Semester I Courses

<table>
<tr><td>Course Title</td><td>Mathematical Foundations of ESD</td><td>Course Number</td><td>EC501T</td></tr>
<tr><td>Department</td><td>Electronics and Communication Engineering</td><td>Structure (IPC)</td><td>3-0-3</td></tr>
<tr><td>Offered to</td><td>M.Tech. ESD</td><td>Status (Core/ Elective)</td><td>Core</td></tr>
<tr><td>Prerequisite</td><td>Nil</td><td>Effective from</td><td>July 2020</td></tr>
<tr><td>Course Aim</td><td colspan="3">This course's objective is to provide a good understanding in thetime complexity analysis of any arithmetic operation, Galois filed theory of any crypto operation, estimation theory, linear programming, and multivariate analysis.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">At the end of this course, the students will be able to
1. Simulate appropriate application/distribution problems.
2. Obtain the value of the point estimators using the method of moments and method of maximum likelihood.
3. Apply the concept of various test statistics used in hypothesis testing for mean and variances of large and small samples.
4. Get exposure to the principal component analysis of random vectors and matrices.
5. Analyse the time complexity of the operation of the digital operations.
6. Apply Galois Field theory in the cryptography applications.</td></tr>
<tr><td>Contents of the course</td><td colspan="3">SPECIAL FUNCTIONS: Bessel's equation – Bessel function – Recurrence relations - Generating function and orthogonal property for Bessel functions of first kind – Fourier-Bessel expansion.
LINEAR PROGRAMMING: Formulation – Graphical solution – Simplex method – Two phase method –Transportation and Assignment Problems.
SIMULATION: Discrete Event Simulation – Monte – Carlo Simulation – Stochastic Simulation – Applications to real time problems.
ESTIMATION THEORY: Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency – Maximum Likelihood Estimation – Method of moments.
MULTIVARIATE ANALYSIS: Random vectors and Matrices – Mean vectors and Covariance matrices – Multivariate Normal density and its properties – Principal components: Population principal components – Principal components from standardized variables.</td></tr>
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	COMPLEXITY ANALYSIS: Introduction to time complexity of an algorithm or operation (worst case, average case, and best case), SAT problems, NP hard and NP complete problems. ABSTRACT ALGEBRA: Introduction to Group, Ring, and Fields, Prime/Polynomial field representation, Irreducible polynomial, primitive polynomial, minimal polynomial, Galois field (GF) addition, GF multiplication, GF exponentiation, and GF multiplicative inverse.
References	1. Jay L. Devore, “Probability and Statistics for Engineering and the Sciences”, Cengage Learning, 9th Edition, Boston, 2016. 2. Johnson, R.A, Irwin Miller and John Freund., “Miller and Freund’s Probability and Statistics for Engineers”, Pearson Education, 9th Edition, New York, 2016. 3. Johnson, R.A., and Wichern, D.W., “Applied Multivariate Statistical Analysis”, Pearson Education, Sixth Edition, New Delhi, 2013. 4. Ross. S.M., “Probability Models for Computer Science”, Academic Press, SanDiego, 2002. 5. Taha H.A. “Operations Research: An Introduction”, Prentice Hall of India Pvt. Ltd. 10th Edition, New Delhi, 2017. 6. Winston, W.L., “Operations Research”, Thomson – Brooks/Cole, Fourth Edition, Belmont, 2003. 7. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, MIT Press, 2009. 8. Ralph P. Grimaldi, "Discrete and combinatorial Mathematics", Pearson Education, 5th Edition, New Jersey, 2004. 9. Erwin Kreyszig. “Advanced Engineering Mathematics”, John Wiley & Sons, 10th Edition, New York, 2010.

Course Title	Product Design and Development	Course Number	DES501T
Department	Electronics and Communication Engineering	**Structure (IPC)**	3-0-3
Offered to	M.Tech. ESD	**Status (Core/ Elective)**	Core
Prerequisite	Nil	**Effective from**	July 2020
Course Aim	1. The course comprises theoretical sessions that are supplemented with practice sessions. 2. The students will be given an overview of systematic approach used during product design and development. 3. The course will highlight the methods for need identification, techniques for creative thinking, concept generation, concept selection, product architecture, aesthetics, ergonomics etc. 4. The students will realize the design through models of using suitable materials		
Course Outcomes	1. The students will be able to understand the need of a customer and use the creative thinking to conceptualize designs. 2. The students will also be able to quickly visualize the concepts using models.		
Contents of the course	Introduction: Importance of engineering design, types of design, total life cycle- types of products, Phases of product development process, product and process cycles. (10 hours) Problem Definition & Need Identification: Identifying customer needs, gathering information classifying customer requirements, engineering characteristics, competitive benchmarking, QFD, product design specification. (10 hours) Conceptual Design: Creativity in design, creativity and problem solving, creative thinking methods, conceptual decomposition morphological methods-TRIZ and contradiction, Bio and Shape mimicry techniques, Decision making and concept selection-decision theories-concept screening and scoring. (8 hours) Embodiment Design: Product architecture, steps in developing product architecture, industrial design human factors design, Nostalgia and Design, Environment factors. (8 hours) Design Profile Preparation (4 hours)		
Textbooks	1. K. Otto, Product Design, Pearson Education, 1st edition, 2011, ISBN: 8177588214. 2. U. Karl and S. Eppinger, Product Design and Development, McGraw-Hill Education, 6th edition, 2015, ISBN: 0078029066.		
References	1. C. A. Harper, Handbook of Materials for Product Design, McGraw-Hill Professional, 1st edition, 2001, ISBN: 0071354069.		

	2. R. Stuer and K. Eissen, Sketching: Drawing Techniques for Product Designers, Thames & Hudson, 1st edition, 2007, ISBN: 9063691718. 3. B. Hallgrimsson, Prototyping and Modelmaking for Product Design, Laurence King Publishing, 1st edition, 2012, ISBN: 9781856698764

Course Title	Product Design and Development Practice	**Course Number**	DES501P
Department	Electronics and Communication Engineering	**Structure (IPC)**	0-3-2
Offered to	M.Tech. ESD	**Status (Core/ Elective)**	Core
Prerequisite	Nil	**Effective from**	July 2020
Course Aim	1. The course comprises theoretical sessions that are supplemented with practice sessions. 2. The students will be given an overview of systematic approach used during product design and development. 3. The course will highlight the methods for need identification, techniques for creative thinking, concept generation, concept selection, product architecture, aesthetics, ergonomics etc. 4. The students will realize the design through models of using suitable materials		
Course Outcomes	1. The students will be able to understand the need of a customer and use the creative thinking to conceptualize designs. 2. The students will also be able to quickly visualize the concepts using models.		
Contents of the course	Method of Expressing and communicating and documenting technical ideas through sketches. Clay, Foam, Wood modelling and modern 3D printing. Problem Definition and Need Identification. Conceptual design: Morphological charts, TRIZ and Contradiction, Bio and Shape mimicry, Concept selection, Screening. Embodiment Design: Product Architecture, Human Factors, Aesthetics, Nostalgia and Environmental factors. Design Profile presentation.		
Textbooks	1. K. Otto, Product Design, Pearson Education, 1st edition, 2011, ISBN: 8177588214. 2. U. Karl and S. Eppinger, Product Design and Development, McGraw-Hill Education, 6th edition, 2015, ISBN: 0078029066.		
References	1. C. A. Harper, Handbook of Materials for Product Design, McGraw-Hill Professional, 1st edition, 2001, ISBN: 0071354069. 2. R. Stuer and K. Eissen, Sketching: Drawing Techniques for		

	Product Designers, Thames & Hudson, 1st edition, 2007, ISBN: 9063691718. 3. B. Hallgrimsson, Prototyping and Modelmaking for Product Design, Laurence King Publishing, 1st edition, 2012, ISBN: 9781856698764

Course Title	Digital VLSI System Design	**Course Number**	EC502T
Department	Electronics and Communication Engineering	**Structure (IPC)**	3-0-3
Offered to	M.Tech. ESD	**Status (Core/ Elective)**	Core
Prerequisite	Digital Logic Design, VLSI Design	**Effective from**	July 2020
Course Aim	The aim of this course is to introduce architecture and design concepts underlying the modern complex VLSI circuits/systems.		
Course Outcomes	At the end of this course, the students will be able to 1. Design digital system using HDL and CMOS transistors. 2. Analyse the circuit/system performance, area, and power dissipation. 3. Implement the low power and high throughput techniques on digital integrated circuits. 4. Develop the Custom IPs to integrate into Digital Systems		
Contents of the course	1. Introduction to Digital design: timing issues, pipelining, folding/ unfolding, resource sharing, metastability, synchronization, clock skew, setup/hold time of flip-flops, synchronization between multiple clock domains using FIFO, PLL, and DLL, reset – recovery/removal time, false path. (5 hours) 2. Digital Systems Design with ASICs: PLDs, Semi/full custom ASIC designs, Emphasis on the synthesis based approach to VLSI Design. Relevant issues related to physical design automation such as partitioning, floor planning, power planning, placement & routing, Algorithms for VLSI Physical Design, IO pads, electro static discharge. (5 hours) 3. Digital Systems Design with FPGAs: Hardware-Software Co-design, Custom IP Development, High level synthesis (HLS), Efficient Coding Techniques in High Level Language for HLS, Partial Reconfiguration. (4 hours) 4. Hardware Verification and Testing Equivalence/model check based formal hardware verification, Binary decision/moment diagram, flexible/vector hardware designs, VLSI testing, logical fault models, fault equivalence, fault dominance, fault collapsing, double/triple modular redundancy, fault simulation, test pattern generation, Built-in-self test, Scan chain based test, fault tolerant designs. (7 hours) 5. CMOS Transistor Logic: I-V characteristics, Short channel		

	effects, Mobility degradation & velocity saturation, channel length modulation, body effect, drain induced barrier lowering, leakage, RC delay model, logical effort, clock gating, dynamic voltage scaling, power gating, glitch free circuits, dual-edge triggering, static CMOS, ratioed circuits, dynamic CMOS, domino logic, pass transistor logic, CMOS latches, CMOS flipflops, dual edge triggered flipflops, synchronizers, arbiters, wave pipelining. (15 hours) 6. Memory Designs: SRAM, DRAM, ROM, PROM, EPROM, EEPROM, Flash, CAM (5 hours)
Evaluation Pattern	The end-sem exam will have at least 50% of weightage. The remaining weightage comprises Minor-1, Minor-2, and projects (or assignments).
Textbooks	1. Neil H.E. Westte and David Money Harris: CMOS VLSI Design : A Circuits and Systems Perspective, Addison Wesley, 4th Edn, 2011.
References	1. Wakerly, J. F., Digital Design: Principles and Practices, 4th Edition, Pearson, 2008 2. Miron Abramovici, Melvin A Breuer, and Arthur D Friedman: Digital Systems Testing and Testable Designs, Wiley-IEEE Press, 1994. 3. N. A. Sherwani, Algorithms for VLSI Physical Design Automation, Bsp Books Pvt. Ltd., 3rd edition, 2005. 4. Samir Palnitkar: Verilog HDL - Guide to Digital design and synthesis, Pearson Education, 3rd Edn, 2003.

Course Title	Digital VLSI System Design Practice	**Course Number**	EC502P
Department	Electronics and Communication Engineering	**Structure (IPC)**	0-3-2
Offered to	M.Tech. ESD	**Status (Core/ Elective)**	Core
Prerequisite	Digital Logic Design, VLSI Design	**Effective from**	July 2020
Course Aim	The lab course is intended to give exposure to the design of different functional components of digital integrated circuits using FPGA development boards and VLSI CAD tools respectively.		
Course Outcomes	At the end of this course, the students will be able to 1. Design the RTL based digital circuits using HDL. 2. Develop the hardware-software co-design using VLSI CAD tool. 3. Develop the custom IP using RTL design and/or high level synthesis 4. Design the digital system with low power and high throughput VLSI techniques 5. Implement the fault tolerant hardware design and formal hardware verification using HDL		
Contents of the course	1. Introduction to RTL Design**:** Basic combinational (half adder, full adder, multiplexer, decoder, and so on) and sequential circuits design (Flip-flops and counters) using HDL with commercial VLSI CAD tools or open source compilers. 2. Familiarity of Datapath elements**:** 32-bit Ripple carry adder, recursive doubling based carry look ahead adder, Braun multiplier, Wallace tree multiplier, non restoring based division, IEEE-754 floating point adder/Subtractor/multiplier/divider, CORDIC, modular multiplier, modular multiplicative inverse, modular exponentiator, cross-bar switch, Banyan switch, Batcher switch, digital FIR filter. 3. Advanced VLSI circuit design concepts**:** Pipelining, clock gating to reduce the switching power dissipation, hardware reuse strategy (folded hardware) to reduce the area, fault tolerant digital circuit design, formal hardware verification using equivalence check, high level synthesis with EDA, performance analysis of RTL design & high level synthesis based digital system using EDA, partial reconfiguration using EDA. 4. Hardware-Software Co-design**:** Design flow of hardware-software co-design using FPGA evaluation board with EDA, Custom IP design (arithmetic circuits as mentioned above), hardware-software partitioning, and performance analysis of various hardware-software co-design techniques.		

	5. Digital Circuits Design using CMOS**:** logic gates, combinational logic circuits, low power CMOS circuits using VLSI CAD tool. 6. Project Work (Individual): Basic 32-bit Processor Design (Harvard Architecture with Microprogramming based Controller) that includes the functional units such as logic unit, fixed/floating point adder, multiplier, and divider. Here, two separate memories are used for data and instruction.
Textbooks	1. Neil H.E. Westte and David Money Harris: CMOS VLSI Design : A Circuits and Systems Perspective, Addison Wesley, 4th Edn, 2011.
References	1. Wakerly, J. F., Digital Design: Principles and Practices, 4th Edition, Pearson, 2008 2. Miron Abramovici, Melvin A Breuer, and Arthur D Friedman: Digital Systems Testing and Testable Designs, Wiley-IEEE Press, 1994. 3. N. A. Sherwani, Algorithms for VLSI Physical Design Automation, Bsp Books Pvt. Ltd., 3rd edition, 2005. 4. Samir Palnitkar: Verilog HDL - Guide to Digital design and synthesis, Pearson Education, 3rd Edn, 2003.

Course Title	Embedded System Design Practice	**Course Number**	EC503I
Department	Electronics and Communication Engineering	**Structure (IPC)**	1-3-3
Offered to	M.Tech. ESD	**Status (Core/ Elective)**	Core
Prerequisite	Microprocessors and Microcontrollers	**Effective from**	July 2020
Course Aim	To provide a hands-on introduction to design of embedded systems with hardware/software and interfacing in real-time to networked cyber-physical systems and real time systems using the microcontrollers.		
Course Outcomes	At the end of this course, the students will be able to 1. Understand the basic elements of embedded systems such as I/O and interfaces. 2. Understand embedded system design using the ARM Cortex-M microcontroller with the Launch pad IDE in C. 3. Develop the rapid prototype of embedded systems using open source microcontrollers and microcomputers such as Arduino, Raspberry Pi, BeagleBone Black, and Intel Edison/Galileo. 4. Build wireless networked embedded systems using Arduino shields and modules (e.g., GPS, GSM/GPRS, Bluetooth, RFID, and ZigBee). 5. Exploit the advanced concepts such as networking and wireless communications, real-time operating systems and control, and Internet of Things in the real time embedded systems. 6. Develop the hardware-software co-design with parallel threads using Xilnx Vivado. 7. Conduct experiments in Internet of Things (e.g., using Arduino Yun, Intel and Microsoft Developer Kits)		
Contents of the course	**Detailed Theory syllabus** 1. Elements of embedded systems (such as microcontrollers, GPIO, communication, interrupts, ADC, and DAC); overview of microcontroller; Comparison between Hardware, Software, and Firmware; Comparison between Hard, Soft, Firm, and Hybrid real time systems; applications of embedded systems; classification of embedded systems; characteristics of embedded systems; hardware-software partitioning; 2. Software aspects of embedded systems; Real-time operating system (RTOS) - mutual exclusion using semaphore; deadlock; critical section; event-driven scheduling; time sharing; earliest		

	deadline first scheduling; pre-emptive scheduling; non-pre-emptive scheduling; multi-tasking; multi-threading; inter-process communication using mboxes, and pipes; priority inversion; 3. Rapid prototyping of embedded systems with advanced microcontroller boards; Basic elements of IoT; IoT systems design using advanced microcontroller boards; **Detailed Syllabus for Lab Practice** 1. Experiments in GPIO such as switches, LEDs, LCD, Key pad, Seven Segment Display, Buzzer, and relay; 2. Serial and parallel interfacing; data acquisition with ADC, audio, and video; timer interrupts; Various bus intereconnects such as I2C, UART, SPI, and so on; 3. DAC Experiments in control of RC servos, stepper motors, and DC motors; 4. Data acquisition and real-time control with TIVA boards, LPC2148 trainer board, FPGA boards, Arduino, Raspberry Pi, and BeagleBone Black microcontrollers; 5. Add-on boards Experiments in wireless networked systems with GPS, GSM/GPRS, ZigBee, Bluetooth, and RFID; 6. Hardware-software co-design experiments using FPGA boards. 6. Experiments in IoT for smart automation using sensors, microcontrollers, and cloud. 7 Free RTOS based applications using TIVA board.
References	1. J. W. Valavano, Embedded Systems: Introduction to Arm Cortex-M Microcontrollers, 2nd edition, Create Space, 2012. ISBN: 978-1477508992. 2. J. W. Valavano, Embedded Systems (Vol-2): Real-Time Interfacing to ARM Cortex-M Microcontrollers, 2nd edition, Create Space, 2011, ISBN: 978-1463590154. 3. J. W. Valavano, Embedded Systems (Vol-3): Real-Time Operating Systems for Arm Cortex M Microcontrollers, 2nd edition, Create Space, 2012. ISBN: 978-1466468863. 4. A. McEwen and H. Cassimally, Designing the Internet of Things, 1st edition, Wiley, 2013. ISBN: 978-8126556861. 5. D. Gajski, F. Vahid, S. Narayan, and J. Gong.Specification and Design of Embedded Systems,Prentice Hall.

Semester II Courses

Course Title	Circuits for Electronic System Design	**Course Number**	EC504T
Department	Electronics and Communication Engineering	**Structure (IPC)**	3-0-3
Offered to	M.Tech. ESD	**Status (Core/ Elective)**	Core
Prerequisite	Analog and Digital Electronics	**Effective from**	July 2020
Course Aim	The aim of offering this course is to provide a proficiency in designing circuits for electronics system design..		
Course Outcomes	1. Apply concepts of Analog circuits for signal conditioning, signal processing, controller circuits, and driver circuits for power electronic circuits. 2. Design transformer and different power sources for various applications 3. Understand the interface of various modules to microcontroller and learn various communication protocols 4. Perform descriptive error analysis for the circuits 5. Demonstrate key concepts in electronics circuit design, including tools, approaches, and application scenarios		
Contents of the course	1. Introduction to Op-Amps: Op-amp Characteristics, Negative feedback, Gain of the Op-Amp 2. Analog Signal conditioning circuits**:** Buffering, scaling, level translation, filtering applications, Analog math circuits - arithmetic circuits, log circuits, trigonometric circuits and applications Timer circuits, pulse width modulation circuits, P, PI and PID controller circuits, protection circuits, base and gate drive circuits for power transistors, MOSFETs and IGBTs, relay and contactor drive circuits. Design and error budget analysis of signal conditioners for low level AC and DC applications. Error Analysis. 3. Power supply circuits: Board level power supply circuits to generate +/-12V, 5V, 3.3V, 1.8V. Linear regulators, low drop out regulators, charge pumps, switched mode power converters. 4. Interfacing circuits**:** A to D, D to A, A to A and D to D interfaces, serial and parallel DACs, sampling, RS-232, USB, I2C, LCD, serial memory, SPI, CAN, wireless (RF, WiFi) Ethernet, RFID, SD card, SIM card, GPS, Touchscreen interfaces. 5. Digital circuit essentials**:**Digital filters, moving average, numeric formats, scaling, normalizing, arithmetic, log, exponential, square root, cube root, hypotenuse, sine, 3 phase waves, PWM etc.		
References	1. Franco, S., Design with operational amplifiers and analog		

	integrated circuits. Mc. Graw Hill book Co. 1988. 2. Horowitz, P., and Hill, W., The art of electronics (2nd edition), Cambridge University Press. 1992. 3.Abraham Pressman, Keith Billings, Taylor Morey, Switching Power Supply Design, McGraw-Hill Education, 2009 4. Warwick A. Smith, ARM Microcontroller Interfacing: Hardware and Software, Elektor Electronics Publishing, 2010 5. Datasheets and Application notes of different Integrated circuits

Course Title	Circuits for Electronic System Design Practice	**Course Number**	EC504P
Department	Electronics and Communication Engineering	**Structure (IPC)**	0-3-2
Offered to	M.Tech. ESD	**Status (Core/ Elective)**	Core
Prerequisite	Analog and Digital Electronics	**Effective from**	July 2020
Course Aim	The aim of offering this laboratory course is to acquire knowledge and proficiency in design circuits for electronics system design.		
Course Outcomes	1. Design and build circuits using OPAMPS 2. Design and develop different power supplies 3. Design and develop signal conditioning circuits for resistive, capacitive, inductive, current current, and voltage-based sensors 4. Analysis of various communication protocols		
Contents of the course	1. Design and build circuits using OPAMPS (summer, integrator, differentiators, and Instrumentation amplifier) 2. Design and build the power supply circuits such as linear power supply, LDO, and DC-DC converter 3. Design and develop the signal conditioning circuits for resistive (RTD), capacitive, inductive (LVDT), current (Photodiode) and voltage based sensors (Thermocouple) 4. Analysis of communication protocols (SPI, CAN, I2C)		
References	1. Franco, S., Design with operational amplifiers and analog integrated circuits. Mc. Graw Hill book Co. 1988. 2. Horowitz, P., and Hill, W., The art of electronics (2^{nd} edition), Cambridge UniversityPress. 1992. 3. Abraham Pressman, Keith Billings, Taylor Morey, Switching Power Supply Design, McGraw-Hill Education, 2009 4. Warwick A. Smith, ARM Microcontroller Interfacing: Hardware and Software, Elektor Electronics Publishing, 2010		

Course Title	Electronic Systems Packaging	**Course Number**	EC505T
Department	Electronics and Communication Engineering	**Structure (IPC)**	3-0-3
Offered to	M.Tech. ESD	**Status (Core/ Elective)**	Core
Prerequisite	Basics of Electrical & Electronics Engineering	**Effective from**	July 2020
Course Aim	The course will sensitize the participants to the fundamentals of electronics systems packaging. The course is multidisciplinary in nature. Today products in electronics industry need to be packaged to current state-of-art if it has to be in the leading edge market.		
Course Outcomes	1. Understands the electronics packaging including package styles or forms, hierarchy and methods of packaging necessary for various environments. 2. Provides industry perspective in the electronics packaging 3. Ability to distinguish between engineering performance and economic considerations to develop cost-efficient and high performance packaging approaches. 4. Predict the reliability of electronic components and structures.		
Contents of the course	Module 1: Overview of Electronic Systems Packaging: Definition of a system and history of semiconductors, Products and levels of packaging, Packaging aspects of handheld products, Definition of PWB, Basics of Semiconductor and Process flowchart, Wafer fabrication, inspection and testing, Wafer packaging; Packaging evolution; Chip connection choices, Wire bonding, TAB and flip chip. Module 2 Electronic systems and needs, physical integration of circuits, packages, boards and complete electronic systems; system applications like computer, automobile, medical and consumer electronics with case studies and packaging levels. Module 3: Electrical design considerations - power distribution, signal integrity, RF package design and Power-delivery in systems. CAD for Printed Wiring Boards (PWBs) and Design for Manufacturability (DFM). PWB Technologies, Single-chip (SCM) and Multi-chip modules (MCM), flex circuits. Recent trends in manufacturing like microvias, sequential build-up circuits and high-density interconnect structures. Module 4: Materials and processes in electronics packaging, joining methods in electronics; lead-free solders. Surface Mount Technology - design, fabrication and assembly, embedded passive components.		

	Module 5: Thermal management of IC and PWBs, Cooling Requirements, Electronic cooling methodsthermo-mechanical reliability, design for reliability, electrical test and green packaging issues, Design for Reliability – Fundamentals, Induced failures. Electrical Testing – System level electrical testing, Interconnection tests, Active Circuit Testing, Design for Testability. Trends in packaging.
References	1. Rao R. Tummala, Fundamentals of Microsystems Packaging, McGraw Hill, NY, 2001, 2. Rao R Tummala& Madhavan Swaminathan, Introduction to System-on-Package, McGraw Hill, 2008, 3. R S Khandpur, Printed Circuit Boards, McGraw Hill, 2006 4.Richard K. Ulrich &William D. Brown Advanced Electronic Packaging - 2nd Edition : IEEEPress, 2006

Course Title	Electronic Systems Packaging Practice	**Course Number**	EC505P
Department	Electronics and Communication Engineering	**Structure (IPC)**	0-3-2
Offered to	M.Tech. ESD	**Status (Core/ Elective)**	Core
Prerequisite	NIL	**Effective from**	July 2020
Course Aim	To understand the manufacturing and assembling aspects of Electronic components in systems.		
Course Outcomes	1. Expected to design optimized layout for printed circuits boards. 2. Exposed to multi-layer PCB design 3. To develop Prototype circuits		
Contents of the course	PCB design flow- Schematic -layout - PCB design using created library -PCB printing using PCB prototyping machine-Testing and debugging of PCB Familiarization of different components and chip packages PCB Design for manufacturability PCB Design consideration for special circuits Design and development of PCBs using different simulator tools and prototyping. Hands-on lab sessions for board manufacturing and assembly. Thermal and Heat Sink Design Electrical Testing and Active Circuit Testing		
References	1. Jan Axelson, Making Printed Circuit Boards, TAB/McGraw Hill, 1993 2. J. Varteresian, Fabricating Printed Circuit Boards. 3. Ronald A. Reis, Electronic project design and fabrication, 6/E, Prentice Hall, 2005. 4. Complete PCB Design Using OrCad Capture and Layout Kraig Mitzner, Elsevier		

Course Title	Digital Signal Processing and Architectures	**Course Number**	EC506T
Department	Electronics and Communication Engineering	**Structure (IPC)**	3-0-3
Offered to	M.Tech. ESD	**Status (Core/ Elective)**	Core
Prerequisite	Digital Signal Processing, Digital Logic Design	**Effective from**	July 2020
Course Aim	The goal of this course is to provide a good understanding of the principles and their corresponding hardware designs of various Digital Signal Processing operations.		
Course Outcomes	At the end of this course, the students will be able to 1. Understand the concepts of digital signal processing : Filtering Techniques and Orthogonal Transformations. 2. Develop the hardware designs of various Digital Filtering Techniques and Orthogonal Transformations.		
Contents of the course	1. Arithmetic Circuits: Fixed point number representation, barrel shifter, logarithmic shifter, ripple carry adder, carry select adder, carry skip adder, carry save adder, recursive doubling based carry look ahead adder, Booth algorithm, Carry save array multiplier, Wallace tree multiplier, distributed arithmetic based multiplication, fixed point multiply accumulate circuit design, restoring/non restoring division techniques, IEEE-754 floating point representation, floating point addition/subtraction, floating point multiplication/division, floating point multiply accumulate circuit design, and CORDIC. (8 hours) 2. Digital filter design: Basics of folded/parallel design, FIR/IIR filter design, steepest- descent LMS algorithm, adaptive FIR filter design, multirate signal processing, polyphase decomposition, and filter banks. (8 hours) 3. Discrete wavelet transform: Haar wavelet, 1D/2D/3D-Convolution based discrete wavelet transform architecture, 1D/2D/3D- (5,3) and (9,7) lifting based discrete wavelet transform architecture. (4 hours) 4. FFT architectures: radix-2/4 SDF, MDC, parallel FFT architectures. (4 hours) 5. HEVC architectures: introduction to DCT, integer DCT architectures, and discrete Hadamard transform architectures. (4 hours)		

	6. Hardware/software co-design: Analogous between ASIC/FPGA/hardware-software co-designs, need for digital signal processing accelerators (or coprocessors), and hardware/software partitioning based digital signal processing architectures, (4 hours) 7. Digital signal processor design: basics of Von-Neumann, Harvard, Modified Harvard, and super Harvard architectures, hazards, hazard resolution techniques, instruction and data level parallelism. (8 hours)
Text Books	1. S. K. Mitra, Digital Signal Processing: A computer base approach, Third edition, Mc Graw Hill Higher Education, 2006. 2. Y.T. Chan, Wavelet Basics, Kluwer Publishers, Boston, 1993. 3. Simon Haykin, Adaptive filter theory, Pearson Education, Fifth edition, 2014. 4. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, and Naraig Manjikian, Computer Organization and Embedded Systems, McGraw Hill Publications, Sixth Edition, 2012.
References	1. A. V. Oppenheium, R. W. Schafer, Discrete-time signal processing, Second edition, Prentice Hall, 1999. 2. Moris M. Mano, Computer System Architecture, Third Edition, Pearson Publication, 2007. 3. John L. Hannessey and David A. Patterson, Computer Architecture: A Quantitative Approach, Fourth Edition, Elsevier, Morgan Kaufmann Publishers, 2007. 4. Research articles on VLSI for Signal Processing

Course Title	Digital Signal Processing and Architectures Practice	**Course Number**	EC506P
Department	Electronics and Communication Engineering	**Structure (IPC)**	0-3-2
Offered to	M.Tech. ESD	**Status (Core/ Elective)**	Core
Prerequisite	Digital Signal Processing, Digital Logic Design	**Effective from**	July 2020
Course Aim	The goal of this course is to provide a good understanding of the principles and their corresponding hardware designs of various Digital Signal Processing operations.		
Course Outcomes	At the end of this course, the students will be able to 1. Denoise the signals. 2. Compress the audio, image, and video signals 3. Develop the RTL designs of various signal processing elements such as compressor and filter.		
Contents of the course	1. Hardware/software co-design of signal processing operations 2. Digital Signal Co-processor design 3. Digital Filter Designs – FIR, IIR, Adaptive filters 4. Discrete Orthogonal Transform Designs – FFT, integer DCT, DHT, DWT 5. Experiments using TMS320 trainer kit.		
Text Books	1. S. K. Mitra, Digital Signal Processing: A computer base approach, Third edition, Mc Graw Hill Higher Education, 2006. 2. Y.T. Chan, Wavelet Basics, Kluwer Publishers, Boston, 1993. 3. Simon Haykin, Adaptive filter theory, Pearson Education, Fifth edition, 2014. 4. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, and Naraig Manjikian, Computer Organization and Embedded Systems, McGraw Hill Publications, Sixth Edition, 2012.		
References	1. A. V. Oppenheium, R. W. Schafer, Discrete-time signal processing, Second edition, Prentice Hall, 1999. 2. Moris M. Mano, Computer System Architecture, Third Edition, Pearson Publication, 2007. 3. John L. Hannessey and David A. Patterson, Computer Architecture: A Quantitative Approach, Fourth Edition, Elsevier, Morgan Kaufmann Publishers, 2007. 4. Research articles on VLSI for Signal Processing		