routing algorithms in MANET.	
5	To implement DSDV routing algorithms in MANET	
6	Build a decentralized sensor network to monitor environmental data (e.g., temperature, humidity, air quality) across multiple nodes.	
7	Design an ad-hoc sensor network to detect motion or presence.	
8	Create an autonomous ad-hoc network for smart indoor lighting based on occupancy.	

MDM-VI: Minor in Signal Processing and Imaging

Course code	R5EL3204T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	PATTERN RECOGNITION						Category: MDM

Course Outcomes:

After the completion of course, the student should be able to

1. Describe concepts of Pattern Recognition and its system, learning and adaptation for the classification.
2. Understand the principles of Bayesian and Maximum-likelihood parameter estimation and apply them in relatively simple probabilistic models such as Gaussian Model.
3. Perform data clustering in an unsupervised manner by means of various algorithms, such as parzen window density estimate
4. Understand the concept of classification using K-means and K-nearest neighbor and its applications

Module	Content	Hrs.
1	**Introduction** Machine perception, pattern recognition example, pattern recognition systems, the design cycle, learning and adaptation.	5
2	**Bayesian Decision Theory** Introduction, continuous features- two categories classifications, minimum error-rate classification- zero-one loss function, classifiers, discriminant functions, and decision surfaces	7
3	**Normal Density** Univariate and multivariate density, discriminant functions for the normal density different cases, Bayes decision theory - discrete features, compound Bayesian decision theory and context	5
4	**Maximum Likelihood and Bayesian Parameter Estimation** Introduction, maximum likelihood estimation, Bayesian estimation, Bayesian parameter estimation-Gaussian case	6
5	**Unsupervised Learning and Clustering** Introduction, mixture densities and identifiability, maximum likelihood estimates, application to normal mixtures, K-means clustering.	7
6	**Component Analyses** Principal component analysis, non-linear component analysis; Low dimensional representations and multi-dimensional scaling	6
7	**Discrete Hidden Markov Models** Introduction, Discrete-time markov process, extensions to hidden Markov models, three basic problems for HMMS	6

Text Book:

1. Duda, R.O., Hart, P.E., Stork, D.G. Pattern Classification , Wiley, 2nd Edition, 2001.
2. Eart Gose, Richard Johnsonburg and Steve Joust, Pattern Recognition and Image Analysis , Prentice-Hall of India- 2003.
3. Lawrence Rabiner, Biing, Hwang Juang, Fundamentals of Speech Recognition, Pearson education, 1st Edition, 2008.
4. T.M. Ross, Fuzzy logic,2nd Edition, Mc-Graw Hill Inc, 2007.

Reference:

1. Bishop, C. M., Pattern Recognition and Machine Learning , Springer, 2nd Edition, 2007.
2. Marsland, S., Machine Learning: An Algorithmic Perspective , CRC Press. 2009.
3. Theodoridis,S.& Koutroumbas, K., Pattern Recognition , 4th Edition, Academic Press, 2008.
4. Russell, S. and Norvig, N.,Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall, Series in Artificial Intelligence, 2009.

MDM-VI:Minor in Internet of Things

Course code	R5EL3203T	Semester	VI	Credits	3	Scheme	3L:0T:0P
Course	PRINCIPLES OF IOT						Category: PEC

Course Objective:

After the completion of course, the student should be able to

1. Define Internet of Things and its components.
2. Perform IoT Systems management
3. Design IoT systems
4. Analyze the system through Data Analytics tools.

Module	Content	Hrs.
1	**Introduction to IoT** Background and Vision; IoT as a Disruptive Technology; Standardization; Thing in the context of IoT; Needs of an IoT Thing; Commonly used smart Things; Machine to Machine (M2M) Technology	6
2	**IoT Standards and Protocols** An overview of Internet Principles; IPv6 and Its Role in IoT; Low Power Wide Area Network (LPWAN); Wireless Technologies supporting IoT application	6
3	**Wireless Sensor Networks in IoT:** Types of WSN and Their Architecture; Characteristics of Wireless Sensor Network; Network Topologies in Wireless Sensor Network; WSN Communication Protocols; Security in WSN; Real World WSN Applications	6
4	**Sensors, Actuators and Open Hardware in IoT** Introduction of sensors for different IoT applications, Perception Layer of IoT; Active sensors vs Passive Sensors; Understanding Various Commonly Used Sensors eg.: Light sensor, accelerometer, gyroscope, magnetometer, proximity, RFID; Environment Measuring Sensors; Flow and Fluid Measuring Sensors; Range and Motion Capture Sensors; Actuators; IoT Examples Open source IoT Hardware; Prototyping Boards for IOT - Arduino and Raspberry-pi	8
5	**IoT Software Platforms** Introduction to Middleware; Functional and Non-functional Requirements of IoT Middleware; Architectures of IoT Middleware; State-of-the-art IoT Middleware - Node-RED Introduction to IoT Software Platforms; Need and characteristics of IoT Platform, Commercial IoT Software Platforms - AWS, Microsoft Azure IoT suite; Open IoT Software Platform- things speak; Important considerations for selection of IoT Platform.	8
6	**Prototyping IoT Applications** Importance of prototyping and its benefits; Physical Design considerations; Prototyping Logical Design; Prototyping using Online API; Examples of Real world applications (Design stage and Test case)	8

Text Book:

1. Surya Durbha and Jyoti Joglekar, “Internet of Things”, Oxford University press,2021

Reference:

1. Cuno Pfister, “Getting Started with the Internet of Things”, O’Reilly Media.
2. Arshdeep Baga and Vijay Madisetti, “Internet of things, A hands-on approach.

Exit Course

Course code	R5EL3901T	Semester	-	Credits	2	Scheme	2L:0T:2P
Course	INDUSTRIAL AUTOMATION						Category: EC

Course Outcomes:

After the completion of course, the student should be able to

1. State the advanced automation system used in industrial level.
2. Illustrate automation hardware configuration for given application.
3. Analyse the given application and prepare a ladder logic program.
4. Understand Distributed Control Systems.

Module	Content	Hrs.
1	**Introduction** Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA).	7
2	**Automation components** Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity measurement. Actuators- Electrical, Hydraulic and Pneumatic.	7
3	**Programmable logic controllers** Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC Hardware, PLC selection, PLC Installation & Troubleshooting, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.	7
4	**Distributed Control System** Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.	7

Text Book:

1. Gary Dunning, *Introduction To Programmable logic control* , Cengage Learning.
2. F.D. Petruzella, *Programmable logic controllers* , (Third edition) TataMcGraw-Hill.
3. C.D. Johnson, *Process Control Instrumentation Technology*, PrenticeHall Of India Pvt. Limited.
4. John Hackworth and Federic Hackworth, Programmable logic controllers, Pearson education.

Reference:

1. Jon Stenerson, *Industrial automation and process Control* ,Prentice Hall.
2. D. Popovic, V. Bhatkar, *Distributed control systems in industrial automation*, Marcel Dekker Inc.

Course code	R5EL3901L	Semester	-	Credits	1	Scheme	0L:0T:2P
Course	INDUSTRIAL AUTOMATION LAB						Category: EC

Course Outcomes:

After the completion of course, the student should be able to

1. State the advanced automation system used at industrial level.
2. Illustrate automation hardware configuration for given application.
3. Analyse the given application and prepare a ladder logic program.
4. Understand Distributed Control Systems.

LIST OF TOPICS FOR INDUSTRIAL AUTOMATION LAB

Any 8-10 experiments are required to be performed

Sr.No.	Topics	
1	Verify functions of logic gates by using PLC	
2	Ladder program for Start stop logic using two inputs.	
3	Ladder program for push to start and push to stop. (Use single Push Button).	
4	Write and verify ladder program for sequential control of DC motors	
5	Use of Timers for Traffic Control	
6	Use of counters for pulse counting using limit switch/ proximity sensor.	
7	Design of temperature On-Off control loop using PLC.	
8	Use of sequencer instructions for stepper motor control.	
9	Development of ladder program for automated parking system.	
10	Design of PLC based application using conveyor system.	
11	Development of ladder program for security Gate to record entry and exit of employee and visitors	

Course code	R5EL3902T	Semester	-	Credits		Scheme	2L:0T:2P
Course	VIRTUAL INSTRUMENTATION SYSTEM						**Category**: EC

Course Outcomes:

After the completion of course, the student should be able to

1. Implement virtual instrumentation with LabVIEWprogramming
2. Write programs involving use of structures, arrays, file IO and data acquisition..

Module	Content	Hrs.
1	**Introduction:** Virtual Instrumentation: Historical Perspective, Block Diagram And Architecture Of A Virtual Instrument, Conventional Instruments Versus.Virtual Instruments, Data-Flow Techniques, Graphical Programming In Data Flow.	
2	**Vi Programming Techniques** Data Types, Vis And Sub-Vis, Structures (For, While Etc.) Arrays, Clusters, Shift Registers, Case And Sequence Structures, Formula Nodes. Debugging Techniques	
3	**Plotting And Export Data** Strings, File I/O, Plotting Data: Graphs And Charts, Report Generation.	
4	**Data Acquisition** Introduction To Data Acquisition On Pc, Digital I/O, Counters And Timers, Software And Hardware Installation, Calibration, Resolution, Data Acquisition Interface Requirements, Visa Programming.	
5	**Measurement Analysis Tools** Use Of Analysis Tools For Measurement Of Max, Min, Peak To Peak Voltage. Time Period Of Signal, Correlation Methods. Design Of Oscilloscope, Digital Multimeter.	
6	**Applications** System Development For A Process. Development Of Graphical User Interface (Gui). Implementation Of Various Controllers (On / Off Control, Pid Control) For A Process. Simulation Of A Simple Second Order System	

References:

1. Virtual Instrumentation using LABVIEW-Sanjay Gupta and Joseph John, TMH Publications, 2013.
2. LabVIEW for Everyone: Graphical Programming Made Easy and Fun by Jeffrey Travis, Jim Kring, Prentice Hall Publications,2006.
3. Learning with LabVIEW 2009,by Robert H. Bishop Prentice Hall Publication,1st edition,2009
4. LabVIEW Applications and Solutions by Rahman Jamal, Herbert Pichlik ,Prentice Hall Publications,1999.
5. LabVIEW Signal Processing by Mahesh L. Chugani,Abhay.R.Samant, Michael Cerna, Prentice Hall Publications,1998.
6. Basic Concepts of LabVIEW, by Leonard Sokoloff ,Prentice Hall Publications,1997.
7. www.ni.com

Course code	R5EL3902L	Semester	-	Credits		Scheme	2L:0T:2P
Course	VIRTUAL INSTRUMENTATION SYSTEM LAB						Category: EC

Course Outcomes:

After the completion of course, the student should be able to

1. Understand and apply basic programming constructs in LabVIEW.
2. Design and implement digital logic circuits and data handling techniques using LabVIEW.
3. Acquire and process real-time data using DAQ systems and file operations.
4. Model and simulate control systems and industrial automation applications.

Understand and apply basic programming constructs in LabVIEW.

Any 8-10 experiments are required to be performed.

Sr.No.	Topics	
1	To develop a VI to calculate speed, convert degree Celsius to Fahrenheit	
2	To develop a Sub VI to implement Half adder and Full ADDER	
3	To develop VI using FOR and WHILE loop to add 10 numbers, calculate Factorial Of a given number.	
4	To create VI to find roots of quadratic equation, user defined unit conversions etc using case structure.	
5	To create a VI student database using String control and Array and cluster functions.	
6	Applications of Graphical Programming Software in digital electronics—binary to decimal conversion etc.	
7	To develop a VI for storing all the points of simulated signal using File I/Os	
8	Build a VI to plot circle in XY graph, generate and plot random numbers on chart, different colors in an intensity graph etc with graph, chart properties and options.	
9	Measurement of AC/ DC voltage and current using DAQ cards	
10	Develop the VI, to On/Off the LED‘s using DAQ devices (Arduino, Raspberry Pi etc.)	
11	Applications of Graphical Programming Software in process tank level / temperature control, alarm annunciator, batch process control etc.	
12	To create VI to simulate bottle filling plant using Sequence structure.	
13	Applications of Graphical Programming Software in control —simulate first and second order system response, effect of damping factor etc.	
14	To create VI to simulate traffic light control, stirred tank heater etc. using Sequence structure.	