B.Tech. in Electrical and Electronics Engineering (170 credits)

SEMESTER -1

Sl no	Course Code	Subjects	Credits	L-T-P
1	EE101	Fundamentals of Electrical and Electronics	4	3-0-2
2	ES101	Engineering Physics	4	3-0-2
3	ES102	Engineering Mathematics	4	3-1-0
4	EE102	Engineering Design Principles	3	2-0-2
5	CS101	Principles of Computer Programming	4	3-0-2
6	HS101	Freshman Skills	2	2-0-0
7	HS102	Sports and Physical Education	2	0-1-2
		Total	**23 credits**	

SEMESTER -2

Sl no	Course Code	Subjects	Credits	L-T-P
1	EE103	Digital Electronics	4	3-0-2
2	ES103	Probability and Statistics	4	3-1-0
3	IT102	Data Structures	4	3-0-2
4	EE104	Hardware Workshop	3	1-0-4
5	CS103	Object Oriented Programming	4	3-0-2
6	HS103	Ecology and Environment Sciences	2	2-0-0
7	CS104	Mobile Application Technologies	2	0-1-2
		Total	**23 credits**	
	MO101	MOOC1 (Optional in Summer)	2/3	

EXIT AFTER YEAR – 1. **Certificate in Engineering Sciences (46 credits)**

SEMESTER -3

Sl no	Course Code	Subjects	Credits	L-T-P
1	HS201	Indian Culture, Ethics and Moral Values	2	2-0-0
2	EE201	Principles of Communication	4	3-1-0
3	EE202	Network Analysis & Synthesis	4	3-1-0
4	CS202	Computer Organization & Architecture	4	3-0-2
5	EE203	Microelectronics: Devices and Materials	4	3-0-2
6	EE204	Analog Electronics	4	3-0-2
		Total	**22 credits**	

SEMESTER -4

Sl no	Course Code	Subjects	Credits	L-T-P
1	MS619	Entrepreneurship and Innovation	2	2-0-0
2	EE205	VLSI Design	4	3-0-2
3	EE206	Wireless Communication	4	3-0-2
4	EE207	Signals & Systems	4	3-1-0
5	EE208	Electromagnetic theory	4	3-1-0
6	EE209	Control System	4	3-1-0
		Total	**22 credits**	
	MO101	MOOC1 (Optional in Summer)	2	

EXIT AFTER YEAR - 2 **Diploma in Electrical and Electronics Engineering (90 credits)**

SEMESTER -5

Sl no	Course Code	Subjects	Credits	L-T-P
1	MS603	Business Economics	3	3-0-0
2		Multidisciplinary Elective/MOOC3	3	3-0-0
3		Department Elective-1	3	3-0-0
4	EE301	Digital Signal Processing	4	3-0-2
5	EE302	System Design using HDL	4	3-0-2
6	EE303	Microprocessor and Interfacing	4	3-0-2
		Total	**21 credits**	

SEMESTER - 6

Sl no	Course Code	Subjects	Credits	L-T-P
1	ENxxx	Art of Engineering Research	2	2-0-0
2		Multidisciplinary/ MOOC4	3	3-0-0
3		Department Elective-2	3	3-0-0
4	EE304	IoT and Applications	4	3-0-2
5	EE305	RF Circuit & Antenna Design	4	3-0-2
6	EE306	Microcontroller and Embedded Systems	4	3-0-2
		Total	**20 credits**	

Colloquium of 3 credits in summer semester (MOOC, NPTEL etc. in lieu of colloquium)

EXIT AFTER YEAR - 3 → **BSc in Electrical and Electronics Engineering (131 credits)**

SEMESTER - 7

Sl no	Course Code	Subjects	Credits	L-T-P
1		Multidisciplinary Elective- 3/MOOC5	3	3-0-0
2		Department Elective -3	3	3-0-0
3	EE401	Trustworthy AI and Machine learning	4	3-0-2
4	EE402	Intelligent Transportation Systems	4	3-0-2
5	EE403	Power Electronics	4	3-0-2
6	EE404	IC Design	3	3-0-0
		Colloquium (Based on Summer training)	3	0-0-6
		Total	**24 credits**	

SEMESTER - 8

Sl no	Course Code	Subjects	Credits	L-T-P
1	EE499	BTech Project/Internship	12	0-0-24
2		Department Elective/MOOC - 4	3	3-0-0
		Total	**15 credits**	

FINAL EXIT AFTER YEAR – 4 → **B.Tech. in Electrical and Electronics Engineering (170 credits)**

Courses for the Minor in EEE (Total 24 credits required)

Sl	Code	Course Name	Credits	L-T-P
1	EE207	Signals & Systems	4	3-1-0
2	EE204	Analog Electronics	4	3-0-2
3	EE205	VLSI Design	4	3-0-2
4	EE303	Microprocessor and Interfacing	4	3-0-2
5	EE304	IoT and Applications	4	3-0-2
6	EE201	Principles of Communication	4	3-1-0
		Total credits	**24**	

Multidisciplinary Electives offered by EEE Department				
1	EE204	Analog Electronics	4	3-0-2
2	EE207	Signals & Systems	4	3-1-0
3	EE303	Microprocessor and Interfacing	4	3-0-2
4	EE205	VLSI Design	4	3-0-2
5	EE201	Principles of Communication	4	3-1-0
6	EE304	IoT and Applications	4	3-0-2
7	EE002	Quantum Electronics	3	3-0-0
8	EE006	Design Verification and Testing	3	3-0-0
9	EE007	Device and Interconnect Modelling	3	3-0-0
10	EE012	Information Theory and coding	3	3-0-0
11	EE025	Drone Technology and Robotics	3	3-0-0

List of Electives

VLSI and Embedded System					
Sl	**Code**	**Course Name**	**Prerequisite**	**Credits**	**L-T-P**
1	EE001	VLSI Architecture	EE205, 302	3	3-0-0
2	EE002	Quantum Electronics	EE203, 204	3	3-0-0
3	EE003	Introduction to MEMS	EE304	3	3-0-0
4	EE004	VLSI Signal Processing	EE205, 201	3	3-0-0
5	EE005	FPGA-based System Design	EE205	3	3-0-0
6	EE006	Design Verification and Testing	EE205	3	3-0-0
7	EE007	Device and Interconnect Modelling	EE205	3	3-0-0
8	EE008	CAD for VLSI	EE205	3	3-0-0
9	EE009	Memory Devices and Circuits	EE205	3	3-0-0
10	EE010	Embedded Software	EE306	3	3-0-0
11	EE011	Organic Semiconductors	EE204	3	3-0-0
12	EE012	Solar Cells-Fundamental & Applications	EE204	3	3-0-0
13	EE013	Energy Storage Materials	EE203	3	3-0-0

Communication and Signal Processing					
Sl	**Code**	**Course Name**	**Prerequisite**	**Credits**	**L-T-P**
1	EE014	Communication Networks and Switching	EE303	3	3-0-0
2	EE015	Information Theory and coding	AS102, AS103	3	3-0-0
3	EE016	High-Performance Computing	EE401	3	3-0-0
4	EE017	Biomedical Signal Processing	EE301	3	3-0-0
5	EE018	Neuromorphic Computing	EE401	3	3-0-0
6	EE019	Advance Signal Processing	EE301	3	3-0-0
7	EE020	Optical Communication	EE207	3	3-0-0
8	EE021	Advanced Communication Engineering	EE207	3	3-0-0
9	EE022	Speech and Audio Signal Processing	EE301	3	3-0-0

Autonomous and Intelligent Transportation					
Sl	**Code**	**Course Name**	**Prerequisite**	**Credits**	**L-T-P**
1	EE023	Sensors for Autonomous Systems	EE304	3	3-0-0
2	EE024	Power Systems	EE403	3	3-0-0
3	EE025	Power Electronic Converters for Renewable Energy	EE403	3	3-0-0
4	EE026	Smart Grid Technology	EE403	3	3-0-0
5	EE027	Electromechanics	EE403	3	3-0-0
6	EE028	Drone Technology and Robotics	EE304	3	3-0-0
7	EE029	Intelligent Control System	EE209	3	3-0-0

Multidisciplinary Electives offered by EEE Department				
Sl.	**Code**	**Course Name**	**Credits**	**L-T-P**
1	EE204	Analog Electronics	4	3-0-2
2	EE207	Signals & Systems	4	3-1-0
3	EE303	Microprocessor and Interfacing	4	3-0-2
4	EE205	VLSI Design	4	3-0-2
5	EE201	Principles of Communication	4	3-1-0
6	EE304	IoT and Applications	4	3-0-2
7	EE002	Quantum Electronics	3	3-0-0
8	EE006	Design Verification and Testing	3	3-0-0
9	EE007	Device and Interconnect Modelling	3	3-0-0
10	EE012	Information Theory and coding	3	3-0-0
11	EE025	Drone Technology and Robotics	3	3-0-0

CODE WITH EExxx

1	**Code of the subject**	EE101
2	**Title of the subject**	Fundamentals of Electrical and Electronics
3	**Any prerequisite**	NA
4	**L-T-P**	3-0-2
5	**Learning Objectives**	After the completion of the course, the students will be able to: • Demonstrate the use of semiconductor diodes in various applications. • Discuss and explain the working of transistors, their configurations and applications. • Apply networks laws and theorems to solve electric circuits. • Analyze transient and steady state response of DC circuits. • Explain and analyse the behaviour of transformer. • Elucidate the principle and characteristics of DC motor and DC generator.
6	**Brief Contents**	Fundamental laws of electrical engineering circuit parameters, Classification of devices of an electrical circuit; Basic devices: resistors, controlled sources, diodes, capacitors and inductors, ideal transformers, Methods of Analysis, DC Network Theorems, Basic circuit analysis methods: nodal, mesh and modified nodal-analysis; Transient analysis of RL, RC, and RLC circuits, Three Phase Circuits and Power Measurements, Single Phase Transformers, Three Phase Induction Machines, DC Machines Semiconductor Materials: Ge, Si, and GaAs; n-Type and p-Type Materials; Semiconductor Diode and types; Construction and application of Bipolar Junction Transistors; Common-Base Configuration, Common-Emitter Configuration, Common-Collector Configuration; Clipper and Clamper, Rectifiers, Basics of MOSFET.
7	**Contents for lab**	Familiarization with CRO, DSO and Electronic Components, Diodes characteristics - Input-Output and Switching, BJT and MOSFET Characteristics, Zener diode as voltage regulator, Rectifiers, Clippers and Clampers, Network laws and theorems, Measurement of R,L,C parameters, A.C. series and parallel circuits, Measurement of power in 3 phase circuits, Reactance calculation of variable reactance choke coil, open circuit and short circuit tests on single phase transformer, Starting of rotating machines.
8	**List of text books/references**	**Text/ Reference Books:** • Electronic Devices and Circuit Theory by R.L. Boylestad and L. Nasheisky, Pearson. • Basic Electrical Engineering by J. Nagrath and D. P. Kothari, TATA Mc Graw Hill. • Electric Circuits by D. A. Bell, Oxford Higher Education. • Modern Semiconductor Device Physics by S.M. Sze, Wiley. • Electrical Technology by E. Hughes, Pearson Education. • Electrical Engg Fundamentals by V. Del Toro, PHI Learning.

		Electronic Devices and Circuits by Milliman, J. and Halkias, C.C., Tata McGraw Hill. Introduction to Electrical Engineering by Naidu, M.S. and Kamashaiah, S., Tata McGraw Hill.

1	**Code of the subject**	EE102
2	**Title of the subject**	Engineering Design Principles
3	**Any prerequisite**	None
4	**L-T-P**	2-0-2
5	**Learning Objectives**	The course should enable the students to: Widen the knowledge on design process. Enable attain knowledge on tools used in Design Methods. Create an understanding on the process of material selection and design. Develop in depth knowledge on Engineering statistics and reliability. Create awareness on legal and ethical issues in Design an Quality Engineering.
6	**Brief Contents**	Design process, Morphology of Design, Design Drawings, Computer Aided Engineering, Designing of, Product life cycle, Human Factors in Design, Industrial Design. Design Methods, Creativity and Problem Solving, Product Design Specifications, Conceptual design, Embodiment Design, Finite Element Modeling, Optimization, Search Methods, Material Selection Processing and Design, Engineering Statistics and Reliability, Legal and Ethical Issues in Design and Quality Engineering
7	**Contents for lab**	Create geometric constructions; drawing parallel and perpendicular lines, and to construct circles, arcs, tangencies, and irregular curves, Apply orthographic projection method to obtain: Multiview , auxiliary view and section view of an object, Create 2-D computer drawing, Create 3-D computer drawing : using Computer Aided Design (CAD) software
8	**List of text books/references**	Fundamentals of Engineering Drawing by W.J. Luzadder and J.M. Duff, PHI. Engineering Design - “A Materials and Processing Approach” by Dieter, George E., McGraw Hill. Product Design and Development by Karl T. Ulrich and Steven D. Eppinger, McGraw Hill. Engineering Design by Pahl, G, and Beitz, W., Springer – Verlag, NY. Elements of Engg. Design by Ray, M.S., Prentice Hall Inc. The principles of Design by Suh, N. P., Oxford University Press, NY. Visualization, Modeling, and Graphics for Engineering Design by D.K. Lieu and S.A. Sor, Cengage Learning. Fundamentals of Computer Graphics by Shirley, Peter, Michael Ashikhmin, Steve Marschner, CRC Press.

1	**Code of the subject**	EE103
2	**Title of the subject**	Digital Electronics
3	**Any prerequisite**	NA

4	**L-T-P**	3-0-2
5	**Learning Objectives**	After the completion of the course, the students will be able to: • Recognize and apply the number systems and Boolean algebra. • Reduce Boolean expressions and implement them with Logic Gates. • Analyze, design and implement combinational and sequential circuits
6	**Brief Contents**	Boolean algebra, K-maps, logic gates, Number Systems, Design of combinational circuits, Design of sequential circuits, Introduction to digital logic families, Data processing and conversion: Sample and hold circuits, ADCs and DACs; Basic memory circuits ROM, RAM and PLA.
7	**Contents for lab**	Implementation of digital logic using switching circuits, Study of universal gates, Design of a 1-bit Full Adder/Subtractor using logic gates, Design and implementation of a 4-bit binary ripple, adder using logic gates, 4 X 3 bit binary multiplier using logic gates, Study of code converters (BCD to excess-3, binary to gray and gray to binary), Study of combinational MSI circuits – 1-bit half/full, adder, 1-bit half/full subtractor and 1-bit magnitude, comparator, Study of sequential circuits – Implementation of Flip-Flops, Design of a synchronous decade counter, Design of 4-bit parallel input serial output (PISO), shift-register.
8	**List of text books/references**	**Text/ Reference Books:** • Digital Circuits and Logic Design by S. Lee, Prentice Hall India. • Digital Principles and Applications by D. P. Leach, A. P. Malvino and G. Saha, McGraw Hill Education. • Digital Design by M. M. Mano and M.D. Ciletti, Pearson, Prentice Hall. • Digital Principles and Design by Donald D Givone, McGraw-Hill. • Digital Design: Principles and Practices by John F Wakerly, Pearson. • Digital Electronics: Principles Design and Applications by AK Maini. • Digital Integrated Electronics by H. Taub and D. Schilling, McGraw Hill.

1	**Code of the subject**	EE104
2	**Title of the subject**	Hardware Workshop
3	**Any prerequisite**	NA
4	**L-T-P**	1-0-4
5	**Learning Objectives**	• To familiarize students with various electronic devices and their specifications. • Develop skill for Design and testing of different types of electronic subsystems using Analog and Digital IC's • Familiarize students with PCB layout tool to prepare PCB print for assigned projects. • Develop skills of writing a structured technical document for project and its presentation.

		Develop the ability to diagnose faults and their rectification.
6	**Brief Contents**	Familiarization /Identification of electronic components with specification and Functionality, type, size, colour coding, package, symbol, cost etc. Active, Passive, Electrical, Electronic, Electro-mechanical, Wires, Cables, Connectors, Fuses, Switches, Relays, Crystals, Displays, Fasteners, Heat sink, Arduino Uno, Rasberry Pi, ESP8266 Module, HC 05 Bluetooth Module. Drawing of electronic circuit diagrams using EDA tools, Interpret data sheets of discrete components and IC's, Estimation and costing, Familiarization/Application of testing instruments and commonly used tools like Multimeter, Function generator, Power supply, CRO etc. Soldering iron, De-soldering pump, Cutters, Wire strippers, Screw drivers, Hot air soldering and desoldering station etc., Testing of electronic components Resistor, Capacitor, Diode, Transistor etc. using multimeter and different IC's using IC tester, Design and fabrication of a single sided PCB for a simple circuit with manual etching, Assembling electronic circuit/system on general purpose PCB, testing and show the functioning
7	**Contents for lab**	Hardware Based Projects for smart city applications, industries, healthcare, education, agriculture, transportation, power, including social development sector etc.
8	**List of text books/references**	**Text/ Reference Books:** https://electronicsforu.com/ https://electronicsforu.com/tag/mini-projects. Electronics Lab Manual by K. A. Navas, PHI. Electronic Projects in Workshop by R.A Penfold, Newnes Technical Books. Electronic Designer's Handbook by T.K. Hamingway, Business Books Limited. Digital Circuits and Logic Design by S. Lee, Prentice Hall India. Digital Principles and Applications by D. P. Leach, A. P. Malvino and G. Saha, McGraw Hill Education. Digital Design by M. M. Mano and M.D. Ciletti, Pearson, Prentice Hall.

1	**Code of the subject**	EE201
2	**Title of the subject**	Signals & Systems
3	**Any prerequisite**	Engineering Mathematics
4	**L-T-P**	3-1-0
5	**Learning Objectives**	This course trains students for an intermediate level of fluency with signals and systems in both continuous time and discrete time, in preparation for more advanced subjects in digital signal processing (including audio, image and video processing), communication theory, and system theory, control and robotics

6	**Brief Contents**	Classification of signals, Continuous-time and discrete-time signals, Basic system properties, Discrete-time LTI systems: convolution sum, Continuous-time LTI systems, Properties of LTI systems, Causal LTI systems described by difference equations (Natural, Forced, and Complete Response), Representation of Periodic (Continuous Time & Discrete-Time) Signals Using Fourier Series, Continuous-time Fourier transform, the discrete-time Fourier transform (DTFT), discrete Fourier transform (DFT) Sampling theorem, Laplace transform, z-transform.
7	**Contents for lab**	NA
8	**List of text books/references**	Signals and systems by A.V. Oppenheim, A.S. Willsky and S. H. Nawab, Prentice Hall India. Linear Systems and Signals by B. P. Lathi, Oxford University Press. Signals & Systems by Simon & Haykins, John Wiley & Sons. Digital Signal Processing: Principles, Algorithms and Applications by Proakis, PHI.

1	**Code of the subject**	EE202
2	**Title of the subject**	Network Analysis & Synthesis
3	**Any prerequisite**	Engineering Mathematics-1 and Engineering Mathematics-2
4	**L-T-P**	3-0-0
5	**Learning Objectives**	To make the students capable of analyzing any given electrical network. To make the students learn how to synthesize an electrical network from a given impedance/admittance function. Apply the knowledge of basic circuital law and simplify the network using reduction techniques. Analyze the circuit using Kirchhoff's law and Network simplification theorems. Infer and evaluate transient response, Steady state response, and network functions. Obtain the maximum power transfer to the load, and analyze the series resonant and parallel resonant circuit.
6	**Brief Contents**	Network concept, Elements and sources, Kirchoff's laws, Tellegen's theorem, Network equilibrium equations, Node and Mesh method, Source superposition, Thevenin's and Norton's theorems, Network graphs, First and second-order networks, State equations, Transient response, Network functions, Determination of the natural frequencies and mode vectors from network functions, Sinusoidal steady-state analysis, Maximum power transfer theorem, Resonance, Equivalent and dual networks, Design of equalizers, Two-port network parameters, Interconnection of two-port networks, Barlett's bisection theorem, Image and Iterative parameters, Design of attenuators, Two-terminal network synthesis, Properties of Hurwitz polynomial and Positive real function, Synthesis of LC, RC and RL Networks, Foster Forms and Cauer Forms.

7	**Contents for lab**	NA
8	**List of text books/references**	□ Engineering Circuit Analysis by Hayt W. H., Kemmerly J. E. and Durbin S. M., Tata McGraw-Hill. □ Network Analysis by Valkenberg V., PHI. □ Network Analysis and Synthesis BY Kuo F. F., Wiley India.

1	**Code of the subject**	EE203
2	**Title of the subject**	Microelectronics Devices and Materials
3	**Any prerequisite**	EE101
4	**L-T-P**	3-0-0
5	**Learning Objectives**	After the completion of the course, the students will be able to understand and have a mental picture for holes, electrons, density of states, doping, majority carriers, minority carriers, Fermi Level, Quasi-Fermi Level and can understand device performance given in terms of energy band diagram or device configuration.
6	**Brief Contents**	Review of materials – Si, Ge, III-V material properties and band structure. Semiconductors and Crystal Structures, Basic Semiconductor Physics, Excess carriers, lifetime, and carrier transport by drift and diffusion, Continuity equation and its solution under different injections, Junction Diode, Bipolar Junction Transistor (BJT), MOS Capacitor, Metal Oxide Semiconductor Field Effect Transistor (MOSFET), Short Channel Effects, Some Important Devices Tunnel Diode, Varactor Diode, Light Emitting Diode (LED), Photodetector, and Solar Cell. Overview of smart materials technology, Characteristics of smart materials such as piezoelectric, Structural modeling and design, Dynamics and control for smart structures, Integrated system analysis, Thermal Management. Smart Sensor, Actuator and Transducer Technologies, Next-generation materials.
7	**Contents for lab**	NA
8	**List of text books/references**	**Text/ Reference Books:** □ Solid State Electronic Devices BY Streetman B.G., Banerjee, S.K, Pearson Education. □ Introduction to Semiconductor Materials and Devices by Tyagi M.S., John Wiley & Sons. □ Semiconductor Devices Physics and Technology by Sze S.M., John Wiley & Sons.

1	**Code of the subject**	EE204
2	**Title of the subject**	Analog Electronics
3	**Any prerequisite**	EE101
4	**L-T-P**	3-0-2

5	**Learning Objectives**	To acquaint the students with the fundamental principles of operation and design of analog circuit building blocks (Diodes, BJT and MOSFET) and their use in analog circuit design. In addition, to get familiar with op-amps applications followed by basic conversion techniques and errors, precision amplifier, logarithmic amplifier, square-root amplifier.
6	**Brief Contents**	MOSFET and BJT models, Transistor Biasing and Thermal Stabilization, Overview of biasing of MOS and BJT amplifiers, Common Source (CS) amplifiers, CS amplifier with source degeneration, common gate amplifers, common drain amplifiers, Brief overview of BJT amplifiers (Common emitter, common base, common collector), MOS and BJT cascode amplifiers, MOS and BJT current mirrors, cascode current mirrors. Differential Amplifiers: MOS and BJT differential pair's large signal analysis, small signal analysis of differential pairs, cascade differential amplifiers, common-mode rejection, and differential amplifiers with active load. Frequency Response, Feedback and Oscillators, OPAMP Basics and Applications.
7	**Contents for lab**	Experiments using BJTs, FETs, op-amps and other integrated circuits: Multistage amplifiers, automatic gain controlled amplifiers, programmable gain amplifiers; frequency response of amplifiers; voltage regulator with short circuit protection; phase-locked loop; waveform generators; filters
8	**List of text books/references**	**Text/ Reference Books:** • Microelectronics Circuits by S. Smith, Oxford. • Analysis & Design of Analog Integrated Circuits by P. Gray, P. Hurst, S. Lewis, and R. Meyer, Wiley. • Fundamentals of Microelectronics by Behzad Razavi, Wiley India. • Electronic Devices and Circuit Theory by Boylestad R. L., Pearson Education. • Integrated Electronics by Millman, J. and Halkias, C.C., Tata McGraw Hill. • Electronic Circuit Analysis and Design by Neamen, Donald A., McGraw Hill. • Microelectronic Circuits by Sedra A. S. and Smith K. C., Oxford University Press.

1	**Code of the subject**	EE205
2	**Title of the subject**	VLSI Design
3	**Any prerequisite**	EE101
4	**L-T-P**	3-0-2
5	**Learning Objectives**	Upon completion of this course, the student will be able to: • Use MOS structures in basic digital circuits. • Describe the general processing steps required to fabricate an integrated circuit. • Implement various CMOS logic circuits. • Design simple circuits to meet stated operating specifications.

6	**Brief Contents**	Introduction to VLSI, MOS Transistor Theory, MOS Structure and its operation, I-V Characteristics, Scaling, Short-Channel Effects, Second order effects, MOS Device Models, Small Signal operation and Equivalent Circuit of MOS Transistor, MOS Capacitors, NMOS & CMOS Process technology, Electrical Design Rules, Stick Diagram, Layout Design, Resistive Load & Active Load MOS Inverters, NMOS Inverters, CMOS Inverters, Interconnect Parasitics, Propagation Delay, Static and Dynamic Power Dissipation, Noise Margin, Logic Threshold Voltage, Logical effort, Driving large loads, MOS Logic Circuits with Depletion NMOS loads, CMOS Logic Circuits, CMOS logic Styles, Realization of simple gates, Complex logic circuits, Pass Gate, Transmission Gate.
7	**Contents for lab**	Familiarization with Circuit design/simulation tools (Cadence/Mentor/Tanner Tools) for schematic and layout entry, Circuit simulation using SPICE. DC transfer Characteristics of Inverters, Transient response, Calculating propagation delays, rise and fall times, Circuit design of inverters, Complex gates with given constraints.
8	**List of text books/references**	**Text/ Reference Books:** • Principles of CMOS VLSI Design by Neil H. E. Weste, Kamran Eshraghian, Addison Wesley. • CMOS Digital Integrated Circuits: Analysis and Design by Sung-Mo Kang and Yusuf Leblebici. • Basic VLSI Design by Pucknell, D.A. and Eshraghian, K., PHI. • Essentials of VLSI Circuit and System by Eshraghian, K., Pucknell, D. A. and Eshraghian, S., PHI. • Introduction to VLSI Circuits and Systems by Uyemera, P.J., John Wiley & Sons.

1	**Code of the subject**	EE206
2	**Title of the subject**	Microprocessor and Interfacing
3	**Any prerequisite**	EE103
4	**L-T-P**	3-0-2
5	**Learning Objectives**	Upon completion of this course, the student will be able to: • To develop background knowledge and core expertise in microprocessor. • To study the concepts and basic architecture of 8085, and 8086 processor. • To know the importance of different peripheral devices and their interfacing to 8086. • To know the design aspects of basic microprocessor. • To write assembly language programs in microprocessor for various application

6	**Brief Contents**	Microprocessors-Evolution and Introduction, Microprocessor based system, Origin of Microprocessor, Classification of Microprocessors, Types of Memory, I/O Devices, Technology Improvements Adapted to Microprocessors and Computers, Introduction to 8085 processor, Architecture of 8085, Microprocessor instructions, classification of instructions, Instruction set of 8085, Basic 80x86 Architecture, Role of Microprocessor in Micro Computer, Features of 8086, Internal Block Diagram of 8086, Execution Unit, Bus Interface Unit, Programming of x86 processor, Interrupt mechanism of x86 & Interfacing of chips, Advanced Processor Technologies Interfacing of Data Converters (D-To-A and A-To-D), Programmable Interfacing Devices Like 8255A PPI, 8253/8254 Timer, 8259A PIT, Serial I/O Concepts, SID And SOD, 8251A USART. Interfacing of above chips with 8085.
7	**Contents for lab**	Assembly language programs for 8085 and 8086, Programs involving Arithmetic & logical operations, Programs involving data transfer instructions, programs involving bit manipulation instructions, programs involving branch/ loop instructions, Interfacing Experiments.
8	**List of text books/references**	**Text/ Reference Books:** • Microprocessors and Interfacing by Douglas V. Hall • The 8051 Microcontroller and Embedded Systems by M.A. Mazidi and J. G. Mazidi, PHI. • The Intel Microprocessors by Barry B. Brey, Prentice Hall. • The 8088 and 8086 Microprocessors by Walter A. Triebel, Avtar Singh, Prentice Hall Inc. • 8086/8088 family: Design, Programming and Interfacing by John Uffenbeck, Prentice Hall. • Advanced Microprocessor and Peripherals, Architecture Programming and Interfacing by A. K. Ray and K. M. Burchandi, Tata McGraw Hill. • Microcontroller and Embedded Systems by M. A. Mazidi, Pearson Education. • 8051 Microcontroller and Embedded Systems by R. Kapadia, Jaico Publishing House. • Fundamentals of Microprocessors and Microcomputers by B. Ram, Dhanpat Rai Publications.

1	**Code of the subject**	EE207
2	**Title of the subject**	Principles of Communication
3	**Any prerequisite**	NA
4	**L-T-P**	3-0-2
5	**Learning Objectives**	• Design /Demonstrate the use of analog and digital modulation techniques. • Analyze and compute the performance of the communication system in presence of noise.

6	**Brief Contents**	Layered view of wireless communication, Historical Background and Applications, Basic tools for communication: Fourier Series/Transform, Analog modulation and demodulation techniques, noise and interference in wireless communication, Probability, random variables and stochastic process, Sampling, Quantization, Delta Modulation, Differential Pulse Code Modulation (DPCM), Baseband Data Transmission, Band-Pass Data Transmission encoding techniques, Principles of Digital Transmission schemes–FSK, BPSK, Error Detection and Correction schemes, Noncoherent Digital Modulation Schemes, M-ary Digital Modulation Schemes
7	**Contents for lab**	To perform analog modulation and demodulation, impact of different parameters on the performance To perform digital modulation and demodulation, impact of different parameters on the performance, To simulate the wireless fading channel, performance analysis (outage, BER) of communication system under different fading channels and noise
8	**List of textbooks/ references**	**Text/ Reference Books:** • Communications Systems by Simon Haykin, John Wiley and Sons. • Fundamentals of Wireless Communication by David Tse • An Introduction to Analog & Digital Communications by Michael Moher Simon Haykin, John Wiley and Sons. • Digital Communications by J. G. Proakis and M. Salehi, McGraw-Hill. • Morden Analog & Digital Communication System by B.P. Lathi • Digital and Analog Communication Systems by K. Sam Shanmugam. • Principle of Communication Systems by Taub & Schilling.

1	**Code of the subject**	EE208
2	**Title of the subject**	Electromagnetic Theory
3	**Any prerequisite**	NA
4	**L-T-P**	3-0-0
5	**Learning Objectives**	The learning objectives of the subject are as follows: • Define the fundamental concepts and principles of electromagnetism • Explain the laws of electrostatics and magnetostatics and apply them to solve problems • Analyze and calculate the electric and magnetic fields of various charge and current distributions • Use Gauss's Law and Ampere's Law to calculate electric and magnetic fields, respectively • Understand the mathematical techniques used in electromagnetic theory, including vector calculus and differential equations • Understand the role of Maxwell's equations in describing the behaviour of electromagnetic fields

		Apply electromagnetic theory to real-world problems and communicate findings effectively.
6	**Brief Contents**	Introduction to electromagnetism and its historical development, Coulomb's law and electric field, Gauss's law and its applications, Electric potential and potential difference, Capacitance and dielectrics, Current, resistance, and Ohm's law, Magnetostatics and Biot-Savart law, Ampere's law and its applications, Faraday's law of electromagnetic induction, Maxwell's equations and their interpretation, Electromagnetic waves and their properties, Wave polarization and reflection and refraction of electromagnetic wave, Transmission lines and waveguides, Applications of electromagnetic theory in various fields, such as electronics, telecommunications, and optics.
7	**Contents for lab**	NA
8	**List of text books/references**	**Text/ Reference Books:** Introduction to Electrodynamics by Griffiths, D. J., Pearson. Field and Wave Electromagnetics by Cheng, D. K., Addison-Wesley. Engineering Electromagnetics by Hayt, W. H., Buck, J. A., & Buck, J. T., McGraw-Hill. Elements of Electromagnetics by Sadiku, M. N. O., Oxford University Press. Fields and Waves in Communication Electronics by Ramo, S., Whinnery, J. R., & Van Duzer, T., Wiley. Advanced Engineering Electromagnetics by Balanis, C. A., Wiley.

1	**Code of the subject**	EE209
2	**Title of the subject**	Control System
3	**Any prerequisite**	EE201
4	**L-T-P**	3-0-0
5	**Learning Objectives**	After the completion of the course, the students will be able to: Develop the mathematical model of the physical systems. Analyze the response and stability of the closed and open loop systems. Design the various kinds of compensators. Develop and analyze state space models.
6	**Brief Contents**	Introduction to Feedback Control, Transfer Function, Modelling Electrical, Mechanical, and Electro-mechanical Systems, Block Diagrams, Signal Flow Graph, State Space Representations, Non-linearities, Stability, Routh-Hurwitz Theorem, Steady State Error, Static Error Constants, Type Classification of Transfer Functions, Root Locus: Qualitative Sketching Rules, P, PI, PD, PID, Lag, Lead, and Lag-Lead Compensator Design, Notch Filters, Frequency Response: Bode Plots, Nyquist Stability Criterion, Gain Margin, Phase Margin, Sensitivity, Design Using Frequency Response, State Space Methods: Pole Placement, Observer Design, and Separation Principle
7	**Contents for lab**	N.A.

8	**List of text books/references**	Control System Engineering, by N. S. Nise (Wiley) Modern Control Engineering, by K. Ogata (Prentice Hall) Modern Control Systems, by R. C. Dorf and R. H. Bishop (Prentice Hall) Control Systems Engineering by Nagrath, I. J., and Gopal, M., New Age International Publishers. Automatic Control Systems by Benjamin C. Kuo, Pearson education. Digital Control of Dynamic Systems by G F Franklin, J D Powell and M Workman. Digital Control and State Variable Methods by M. Gopal, McGraw-Hill.

1	**Code of the subject**	EE301
2	**Title of the subject**	Digital Signal Processing
3	**Any prerequisite**	EE201
4	**L-T-P**	3-0-2
5	**Learning Objectives**	After the completion of the course, the students will be able to: Understand the analytical tools such as Fourier transforms, Discrete Fourier transforms, Fast Fourier Transforms and Z-Transforms required for digital signal processing. Get familiarized with various structures of IIR and FIR systems. Design and realize various digital filters for digital signal processing. Understand the applications of DSP in speech processing and spectrum analysis.
6	**Brief Contents**	Review of z-transform and DFT algorithms. Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithm, signal flow graph, Butterflies, computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations and exercises. Basic concepts of IIR and FIR filters, difference equations, design of Butterworth IIR analog filter using impulse invariant and bilinear transform, design of linear phase FIR filters no. of taps, rectangular, Hamming and Blackman windows. Effect of quantization. Digital Signal Processor: Elementary idea about the architecture and important instruction sets of TMS320C 5416/6713 processor, writing of small programs in assembly Language.
7	**Contents for lab**	Understanding mathematical operation on discrete signals. Sketch the magnitude and phase response of DFT, Inverse DFT and FFT of discrete-time signals. Calculate linear and circular convolution of discrete signals. Model IIR and FIR filter using window techniques, architecture of DSP processor.
8	**List of text books/references**	Digital Signal Processing : Principles, Algorithms and Applications by Proakis, J. & D. G. Manolakis, Pearson Education. Digital Signal Processing by Alan V. Oppenheim and Ronald W. Schafer, PHI. Digital Signal Processing "A – Computer Based Approach" by Sanjit K. Mitra, Tata Mc Graw Hill.

		Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Learning.

1	**Code of the subject**	EE302
2	**Title of the subject**	System Design using HDL
3	**Any prerequisite**	EE103
4	**L-T-P**	3-0-2
5	**Learning Objectives**	Correctly describe the detailed behavior of given digital logic circuits as defined by VHDL, state diagrams, or other means, including those circuits related to modern computer architecture. Translate system requirements into a practical digital design, making use of modern engineering tools such as Xilinx Vivado, Verilog HDL, and FPGA prototyping boards. Demonstrate the ability to modify existing HDL code to meet new system requirements. Demonstrate hands-on test bench and prototyping skills to ensure that a design meets the specified system requirements.
6	**Brief Contents**	Basic concepts of hardware description languages (VHDL, Verilog HDL), logic and delay modeling, Structural, Data-flow and Behavioral styles of hardware description, Architecture of event driven simulators, operators, operands, operator types, blocking and non-blocking statements, delay control, generate statement, event control, Sequential Logic Design, FSM, Configuration Specifications, Sub-Programs, Test Benches.
7	**Contents for lab**	HDL code for all the gates, Half Adder, Half Subtractor, Full Adder & Full subtractor, decoder, encoder, mux, demux, code converter, counter, registers etc. and implementation of the same on FPGA.
8	**List of text books/references**	**Text/ Reference Books:** Digital Systems Design Using VHDL by Charles H. Roth, Jr and Lizy Kurian John. A VHDL Primer by Bhaskar, J., Pearson Education India. Verilog HDL: A Guide to Digital Design and Synthesis by Samir Palnitkar, Prentice Hall PTR. A Verilog® HDL Primer, by J. Bhasker. The Designer's Guide To VHDL by Ashenden, P., Elsevier.

1	**Code of the subject**	EE303
2	**Title of the subject**	Wireless Communication
3	**Any prerequisite**	EE207
4	**L-T-P**	3-0-0
5	**Learning Objectives**	Apply Cellular concepts to evaluate the signal reception performance in a cellular network. To design cellular network with given quality of service constraints.

		• Determine the appropriate model of wireless fading channel based on the system parameters and the property of the wireless medium. • Analyze and design receiver and transmitter diversity techniques. • Application of Fundamental Digital Communication Concepts in Fading Channel. Understanding suitable Modulation Schemes for Wireless Channel
6	**Brief Contents**	Introduction to cellular and Mobile communication systems, Wireless channel models, Cellular systems concepts, principles, system design fundamentals, traffic theory. Characterization of wireless radio channel, Transmit and receive Diversity techniques-SC, MRC, EGC, Switch & Stay, BER and Outage with Diversity, MIMO fundamentals-channel model and performance analysis, Equalization, Capacity of fading Channels: Multi User Capacity, Multiple access techniques: TDMA, FDMA, spread spectrum techniques, Cellular CDMA, Wideband CDMA, OFDMA, Multiple access Performance analysis, Wireless Networks and Standards: GSM, CDMA Cellular standard, 3G, 4G, 5G: challenges and Key technologies
7	**Contents for lab**	NA
8	**List of textbooks/references**	**Text/ Reference Books:** • Wireless Communication by Andrea Goldsmith, Cambridge University Press. • Principles of Modern Wireless Communication Systems Theory and Practice by Aditya K Jagannathan, McGraw-Hill India. • Fundamentals of Wireless Communication by David TSE and Pramod Viswanathan, Cambridge University Press. • Wireless Communications: Principles and Practice by Theodore Rappaport, Pearson. • Wireless Communication by Andreas. F. Molisch, John Wiley and Sons. • Wireless Communication and Networking by Mark and Zhuang, PHI

1	**Code of the subject**	EE304
2	**Title of the subject**	IoT and Applications
3	**Any prerequisite**	NA
4	**L-T-P**	3-0-2
5	**Learning Objectives**	After the completion of the course, the students will be able to: • Understand the definition and significance of the Internet of Things. • Discuss the architecture, operation, and business benefits of an IoT solution. • Explore the relationship between IoT, cloud computing, and big data. • Identify how IoT differs from traditional data collection systems.
6	**Brief Contents**	Introduction to IoT: Sensing, Actuation, Basics of Networking, Communication Protocols, Sensor Networks, Machine-to-

		Machine Communications, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi, Cloud Computing, Sensor-Cloud, Fog Computing, Smart Cities and Smart Homes, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring.
7	**Contents for lab**	Coding for the various components of the IoT system, coming up with a micro-controller-based embedded system, building and testing it extensively, the various programming aspects of interfacing with the physical world, system design, microcontrollers, coming up with new and creative ways to solve a problem using coding.
8	**List of text books/references**	The Internet of Things: Enabling Technologies, Platforms, and Use Cases by Pethuru Raj, Anupama C. Raman, CRC Press. Internet of Things: A Hands-on Approach by Arshdeep Bahga, Vijay Madisetti, Universities Press. Introduction to internet of things (NPTEL Course)", Sudip Misra. (https://nptel.ac.in/syllabus/106105166/)

1	**Code of the subject**	EE305
2	**Title of the subject**	RF Circuit and Antenna Design
3	**Any prerequisite**	NA
4	**L-T-P**	3-0-2
5	**Learning Objectives**	The learning objectives of the subject will be to Understand the properties of electromagnetic waves and their relevance Analyze and design RF circuits using various passive and active components, including filters, amplifiers, and mixers. Understand the principles of impedance matching. Understand the concept of noise in RF circuits. Understand the principles of antenna design, including antenna types, radiation patterns, and impedance matching.
6	**Brief Contents**	Introduction to RF circuit and antenna design, Passive RF components, including resistors, capacitors, and inductors, RF filters and their design principles, Amplifiers and their design principles, including noise figure and gain, Mixers and their design principles, including image rejection and spurious response, Impedance matching techniques and design of matching networks, Introduction to antenna design and its applications, Fundamental principles of antennas, including radiation pattern and impedance matching Analysis and design of various antenna structures, such as dipole, monopole, patch, and slot antennas, Simulation and design of RF circuits and antennas using CAD tools, such as HFSS and ADS
7	**Contents for lab**	Introduction to RF circuit and antenna design software tools, such as HFSS and ADS, Analysis and design of resonant circuits, filters, and transmission lines, analysis and design of amplifiers and mixers, design and simulation of matching networks using lumped and distributed elements, Antenna fundamentals: analysis and design of dipole and monopole antennas, Antenna types and characteristics: analysis and design of patch, slot, and horn

		antennas, application of RF circuit and antenna design principles to a real-world problem, such as designing a wireless communication or radar system.
8	**List of text books/references**	**Text/ Reference Books:** • Microwave Engineering by Pozar, D. M., Wiley. • Antenna Theory: Analysis and Design by Balanis, C. A., Wiley. • Antenna Theory and Design by Stutzman, W. L., & Thiele, G. A., Wiley. • Microstrip Lines and Slot lines by Gupta, K. C., & Garg, R., Artech House. • RF Microelectronics by Razavi. • RF Circuit Design by Bowick. • Foundations for Microwave Engineering by Collin

1	**Code of the subject**	EE306
2	**Title of the subject**	Microcontroller and Embedded Systems
3	**Any prerequisite**	Nil
4	**L-T-P**	3-0-2
5	**Learning Objectives**	The student will be able to: • Understand the concept of embedded system, microcontroller, different components of microcontroller and their interactions. • Get familiarized with programming environment to develop embedded solutions. • Program ARM microcontroller to perform various tasks. • Understand the key concepts of embedded systems such as I/O, timers, interrupts and interaction with peripheral devices.
6	**Brief Contents**	8051 Microcontroller, PIC Microcontrollers, RM7TDMI Microcontrollers, Hardware Interfacing: Interfacing with LEDs, Seven Segment, Sensors, Basic concepts of LCD, ADC, DAC, Relays etc. and their interfacing to microcontroller. Introduction to Embedded Systems: Background, History and classification, Core of the embedded system-general purpose and domain-specific processors, ASICs, PLDs, COTs; Communication Interface, Embedded Firmware Design and Development, RTOS Based Embedded System Design.
7	**Contents for lab**	ALP for all ALU, generate clock, display a string, interface of seven segment display, DAC etc. Arduino and Raspberry Pi Microcontroller based Projects.
8	**List of text books/references**	**Text/ Reference Books:** • The 8051 Microcontroller: Architecture, programming and applications, by Ayala J.K., Penram International. • The 8051 Microcontroller and Embedded Systems by Mazidi, E. and Mazidi, F., Prentice-Hall of India. • Embedded system Design using PIC18Fxxx by Peatman J., Prentice Hall. • ARM System-on-Chip Architecture by Steve Furber, PEARSON.

		ARM System Developer's Guide Designing and Optimizing System Software by Andrew N. Sloss, Morgan Kaufman Publication. Embedded Systems Design: An Introduction to Processes, Tools & Techniques by Arnold S. Berger. PIC Microcontroller and Embedded Systems using assembly and C for PIC18 by Muhammad Ali Mazidi, Rolin D. McKinlay. Dann.

1	**Code of the subject**	EE401
2	**Title of the subject**	Artificial Intelligence and Machine learning
3	**Any prerequisite**	Engineering Mathematics I, Engineering Mathematics –II, Object-oriented Programming
4	**L-T-P**	3-0-2
5	**Learning Objectives**	After completing this course students have Understand fundamental concepts of machine learning and its various algorithms. Understand various strategies of generating models from data and evaluating them. Able to apply ML algorithms on given data and interpret the results obtained. Capable to design appropriate ML solution to solve real world problems in AI domain.
6	**Brief Contents**	Terminologies in machine learning, Discriminative Models: Least Square Regression, Gradient Descent Algorithm, Linear Regression, Logistic regression, Support Vector Machines- Large margin classifiers. Model evaluation and improvement, Regularization, Bias Variance, Hyper- parameter Tuning, Convolutional Neural Network. Computational Learning theory-Sample complexity. Gaussian models, Generative models: Unsupervised Learning Algorithms: Dimensionality Reduction Principal Component Analysis (PCA). Clustering – Hierarchical, Partitioned clustering. Problem-solving through Search: forward and backward, state-space, blind, heuristic, hill climbing, best-first, A, A*, AO*, minimax. Intelligent agents - reactive, deliberative. Artificial Intelligence programming techniques; Planning: planning as search, partial order planning, construction and use of planning graph, ANN
7	**Contents for lab**	Implement linear regression using python. Implement Naïve Bayes theorem to classify the English text Implement K-Means clustering using python. Implementing a CNN based classifier using python. Build Artificial Neural Network model with back propagation on a given dataset.
8	**List of text books/references**	Hands-On Machine Learning with Scikit-Learn and TensorFlow by Aurolien Geron. Introduction to Machine Learning with Python: A Guidefor Data Scientists by Andreas Muller and Sarah Guido. Explainable Artificial Intelligence (XAI): Concepts, taxonomies, opportunities and challenges toward responsible AI by Alejandro Barredo Arrieta et. al., Information Fusion, volume 58. https://doi.org/10.1016/j.inffus.2019.12.012.

1	**Code of the subject**	EE402
2	**Title of the subject**	Intelligent Transportation Systems
3	**Any prerequisite**	N.A.
4	**L-T-P**	3-0-0
5	**Learning Objectives**	After the completion of the course, the students will be able to: Model and simulate vehicle dynamics. Understand basic of autonomous and connected-vehicles. Implement intelligent perception and decision procedures needed for self-driving cars. Understand Industrial practice of model-based design to simulate the vehicle and develop efficient algorithms.
6	**Brief Contents**	Basic elements of intelligent transportation systems (ITS), Model-based system engineering for transportation systems, Dynamic and control of connected vehicles. Perception for transportation systems, Decision-making for autonomous vehicles, Communication for V2X, Technological, systems and institutional aspects, Advanced traveler information systems, transportation network operations, commercial vehicle operations and intermodal freight, public transportation applications, ITS and regional strategic transportation planning, ITS and safety, ITS and security, ITS as a technology deployment program, ITS and sustainable mobility, travel demand management, electronic toll collection, and ITS and road-pricing, Advanced topic in intelligent transportation systems
7	**Contents for lab**	N.A.
8	**List of text books/references**	Intelligent transport systems, Selected Lectures (Sadko Mandžuka, 2015) Perspectives on Intelligent Transportation Systems (ITS) by Sussman, Joseph, Springer. Fundamentals of Intelligent Transportation Systems Planning by Mashrur A. Chowdhury, and Adel Sadek, Artech House. Research papers (recommended by the faculty)

1	**Code of the subject**	EE403
2	**Title of the subject**	Power Electronics
3	**Any prerequisite**	NA
4	**L-T-P**	3-0-2
5	**Learning Objectives**	To familiarize students with various Power Electronic devices and their specifications. To prepare the students to analyse and design different power converter circuits. Acquire knowledge about fundamental concepts and techniques used in power electronics. Ability to analyse various single phase and three phase power converter circuits and understand their applications.

6	**Brief Contents**	Power Semiconductor Devices: Diode, BJT, MOSFET, SCR, Triac, GTO, IGBT, MCT and their V-I characteristics, ratings, driver circuits, protection and cooling; AC-DC Converters (Rectifiers): Diode rectifier, thyristor based rectifier, effect of source inductance, single/three phase rectifiers, semi/full rectifiers, power factor, harmonics; DC-AC Converters (Inverters): Concept of switched mode inverters, PWM switching, voltage and frequency control of single/ three phase inverters, harmonics reduction, other switching schemes - square wave pulse switching, programmed harmonic elimination switching, current regulated modulation switching - tolerance band control, fixed frequency control; voltage source inverter (VSI), current source inverter (CSI); DC-DC Converters (Chopper): Principle; buck, boost and buck-boost converters; AC Voltage Controllers: Principle of ON-OFF control and phase control, single/three phase controllers, PWM AC voltage controller, cycloconverters;
7	**Contents for lab**	Study of Characteristics of SCR, MOSFET & IGBT, Single Phase Half controlled converter with R load, Single Phase fully controlled bridge converter with R and RL loads, Three Phase half controlled bridge converter with R load, Single Phase AC Voltage Controller with R and RL Loads, Single Phase Cyclo converters with R and RL loads, Single Phase series inverter with R and RL loads, DC Jones chopper with R and RL Loads
8	**List of text books/references**	**Text/ Reference Books:** • Power Electronics- Converters, Applications and Design by N. Mohan, John Wiley & Sons. • Introduction to Modern Power Electronics by Andrzej M. Trzynadlowski, John Wiley & Sons. • Power Electronics Circuits, Devices and Applications by M.H. Rashid, PHI.

1	**Code of the subject**	EE404
2	**Title of the subject**	IC Technology
3	**Any prerequisite**	Nil
4	**L-T-P**	3-0-0
5	**Learning Objectives**	Students will be able to learn: • Fundamental principles of fabrication of VLSI devices and circuits. • To demonstrate a clear understanding of CMOS fabrication flow and technology scaling • To demonstrate a clear understanding of various MOS fabrication processes, semiconductor measurements, packaging, testing and advanced semiconductor technologies.
6	**Brief Contents**	Historical perspective, processing overview, crystal growth, wafer fabrication and basic properties of Silicon Wafers, Clean Rooms, Wafer Cleaning, Epitaxy, Thermal Oxidation of Silicon, Lithography, Wet and Dry Etching, Thin film deposition technique (ALD), Diffusion, Ion Implantation, Metallization, Process Integration: Passive components, Bipolar Technology, MOSFET Technology, CMOS Technology, MESFET Technology, MEMS Technology, IC Manufacturing: Electrical

		Testing, Packaging, Yield, Future trends and Challenges: Challenges for integration, system on chip, Novel Devices.
7	**Contents for lab**	NA
8	**List of text books/references**	**Text/ Reference Books:** - Fundamentals of Semiconductor Fabrication by G. S. May and S. M. Sze, Wiley. - Silicon VLSI Technology, Fundamentals, Practice and Modeling by J. D. Plummer, M. D. Deal and P. B. Griffin, Pearson education. - VLSI Technology by S. M. Sze, TMH. - Semiconductor Devices: Physics and Technology by S. M. Sze, Wiley. - Semiconductor Integrated Circuit Processing Technology by W. R. Runyan and K. E. Bean, Addison Wesley Publishing Company. - The Science and Engineering of Microelectronic Fabrication by S. A. Campbell, Oxford University Press. - Fundamentals of Microfabrication by M. J. Madou, CRC Press.

1	**Code of the subject**	EE499
2	**Title of the subject**	BTech Project/ Internship
3	**Any prerequisite**	
4	**L-T-P**	0-0-24
5	**Learning Objectives**	To develop deeper knowledge, understanding, capabilities and attitudes in the context of the programme of study.
6	**Brief Contents**	The purpose of this course is to enable the student to develop deeper knowledge, understanding, capabilities and attitudes in the context of the programme of study. The student is expected to demonstrate the abilities of the major subject/field of study, including deeper insight into hardware/software application development work. Develop the capability to create, analyse and critically evaluate different technical/architectural solutions. Equip with the needed skills to clearly present and discuss theconclusions as well as the knowledge and arguments that form the basis for the learning outcome in written and spoken English. Importantly it is necessary to march on the ethical aspects of research and development work.
7	**Contents for lab**	There are no specific laboratory sessions for this. However, this being a completely practical oriented course, the student has to devote significant time to achieve the objectives.
8	**List of text books/references**	https://grad.wisc.edu/wp-content/uploads/sites/329/2018/02/2018-Project-Management-for-Graduate-Students-Course-Workbook.pdf

1	**Code of the subject**	EE001
2	**Title of the subject**	VLSI Architecture
3	**Any prerequisite**	EE205, 302
4	**L-T-P**	3-0-0

5	**Learning Objectives**	The course objective is to cover the architecture design of VLSI systems and subsystems with the notion of optimization for area, speed, power dissipation, cost and reliability. Different aspects of VLSI system design and its applications invarious field. The course also discusses traditional and state of the art analog and digital VLSI architectures optimized techniques.
6	**Brief Contents**	ISA, Datapath and control path design, Single Cycle MIPS , 5 Stage pipeline MIPS, CISC Architecture, RISC architecture, Arithmetic unit design, Fixed point and floating point, memory units, Optimization, Instruction level parallelism, Super scalar processor, Multi-core and multi thread Architecture, Network on chip, Dynamically reconfigurable gate array, Static vs dynamic reconfiguration, single context vs multi-context dynamic reconfiguration, full vs partial run time reconfiguration.
7	**Contents for lab**	NA
8	**List of text books/references**	Digital Integrated Circuit Design: From VLSI Architectures to CMOS Fabrication by Hubert Kaeslin, Cambridge University Press. Synthesis and Optimization of Digital Circuits by Giovanni De Micheli, McGraw Hill. VLSI Array Processors by S.Y. Kung, Prentice Hall. VLSI Design Methodologies for Digital Signal Processing Architectures by Magdy A. Bayoumi, Springer.

1	**Code of the subject**	EE002
2	**Title of the subject**	Quantum Electronics
3	**Any prerequisite**	EE203, EE204
4	**L-T-P**	3-0-0
5	**Learning Objectives**	The course gives an introduction to solid state physics, and will enable the student to employ classical and quantum mechanical theories needed to understand the physical properties of solids. Emphasis is put on building models able to explain several different phenomena in the solid state.
6	**Brief Contents**	The crystal structure of solids, Introduction to quantum mechanics: Principles of Quantum mechanics, Application of Schrodinger's Wave Equations, Introduction to Quantum Theory of Solids: The kronig-Penney Model, Electrical conduction in Solids, DOS, Statistical Mechanics, The semiconductor in Equilibrium Carrier transport Phenomenon, Non-equilibrium Excess Carriers in Semiconductor, PN-Junction, MOSCAP, Thin film Transistors, QCA
7	**Contents for lab**	NA
8	**List of text books/references**	Semiconductor physics and devices: basic principles by Neamen, Donald A., McGraw-hill. Fundamentals of modern VLSI devices by Taur, Yuan, and Tak H. Ning, Cambridge university press. Quantum nano-electronics: An Introduction to Electronic Nanotechnology and Quantum Computing by Edward L. Wolf Quantum Electronics by Amnon Yariv Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience by Edward L. Wolf

1	**Code of the subject**	EE003
2	**Title of the subject**	Introduction to MEMS
3	**Any prerequisite**	EE304
4	**L-T-P**	3-0-0
5	**Learning Objectives**	After completion of the course student will be able to: - Understand the Basic concept of MEMS Fabrication Technologies, Piezoresistance Effect, Piezoelectricity, Piezoresistive Sensor. - Explain Mechanics of Beam and Diaphragm Structures. - Understand the Basic concept of Air Damping and Basic Equations for Slide-film Air Damping, Couette-flow Model, Stokes-flow Model. - Know the concept of Electrostatic Actuation. - Understand the applications of MEMS in RF
6	**Brief Contents**	Historical Background, Silicon Pressure sensors, Micromachining, Micro Electro-Mechanical Systems, Microfabrication and Micromachining: Integrated Circuit Processes, Bulk Micromachining, Physical Microsensors, Sensor Principles and Examples, Microactuators, Microactuator systems, Surface Micromachining, Surface Micro-machined Systems, Application Areas: All-mechanical miniature devices, 3-D electromagnetic actuators and sensors, RF/Electronics devices, Optical/Photonic devices, Medical device e.g. DNA-chip, micro-arrays.
7	**Contents for lab**	NA
8	**List of text books/references**	**Text/ Reference Books:** - Foundations of MEMS by C. Liu, Pearson/PH. - Essentials of Mechatronics by J. Billingsley, Wiley. - Mechatronics by S. Cetinkunt, Wiley. - RF MEMS: Theory, Design, and Technology by G. M. Rebeiz, Wiley. - Mechatronics System Design by D. Shetty and R. Kolk, Thomson. - Robot Modeling and Control by M. W. Spong, S. Hutchinson and M. Vidyasagar, Wiley.

1	**Code of the subject**	EE004
2	**Title of the subject**	VLSI Signal Processing
3	**Any prerequisite**	EE201, EE205
4	**L-T-P**	3-0-0
5	**Learning Objectives**	This course aims at providing comprehensive coverage of the important techniques for designing efficient VLSI architectures for DSP. This course will enable students to understand industrial challenges in the implementation of DSP systems, like capability to process high throughput data in real-time, as well as requiring less power and less chip area.
6	**Brief Contents**	Graphical representation of DSP algorithms, signal flow graph (SFG), data flow graph (DFG) and dependence graph (DG), high-level transformation, critical path, Retiming of DFG, critical path minimization by retiming, loop retiming and iteration bound,

		Cutset retiming, design of pipelined DSP architectures. Parallel realization of DSP algorithms, unfolding theorem, polyphase decomposition, hardware efficient parallel realization of FIR filters, 2-parallel and 3-parallel filter architectures, Hardware minimization by folding, delay optimization by folding, lifetime analysis. Pipelining digital filters, combining parallel processing with pipelining in digital filters.
7	**Contents for lab**	NA
8	**List of text books/references**	□ VLSI Digital Signal Processing Systems by Keshab K. Parhi, Wiley Eastern. □ Digital Signal Processing for Multimedia Systems by Keshab K. Parhi, Takao Nishitani, and Marcel Dekker. □ Pipelined Lattice and Wave Digital Recursive Filters by J. G. Chung and Keshab K. Parhi, Kluwer. □ VLSI Digital Signal Processing Systems: Design and Implementation by Parhi, K.K., John Wiley. □ Discrete-Time Signal Processing by Parhi, K.K., Prentice Hall.

1	**Code of the subject**	EE005
2	**Title of the subject**	FPGA Based System Design
3	**Any prerequisite**	EE103, 205
4	**L-T-P**	3-0-0
5	**Learning Objectives**	The goal of the course is to study the basic principles and methods of FPGA prototyping. Understanding of principles of IC prototyping; hardware and software; design strategies and methods
6	**Brief Contents**	ROM, SPLD, CPLD Architecture and Features of FPGA and designing techniques, Architecture of ROM, Programming, Architecture of SPLDs, SPLDs programming, Architecture of CPLDs, Basics of FPGAs, Structure of FPGAs, Implementation of Digital circuits in FPGA processor, Education FPGA kit, FPGA pin assignment, Interfacing Input/Output devices with FPGA, SPI, I2C, I3C, UART protocol RTL design, System Design Examples using Xillinx FPGAs, Traffic light Controller, Real Time Clock, VGA, Keyboard, LCD, Embedded Processor Hardware Design
7	**Contents for lab**	No
8	**List of text books/references**	□ Application Specific Integrated Circuits by M. J. S. Smith, Pearson. □ Digital Design using VHDL by Peter Ashenden, Elsevier. □ Digital Design using Verilog by Peter Ashenden, Elsevier. □ FPGA based system design by W. Wolf, Pearson. □ The Design Warriors's Guide to FPGAs by Clive Maxfield, Elsevier. □ Verilog HDL: A Guide to Digital Design and Synthesis by Samir Palnitkar, Prentice Hall. □ Digital VLSI System Design: A Design Manual for implementation of Projects on FPGAs and ASICs Using Verilog by S. Ramachandran, Springer Publication.

		Wayne Wolf, “FPGA Based System Design”, Prentices Hall Modern Semiconductor Design Series. Digital Logic Design with Verilog HDL by Stephen Brown & ZvonkoVranesic, TATA McGraw Hill Ltd.

1	**Code of the subject**	EE006
2	**Title of the subject**	Design Verification and Testing
3	**Any prerequisite**	EE205
4	**L-T-P**	3-0-0
5	**Learning Objectives**	The main objective of this course is to provide in-depth understanding of the problems encountered in testing large circuits, approaches to detect and diagnose the faults and methods to improve the design to make it testable. The students will be able to develop algorithms and tools for VLSI testing, designing of testable and trustworthy circuits. The scope of this course is to particularly address the challenges in the VLSI testing domain and get motivated towards research in this field.
6	**Brief Contents**	Introduction and Fault Modeling, Testing Techniques, Time frame expansion methods, Boolean Satisfiability, transitive-closure based and Neural Network based approaches, Fault Simulation, Design for Testability and Built-in-self-test, Controllability and observability measures, TEMEAS, SCOAP, ad-hoc design built-in-logic-block-observer (BILBO), linear feedback shift register (LFSR), theory of LFSRs, Design for Trust Techniques: Different Types of Attacks, Counter Measures for different types of attacks, Prevention based Approaches, Importance of verification, Verification plan, Verification flow, Levels of verification, Verification methods and languages, Introduction to Hardware Verification methodologies, Verifications based on simulation, analytical and formal approaches. Functional verification, Timing verification, Formal verification. Basics of equivalence checking and model checking.
7	**Contents for lab**	NA
8	**List of text books/references**	Essential of Electronic Testing for Digital, Memory, and Mixed Signal VLSI Circuits by M. L. Bushnell and V.D Agrawal, Springer. VLSI Test Principles and Architectures by L.W. Wang, C.W. Wu, W. Xioqing, Academic Press. Hardware Design Verification by William Lam, Prentice Hall, Logics in Computer Science by M. Huth and M. Ryan, Cambridge University Press. Introduction to Formal Hardware Verification by Thomas Kropf, Springer.

1	**Code of the subject**	EE007
2	**Title of the subject**	Device and Interconnect Modelling
3	**Any prerequisite**	EE205
4	**L-T-P**	3-0-0

5	**Learning Objectives**	Upon the completion of this course, the students are able to: • Concept of MOS modeling • Understand the advanced interconnect materials. • Acquire knowledge about Technology trends, Device and interconnect scaling. • Identify basic device and Interconnect Models. • Perform RLC based Interconnect analysis. • Analyse the problem with existing material in deep submicron.
6	**Brief Contents**	Technology trends, Device and interconnect scaling, Interconnect Models: RC model and RLC model, Effect of capacitive coupling, Effect of inductive coupling, Transmission line model, Power dissipation, Interconnect reliability, Driver and Load Device Models, Interconnect Analysis, Time domain analysis, RLC network analysis, RC network analysis and responses in time domain, S domain analysis, circuit reduction via matrix approximation, Analysis using moment matching, Crosstalk Analysis, Advanced Interconnect Materials. Introduction to the TCAD Simulation Tool, Examples of TCAD Simulations, Moore law, Technology nodes and ITRS, Physical & Technological Challenges to scaling, Two terminal MOS Device threshold voltage modelling, C-V Characteristics, Four terminal MOSFET threshold voltage I-V modelling, short channel effect (SCE), High-K gate dielectric, Nonconventional MOSFET – (FDSOI, SOI, Multi-gate MOSFETs). Nonconventional MOSFET – (FDSOI, SOI, Multi-gate MOSFETs).
7	**Contents for lab**	NA
8	**List of text books/references**	**Text/ Reference Books:** • Interconnect Analysis and Synthesis by Chung-Kang Cheng, John Lillis, Shen Lin and Norman H.Chang, A Wiley Interscience Publication. • CMOS Digital integrated circuits analysis and design by Sung-Mo (Steve) Kang, Yusuf Leblebigi, Tata Mcgraw-Hill. • Electronic properties of Carbon Nanotubes by Mauricio Marulanda, InTech publisher. • Computational Electronics: Semiclassical and Quantum Device Modeling and Simulation by Dr VagicaVasileska and Stephen M. Goodnick. • Silicon Nanoelectronics by Shundri Oda & David Ferry, CRC Press.

1	**Code of the subject**	EE008
2	**Title of the subject**	CAD for VLSI
3	**Any prerequisite**	EE205
4	**L-T-P**	3-0-0
5	**Learning Objectives**	The main objective of this course is to provide in-depth understanding of the theoretical as well as practical concepts of the designing algorithms for CAD toolsfor VLSI design. The students will be able to identify and develop new algorithmsand CAD tools for VLSI design. The scope of this course is also to visualize new Design Automation (DA) research problems in view of the challenges of designing multi-core and/or many-core

		system-on-chip in the nanometer regime. Another objective of this course is to give the exposure to machine learning and deep learning algorithms for designing efficient hardware in IOT era.
6	**Brief Contents**	Introduction to VLSI-CAD, module generation, PLAs and FPGAs, Digital hardware modeling, benchmark circuits (ISCAS'85, ISCAS'89…), Simulation algorithms design verification, graph datastructure and algorithms for VLSI-CAD, High-level synthesis, Algorithms for physical design automation, slicingand non-slicing floorplans, polar graphs and adjacency graphs for floorplans, Introducing NOC as a future SOC paradigm, Timing analysis, SDC, set-up & hold time concept, timing exceptions, set-up & hold calculations, noise analysis.
7	**Contents for lab**	NA
8	**List of text books/references**	• Synthesis and Optimization of Digital Circuits by Giovanni De Micheli,Tata McGraw Hill. • High Level Synthesis: Introduction to Chip and System Design by D.D Gajski et al., Kluwer Academic Publishers. • Computer Arithmetic: Algorithms and Hardware Designs by B. Parhami, Oxford Univ. Press. • VLSI physical design automation: theory and practice by S.M. Sait and H. Youssef, World Scientific Pub. Co.

1	**Code of the subject**	EE009
2	**Title of the subject**	Memory Devices and Circuits
3	**Any prerequisite**	EE205
4	**L-T-P**	3-0-0
5	**Learning Objectives**	The objective of the Memory Design is to acquaint the students with memory cell, memory peripherals, novel SRAM cell, next-generation memory. The subject gives the platform to analyze the read/write/hold operations of different memory structures using CAD tools.
6	**Brief Contents**	Overview of volatile memory, non-volatile memory, on-chip memory, on-chip memory types. Review of CMOS circuit design, sensing circuitry basics, read/write assist circuitry and other peripheral circuitries, next generation SRAM cell, Introduction to DRAM, high speed DRAM architectures, open and folded arrays organizations, bandwidth, latency, and cycle time, power, timing circuits, STT-MRAM, data migration policy for hybrid cache, Operation of FLASH memories (FLASH array sensing and programming), Charge Pump circuits. Basic of memory compiler for SRAM architecture using scripting language
7	**Contents for lab**	NA

8	**List of text books/references**	□ VLSI Memory Chip Design by Kiyoo Itoh, Springer. □ Ultra-low Voltage Nano-scale Memories by Kiyoo Itoh, Masashi Horiguchi, Hitoshi Tanaka, Springer. □ Semiconductor Memories: Technology, Testing, and Reliability by Ashok K.Sharma, Wiley IEE. □ Semiconductor Memories: A Handbook of Design, Manufacture and Application by Betty Prince, Wiley. □ DRAM Circuit Design: Fundamental and High-Speed Topics by Keeth, Baker,Johnson, and Lin, Wiley.

1	**Code of the subject**	EE011
2	**Title of the subject**	Communication Networks and Switching
3	**Any prerequisite**	Data Structures, Object Oriented programming
4	**L-T-P**	3-0-0
5	**Learning Objectives**	□ To provide a foundational view of layered communication architectures (OSI and TCP/IP). □ Understand the client/server model and key application of layer protocols. □ To provide the concepts of reliable data transfer and how TCP implements these concepts. □ To appraise the knowledge of the student with current topics; security, network management, sensor networks, and/or other topics.
6	**Brief Contents**	Introduction to layered network architecture, protocol layers, and their service models (OSI and Internet protocol); Link Layer protocols, high-speed packet switching, queueing theory, routing; Internet Protocol; reliability, flow control, congestion control, and their embodiment in TCP; quality of service; and network security, Local Area Networks, and Wide Area Networking issues including routing and flow control; Fundamentals of SDN and IoT Implementation of Network topologies, error detection and correction methods, To connect two pc's using peer to peer communication, Implementation of small network using hub and switch, Network Socket Programming
7	**Contents for lab**	NA
8	**List of text books/references**	□ Computer Networking: A Top-Down Approach, by J. F. Kurose and K. W. Ross, Addison Wesley. □ Data and Computer Communications, W. Stallings □ Computer Networks and Internets, D. E. Comer and R. E. Droms □ Data Networks by R. Gallager and D. P. Bertsekas, Prentice-Hall.

1	**Code of the subject**	EE012
2	**Title of the subject**	Information Theory and coding
3	**Any prerequisite**	EM-1, EM-2
4	**L-T-P**	3-0-0

5	**Learning Objectives**	□ Understand and appreciate how information theory is concerned with the fundamental limits of communication. □ Understand the application of Information Theory to Source Coding and Data Compression □ Understand the concept of channel coding and error correction techniques
6	**Brief Contents**	Mutual information, entropy for discrete ensembles, Shannon`s noiseless coding theorem, Encoding of discrete sources. Markov sources, Shannon`s noisy coding theorem and converse for discrete channels, Calculation of channel capacity and bounds for discrete channels, Application to continuous channels. Techniques of coding and decoding, Huffman codes and uniquely detectable codes, Cyclic codes, convolutional arithmetic codes, Combinatorial Designs, Network Coding.
7	**Contents for lab**	NA
8	**List of textbooks/references**	□ Information and Coding by N. Abramson, McGraw Hill. □ Introduction to Information Theory by M. Mansurpur, McGraw Hill. □ Elements of information theory by J. A. Thomas and T. M. Cover, Wiley. □ Network Coding– Fundamentals and Applications by M. Medard and A. Sprintson, Acadamic Press. □ The theory of information and coding by R. J. McEliece, Cambridge □ Error Control Coding by Shu Lin and Daniel J. Costello, Prentice Hall.

1	**Code of the subject**	EE013
2	**Title of the subject**	High-Performance Computing
3	**Any prerequisite**	EE401
4	**L-T-P**	3-0-0
5	**Learning Objectives**	□ Understand and appreciate how information theory is concerned with the fundamental limits of communication. □ Understand the application of Information Theory to Source Coding and Data Compression □ Understand the concept of channel coding and error correction techniques
6	**Brief Contents**	Parallel Processing Concepts, Levels of parallelism, Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation etc), N-wide superscalar architectures, multi-core, multi-threaded, Parallel Programming with CUDA: Processor Architecture, Interconnect, Communication, Memory Organization, and Programming Models in high-performance computing architectures: (Examples: IBM CELL BE, Nvidia Tesla GPU, Intel Larrabee Microarchitecture and Intel Nehalem microarchitecture), Memory hierarchy and transaction-specific memory design, Thread Organization Fundamental Design Issues in Parallel Computing, Fundamental Limitations Facing Parallel Computing, Power-Aware Computing and Communication, Advanced Topics: Petascale

		Computing, Optics in Parallel Computing, Quantum Computers, Recent developments in Nanotechnology and its impact on HPC
7	**Contents for lab**	NA
8	**List of textbooks/references**	Highly Parallel Computing by George S. Almasi and Alan Gottlieb Advanced Computer Architecture: Parallelism, Scalability, Programmability by Kai Hwang, McGraw Hill. Parallel Computer Architecture: A hardware/Software Approach by David Culler Jaswinder Pal Singh, Morgan Kaufmann. Scalable Parallel Computing by Kai Hwang, McGraw Hill. Principles and Practices on Interconnection Networks by William James Dally and Brian Towles, Morgan Kauffman. GPU Gems 3 by Hubert Nguyen (Chapter 29 to Chapter 41) Introduction to Parallel Computing by Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar. Petascale Computing: Algorithms and Applications by David A. Bader (Ed.), Chapman & Hall/CRC, Computational Science Series.

1	**Code of the subject**	EE014
2	**Title of the subject**	Biomedical Signal Processing
3	**Any prerequisite**	EE301
4	**L-T-P**	3-0-0
5	**Learning Objectives**	Understand practical problems in objective analyses of biomedical signals. Understand the theoretical background underlying the use of digital signal processing and statistical techniques for biomedical applications. Identify the best solution for specific problems by considering the benefits and limitations of various digital signal processing approaches. iv. Implement appropriate signal processing algorithms for practical biomedical applications.
6	**Brief Contents**	Overview of biomedical signals such as ECG, EEG, MEG, Ultrasound; Fourier transforms review and filter design, Random and Structured Noise, Physiological Interference, Stationary and Nonstationary Processes, Noises and Artifacts Present in ECG, Time and Frequency Domain Filtering statistical inference on signals and images; EEG Signal Processing and Event Detection in Biomedical Signals, estimation theory with application to inverse imaging and system identification; spectra, spectrograms and wavelet analyses; pattern classification and diagnostic decisions, Analysis of Nonstationary Signals.
7	**Contents for lab**	NA
8	**List of text books/references**	Biomedical Signal Processing: Principles and Techniques by D.C. Reddy, Tata McGrawHill Education.

		□ Biomedical signal analysis by Rangayyan, R.M., John Wiley & Sons. □ Biomedical digital signal processing by Tompkins, W.J., Editorial Prentice Hall. □ Bioelectrical signal processing in cardiac and neurological applications by Sörnmo, L. and Laguna, P., Academic Press.

1	**Code of the subject**	EE015
2	**Title of the subject**	Neuromorphic Computing
3	**Any prerequisite**	EE401
4	**L-T-P**	3-0-0
5	**Learning Objectives**	□ Understand volatile/non-volatile memories in greater detail. □ Electrical equivalent model of neuron □ Basic understanding of Perceptron (Artificial Neural Network) □ Emerging memory devices for the realization of dynamics of biological neuron and synapse
6	**Brief Contents**	Memory Organization and overview of memory technology: markets trends and technology, Volatile memory (SRAM and 1T/1C-DRAM), capacitorless DRAM Flash Memory: Pool Frenkel Emission and Fowler-Nordheim tunnelling, floating gate and charge-trap (O/N/O) gate, reliability and scaling, Embedded Flash memory technology: silicon and nanocrystals, engineered CT layers and Split-gate memory architecture. Neuronal dynamics: Overview biological neuron and synapse, Hodgkin-Huxley Model, Leaky Integrated Fire (LIF) and Integrated Fire (IF) model, Atkinson and Shiffrin stage model of memory storage, Artificial neural network (ANN) and Spiking Neural Network (SNN). Realization of artificial neuron and synapse using two terminal devices and MOS transistors, Hardware accelerators.
7	**Contents for lab**	NA
8	**List of text books/references**	□ Advances in non-volatile memory and storage technology by Y. Nishi and Magyari-Kope, Woodhead Publishing. □ Neuromorphic Computing and Beyond: Parallel, Approximation, Near Memory, and Quantum by Khaled Salah Mohamed. □ Neuromorphic Devices for Brain-inspired Computing: Artificial Intelligence, Perception, and Robotics by Qing Wan, and Yi Shi.

1	**Code of the subject**	EE016
2	**Title of the subject**	Advance Signal Processing
3	**Any prerequisite**	Digital Signal Processing (EE301)
4	**L-T-P**	3-0-0
5	**Learning Objectives**	

		• Analyse and synthesise multirate DSP systems. • Understanding filter banks and wavelets for industrial applications. • Estimation of parameters to take a wavelet transform, and interpret and process the result. • Have an in-depth knowledge of use of digital systems in real time applications • Apply the algorithms for wide area of recent applications.
6	**Brief Contents**	Review of DFT, z-transform, and digital filters, Decimation and interpolation, Filters in sampling rate alteration systems, Polyphase decomposition and efficient structures, and filter banks. STFT, Wavelet theory, Spectral estimation, Periodogram, Bartlett's method, Welch's method, and ARMA modelling. Adaptive signal processing, Wiener Filter, Kalman Filter, LMS, and RLS.
7	**Contents for lab**	NA
8	**List of text books/references**	• Digital Signal Processing: Principles, Algorithms, and Applications by J. G. Proakis, D. G. Manolakis, Prentice Hall. • Digital Signal Processing: A Computer Based Approach by S. K. Mitra, McGraw Hill Higher Education. • Discrete-time signal processing by A. V. Oppenheim, R. W. Schafer, Prentice Hall. • Statistical Signal Processing and Modeling by M. H. Hayes, John Wiley and Sons.

1	**Code of the subject**	EE017
2	**Title of the subject**	Optical Communication
3	**Any prerequisite**	EE207
4	**L-T-P**	3-0-0
5	**Learning Objectives**	• Enrich the knowledge of the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices. • Familiarize with the Design considerations of fiber optic systems
6	**Brief Contents**	Introduction to fiber optics, principles and motivation, Optical Sources : LED, Need for Laser Diodes, Resonator Concepts, Laser Diodes, Modulation response of LD, Chirp, Noise in Lasers, different modulation schemes, Optical Fibers, Photo detectors, Optical Link Design, Nonlinear effects, Coherent Detection and DSP, Optical Networks: SDH/SONET Layering, Frame Structure, Physical network topologies, Access Networks-PON, Optical Interconnects, Data Centers, Optical communication for Wireless Fronthauling
7	**Contents for lab**	NA
8	**List of text books/references**	• Fiber Optics Communication and Other Application by Henry Zanger and Cynthia Zanger, Macmillan Publishing Company, Singapore. • Optical Fiber Communication by G. Keiser, McGraw Hill. • Optical Fiber Communications by J. M. Senior, PHI.
1	**Code of the subject**	EE018

2	**Title of the subject**	Advanced Communication Engineering
3	**Any prerequisite**	EE207
4	**L-T-P**	3-0-0
5	**Learning Objectives**	□ Analyze error performance of digital communication systems in the presence of additive noise. □ Develop strong mathematical foundation and intuition to pursue any advanced topic in communications (wireless communication, detection and estimation theory, etc.) □ Enriched understanding on recent communication technology viz., mm wave and THz Communication, IRS and UAV aided communication
6	**Brief Contents**	Introduction, Autocorrelation, Cross correlation, Energy Spectral Density (ESD) and Power Spectral Density (PSD), Optimum receivers for AWGN channels: Correlation and matched filter receivers, Fundamentals of detection: Maximum likelihood decoding etc, Coherent and noncoherent modulation, Digital communication through band-limited channels, Spread spectrum for digital communications, Multichannel communications with OFDM fundamentals. Introduction to wireless communication systems and wireless channels, Wireless channel models, MIMO channel model, Information Theory basics for MIMO communication, Capacity of MIMO Communication systems, Diversity performance of MIMO channels, Space Time Coding schemes, Multi-user MIMO communication, distributive MIMO, mm and THz communication: Characteristics, Standardization and Regulation, Radio Propagation at mm Waves, THz Propagation and Channel Modelling, THz Devices, Transceiver Technologies, Integrated Passive Components, Circuits and Interconnects, Modulation, radiating systems, mm Wave MIMO, Beam Steering and Beam Forming, IRS aided Communication, Cognitive radio, cooperative communication, Relay networks, free space optical (FSO) communication, UAV aided communication
7	**Contents for lab**	NA
8	**List of text books/references**	**Text/ Reference Books:** □ Advanced Millimeter-wave Technologies Antennas, Packaging and Circuits by Duixian Liu, Brian Gaucher, Ulrich Pfeiffer and Janusz Grzyb, John Wiley & Sons Ltd, United Kingdom. □ Millimeter wave communication systems by Kao-Cheng Huang, Zhaocheng Wang, John Wiley & Sons. □ THz Communications by Thomas Kürner, Daniel M. Mittleman and Tadao Nagatsuma; Springer Series in Optical Sciences. □ Microwave Engineering: Passive Circuits by P A Rizzi, PHI. □ Foundations of Microwave Engineering by R E Collin, John Wiley and Sons India Pvt. Ltd. □ High Frequency Integrated Circuits by Sorin Voinigescu, Cambridge University Press, UK.

1	**Code of the subject**	EE019
2	**Title of the subject**	Speech and Audio Signal Processing
3	**Any prerequisite**	Digital Signal Processing (EE301)
4	**L-T-P**	3-0-0
5	**Learning Objectives**	After the completion of the course, the students will be able to: - Understand basic concepts of speech production, speech analysis, speech coding and parametric representation of speech and apply it in practical applications - Develop systems for various applications of speech processing. - Learn Signal processing models of sound perception and application of perception models in audio signal processing. - Implement audio compression algorithms and standards.
6	**Brief Contents**	Speech production, Time domain analysis, Frequency domain analysis, Cepstral analysis, LPC analysis, Speech coding, Speech recognition, Speech enhancement, Text to speech conversion. Signal Processing Models of Audio Perception, Psycho-acoustic analysis, Spatial Audio Perception and rendering, Audio compression methods, Parametric Coding of Multichannel audio, Transform coding of digital audio, audio quality analysis.
7	**Contents for lab**	NA
8	**List of text books/references**	- Speech Communications: Human & Machine by Douglas O'Shaughnessy, IEEE Press. - Speech and Audio Signal Processing: Processing and Perception Speech and Music by Nelson Morgan and Ben Gold, John Wiley & Sons. - Fundamentals of Speech Recognition by Rabiner and Juang, Prentice Hall. - Digital Processing of Speech Signals by Rabiner and Schafer, Prentice Hall. - Discrete-Time Speech Signal Processing: Principles and Practice by Thomas F. Quatieri, Prentice Hall.

1	**Code of the subject**	EE020
2	**Title of the subject**	Sensors for Autonomous Systems
3	**Any prerequisite**	EE304
4	**L-T-P**	3-0-0
5	**Learning Objectives**	- Deeply understand the Fundamentals common to widely used sensing and filtering systems. - Select appropriate sensors and data acquisition hardware to instrument electro-mechanical equipment, with a full awareness of practical constraints and real-world problems. - Be able to use model based and state-based control to module systems, and carry out system analysis.
6	**Brief Contents**	Use of autonomous systems, Sensing, methods for data acquisition, issues associated with different techniques (e.g. Nyquist, noise, etc.), Control Strategies, modelling dynamic systems using transfer functions, model based control, stability of control systems, state space analysis, feedback control methods using observability and parameter estimation, Fuzzy control, digital control, rule based and optimisation approaches,

		Brute Force and enumeration, linear programming, genetic algorithms, graph based approaches, dynamic programming, simulated annealing, ant colony, Tabu search, other artificial intelligence approaches, Actuation and systems.
7	**Contents for lab**	N.A.
8	**List of text books/references**	Introduction to Autonomous Mobile Robots by Illah R. Nourbaksh and Roland Siegwart, The MIT Press State Estimation for Robotics by Timothy Barfoot, Cambridge: Cambridge University Press. Sensing and Control for Autonomous Vehicles: Applications to Land, Water and Air Vehicles by Thor I. Fossen, Kristin Y. Pettersen, Henk Nijmeijer

1	**Code of the subject**	EE021
2	**Title of the subject**	Power Systems
3	**Any prerequisite**	EE403
4	**L-T-P**	3-0-0
5	**Learning Objectives**	Understanding the basics of power system generation, transmission, distribution system. Modeling, Design, and Evaluation of various parameters of transmission lines. Understand power system stability and control. Acquire knowledge of underground cables: construction, methods of laying, grading, and determination of fault location.
6	**Brief Contents**	Energy resources, power generation: Thermal, hydro and nuclear power plants. Transmission lines, line parameters, corona, interference of power lines with communication circuits, line insulators. Cables, per unit system, symmetrical components, fault analysis, switching surges. Integrated operation of power systems, basic concepts of load flow, economic operation, stability, protection, HVDC transmission. Load management and tariffs
7	**Contents for lab**	N.A.
8	**List of text books/references**	Power System Engineering, D. Kothari, I. Nagrath, McGraw Hill Education Power system analysis, John Grainger, W. D. Stevenson, McGraw Hill Education

1	**Code of the subject**	EE022
2	**Title of the subject**	Power Electronic Converters for Renewable Energy
3	**Any prerequisite**	EE403
4	**L-T-P**	3-0-0
5	**Learning Objectives**	Able to analyze and enhance the knowledge of single and three phase AC voltage controllers. Knowledge of renewable energy sources and their power convertors. Understand the design and control power convertor of smart grids.

6	**Brief Contents**	Introduction: Potential of renewable energies in India's future Power generation, Need of power electronics for power generation from renewable energies; Single and three phase convertor; Solar PV Systems: Solar PV characteristics, Grid requirement for PV, Power electronic converters used for solar PV, Control techniques, battery charging in PV systems; Wind Energy Conversion: Wind Turbine characteristics, Grid requirement for Wind, Power electronic converters for PMSM and DFIG, Control techniques; Other renewable energy systems: Fuel Cells, Biogas, Biomass etc; Power electronic converters and control for Microgrids and Smart grids.
7	**Contents for lab**	N.A.
8	**List of text books/references**	Grid Converters for Photovoltaic and Wind Power Systems by Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Wiley-IEEE Press. Power Electronic Converters for Microgrids by Suleiman M. Sharkh, Mohammad A. Abu-Sara, Georgios I. Orfanoudakis, Babar Hussain, Wiley-IEEE Press. Advanced DC/AC Inverters: Applications in Renewable Energy Fang Lin Luo, Hong Ye, CRC Press. Power Electronics for Renewable and Distributed Energy Systems by Sudipta Chakraborty, Marcelo G. Simões, William E. Kramer, Springer.

1	**Code of the subject**	EE023
2	**Title of the subject**	Smart Grid Technology
3	**Any prerequisite**	EE403 (Power Electronics)
4	**L-T-P**	3-0-0
5	**Learning Objectives**	To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc. To have knowledge on smart substations, feeder automation and application for monitoring and protection. To have knowledge on micro grids and distributed energy systems. To know power quality aspects in smart grid and to understand latest developments in ICT for smart grid. Analyse micro grids and distributed generation systems.

6	**Brief Contents**	Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self-Healing Grid. Introduction to Smart Meters, Real Time pricing, Smart Appliances, AMR, OMS, PHEV, V2G, Smart Sensors, Home & Building Automation, Phase Shifting Transformers, Smart Substations, Substation Automation, Feeder Automation. GIS, Intelligent Electronic Devices & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, WAMS, Phase Measurement Unit. Concept of micro grid, need & applications of micro grid, formation of micro grid, Issues of interconnection, protection & control of micro grid. Plastic & Organic solar cells, thin film solar cells, Variable speed wind generators, fuel cells, micro turbines, Captive power plants, Integration of renewable energy sources. Power Quality Management in Smart Grid.
7	**Contents for lab**	NA
8	**List of text books/references**	□ The Smart Grid: Enabling Energy Efficiency and Demand Response by Clark W. Gellings, CRC Press. □ Smart Grid: Technology and Applications by Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Wiley. □ Microgrids and Active Distribution Networks by S. Chowdhury, S. P. Chowdhury, P. Crossley, Institution of Engineering and Technology. □ Smart Grids (Power Engineering), Stuart Borlase, CRC Press. □ The Advanced Smart Grid: Edge Power Driving Sustainability by Andres Carvallo, John Cooper, Artech House Publishers. □ Communication and Networking in Smart Grids by Yang Xiao, CRC Press.

1	**Code of the subject**	EE024
2	**Title of the subject**	Electromechanics
3	**Any prerequisite**	EE403
4	**L-T-P**	3-0-0
5	**Learning Objectives**	□ Analyze magnetic circuits. □ Resolve three-phase circuit problems □ Analyze single-phase and three-phase transformers. □ Analyze dc motors and synchronous machines. □ Analyze induction motors.
6	**Brief Contents**	Magnetic Circuits- Simple magnetic circuit, analogy between magnetic circuits and electrical circuits, hysteresis and eddy current losses; Transformers: Single Phase transformers, equivalent circuit, determination of transformer equivalent circuit parameters, Three Phase transformers, Special Multiphase Transformers.; Electro-Mechanical Conversion: Principle of conservation of energy, Force and torque in electro-mechanical systems; DC Machines: Principle of EMF and torque production, energy conversion through electromagnetic

		field, DC Generators types, DC Motors; Synchronous Machines: Synchronous Generators, voltage regulation, Characteristics, Synchronous motors; Induction Machines: working, cage and slip ring rotors, equivalent circuit, determination of circuit parameters, Induction Generators; Fractional kW Machines: Single phase induction motors, Reluctance motors, Hysteresis motors, Universal motors.
7	**Contents for lab**	N.A.
8	**List of text books/references**	Electric Machinery by A. E. Fitzgerald, C. Kingsley, S. D. Umans, McGraw-Hill Electromechanics: Principles, Concepts, and Devices by James H. Harter, Pearson

1	**Code of the subject**	EE025
2	**Title of the subject**	Drone and Robotics Technology
3	**Any prerequisite**	EE304
4	**L-T-P**	3-0-0
5	**Learning Objectives**	to describe in detail how industrial robot systems are used, structured and operate, describe in detail the structure and operation of robotic tooling, including actuators, mechanics and sensors. describe other parts of automated manufacturing systems, including process control, component flows, machine safety and personal safety. describe computer-aided production tools and data communication within an industrial robotics network. identify fundamental issues within sustainable industrial development from an automation perspective and be able to exemplify the consequences of these.
6	**Brief Contents**	Introduction to Robotics: Basic definitions, mechanism, degree of freedom, classification and specifications of Robots, Industrial Robots, sensors, controller, actuator. Kinematics: Position and orientation of links, Coordinate transformation, d-h parameters, joint variable and position of end effectors, inverse kinematic analysis. Velocity analysis – Jacobian. Static force analysis. Trajectory generation. Determining the joint variables for desired trajectory generation. Manipulator Dynamics – Newtons laws, Eulers equation and Lagrange formulation. Linear and nonlinear control of manipulators, Computer-Aided Design and 3D Printing. Introduction to fixed-wing UAVs, Introduction to Design, Basic Design Parameters, Design Algorithm, Layout, Performance and Stability Analysis, Simulation, Detailed Sizing, Estimation of inertial properties using 3D modelling, Prototype Fabrication, Wind Tunnel Testing, Aerodynamic Characterization through Wind Tunnel Testing
7	**Contents for lab**	NA
8	**List of text books/references**	Mark W. Spong, Seth Huchinson and M. Vidyasagar, "Robot Modeling and Control", John Wiley and Sons, Inc., 2005

		□ John J. Craig, "Introduction to Robotics: Mechanics & Control", 3rd Edition, Prentice Hall, 2004 □ Richard Murray, A. Lee, S. Sastry, "A Mathematical Introduction to Robotic Manipulation", CRC Press, 1994 □ Robert J Schilling, Fundamentals of Robotics, Prentice Hall India, 200 □ John J Craig, Introduction to Robotics, Prentice Hall International, 2005 □ Niku Saeed B., "Introduction to Robotics: Analysis, Systems, Applications", Second edition, 2011 Wiley.

1	**Code of the subject**	EE026
2	**Title of the subject**	Intelligent Control System
3	**Any prerequisite**	EE209
4	**L-T-P**	3-0-0
5	**Learning Objectives**	□ Gaining an understanding of the functional operation of a variety of intelligent control techniques and their bio-foundations. □ develop Neural Networks, Fuzzy Logic, and Genetic algorithms. □ Implement soft computing to solve real-world problems mainly pertaining to control system applications.
6	**Brief Contents**	Introduction to Intelligent Control System Concepts, Control and Intelligent Systems, Dimensions of Intelligent Systems, Working Definitions, Techniques in Intelligent Control, Control System Architectures, Need for Learning, Learning and Adaptation, Learning Algorithms, Decision-Making Techniques, Neural Networks, Fuzzy Systems, Heuristic Optimization Techniques, Neural Network Architectures for Modeling and Control, System Identification and Control, Neural Network Based Control System, Architecture for Diagonal Recurrent Neural Network (DRNN), Convergence and Stability, Fuzzy Systems, Evolutionary Algorithms, Evolutionary Algorithms, Biological Basis, Genetic Algorithms (GA), Continuous and Discrete GA, Evolutionary Strategies, Evolutionary Programming; Differential Evolutionary Algorithm, Multiobjective Decision Problems, Pareto Multi-Objective Optimization, Swarm Intelligence
7	**Contents for lab**	N.A.

8	**List of text books/references**	• Fuzzy Control by Kevin M. Passino and Stephen Yurkovich, Addison-Wesley Longman Inc. • Fuzzy Control Systems Design and Analysis: A Linear Matrix Inequality Approach by Kazuo Tanaka, Hua O. Wang, John Wiley & Sons. • Artificial Intelligence: A Modern Approach by Stuart J. Russell and Peter Norvig, Pearson Education. • An Introduction to Genetic Algorithms by Melanie Mitchell, the MIT press. • Neural Network Learning and Expert Systems by Stephen I. Gallant, the MIT press. • Intelligent Systems: Modeling, Optimization, and Control, by Y. C. Shin and C. Xu, CRC Press: Boca Raton, FL. • Intelligent Systems and Control: Principles and Applications, by L. Behera and I. Kar, Oxford: New Delhi, India. • Intelligent Control: A Hybrid Approach Based on Fuzzy Logic, Neural Networks and Genetic Algorithms by N. Siddique, Springer: Switzerland.