

**Department of Electrical, Electronics and Communication Engineering**  
**Master of Technology in Electronics and Communication Engineering**  
**Specialization: Communication Engineering / VLSI Design**

<b>Category</b>	<b>PC</b>	<b>PE</b>	<b>Total</b>
Credits	46	15	61

**Programme Core (PC)**

<b>Sl.No.</b>	<b>Course Code</b>	<b>Title</b>	<b>L-T-P</b>	<b>Credits</b>
1	ECL501	Digital Signal Processing	3-0-2	4
2	ECL503	Advanced Processors	3-0-2	4
3	ECL505	Advanced Digital Communication	3-0-2	4
4	ECL523	Digital VLSI Design	3-0-2	4
5	ECL582	Data structures & algorithms using C++	3-0-2	4
6	MAL606	Interdiction to Research Methodology	2-1-0	3
7	ECC509	Seminar	0-0-4	2
8	ECD512	Minor Project	0-0-4	2
9	ECD605	Dissertation (Phase-1)	0-0-8	4
10	ECD602	Dissertation (Phase-2)	0-0-24	12
11	ECV529	Linux/Scripting/ Emerging Technologies/PDP	0-0-2	1
12	ECV539	Project Management	0-0-2	1
13	ECV609	Special software Package/Emerging Technologies	0-0-2	1
		<b>Total Credits</b>		45



## Track-I Communication Engineering

### Program Electives

<b>TRACK I: Communication Engineering</b>		
<b>Sem II</b>		<b>Sem III</b>
<b>PE-1</b>	<b>PE-2</b>	<b>PE-3</b>
ECL506 Optical Communication	ECL502 Digital Image Processing	ECL564 Soft Computing
ECL517 Information Theory and Coding	ECL504 Modern Telecom Switching	ECL576 Network Security
ECL535 Microwave Theory and Circuits	ECL508 Wireless Mobile communication	ECL578 Broadband Communication
ECL537 Detection and Estimation Theory	ECL562 Millimeter Wave Integrated Circuits	ECL621 Statistical Signal Processing
ECL539 Speech Communication	ECL570 Internet of Things	ECL623 Network Management
ECL532 Embedded System Design	ECL572 Modern Antennas and Arrays	ECL611 Mobile Computing
ECL516 Special Topics in Electronics and Communication	ECL555 Special Topics in Electronics and Communication	ECL653 Telecom Systems and Technologies
		ECL655 Access Networks
		ECL657 Wireless Sensor Networks

## Track-II VLSI Design

### Program Electives

<b>TRACK II: VLSI Design</b>		
<b>Sem II</b>		<b>Sem III</b>
<b>PE-1</b>	<b>PE-2</b>	<b>PE-3</b>
ECL525 Semiconductor device modeling and Technology	ECL534 CMOS RF Circuit Design	ECL629 Cryptography and Crypto Chip Design
ECL527 Digital System Design with Verilog HDL	ECL530 Computer Aided VLSI Design	ECL631 Design of VLSI systems
ECL531 Design and Analysis of Computer Architecture	ECL538 Hardware Software CoDesign	ECL633 Mixed Signal Design
ECL536 VLSI Fabrication and Technology	ECL540 Real Time Systems and Software	ECL635 Microwave and Optoelectronic Devices
ECL532 Embedded System Design	ECL542 Designing with ASICs	ECL637 VLSI Test and Testability
ECL542 Special Topics in VLSI Design	ECL528 Analog VLSI Design	ECL524 Low Power VLSI Design
	ECL570 Internet of Things	ECL625 ASIC Design and Verification with SV
		ECL627 MEMS



**Department of EECE**  
**M. Tech (Electronics and Communication Engineering)**  
 With specialization in  
 Communication Engineering / VLSI Design  
**2018**

Semester	Course Code					Modular Course	Lecture Course	L	T	P	Week Cont. (Hrs.)	Credits	
	Course Name												
I	<b>ECL501</b> Digital Signal Processing 3-0-2(4)	<b>ECL503</b> Advanced Processors 3-0-2(4)	<b>ECL505</b> Adv. Digital Communication 3-0-2(4)	<b>ECL523</b> Digital VLSI Design 3-0-2(4)		<b>ECC509</b> Seminar 0-0-4(2)	4	12	0	10	22	19	
II	<b>ECL582</b> Data structures & algorithms using C++ 3-0-2(4)	<b>Program Elective</b> Elective-1 2-0-2(3)	<b>Program Elective</b> Elective-2 2-0-2(3)	<b>Open Elective-I</b> <b>2-0-2(3)</b>	<b>MAL606</b> <b>Introduction to Research Methodology</b> <b>2-1-0(3)</b>	<b>ECD512</b> Minor Project 0-0-4(2)	<b>ECV539</b> Project Management 0-0-2(1)	5	11	1	10	22	19
III	<b>Program Elective</b> Elective-3 2-0-2(3)	<b>Open Elective-2</b> <b>2-0-2(3)</b>				<b>ECD605</b> Dissertation (Phase-1) 0-0-8(4)	<b>ECV 609</b> Special software Package/Emerging Technologies 0-0-2(1)	2	4	0	6	10	11
IV	<b>ECD602</b> Dissertation ( Phase-2 ) 0-0-24(12)					<b>ECV604</b> Laboratory* Teaching Training  4hrs/week	0	0	0	24	0	12	
							<b>54</b>					<b>61</b>	

## **Program Core**

### **ECL501 Digital Signal Processing**

#### **4 Credits (3-0-2)**

Basics of signal processing, Types of discrete type signals & Types of discrete time systems, Z transform, DFT, FFT, Digital filters-FIR,IIR, Multirate Signal Processing, Polyphase decomposition, Digital Filter Banks, Advanced Digital Signal Processors, Code Composer Studio, Introduction to RTOS, Introduction to DSP/BIOS and its components, Case studies and analysis of Real time Situations

### **ECL503 Advanced Processors**

#### **4 credits (3-0-2)**

Basics of Von Neumann Architecture and the early Microprocessors, CISC and RISC concepts; Parallelism in Processor Architecture: Pipelining, Super-scalar, Super-pipeline and VLIW Architectures, Processor Architecture with hierarchical memory organization; Built-in Multi-user and multitasking support in 16-bit and 32-bit microprocessors, Interfacing of sensors and transducers with 8051, Case studies

### **ECL505 Advanced Digital Communication**

#### **4 Credits (3-0-2)**

Random variables and Processes, Communication over additive Gaussian noise channels, Signal Space representation, Scalar and vector communication over Memory less channels, Additive white Gaussian noise, matched filter and error probabilities, AWGN Channels, M-Ary Orthogonal signals and matched filters, Carrier recovery and symbol synchronization in signal demodulation, Phase estimation, Communication over band limited channels, Nyquist criterion for zero ISI, Decision feedback

### **ECC509 Seminar**

#### **2 Credits (0-0-4)**

Independent study on any recent research area of Electronics and Communication Engineering e.g. Wireless Communication, Signal and Image Processing, Optical Communication, Biomedical Electronics etc.

### **ECL 523 Digital VLSI Design**

#### **4 Credits (3-0-2)**

MOS transistor, Enhancement and Depletion MOS transistors, Threshold Voltage, Fabrication and Modeling, MOSFET Scaling, CMOS Inverter, transfer characteristics, Power, Delay and Energy parameters, Combinational MOS Logic Design, Sequential MOS Logic Design, Static and Dynamic Latches and Registers, Low-Power Design Techniques, Design of Arithmetic Building Blocks, Memory Cells Design

### **Data Structures & Algorithm in C++**

#### **4 Credits (3-0-2)**

Mathematics for Algorithmic Algorithm Analysis, Asymptotic Notations, Computational Complexity of an algorithm, Divide and Conquer Algorithms: Master theorem, Recurrence relation. Sorting Bubble Sort, Insertion Sort, Selection Sort, Heap Sort, Merge Sort, Quick Sort. Shortest Path Algorithm, Greedy Algorithms, Knapsack Problem, NP Hard and NP complete Problems, Cooks Theorem, Back Tracking General Method, the 8 Queen Problem, Subset Problem, Graph Coloring Problem, Hamiltonian Cycle.

### **MAL616 Introductions to Research Methodology**

#### **3 Credits (2-1-0)**

Foundations of Research, Scientific Research, Motivation, Research Objectives, Research Designs, Research Processes, Design of Experiments, Understanding Feasibility of Objectives and Processes, Qualitative and Quantitative Research Methods, Data Collection Processes, Biases in Data Collection, Data Pre-processing, Sampling Distribution and Confidence Intervals, Hypothesis Testing, Interpretation of Results, Literature Review, Technical Writing, Citations, IPR, Research Ethics, Reference management software, Plagiarism, Software for Detection of Plagiarism

### **ECD 512 Minor Project**

#### **2 Credits (0-0-4)**

Hardware and software implementation of the latest research work under the guidance of a faculty, Students are expected to complete literature survey, feasibility testing, develop or implement the research work.

**ECD 605 Dissertation (Phase-1)**

**4 Credits (0-0-8)**

Simulation or hardware implementation of new or recent technological research trend under the guidance of a faculty, Students are expected to complete literature survey, feasibility testing, circuit design, component arrangement, development and publications.

**ECD602 Dissertation (Phase-2)**

**12 Credits (0-0-24)**

Completion of the research work and dissertation report submission which was undertaken as ECD605, Simulation or hardware implementation of new or recent technological research trend under the guidance of a faculty, Students are expected to complete literature survey, feasibility testing, circuit design, component arrangement, development and publications.

**ECV 604 Laboratory Teaching training (4hrs/week)**

Students are associated with senior faculty in the labs for 4 hrs/week to give them teaching exposure. Students pursuing internship in the industry are exempted from this course.

**Track I**  
**Electives**  
**Specialization: Communication Engineering**

**Program Elective**

**ECL502 Digital Image Processing**

**3 Credits (2-0-2)**

Introduction to image processing, processing and enhancement of images in spatial and frequency domain. Various transforms like DFT, DCT, Walsh and K-L transforms, Image segmentation, Image compression, Image restoration and noise models, Introduction to wavelets and Haar transforms. Advanced techniques for image processing.

**ECL504 Modern Telecom Switching System**

**3 Credits (2-0-2)**

Electronic switching systems: basics of a switching system - electronic space division switching - stored program control - time division switching, Network traffic load and parameters - grade of service and blocking probability - incoming traffic and service time characterization - blocking models and loss estimates –delay systems. Traffic analysis, The concept of ISDN, narrowband ISDN and broadband ISDN, ISDN interfaces and End-user applications, ISDN architecture, voice over IP and ATM Networks.

**ECL506 Optical Communication**

**3 Credits (2-0-2)**

Introduction to optical sources and detectors, coherent systems - homodyne and heterodyne systems, coherent systems using PSK, FSK, ASK and DPSK modulations, related noise effects, synchronous, asynchronous and self - synchronous demodulation, sub carrier modulation , optical line coding schemes, optical receiver circuit, optical power budgeting line loading ,optical multiplexing and signaling schemes, optical amplifiers- Raman amplifier, Brillouin amplifier, optical components, free space optics, FTTH, optical CDMA, PON , EPON.

**ECL508 Wireless Mobile Communication**

**3 Credits (2-0-2)**

Access schemes, MAC protocols, problems and limitations of different protocols, cellular concepts, Evolution of mobile communication, GSM standard, call flows, location tracking, mobility management, GPRS, UMTS, Fading and Diversity effects

in wireless communication, combining techniques, Spread spectrum, types, CDMA, SCDMA, capacity analysis, bit error analysis, power control, OFDM, MCDMA, MIMO Systems, Capacity analysis. Introduction to 4G and 5G, Case studies and analysis of Real time Situations

**ECL516 Special Topics in Electronics & Communication**

**3 Credits (2-0-2)**

Latest topics on electronics and communication engineering are selected by the concerned faculty to teach them to the students.

**ECL517 Information Theory and Coding**

**3 Credits (2-0-2)**

Entropy and lossless sources, Shannon's source coding theorem, Kraft's inequality, Optimal codes, Shannon's source coding theorem and its converse, Capacity computation for some simple channels, Joint source channel coding theorem, Differential entropy, Gaussian Channels, Introduction to rate distortion function, rate distortion optimization, finite field arithmetic, Linear Block codes, Cyclic codes, LDPC codes, Wolf coding, Space time codes, Turbo coding.

**ECL 532 Embedded System Design**

**3 Credits (2-0-2)**

Introduction to ESD, Emulator, RTOS, Task, Semaphores and Shared Data Operating system, Processor selection in Embedded System (Microprocessor V/s Microcontroller), Detailed Architecture of 8-bit Microcontroller 8051, Embedded System Development, Networks for Embedded Systems, Introduction to 32-bit controller (ARM7)

**ECL535 Microwave Theory and Circuits**

**3 Credits (2-0-2)**

Basics and history of Microwaves, and Applications of Microwaves, Concept of Mode, impedance matching, Passive Components: Directional Coupler, Power Divider, Magic Tee. Active Components: Diodes, Oscillators, Transistors and Mixers, Microwave antenna for ground based systems, Microwave antenna for airborne based system and satellite borne system.

**ECL537 Detection and Estimation Theory  
3 Credits (2-0-2)**

Statistical Decision Theory: Bayesian, minimax, and Neyman-Pearson decision rules, Detection of Deterministic Signals: Matched filter detector and its performance, detection of sinusoid with unknown amplitude, phase, frequency, Detection of Random Signals: Estimator-correlator, linear model, general Gaussian detection, M-ary hypothesis testing, MAP and ML decision rules, MMS and MAP estimates, Estimation of nonrandom parameters :Cramer-Rao inequality, Signal Estimation in Discrete-Time: Weiner filtering, discrete Kalman filtering, Bounds on estimation errors

**ECL539 Speech communication  
3 Credits (2-0-2)**

Speech production mechanism, Classification of speech, sounds, nature of speech signal, Time domain parameters of speech, methods for extracting the parameters, Short time Fourier analysis, filter bank analysis, spectrographic analysis, solution of normal equations, Interpretation of linear prediction in auto correlation, Applications of speech processing - Speech recognition

**ECL555 Special Topics in Electronics & Communication  
3 Credits (2-0-2)**

Latest topics on electronics and communication engineering are selected by the concerned faculty to teach them to the students.

**ECL562 Millimetre Wave Integrated Circuits  
3 Credits (2-0-2)**

Introduction to millimeter wave systems and applications. Working principle and design of millimeter wave devices and circuits, Analysis of basic transmission lines for mm wave frequency, Integrated fin lines, H-guide, Groove-guide, Transitions, Comparison between SGP and VBIC models .Detectors, Attenuators, Power Divider/Combiners, Low power front-end receivers. SG-25 Series Technologies : On-chip transmission line design

**ECL564 Soft Computing  
3 Credits (2-0-2)**

Introduction to artificial intelligence, expert system, soft computing techniques such as

Artificial Neural Network- Activation Functions, Generalization, Back-Propagation algorithm, Self-organizing networks, Radial Basis Function Network Fuzzy logic-membership functions , fuzzy If – Then rules, fuzzy mapping rules and fuzzy implication functions and Genetic Algorithm. Hybrid systems such as fuzzy-neural, neuro-fuzzy, etc. Case studies, Applications and use of MATLAB.

**ECL570 The Internet of Things  
3 Credits (2-0-2)**

Introduction; The IoT paradigm, Smart objects, Bits and atoms, Technologies behind the Internet of Things: RFID + NFC, Wireless networks + WSN, RTLS + GPS, Agents + Multiagent systems, IoT architecture, components, Application of IoT; IoT network connectivity techniques; IoT Platforms overview; Challenges in IoT: Security, Data Analytics, Protocols; Environmental challenges: excess waste disposal

**ECL572 Modern Antenna and Arrays  
3 Credits (2-0-2)**

Conformal antenna arrays-Characteristics, Radiation mechanism, Antenna impedance, Mutual coupling effects, Beam width, Beam steering, Mutual coupling and radiation patterns. Circular array antennas- working principle and design, comparison of linear and circular arrays, Printed Microstrip Rectangular and Circular patch Antenna arrays, Planar arrays, Phased arrays, Quasi-optical antenna, Smart antenna, Monolithic Integrated antennas.

**ECL576 Network Security  
3 Credits (2-0-2)**

Common attacks and defense mechanisms, attacker profiles, basic security model, Data encryption design criterion, DES, multiple DES, AES, standard block cipher mode operations, stream ciphers, key generations, number theory, diffie-hellman key exchange, RSA, Elliptical cryptography, Key distribution and management, Cryptographic hash functions, cryptographic checksums, HMAC, offset codebook mode operations, birthday attacks, digital signature, dual signature and electronic transactions, blind signature and electronic cash, public key infrastructure, IPsec, SSL/TLS

**ECL578 Broadband Communication  
3 Credits (2-0-2)**



Broadband networks and services, ISDN, broadband ISDN, B-ISDN standards and interface, B-ISDN protocol, ATM technology -VP,VC,ATM Packet, ATM Network Management, ATM digital exchange interface Management, Internet Telephony and voice over IP (VoIP)- RTP and RTCP, Next generation internet, multicasting in internet, real time communication over internet, Internet and web Traffic measurement and characterization

### **ECL 611 Mobile Computing**

#### **3 Credits (2-0-2)**

Introduction to mobile computing, SS7 and GSM, wireless networking protocols: mobile IP, Mobile TCP and other OSI layer Ad-hoc networks, routing, routing algorithms and Protocols, wireless protocols: wireless TCP, data broadcasting, mobile data management, location awareness, adaptations, user interfacing issues, security issues, Technology surveys and case studies.

### **ECL621 Statistical Signal Processing**

#### **3 Credits (2-0-2)**

Introduction to Random variables and Random Processes, Detection theory: Binary Hypothesis testing, Detection of signals in discrete time, detection of stochastic signals, Introduction to Estimation theory: Bayesian Parameter Estimation, Estimation of waveforms, Signal Modeling, Levinson recursion, Spectrum Estimation, Nonparametric Methods, Parametric Methods, Optimal and Adaptive filtering: Kalman Filters, Wiener Filters, Estimation Algorithms .

### **ECL623 Telecom Network Management**

#### **3 Credits (2-0-2)**

Data communications and Network Management Overview, Protocols and standards, SNMPv1 Network Management, SNMPv2 Network architecture and protocols, SNMP Management, Communication and functional models, Telecommunications Management Network, Network Management Tools and Systems and Web-Based Management, Enterprise Management Solutions, Case studies and real time problems.

### **ECL653 Telecom Systems and Technologies**

#### **3 Credits (2-0-2)**

Classification of communication systems, wired and wireless communication system,

multiplexing techniques, Access schemes, packet switching systems: X.25, frame and cell relay, ATM, signal impairments and the channel length, DSL techniques, different versions of DSL, TDM technique and digital transmission techniques, PDH, synchronous digital multiplexing, Introduction, measurement areas, measurement of power levels in telecommunication system, high frequency power measurement, spectrum measurement, Markov chain

### **ECL655 Access Networks**

#### **3 Credits (2-0-2)**

Emerging access technologies, concept of all multiple access technologies, DSL, ADSL, XDSL access network: technology overview, Fiber access topologies: point to point, passive star, ring, passive optical network, Wi-Fi, Wi-Max, LTE, WPAN, Zig bee, WSN, WBAN, IP QoS Control Mechanisms, Resource Reservation Protocol (RSVP), Differentiated Services, Multi-Protocol Label Switching (MPLS), IP Multimedia Sub-system

### **ECL657 Wireless Sensor Networks**

#### **3 Credits (2-0-2)**

WSN architecture and protocol Stack, mote platforms, WSN applications, Factors influencing WSN design, physical and MAC layer technologies, channel effects, challenges for routing and transport protocols, cross layered solutions, time synchronization, Network time protocol, Localization, ranging techniques, wireless sensor and actor networks

**Track II  
Electives  
Specialization: VLSI Design**

**ECL 525 Semiconductor Device Modeling & Technology**

**3 Credits (2-0-2)**

Working of FIN-FET, MOSFET scaling, Short channel effects on MOSFET, SOI MOSFET, Buried Channel MOSFET, Channel Length Modulation, CMOS process flow, Fabrication details of devices.

**ECL542 Special Topics in VLSI Design**

**3 Credits (2-0-2)**

Latest topics on VLSI Design are selected by the concerned faculty to teach them to the students

**ECL 527 Digital System Design with Verilog HDL**

**3 Credits (2-0-2)**

ASIC Design Flow, Language Constructs and Conventions in Verilog HDL, Combinational Logic Design, Sequential Logic Design, Architecture of FPGA, Behavioral Modeling, Modeling Techniques, State Machine, Moore and Mealy State Model, User Defined Primitives, Programming Language Interface, Current Trends.

**ECL 531 Design & Analysis of Computer Architecture**

**3 Credits (2-0-2)**

Classification of parallel computing structures; Instruction level parallelism - static and dynamic pipelining, improving branch performance, superscalar and Very Long Instruction Word (VLIW) processors; High performance memory system; Shared memory multiprocessors and cache coherence; Multiprocessor interconnection networks; Performance modeling; Issues in programming multiprocessors; Data parallel architectures

**ECL 532 Embedded System Design**

**3 Credits (2-0-2)**

Introduction to ESD, Emulator, RTOS, Task, Semaphores and Shared Data Operating system, Processor selection in Embedded System (Microprocessor V/s Micro-controller), Detailed Architecture of 8-bit Microcontroller 8051, Embedded System Development, Networks for Embedded Systems, Introduction to 32-bit controller (ARM7)

**ECL536 VLSI Fabrication and Technology**

**3 Credits (2-0-2)**

Crystal growth, wafer preparation, Czochralski process, float zone process, Oxidation of silicon, dry oxidation, wet oxidation, epitaxial growth of thin films, diffusion of different dopants in silicon and GaAs, ion implantation, thermal evaporation, sputtering, wet etching, dry etching, photolithography, electron beam lithography, Advance lithography techniques, process integration and IC packaging.

**ECL-534 CMOS RF Circuit Design**

**3 Credits (2-0-2)**

Basic Concepts in RF Design using CMOS, Modulation and Detection, Random Processes and Noise, Analog and Digital Modulation, Non Coherent Detection, Transceiver Architectures, Low-Noise Amplifiers, Mixers, Oscillators, Frequency Synthesizers, Phase Locked loop, Voltage Controlled oscillator, Frequency Divider, Power Amplifiers, Impedance Matching, Advanced Trends for wireless systems.

**ECL 530 Computer Aided VLSI Design**

**3 Credits (2-0-2)**

ASIC Design Flow. Different File Formats used in ASIC Flow. Static Timing Analysis. CTS

**ECL-538 Hardware – Software Co-design**

**3 Credits (2-0-2)**

Introduction to hardware & software co-design, Hardware Software back-ground and Hardware Software co-design research, Co-design concepts as functional decomposition and virtual machines, Methodology for co-design and Unified representation for Hardware & Software, Abstract Hardware & Software model, Performance Evaluation, Object oriented techniques in hardware design

**EC5-540 Real Time System & Software**

**3 Credits (2-0-2)**

Real-time Versus Conventional Software, Computer Hardware for Monitoring and Control, Data Flow Diagrams, State machine, Software Engineering Issues. Process and State-based Systems model, Requirements and Design Specifications, Declarative Specifications & Deterministic Scheduling, Execution Time Prediction & Timer Applications, Programming Languages & Operating Systems.

RISC Microcontroller, ATM Switch, etc.

### **ECL542 Designing with ASICs**

#### **3 Credits (2-0-2)**

ASIC Design Flow, Types of ASICs, ASIC Cell Libraries, CMOS logic cell, Data Path Logic Cells, I/O Cells, ASIC Library Design, Logical effort, PLA Tools, Logic synthesis, Low Level Design Entry, Overview of VHDL & VerilogHDL, PLA Tools, Floorplanning, Placement & Routing, EDIF. Logic Synthesis in Verilog and VHDL Simulation. ASIC Construction, Floor Planning, Placement, and Routing.

### **ECL528 Analog VLSI Design**

#### **3 Credits (2-0-2)**

Introduction to MOS Device Physics, Small Signal & Large Signal Models of MOS & BJT transistor. Single Stage Amplifiers: Differential Amplifiers, Passive and Active Loaded Differential Amplifiers: Common Emitter, Common base, Common Collector, Common Drain, Common Gate & Common Source Amplifiers, Current Mirror Circuits, Frequency Response of Amplifiers, CMOS Operational Amplifiers, Stability and Frequency Compensation, Design of two stage MOS Operational Amplifier, two stage MOS operational Amplifier with cascodes, MOS telescopic cascode operational amplifiers, MOS Folded-cascode operational amplifiers.

### **ECL570 The Internet of Things**

#### **3 Credits (2-0-2)**

Introduction; The IoT paradigm, Smart objects, Bits and atoms, Technologies behind the Internet of Things: RFID + NFC, Wireless networks + WSN, RTLS + GPS, Agents + Multiagent systems, IoT architecture, components, Application of IoT; IoT network connectivity techniques; IoT Platforms overview; Challenges in IoT: Security, Data Analytics, Protocols; Environmental challenges: excess waste disposal

### **ECL 629 Cryptography & Crypto-Chip Design**

#### **3 Credits (2-0-2)**

Information system reviewed, LAN, MAN, WAN. Threats to Security, Physical, Biometric security, data security, system security, etc. Encryption Techniques: Conventional and Modern techniques, Algorithms, and Key managements. Message Authentication and Hash Algorithm, Firewalls and Cyber laws: Design principles, trusted systems, IT act, and virtual private networks. Future Threats to Network and Recent attacks on networks. Applications: AES Algorithms, Development of digital signature chip design. Hardware and software design tradeoffs.

### **ECL-631 Design of VLSI Systems**

#### **3 Credits (2-0-2)**

VLSI System Design Methodology: Hierarchy, Modularity, Locality. Chip Design Methods and Optimization. Design Capture EDA Tools: HDL Design, Schematic Design, Layout Design, Design Verification, Design for Test, System Level Testing. Data Path Sub System Design: Addition, Subtraction,

etc. Array Subsystem Design and Control Unit Design: SRAM, FSM, PLA, etc. Special purpose Subsystems: Clocking strategies, PLL techniques, Clock distribution and I/O structures. VLSI Applications, Case Study:

### **ECL 633 Mixed Signal Design**

#### **3 Credits (2-0-2)**

Signals, Sampling, Aliasing and Tools: Sampling Techniques and circuits for signal sampling. Mixed signal design challenges and issues. Analog Filters: implementation with Integrator, Analog filtering topology for LP, BP, etc., Analog filters, analog to Digital Converters Digital Filters: Digital to analog Converters, Digital Filtering topology. SNR of data converters: Quantization, SNR Improvement. Design Basics and Noise-Shaping of Data Converters: First and Second Order Noise Shaping. Bandpass Data Converters and A High-Speed Data Converter: Continuous time BP noise shaping. Mixed signal design Applications and latest trends

### **ECL 635 Microwave & Optoelectronics Devices**

#### **3 Credits (2-0-2)**

Microwave frequencies, microwave transistor, Avalanche Transit Time Devices -IMPATT Diode, Microwave Integrated Circuit, Microwave tubes-Klystron, Reflex Klystron and Magnetron, Optoelectronics-Photovoltaic devices, Optoelectronic & Display Devices. Characterization of displays, Plasma display, LCD, Electrochromic display and electrophoretic display.

### **ECL637 VLSI Test & Testability**

#### **3 Credits (2-0-2)**

Testing need and problems related to digital and analog testing, Design for test, Software testing. Faults in Digital circuits. Fault models. Digital test pattern generation. Roth's algorithm. Pseudo random test pattern generation. Delay fault testing, Signatures and self-test, Reed-Muller and spectral coefficients, Signature analysis and Online self-test Testability Techniques, Boundary scan and IEEE standard 1149.1, Offline built in Self-Test (BIST), Hardware description languages and test Testing of Analog and Digital circuits. Testing techniques for Filters, A/D Converters, RAM, Programmable logic devices and DS

### **ECL-524 Low-Power VLSI Design**

#### **3 Credits (2-0-2)**

Need for low-power VLSI Chips, Sources of Power dissipation-static and dynamic, transistor sizing and technology scaling, Device & Technology Impact on Low Power, Power estimation Simulation Power analysis: SPICE level circuit simulation, gate level logic simulation, Monte Carlo System, Probabilistic power analysis, Low Power Design Circuit level, Logic level, Low power Architecture & Systems, Low power Clock Distribution Methodology; Signal Drivers and buffers, skews, clock network. Architectural level

power estimation and advanced developments in low-power VLSI design

**ECL 625 ASIC Design and Verification with SystemVerilog**

**3 Credits (2-0-2)**

Verification Guidelines: Verification Methodology, Data Types, Procedural Statements, Task and Functions, Routine Arguments, Local Data Storage, Basic OOP, Static and Global variables, Objects and Classes, Connecting the Testbench and Design, Stimulus Timing, SystemVerilog Assertion, Four-Port ATM Routers, Randomization, Constraints Details, Pre and Post Randomization, Threads and Interprocess Communication, Events, Semaphore, Mailbox, Testbench Building, Advanced OOPs and Guidelines.

**ECL627 MEMS**

**3 Credits (2-0-2)**

Overview of MEMS Technology, MEMS system-level design methodology, Equivalent Circuit representation of MEMS, signal-conditioning circuits, and sensor noise calculation. Pressure sensors with embedded electronics (Analog/Mixed signal): Accelerometer with transducer, Gyroscope, RF MEMS switch with electronics, Bolo meter design. RF MEMS, and Optical MEMS, actuators, accelerometers.

