CURRICULUM FRAMEWORK FOR POST GRADUATE PROGRAMME IN ELECTRONICS AND COMMUNICATION ENGINEERING

AS PER NATIONAL EDUCATION POLICY (NEP)-2020

RAJIV GANDHI UNIVERSITY - A CENTRAL UNIVERSITY

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

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WITH EFFECT FROM ACADEMIC YEAR: 2026-27

1. **Program Educational Objectives (PEOs)** for a Master of Technology (M.Tech) in Electronics and Communication Engineering program involves defining clear, broad goals that align with the educational, career, and personal development of graduates.

PEO 1: Graduates will possess advanced knowledge and skills in computer science and engineering, enabling them to design, develop, and implement innovative solutions to complex computing problems.

PEO 2: Graduates will engage in cutting-edge research, contributing to the advancement of computer science and engineering through publications, patents, and innovative technologies.

PEO 3: Graduates will demonstrate leadership and management skills in professional environments, effectively leading teams, managing projects, and making strategic decisions.

PEO 4: Graduates will uphold high standards of ethical and professional conduct, considering the societal, environmental, and legal impacts of their work.

PEO 5: Graduates will commit to lifelong learning, continuously updating their skills and knowledge to keep pace with the rapidly evolving field of computer science and engineering.

These Program Educational Objectives aim to produce well-rounded graduates who are not only technically competent but also capable of leading, innovating, and acting ethically in their professional careers.

2. **Program Outcomes (POs)** for a postgraduate program in engineering are specific abilities and competencies that students are expected to acquire by the end of the program. Here are five POs for a Master of Technology (M.Tech) in Engineering program:

PO 1: Demonstrate advanced knowledge and technical skills in specialized areas of engineering, enabling the design, analysis, and implementation of complex systems.

PO 2: Conduct independent research and contribute to the body of knowledge in engineering by identifying research gaps, formulating research questions, and applying appropriate methodologies.

PO 3: Apply critical thinking and problem-solving skills to analyze complex engineering problems, develop innovative solutions, and make informed decisions.

PO 4: Utilize modern engineering tools, techniques, and software effectively for modeling, simulation, analysis, and design of engineering systems.

PO 5: Integrate knowledge from various engineering disciplines and apply interdisciplinary approaches to address complex engineering challenges.

PO 6: Communicate technical information effectively through written reports, presentations, and verbal discussions with both technical and non-technical audiences.

PO 7: Recognize and apply ethical principles and professional responsibilities in engineering practice, considering the impact of engineering solutions on society and the environment.

PO 8: Engage in lifelong learning and professional development to stay updated with advancements in technology, industry trends, and emerging engineering practices.

PO 9: Demonstrate project management skills and leadership qualities to plan, execute, and manage engineering projects efficiently, including resource management and teamwork.

PO 10: Understand the global and societal context of engineering practices and solutions, including sustainability, economic, environmental, and cultural considerations.

PO 11: 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

PO 12: 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

These Program Outcomes aim to equip graduates with a well-rounded set of skills and competencies, preparing them for successful careers in engineering and enabling them to contribute effectively to their fields and society.

3. **Program Specific Outcomes (PSOs)** are detailed, discipline-specific abilities that graduates of a particular program are expected to demonstrate. PSOs for a Master of Technology (M.Tech) in Electronics and Communication program are:

PSO1: Graduates will demonstrate expertise in emerging areas such as artificial intelligence, machine learning, big data analytics, cloud computing, and cybersecurity.

PSO2: Graduates will be capable of designing and architecting robust, scalable, and secure computer systems and networks, addressing both hardware and software aspects.

These Program Specific Outcomes aim to ensure that graduates of the M.Tech in Electronics and Communication program are well-prepared to tackle advanced technical challenges, contribute to innovative projects, and excel in specialized areas of their field.

MASTER OF TECHNOLOGY IN ELECTRONICS AND COMMUNICATION

Semester – I											
S/N	**Course Code**	**Course Name**	**Total Credits**	**Credits**			**Contact Hours**	**T/ P**	**Internal**	**End-Semester**	**Total Marks**
				L	**T**	**P**					
1	ECE-101-CC-5110	Advanced Digital Signal Processing	4	3	0	1	75	T	20	80	100
								P	20	80	100
2	ECE -101-CC-5120	Advanced Digital System Design	4	3	0	1	75	T	20	80	100
								P	20	80	100
3	ECE -101-CC-5130	MOS-VLSI Circuit Design	4	3	1	0	60	T	20	80	100
4	ECE -101-CC-5140	Digital Image and Video Processing	4	3	1	0	60	T	20	80	100
5	ECE-101-RC-5110	Research Methodology and IPR	4	3	1	0	60	T	20	80	100
		TOTAL	20	15	3	2					

Semester – II

S/N	Course Code	Course Name	Total Credits	Credits			Contact Hours	T/ P	Internal	End-Semester	Total Marks
				L	T	P					
1	ECE-101-CC-5210	Information Theory and Coding	4	3	0	1	75	T	20	80	100
								P	20	80	100
2	ECE -101-CC-5220	MEMS and Microsystems	4	3	0	1	75	T	20	80	100
								P	20	80	100
3	ECE -101-DE-52110	Artificial Intelligence	4	3	1	0	60	T	20	80	100
	ECE -101-DE-52120	Advanced Computer Architecture									
	ECE -101-DE-52130	Wireless Communication									
4	ECE -101-DE-52210	VLSI Testing and Testability	4	3	1	0	60	T	20	80	100
	ECE -101-DE-52220	Low Power VLSI Design									
	ECE -101-DE-52230	MIMO System									
5	ECE-101-RC-5210	Research and Publication Ethics	4	3	1	0	60	T	20	80	100
		TOTAL	20	15	3	2					

(M.TECH. WITH RESEARCH)

Semester – III & IV

S/N	Course Code	Course Name	Total Credits	Credits			Contact Hours	SEM	Internal	End-Semester	Total Marks
				L	T	P					
1	ECE-101-RD-6110	Dissertation-I	0	0	0	00	0	SEM-III	100	400	500
2	ECE-101-RD-6210	Dissertation-II	40	0	0	40	600	SEM-IV	100	400	500

(M.TECH. WITH COURSEWORK AND RESEARCH)

Semester – III											
S/N	Course Code	Course Name	Total Credits	Credits			Contact Hours	T/ P	Internal	End-Semester	Total Marks
				L	T	P					
1	ECE -101-CW-61010	Advanced Biomedical Signal Processing	4	3	1	0	60	T	20	80	100
2	ECE -101-CW-61020	Industrial and Process Control Instrumentation	4	3	1	0	60	T	20	80	100
3	ECE -101-CW-61030	Semiconductor Physics	4	3	1	0	60	T	20	80	100
4	ECE -101-CW-61040	Semiconductor Sensors and Actuators	4	3	1	0	60	T	20	80	100
5	ECE-101-PR-6110	Project	4	0	0	4	120	P	20	80	100
		TOTAL	20	12	4	4	360				

Semester – IV											
S/N	**Course Code**	**Course Name**	**Total Credits**	**Credits**			**Contact Hours**	**T/ P**	**Internal**	**End-Semester**	**Total Marks**
				L	**T**	**P**					
1	ECE-101-RP-6210	Research Project	20	0	0	20	600	P	100	400	500
		TOTAL	20	0	0	20					

SEMESTER I

ECE-101-CC-5110: Advanced Digital Signal Processing

Learning Objectives

LO1: To be able to understand the Filters.

LO2: To be able to designed filters for signal processing.

Course Outcomes

CO1: Learn different techniques for filter design.

CO2: Understanding of sampling techniques.

CO3: Understanding of linear filters.

CO4: Understand the techniques for various adaptive filtering.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Introduction to DSP, time and frequency representation of signal, DTFT, FFT Algorithms, Digital filter design and structures: Basic FIR/IIR filter design &structures, design techniques of FIR filters, IIR filters by impulse invariance, bilinear transformation, FIR/IIR Cascaded lattice structures.	15	1
2	Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, digital filter banks, Multi rate DSP. Stationary random processes — autocorrelation, PSD, Linear prediction, forward-backward linear prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.	15	1,2
3	Introduction to adaptive filtering and applications, Gradient descent and steepest descent method, Minimum Mean Square Error (MMSE) criterion, LMS algorithm, Recursive Least Square algorithm. Estimation of Spectra from Finite-Duration Observations of Signals. Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation	15	3, 4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

The Mapping Level Contribution between COs-POs/PSOs are Categorized as [3: High; 2: Medium; 1: Low; -: No Correlation]

Books Recommended

1. Proakis and D.G. Manolakis "Digital signal processing: Principles, Algorithm and Applications", 4th Edition, Prentice Hall, 2007.
2. N. J. Fliege, "Multirate Digital Signal Processing: Multirate Systems -Filter Banks –Wavelets", 1st Edition, John Wiley and Sons Ltd, 1999.

References

1. Bruce W. Suter, "Multirate and Wavelet Signal Processing",1st Edition, Academic Press, 1997.

SEMESTER I

ECE -101-CC-5120: Advanced Digital System Design

Learning Objectives

LO1: To be able to understand the Logic Design.

LO2: To be able to designed digital System.

Course Outcomes

CO1: Understand the combinational and sequential circuit logic.

CO2: Learn the different technique to realize the sequential circuit from the Boolean equation.

CO3: Understanding of design procedure of logic circuits.

CO4: Learn the realization of state machine using mealy and moore machine.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Introductory concepts of Basic logic gates, Decoders, Encoders, Multiplexers, Implementing functions using Multiplexers, Demultiplexers, half adder, full adder, half subtractor, full subtractor, Parity Generators and Checkers, Signed Binary Arithmetic, ripple carry adders, BCD adders, carry look ahead adder.	15	1
2	Introduction to sequential circuits, latch, flip-flop, Synchronous and Asynchronous Digital Counters and shift registers, Mealy machine, Moore machine, State diagrams, State table minimization, realization of Mealy and Moore machine. State transition table- state assignment for FPGAs, Algorithmic State Machine Charts, Derivation of ASM Charts, Realization of ASM charts, linked state machines, Implementation of Binary Multiplier, dice game controller.	15	1,2
3	Basic concepts, Programming technologies, Programmable Logic Element (PLE), Programmable Logic Array (PLA), Programmable Array Logic (PAL), Fault table method-path sensitization method - Boolean difference method-D algorithm Tolerance techniques - The compact algorithm - Fault in PLA. Structure of standard PLDs, complex PLDs (CPLD). Design of combinational and sequential circuits using PLD's, Introduction to Field Programmable Gate Arrays-types of FPGA- XILINX XC 3000 series and 4000 series.	15	3, 4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

The Mapping Level Contribution between COs-POs/PSOs are Categorized as [3: High; 2: Medium; 1: Low; -: No Correlation]

Books Recommended

1. Digital Design – Morris Mano, M.D.Ciletti, 4th Edition, PHI.
2. Verilog HDL – Guide to Digital Design and Synthesis- Samir Palnitkar, Pearson Education, 3rd Edition, 2003.

References

3. Fundamentals of Logic Design – Charles H. Roth, 5th Ed., Cengage Learning.

SEMESTER I

ECE -101-CC-5130: MOS-VLSI Circuit Design

Learning Objectives

LO1: To be able to CMOS Circuit.

LO2: To be able to designed CMOS Circuits.

Course Outcomes

CO1: Understand realization of digital logic using CMOS.

CO2: Understand the physics of MOSFET.

CO3: Learn the analysis of static and dynamic power dissipation of circuits.

CO4: Learn the concept of digital switches

Course Contents

Unit No.	Content	Contact Hours	CO
1	Classification of CMOS digital circuits and Circuit design, Overview of VLSI design methodologies, VLSI design flow, Design hierarchy and concepts, VLSI design styles, Design quality, Packing technology, CAD technology, Fabrication process flow, CMOS n-well process, layout design rules.	15	1
2	MOS structure, MOS system under external bias, structure and operation of MOS transistor, MOSFET current/voltage characteristics, MOSFET scaling and small-geometry effects, MOSFET capacitances, Modeling of MOS transistor.	15	1,2
3	Introduction, Resistive-Load Inverter, Inverter with n-type MOSFET load, CMOS Inverter, Delay-Time Definitions, Calculation of Delay Times, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitics, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters	15	3, 4
4	Introduction, MOS logic circuits with depletion nMOS loads, CMOS logic Circuits, Complex logic circuits, CMOS transmission gates (Pass gates), Behavior of bistable elements, SR latch circuit, clocked latch and flip-flop circuits, CMOS D-latch and Edge-triggered flip-flop.	15	4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

The Mapping Level Contribution between COs-POs/PSOs are Categorized as [3: High; 2: Medium; 1: Low; -: No Correlation]

Books Recommended

1. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits" TMH 2003
2. Neil H. E. Weste and David. Harris Ayan Banerjee "CMOS VLSI Design" - Pearson Education, 1999.

References

1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits" Pearson Education, 2003

SEMESTER I

ECE -101-CC-5140: Digital Image and Video Processing

Learning Objectives

LO1: To be able understand the different image format.

LO2: To be able to understand techniques for image and video segmentation.

Course Outcomes

CO1: Understand the different image format.

CO2: Learn different techniques for image enhancement, video and image recovery.

CO3: Understand techniques for image and video segmentation.

CO4: Apply morphological image processing and spatiotemporal analysis techniques for object extraction, tracking, and motion-based video processing applications.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Digital image and video fundamentals and formats, 2-D and 3-D sampling and aliasing, 2-D/3-D filtering, image decimation/interpolation, video sampling and interpolation, Basic image processing operations, Image Transforms Need for image transforms, DFT, DCT, Walsh, Hadamard transform, Haar transform, Wavelet transform.	15	1
2	Histogram, Point processing, filtering, image restoration, algorithms for 2-D motion estimation, change detection, motion-compensated filtering, frame rate conversion, deinterlacing, video resolution enhancement, Image and Video restoration (recovery).	15	1,2
3	Discontinuity based segmentation- Line detection, edge detection, thresholding, Region based segmentation, Scene Change Detection, Spatiotemporal Change Detection, Motion Segmentation, Simultaneous Motion Estimation and Segmentation, Semantic Video Object Segmentation, Morphological image processing.	15	3, 4
4	Colour fundamentals, Colour models, Conversion of colour models, Pseudo color image processing, Full colour processing.	15	4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

The Mapping Level Contribution between COs-POs/PSOs are Categorized as [3: High; 2: Medium; 1: Low; -: No Correlation]

Books Recommended

1. Ed. Al Bovik ,"Handbook of Image and Video Processing", 2nd Edition, Academic Press, 2000.
2. J. W. Woods, "Multidimensional Signal, Image and Video Processing and Coding",2nd Edition, Academic Press, 2011.

References

1. Rafael C. Gonzalez and Richard E. Woods," Digital Image Processing", 3rd Edition, Prentice Hall, 2008.

SEMESTER I

ECE-101-RC-5110: Research Methodology and IPR

Learning Objectives

LO1: Will be able to understand research problem formulation.

LO2: To be able to understand that IPR protection provides an incentive to inventors for further research

Course Outcomes

CO1: Understand research problem formulation.

CO2: Analyze research related information.

CO3: Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.

CO4: Understand that IPR protection provides an incentive to inventors for further research.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations	15	1
2	Effective literature studies approaches, analysis Plagiarism, Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	15	1,2
3	Nature of Intellectual Property: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.	15	3, 4
4	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	15	4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

The Mapping Level Contribution between COs-POs/PSOs are Categorized as [3: High; 2: Medium; 1: Low; -: No Correlation]

Books Recommended

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

References

3. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007

SEMESTER II

ECE-101-CC-5210: Information Theory and Coding

Learning Objectives

LO1: Will be able to design the channel performance using information theory.

LO2: To be able to comprehend various error control properties.

Course Outcomes

CO1: Design the channel performance using information theory.

CO2: Comprehend various error control properties.

CO3: Apply linear block codes for error detection and correction.

CO4: Apply convolution codes for performance analysis & cyclic codes for error detection and correction.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Source Coding - Introduction to information theory, uncertainty and information, average mutual information and entropy, source coding theorem, Shannon-fano coding, Huffman coding, Adaptive Huffman coding, Arithmetic coding, Lempel-Ziv algorithm, run-length encoding and rate distortion function.	15	1
2	Channel capacity and coding - channel models, channel capacity, channel coding, information capacity theorem, random selection of codes. Error control coding: linear block codes and their properties, decoding of linear block code, perfect codes, hamming codes, optimal linear codes and MDS codes.	15	1,2
3	Cyclic codes - polynomials, division algorithm for polynomials, a method for generating cyclic codes, matrix description of cyclic codes, burst error correction, fire codes, golay codes, CRC codes, circuit implementation of cyclic codes. BCH codes: minimal polynomials, generator polynomial for BCH codes, decoding of BCH codes, Reed-Solomon codes and nested codes. Convolutional codes - tree codes and trellis codes, polynomial description of convolutional codes, distance notions for convolutional codes, generation function, matrix description of convolutional codes, viterbi decoding of convolutional codes, distance bounds for convolutional codes, turbo codes and turbo decoding.	15	3, 4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

The Mapping Level Contribution between COs-POs/PSOs are Categorized as [3: High; 2: Medium; 1: Low; -: No Correlation]

Books Recommended

1. Ranjan Bose, "Information theory, coding and cryptography", Tata McGraw Hill, 2002.
2. Viterbi, "Information theory and coding", McGraw Hill, 1982.

References

1. John G. Proakis, "Digital Communications", 2nd Edition, McGraw Hill, 1989.

SEMESTER II

ECE-101-CC-5210: MEMS and Microsystems

Learning Objectives

LO1: Will be able to understand the semiconductor-based MEMS Devices.

LO2: To be able to learn the various types of actuators and sensors.

Course Outcomes

CO1: Understand the semiconductor-based MEMS Devices.

CO2: Understand the working principle of MEMS devices.

CO3: Learn the various types of actuators and sensors.

CO4: Learn the modelling and simulation of MEMS Devices.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Introduction to MEMS, Micro-System; Evolution of Micro-System; Integrated Microsystem: Micromechanical Structure; Micro-Sensor, Micro-Actuator, Sensor Characteristic; Physical Principle of Sensing; Application of Smart Material and Microsystem. MEMS Materials and their Preparation: Overview, Atomic Structure and the Periodic Table, Atomic Bonding, Crystallinity; Metals: Physical and Chemical Properties, Metallization, Semiconductors: Semiconductors: Electrical and Chemical Properties, Semiconductors: Growth and Deposition; Ceramic, Polymeric, and Composite Materials.	15	1
2	Microsystem: Silicon Capacitive Accelerometer, Piezoresistive Pressure Sensor, Conductometric Gas Sensor, Electrostatic Comb Drive, Magnetic Microrelay, Smart Material: Thermoresponsive Material, Piezoelectric Material, Electrostatic/ Electromagnetic Material, Rheological Material, Electrochromic Material, Biomimetic Material, Smart Gel. Mechanics of beam and diaphragm structures	15	1,2
3	Electronics Circuit and Control for Micro and Smart System: Semiconductor Devices; Electronics Amplifier; Practical Signal Conditioning Circuit for Microsystem; Circuit for Conditioning Sensed Signal; Introduction to control System.	15	3, 4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

The Mapping Level Contribution between COs-POs/PSOs are Categorized as [3: High; 2: Medium; 1: Low; -: No Correlation]

Books Recommended

1. "Microsystem Design", Stephen D.Senturia, Kluwer Academic publishers, ISBN: 0-7923-7246-8
2. Handbook Of Modern Sensors Physics, Designs, and Applications", Jacob Fraden, Springer, ISBN 0-387-00750-4.

References

1. "Microsensors, MEMS, and Smart Devices" Julian W. Gardner, Vijay K., Awadelkarim, John Wiley & Sons, Ltd, ISBN 0-471-86109-X

SEMESTER II

ECE -101-DE-52110: Artificial Intelligence

Learning Objectives

LO1: Will be able understand the different search technique.

LO2: To be able to understand the concept of Artificial Intelligence, search techniques and knowledge representation issues.

Course Outcomes

CO1: Understand the different search technique.

CO2: Understand the concept of Artificial Intelligence, search techniques and knowledge representation issues.

CO3: Understand the statistical problem solving.

CO4: Understanding reasoning and fuzzy logic for artificial intelligence.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Introduction to AI; Human Brain; Model of Neurons; Knowledge Representation; Search Methodology: Problem Solving as Search; Data-Driven or Goal-Driven Search; Generate and Test; Depth-First Search; Breadth-First Search; Properties of Search Methods: Complexity, Completeness, Optimality, Irrevocability; Hill Climbing; Best-First Search; Beam Search; Identifying Optimal Paths: A* Algorithms, Uniform Cost Search, Greedy Search.	15	1
2	Learning Process: Introduction; Error Correction Learning; Memory Base Learning; Hebbian, Learning; Competitive Learning; Boltzmann Learning; Credit Assign Learning; Learning with a Teacher; Learning without a Teacher; Learning Task; Memory; Adaptation; Statistical Nature of the Learning Process.	15	1,2
3	Introduction to Perceptron, Multilayer Neural Networks: Back Propagation, Improving the performance of Back Propagation; Recurrent Network: Hopfield Networks, Bidirectional Associative Memories; Issues in Back propagation: Batch versus online Learning, Activation Function, Initialization of weight, Moment and speed of conversance, Stopping Criteria, Local Minima, Weight decay and Generation. Adaptive parameter, The number of Hidden Neurons. Introduction to CNN	15	2,3
4	Fuzzy logic: Introduction, Fuzzy set, Set operation, Boolean logic, Basic Concept of Fuzzy set, Representation of Fuzzy Set, Fuzzy set Properties, Operation of Fuzzy set, Algebraic Operations on Fuzzy Sets, Classical Relations, Classical Reasoning, Fundamentals of Fuzzy Relations, Operations on Binary Fuzzy Relations, Types of Fuzzy Relations, Fuzzy Reasoning, Examples.	15	3,4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

Books Recommended

1. Elaine Rich and Kevin Knight "Artificial Intelligence", 2nd Edition, Tata Mcgraw-Hill, 2005.
2. Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall, 2009.

References

1. Artificial Intelligence: Foundations of Computational Agents *is a comprehensive textbook by David L. Poole and Alan K. Mackworth.*

SEMESTER II

ECE -101-DE-52110: Artificial Intelligence

Learning Objectives

LO1: Will be able understand the different search technique.

LO2: To be able to understand the concept of Artificial Intelligence, search techniques and knowledge representation issues.

Course Outcomes

CO1: Understand the different search technique.

CO2: Understand the concept of Artificial Intelligence, search techniques and knowledge representation issues.

CO3: Understand the statistical problem solving.

CO4: Understanding reasoning and fuzzy logic for artificial intelligence.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Introduction to AI; Human Brain; Model of Neurons; Knowledge Representation; Search Methodology: Problem Solving as Search; Data-Driven or Goal-Driven Search; Generate and Test; Depth-First Search; Breadth-First Search; Properties of Search Methods: Complexity, Completeness, Optimality, Irrevocability; Hill Climbing; Best-First Search; Beam Search; Identifying Optimal Paths: A* Algorithms, Uniform Cost Search, Greedy Search.	15	1
2	Learning Process: Introduction; Error Correction Learning; Memory Base Learning; Hebbian, Learning; Competitive Learning; Boltzmann Learning; Credit Assign Learning; Learning with a Teacher; Learning without a Teacher; Learning Task; Memory; Adaptation; Statistical Nature of the Learning Process.	15	1,2
3	Introduction to Perceptron, Multilayer Neural Networks: Back Propagation, Improving the performance of Back Propagation; Recurrent Network: Hopfield Networks, Bidirectional Associative Memories; Issues in Back propagation: Batch versus online Learning, Activation Function, Initialization of weight, Moment and speed of conversance, Stopping Criteria, Local Minima, Weight decay and Generation. Adaptive parameter, The number of Hidden Neurons. Introduction to CNN	15	2,3
4	Fuzzy logic: Introduction, Fuzzy set, Set operation, Boolean logic, Basic Concept of Fuzzy set, Representation of Fuzzy Set, Fuzzy set Properties, Operation of Fuzzy set, Algebraic Operations on Fuzzy Sets, Classical Relations, Classical Reasoning, Fundamentals of Fuzzy Relations, Operations on Binary Fuzzy Relations, Types of Fuzzy Relations, Fuzzy Reasoning, Examples.	15	3,4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

Books Recommended

1. Elaine Rich and Kevin Knight "Artificial Intelligence", 2nd Edition, Tata Mcgraw-Hill, 2005.
2. Stuart Russel and Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall, 2009.

References

1. Artificial Intelligence: Foundations of Computational Agents *is a comprehensive textbook by David L. Poole and Alan K. Mackworth.*

SEMESTER II

ECE -101-DE-52120: Advanced Computer Architecture

Learning Objectives

LO1: Will be able understand the application of pipelining and parallelism.

LO2: To understand parallelism and pipelining concepts, the design aspects and challenges.

Course Outcomes

CO1: Understand parallelism and pipelining concepts, the design aspects and challenges.

CO2: Understand the application of pipelining and parallelism.

CO3: Evaluate the issues in vector and array processors.

CO4: Study and analyze the high performance scalable multithreaded and multiprocessor systems.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Parallel Processing and Pipelining Processing- Architectural Classification, Applications of parallel processing, Instruction level Parallelism and Thread Level Parallelism, Explicitly Parallel Instruction Computing (EPIC) Architecture.	15	1
2	Pipeline Architecture-Principles and implementation of Pipelining, Classification of pipelining processors, Design aspect of Arithmetic and Instruction pipelining, Pipelining hazards and resolving techniques, Data buffering techniques, Advanced pipelining techniques, Software pipelining, VLIW (Very Long Instruction Word) processor.	15	1,2
3	Vector and Array Processor- Issues in Vector Processing, Vector performance modeling, SIMD Computer Organization, Static Vs Dynamic network, Parallel Algorithms for Array Processors: Matrix Multiplication.	15	2,3
4	Multiprocessor Architecture - Loosely and Tightly coupled multiprocessors, Inter Processor communication network, Time shared bus, Multiport Memory Model, Memory contention and arbitration techniques, Cache coherency and bus snooping, Massively Parallel Processors (MPP).	15	3,4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

The Mapping Level Contribution between COs-POs/PSOs are Categorized as [3: High; 2: Medium; 1: Low; -: No Correlation]

Books Recommended

1. Kai Hwang, Faye A. Briggs, "Computer Architecture and Parallel Processing" McGraw Hill Education, 2012.
2. Kai Hwang, "Advanced Computer Architecture", McGraw Hill Education, 1993.

References

3. Kai Hwang, "Scalable Parallel Computing", McGraw Hill Education, 1998.

SEMESTER II

ECE -101-DE-52130: Wireless Communication

Learning Objectives

LO1: Will be able to Design appropriate mobile communication systems.

LO2: Will be able to Analyze path loss and interference for wireless telephony and their influences on a mobile-communication system's performance.

Course Outcomes

CO1: Design appropriate mobile communication systems.

CO2: Apply frequency-reuse concept in mobile communications, and to analyze its effects on interference, system capacity, handoff techniques

CO3: Analyze path loss and interference for wireless telephony and their influences on a mobile-communication system's performance.

CO4: Distinguish various multiple-access techniques for mobile communications e.g. FDMA, TDMA, CDMA, and their advantages and disadvantages.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Cellular Communication Fundamentals: Cellular system design, Frequency reuse, cell splitting, handover concepts, Co channel and adjacent channel interference, interference reduction techniques and methods to improve cell coverage, Frequency management and channel assignment.GSM architecture and interfaces, GSM architecture details, GSM subsystems, GSM Logical Channels, Data Encryption in GSM, Mobility Management, Call Flows in GSM.2.5 G Standards: HSCSD, GPRS, 2.75 G Standards: EDGE.	15	1
2	Spectral efficiency analysis based on calculations for Multiple access technologies: TDMA, FDMA and CDMA, Comparison of these technologies based on their signal separation techniques, advantages, disadvantages and application areas. Wireless network planning.	15	1,2
3	Mobile Radio Propagation: Large Scale Path Loss, Free Space Propagation Model, Reflection, Ground Reflection Model, Diffraction, Scattering, Practical Link Budget Design using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings. Small Scale Fading and Multipath Propagation, Impulse Response Model, Multipath Measurements, Parameters of Multipath channels, Types of Small-Scale Fading: Time Delay Spread; Flat, Frequency selective, Doppler Spread; Fast and Slow fading	15	2,3
4	Equalization, Diversity: Equalizers in a communications receiver, Algorithms for adaptive equalization, diversity techniques, space, polarization, frequency diversity, Interleaving. Code Division Multiple Access: Introduction to CDMA technology, IS 95 system Architecture, Higher Generation Cellular Standards:3G Standards: evolved EDGE, enhancements in 4G standard, Architecture and representative protocols, call flow for LTE, VoLTE, UMTS, introduction to 5G	15	3,4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

Books Recommended

1. V.K. Garg, J.E. Wilkes, "Principle and Application of GSM", Pearson Education, 5th edition, 2008.
2. V.K. Garg, "IS-95 CDMA & CDMA 2000", Pearson Education, 4 th edition, 2009.

References

1. Asha Mehrotra, "A GSM system Engineering" Artech House Publishers Bosten, London,1997.

SEMESTER II

ECE -101-DE-52210: VLSI Testing and Testability

Learning Objectives

LO1: Will be able to understand the different types of faults in digital circuits

LO2: Learn the use of scan chain in digital circuit testing

Course Outcomes

CO1: Understand the different types of faults in digital circuits

CO2: Learn the ATPG algebra for both combinational and sequential circuits

CO3: Learn the use of scan chain in digital circuit testing

CO4: Learn the Ad-hoc design for testability.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Physical Faults and their modelling: Stuck at Faults, Bridging Faults, Fault detection, Fault Equivalence, Fault Dominance, Fault Collapsing and Checkpoint Theorem, General fault simulation techniques serial, parallel, concurrent and deductive fault simulation, critical path tracing.	15	1
2	Introduction to Automatic Test Pattern Generation (ATPG) and ATPG Algebras. ATPG for single stuck-at faults and multiple stuck-at faults. Standard ATPG Algorithms: D-algorithm. Basics of PODEM and FAN.	15	1,2
3	ATPG for Single-Clock Synchronous Circuits, Use of Nine-Valued Logic and Time-Frame Expansion Methods, Complexity of Sequential ATPG Scan Chain based Sequential Circuit Testing: Scan Cell Design, Design variations of Scan Chains, Sequential Testing based on Scan Chains, Overheads of Scan Design.	15	2,3
4	Ad-hoc design for testability- test points, Controllability and Observability of digital circuits, partial scan and full scan, serial and non-serial scan; boundary scan standard. Built in Self-test, Architecture of BIST, LFSR and Compaction Techniques, Memory Testing: Memory architecture, types of faults in memory and March Test	15	3,4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

The Mapping Level Contribution between COs-POs/PSOs are Categorized as [3: High; 2: Medium; 1: Low; -: No Correlation]

Books Recommended

1. Bushnell and V D Agarwal," Essential of Electronics Testing", Kluwer.
2. Laung, Cheng and Xiaoqing" VLSI Test principles and architectures"Elsevier.
3. Abramovici, M., Breuer, M. A. and Friedman, "A. D. Digital Systems Testing And Testable Design". IEEE press (Indian edition available through Jayco Publishing house), 2001

SEMESTER II

ECE -101-DE-52220: Low Power VLSI Design

Learning Objectives

LO1: Will be able to identify the sources of power dissipation in digital IC systems & understand the impact of power on system performance and reliability.

LO2: Will be able to characterize and model power consumption & understand the basic analysis methods.

Course Outcomes

CO1: Identify the sources of power dissipation in digital IC systems & understand the impact of power on system performance and reliability.

CO2: Characterize and model power consumption & understand the basic analysis methods.

CO3: Design techniques of low power circuit.

CO4: Understand leakage sources and reduction techniques.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Technology & Circuit Design Levels: Sources of power dissipation in digital ICs, degree of freedom, recurring themes in low-power, emerging low power approaches, dynamic dissipation in CMOS, effects of Vdd & Vt on speed, constraints on Vt reduction, transistor sizing & optimal gate oxide thickness, impact of technology scaling, technology innovations.	15	1
2	Low Power Circuit Techniques: Power consumption in circuits, flip-flops & latches, high capacitance nodes, energy recovery, reversible pipelines, high performance approaches.	15	1,2
3	Low Power Clock Distribution: Power dissipation in clock distribution, single driver, Versus distributed buffers, buffers & device sizing under process variations, zero skew Vs. Tolerable skew, chip & package co-design of clock network.	15	2,3
4	Logic Synthesis for Low Power estimation techniques: Power minimization techniques, low power arithmetic components- circuit design styles, adders, multipliers. Low Power Memory Design: Sources & reduction of power dissipation in memory subsystem, sources of power dissipation in DRAM & SRAM, low power DRAM circuits, low power SRAM circuits.	15	3,4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

The Mapping Level Contribution between COs-POs/PSOs are Categorized as [3: High; 2: Medium; 1: Low; -: No Correlation]

Books Recommended

1. P. Rashinkar, Paterson and L. Singh, "Low Power Design Methodologies", Kluwer Academic, 2002
2. Kaushik Roy, Sharat Prasad, "Low power CMOS VLSI circuit design", John Wiley sons Inc.,2000.

References

1. J.B.Kulo and J.H Lou, "Low voltage CMOS VLSI Circuits", Wiley, 1999.

SEMESTER II

ECE -101-DE-52230: MIMO System

Learning Objectives

LO1: To understand channel modelling and propagation, multi-user Communications,

LO2: Will be able to • Understand MIMO Capacity, space-time coding, MIMO receivers

Course Outcomes

CO1: Understand channel modelling and propagation, multi-user Communications,

CO2: Understand MIMO Capacity, space-time coding, MIMO receivers

CO3: Understand MIMO for multi-carrier systems (e.g. MIMO-OFDM),

CO4: Understand cooperative and coordinated multi-cell MIMO.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Introduction to Multi-antenna Systems, Motivation, Types of multi-antenna systems, MIMO vs. multi-antenna systems. Diversity, Exploiting multipath diversity, Transmit diversity, Space-time codes, The Alamouti scheme, Delay diversity, Cyclic delay diversity, Space-frequency codes, Receive diversity, The rake receiver, Combining techniques, Spatial Multiplexing, Spectral efficiency and capacity, Transmitting independent streams in parallel, Mathematical notation.	15	1
2	The generic MIMO problem, Singular Value Decomposition, Eigen values and eigenvectors, Equalising MIMO systems, Disadvantages of equalising MIMO systems, Pre-distortion in MIMO systems, Disadvantages of pre-distortion in MIMO systems, Pre-coding and combining in MIMO systems, Advantages of pre-coding and combining, Disadvantages of pre-coding and combining, Channel state information.	15	1,2
3	Codebooks for MIMO, Beamforming, Beamforming principles, Increased spectrum efficiency, Interference cancellation, Switched beamformer, Adaptive beamformer, Narrowband beamformer, Wideband beamformer.	15	2,3
4	MIMO in LTE, Codewords to layers mapping, Pre-coding for spatial multiplexing, Pre-coding for transmit diversity, Beamforming in LTE, Cyclic delay diversity-based pre-coding, Pre-coding codebooks, Propagation Channels, Time & frequency channel dispersion, AWGN and multipath propagation channels, Delay spread values & time variations, Fast and slow fading environments, Complex baseband multipath channels, Narrowband and wideband channels, MIMO channel models	15	3,4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

Books Recommended

1. Claude Oestges, Bruno Clerckx, "MIMO Wireless Communications: From Real-world Propagation to Space-time Code Design", Academic Press,1st edition, 2010.
2. Mohinder Janaki Raman, "Space - Time Codes and MIMO Systems", Artech House.

References

1. *MIMO Wireless Communications*, 2007 by Ezio Biglieri, Robert Calderbank, Anthony Constantinides, Andrea Goldsmith, Arogyaswami Paulraj, and H. Vincent Poor

SEMESTER II

ECE-101-RC-5210: Research and Publication Ethics

Learning Objectives

LO1: To bring awareness about the publication ethics and publication misconducts.
LO2: To know the basics of philosophy of science and ethics, research integrity, publication ethics. LO3: To identify research misconduct and predatory publications.

Course Outcomes

CO1: To orient students towards the philosophy of ethics and misconducts.

CO2: Develop understanding about research integrity and publication guidelines

CO3: Understand various guidelines and regulation in publication ethics

CO4: Identifying research misconduct.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Ethics and Research: Introduction, Definition, Importance of Ethics, Principles of Ethics, Research Ethics, History of Research Ethics, Moral Philosophy, Moral Judgement and Reactions, Importance of Ethics in Research, Principles of Research Ethics, Intellectual Honesty and Research Integrity, Integrity of the Individual Scientist, Integrity at Institutional Level, Scientific Misconduct, Long-term Damaging Impact of Unethical Conduct in Research.	15	1
2	Scientific Conduct: Ethics with Respect to Science and Research. Intellectual Honesty and Research Integrity, Regulatory Organisations for Publication Ethics, Best Practices/Standards Setting Initiative and Guidelines. Guidelines for Authors, Editors and Reviewers. Scientific Misconducts: Falsification, Fabrication, and Plagiarism (FFP).	15	2
3	Publication Ethics: Publication Ethics: Definition, Introduction and Importance. Best Practices / Standards Setting Initiatives and Guidelines: COPE, WAME, etc. Conflicts of Interest.	15	3
4	Publication Misconduct: Definition, Concept, Problems That Lead to Unethical Behavior and Vice-Versa, Types. Violation of Publication Ethics, Authorship and Contributorship. Identification of Publication Misconduct. Unethical Behaviour in Publication: Redundant Publications: Duplicate and Overlapping Publications, Why do Duplicate Publications Occur?, What Problems does Duplicate Publishing Cause?, Overlapping Publishing be Avoided?, How can Salami Publishing be Avoided?, Selective Reporting, Types of Selective Reporting	15	4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

Books Recommended

1. Bird, A. (2006). Philosophy of Science. Routledge.
2. MacIntyre, Alasdair (1967) A Short History of Ethics. London

References

1. Research Methodology: Methods and Techniques, C. R. Kothari and Gaurav Garg

SEMESTER III

ECE -101-CW-61010: Advanced Biomedical Signal Processing

Learning Objectives

LO1: To bring an overview of the computational and mathematical methods in medical image processing

LO2: To know the Learn the different medical optimization techniques.

Course Outcomes

CO1: Understand different types of biomedical signal.

CO2: Understand the data acquisition for various biomedical signal.

CO3: Identify and analyze different biomedical signals.

CO4: Find applications related to biomedical signal processing

Course Contents

Unit No.	Content	Contact Hours	CO
1	Acquisition, Generation of Bio-signals, Origin of bio-signals, Types of bio-signals, Study of diagnostically significant bio-signal parameters, Electrodes for bio-physiological sensing and conditioning, Electrode-electrolyte interface, polarization, electrode skin interface and motion artefact, biomaterial used for electrode, Types of electrodes (body surface, internal, array of electrodes, microelectrodes), Practical aspects of using electrodes, Acquisition of bio-signals (signal conditioning) and Signal conversion (ADC's DAC's) Processing.	15	1
2	Biomedical signal processing by Fourier analysis, Biomedical signal processing by wavelet (time frequency) analysis, Analysis (Computation of signal parameters that are diagnostically significant)	15	2
3	Classification of signals and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals, Coherent treatment of various biomedical signal processing methods and applications.	15	3
4	Principal component analysis, Correlation and regression, Analysis of chaotic signals Application areas of Bio–Signals analysis Multiresolution analysis (MRA) and wavelets, Principal component analysis (PCA), Independent component analysis (ICA), Introduction to Neural Networks.	15	4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

Books Recommended

1. J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall, 1993.
2. Myer Kutz, "Biomedical Engineering and Design Handbook, Volume I", McGraw Hill, 2009.

References

1. D C Reddy, "Biomedical Signal Processing", McGraw Hill, 2005

SEMESTER III

ECE -101-CW- 62020: Industrial and Process Control Instrumentation

Learning Objectives

LO1: To make the students understand the fundamentals of automation and various automation systems used in industry such as PLC, DCS and SCADS

LO2: To Understand SCADS architecture, communication in SCADS, develop any application based on SCADS along with GUI using SCADA software

Course Outcomes

CO1: Understand evolution and architecture o DCS, hierarchical control in DCS

CO2: Understand SCADS architecture, communication in SCADS, develop any application based on SCADS along with GUI using SCADA software

CO3: The students will be able to handle any kind of process by framing it in block diagram, mathematical model and different process variables.

CO4: The students will be able to handle different types of controllers like electronics, pneumatic and hydraulic.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Process Dynamics : Process variables - Load variables -Dynamics of simple pressure, flow level and temperature process -interacting and non-interacting systems - continuous and batch process - self-regulation - Servo and Regulator operation. Control Actions and Controllers: Basic control actions-characteristics of two position, three position, Proportional, Single speed floating, Integral and Derivative control modes - PI, PD, PID control modes - Pneumatic, Hydraulic and Electronic Controllers to realize various control actions.	15	1
2	Programmable Logical Controllers Introduction - Advantages of Programmable logic controllers in comparison to relay based system - Configuration of Programmable Logic controllers. Distributed Control Systems Introduction - Overall control configuration- Block diagram of a Generalized control system- Relationship of hierarchy to plant structure - Single loop controllers and Double loop controllers.	15	2
3	Velocity and Acceleration measurement Relative velocity - Translational and Rotational velocity measurement - Revolution counters and Timers - Magnetic and Photoelectric pulse counting stroboscopic methods - Accelerometers of different types - Gyroscopes. Force and Torque measurement Force measurement - Different methods -Torque measurement - Dynamometers Gyroscopic Force and Torque Measurement -Vibrating wire Force transducer	15	3
4	Density Measurement: Volume Flow meter Plus Density measurement - Strain Gauge load cell method - Buoyancy method - Air pressure balance method - Gamma ray method — Vibrating probe method. Direct Mass Flow meters. Radiation And other Measurements: Radiation Fundamentals. GM counter, Scintillation counter, Radio dating, Sound-Level Meter. Microphones. Time, Frequency, and Phase-Angle measurement. Liquid Level. Humidity. Particle Instruments and Clean-Room Technology.	15	4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

The Mapping Level Contribution between COs-POs/PSOs are Categorized as [**3**: High; **2**: Medium; **1**: Low; -: No Correlation]

Books Recommended

1. Chemical Process Control: An introduction to Theory and Practice -Stephanopoulos
2. Process Control - Harriott P.

References

1. Process Control Instrumentation Technology is a textbook on industrial process control and instrumentation, written by Curtis D. Johnson. Widely

SEMESTER III

ECE -101-CW- 62030: Semiconductor Physics

Learning Objectives

LO1: Interpret the characteristics of IGFETs/MOS devices, surface field effects, memory devices, and advanced semiconductor device structures for modern electronic applications.

LO2: Examine metal-semiconductor devices, Schottky barrier devices, metal-semiconductor contacts, and their current transport mechanisms.

Course Outcomes

CO1: Explain the physics of semiconductors, charge transport mechanisms, and the operating principles of p-n junction devices.

CO2: Analyze the characteristics, switching behavior, breakdown phenomena, and applications of semiconductor diodes including tunnel, backward, and IMPATT diodes.

CO3: Evaluate the operation and performance characteristics of bipolar junction transistors (BJTs), microwave transistors, power transistors, switching transistors, and unijunction transistors.

CO4: Examine metal-semiconductor devices, Schottky barrier devices, metal-semiconductor contacts, and their current transport mechanisms.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Physics and Properties of Semiconductors; p-n Junction Diodes: Depletion Region and Depletion Capacitance, Current-Voltage Characteristics, Junction Breakdown, Transient Behavior and Noise, Terminal Functions, Heterojunction; Tunnel Diode and Backward Diode; Impact-Avalanche Transit-Time Diodes.	15	1
2	Junction Transistors: Static Characteristics, Microwave Transistor, Power Transistor, Switching Transistor, Unijunction Transistor; p-n-p-n and Junction Field-Effect Devices: Shockley Diode and Semiconductor-Controlled Rectifier, Junction Field-Effect Transistor and Current Limiter	15	2
3	Metal-Semiconductor Devices: Schottky Effect, Energy Band Relation at Metal-Semiconductor Contact, Current Transport Theory in Schottky Barriers, Measurement of Schottky Barrier Height., Clamped Transistor, Schottky Gate FET, Metal-Semicondutor IMPATT Diode, Mott Barrier, Point-Contact Rectifier, and Ohmic Contact, Space-Charge-Limited Diode.	15	3
4	IGFET and Related Surface Field Effects: Surface-Space-Charge Region Under Nonequilibrium Condition, Channel Conductance, Basic Device Characteristics, General Characteristics, IGFET with Schottky Barrier Contacts for Source and Drain, IGFET with a Floating Gate-A Memory Device, Surface Field Effects on p-n Junctions and Metal Semiconductor Devices	15	4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

Books Recommended

1. S. M. Sze and Ming-Kwei Lee, Semiconductor Devices: Physics and Technology, 3rd Edition, Wiley India, 2012.
2. Robert F. Pierret, Semiconductor Device Fundamentals, 1st Edition, Pearson Education, 1996.

References

1. Solid State Physics by Neil W. Ashcroft and N. David Mermin

SEMESTER III

ECE -101-CW- 62040: Semiconductor Sensors and Actuators

Learning Objectives

LO1: Understand the principles of semiconductor-based sensing and actuation.

LO2: Develop knowledge of modern applications in healthcare, industry, environment, and IoT.

Course Outcomes

CO1: Explain the fundamental principles of semiconductor sensors, transduction mechanisms, and sensing materials.

CO2: Analyze the characteristics and performance of temperature, optical, magnetic, and pressure sensors based on semiconductor technologies.

CO3: Evaluate the operation and applications of gas, humidity, chemical, and biosensors.

CO4: Design sensor interfacing and signal conditioning circuits for smart sensing applications.

Course Contents

Unit No.	Content	Contact Hours	CO
1	Fundamentals of Semiconductor Sensors: Sensor Characteristics and Performance Parameters, Semiconductor Materials for Sensors, Charge Transport Mechanisms, Transduction Principles, Sensitivity, Selectivity, Response Time and Stability, Smart Sensors.	15	1
2	Semiconductor Physical Sensors: Temperature Sensors (Thermistors, Semiconductor Temperature Sensors), Optical Sensors (Photodiodes, Phototransistors, CCD and CMOS Image Sensors), Magnetic Sensors (Hall Effect Sensors, Magnetoresistive Sensors), Pressure and Strain Sensors (Piezoresistive Sensors, Capacitive Pressure Sensors)	15	2
3	Chemical and Gas Sensors: Gas Sensing Mechanisms, Metal Oxide Semiconductor (MOS) Gas Sensors, Hydrogen and HCN Gas Sensors, Electrochemical Sensors, Humidity Sensors, Chemical Sensors, Semiconductor Biosensors, Wearable and Biomedical Sensors.	15	3
4	Sensor Interfacing and Applications: Signal Conditioning Circuits, Instrumentation Amplifiers, Analog-to-Digital Conversion, Sensor Calibration Techniques, IoT-Based Smart Sensors, Automotive Sensor Systems, Industrial Automation Sensors, Biomedical Monitoring Systems, Environmental Monitoring Applications.	15	4

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	-	-	2	-	-	-	3	3	3	3
CO2	3	3	-	3	1	2	2	3	3	-	3	-	3	3
CO3	3	3	-	3	1	2	2	3	3	2	3	-	3	3
CO4	3	3	-	3	-	2	2	2	-	3	3	-	3	3
Average	3	3	0.75	3	0.5	1.5	2	2	1.5	1.25	3	0.75	3	3

Books Recommended

1. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs and Applications, 5th Edition, Springer, 2016.
2. Julian W. Gardner, Vijay K. Varadan and Osama O. Awadelkarim, Microsensors, MEMS and Smart Devices, 1st Edition, Wiley, 2001.

References

1. Sensors and Actuators: Engineering System Instrumentation by Clarence W. de Silva

SEMESTER III and IV

(Course Work and Research)
ECE-101-PR-6110: Project
ECE-101-RP-6210:Research Project

Background

They will do research project work or dissertation under the guidance of a faculty member of the Department of Electronics The project work/dissertation will be in the major discipline.

Course Outcomes

CO1: The post-graduates would be able to demonstrate the ability to apply knowledge, understanding, and/or skills with an appropriate degree of independence relevant to the level of the qualification.

CO2: The post-graduates would work independently, identify appropriate resources required for a project, and manage a project through to completion.

CO3: The post-graduates would exercise responsibility and demonstrate accountability in applying knowledge and/or skills in work and/or learning contexts appropriate for the level of the qualification, including ensuring safety and security at workplaces.

CO4: The post-graduates should be able to demonstrate the capability to participate in community-engaged services/ activities for promoting the well-being of society.

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	-	2	-	-	-	3	3	3	3
CO2	3	3	3	3	-	2	2	3	3	-	3	3	3	3
CO3	3	3	3	3	-	2	2	3	3	2	3	3	3	3
CO4	3	3	3	3	0	2	2	2	-	3	3	3	3	3
Average	3	3	3	3	**0.75**	**1.5**	2	2	**1.5**	**1.25**	3	3	3	3

The Mapping Level Contribution between COs-POs/PSOs are Categorized as [**3**: High; **2**: Medium; **1**: Low; -: No Correlation]

Norms

1. The project work/dissertation will be on a topic in the disciplinary programme of study or an interdisciplinary topic.
2. The students are expected to complete the Project in the six semesters. The research outcomes of their project work may be published in peer-reviewed journals or may be presented in conferences /seminars or may be patented.
3. Students may be permitted to carry out a project work or dissertation in another department of RGU or another institution provided the required facilities are available.

Learning Assessment

Evaluation will be based on continuous assessment, in which sessional work and the terminal examination will contribute to the final grade. Sessional work will consist of class tests, mid-semester examination(s), homework assignments, etc., as determined by the faculty in charge of the courses of study. Research Project work in Electronics discipline would generally be carried out under the supervision of an expert of the given external entity. The curricular component of 'community engagement and service' will involve activities that would expose students to the socio-economic issues in society so that the theoretical learnings can be supplemented by actual life experiences to generate solutions to real-life problems. The 3rd and 4th semester will be devoted to seminar presentation, preparation, and submission of project report/dissertation.

SEMESTER III and IV

(Research)

ECE-101-RD-6110:Dissertation-I

ECE-101-RD-6210:Dissertation-II

Background

They will do research project work or dissertation under the guidance of a faculty member of the Department of Electronics The project work/dissertation will be in the major discipline.

Course Outcomes

CO1: The post-graduates would be able to demonstrate the ability to apply knowledge, understanding, and/or skills with an appropriate degree of independence relevant to the level of the qualification.

CO2: The post-graduates would work independently, identify appropriate resources required for a project, and manage a project through to completion.

CO3: The post-graduates would exercise responsibility and demonstrate accountability in applying knowledge and/or skills in work and/or learning contexts appropriate for the level of the qualification, including ensuring safety and security at workplaces.

CO4: The post-graduates should be able to demonstrate the capability to participate in community-engaged services/ activities for promoting the well-being of society.

Mapping of POs/PSOs with COs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	-	2	-	-	-	3	3	3	3
CO2	3	3	3	3	-	2	2	3	3	-	3	3	3	3
CO3	3	3	3	3	-	2	2	3	3	2	3	3	3	3
CO4	3	3	3	3	0	2	2	2	-	3	3	3	3	3
Average	3	3	3	3	0.75	1.5	2	2	1.5	1.25	3	3	3	3

The Mapping Level Contribution between COs-POs/PSOs are Categorized as [3: High; 2: Medium; 1: Low; -: No Correlation]

Norms

1. The project work/dissertation will be on a topic in the disciplinary programme of study or an interdisciplinary topic.
2. The students are expected to complete the Project in the six semesters. The research outcomes of their project work may be published in peer-reviewed journals or may be presented in conferences /seminars or may be patented.
3. Students may be permitted to carry out a project work or dissertation in another department of RGU or another institution provided the required facilities are available.

Learning Assessment

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