SECB5101	TRANSFORMS AND RANDOM PROCESS FOR ELECTRONICS ENGINEERING (For AE and Embedded & IoT)	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To reinforce the mathematical foundation with advanced topics.
- To enable the student to appreciate the engineering aspect of mathematics.
- To equip the student with tools to confront continual mathematical.
- To understand probabilistic models and their applications.
- To expose the students to different Transform techniques.

UNIT 1 2D TRANSFORMS 9 Hrs.

Need for transform – Review of 1D Transform – 2D DFT – IDFT – properties – Image transforms–2D Orthogonal and Unitary transform and its properties–Separable transforms– Walsh, Hadamard, Haar, DST, DCT, Slant, SVD and KL transforms.

UNIT 2 WAVELET TRANSFORMS & ITS APPLICATIONS 9 Hrs.

Wavelet transforms – 1D & 2D Wavelet transform – basis and orthogonal basis – Time and frequency decompositions – STFT – CWT, DWT, Haar wavelet and Shannon wavelet – MRA – Orthonormal Wavelets – Fast Wavelet transform – Wavelet Packets – Bi-Orthogonal Wavelet Bases – SPIHT Algorithm – Wavelet Denoising – Wavelet based Signal Processing – Signal & Image compression.

UNIT 3 PROBABILITY & RANDOM VARIABLES 9 Hrs.

Probability concepts – Random variable – moment generating function – discrete types, continues types – Distributions - Binomial, Poisson, Geometric, Uniform, Normal and Exponential – Transformation of random variables – 2D random variables – marginal, conditional, joint probability – Correlation – Regression – Lindberg-Levy and Demoivre theorem- Sampling Distributions of chi square - Central Limit Theorem.

UNIT 4 RANDOMPROCESS 9 Hrs.

Notion of Stochastic processes – Stationary and Independence; WSS & Ergodicity – Correlation Functions; Auto Correlation, Cross Correlation & its properties – expectations – variance, co variance – Power Spectral Density – properties– Energy spectral density – Parseval's theorem – Wiener Khintchine relation –Renewal process-Linear systems with Random inputs–response off linear systems to white noise.

UNIT 5 QUEUING THEORY 9 Hrs.

Introduction to queuing theory – Characteristics of Queuing Systems – Little's Law – Markovian Queues –Single server models – Multiple server models – Non-Markovian Queues– Pollaczek- Khinchine formula – Machine interference model – steady state analysis – self-service queue – Priority Queues – Open and Closed Networks – queuing applications.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Asses random variables as an intrinsic need for the analysis of random phenomena.
CO2 - Apply time domain and frequency domain transform techniques for different applications.
CO3 - Apply the regression model in practical applications.
CO4 - Evaluate covariance and spectral density of stationary random processes.
CO5 - Demonstrate the specific applications of Poisson and Gaussian processes.
CO6 - Acquire skills in analyzing queuing models.

TEXT /REFERENCE BOOKS

1. Rafael C.Gonzalez& Richard E Woods, "Digital Image Processing", 5thEdition, Pearson Prentice Hall, 2018
2. Peyton Z.Peebles, "Probability, Random Variables and random signal principles", 4thEdition, TMH Publication, 2010.
3. Anil K Jain, "Fundamentals of Digital Image Processing", Prentice Hall, 2015.
4. Raghuveer M. Rao&Ajit S. Bopardikar, "Wavelet Transform: Introduction to Theory & Applications", Pearson Education,4th 2018.
5. Donald Gross, John F. Shortle, James M. Thompson and Carl W. Harris, "Fundamentals of Queuing Theory", 6thEdition, Wiley, 2018.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SECB5102	ADVANCED DIGITAL SYSTEM DESIGN (For AE and Embedded & IoT)	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To know about the functioning of combinational and sequential logic circuits in detail.
- To analyze the behaviour of CSSN using different tables and diagrams.
- To model a CSSN and to understand its behaviour.
- To understand about Algorithmic State Machines (ASM) and to design digital circuits with the aid of ASM chart.
- To analyze the behaviour of Asynchronous Sequential Circuit (ASN) using different tables and diagrams.
- To implement the digital design using PLDs and FPGAs.

UNIT 1 INTRODUCTION TO COMBINATIONAL AND SEQUENTIAL LOGIC CIRCUITS 9 Hrs.

Combinational: Introduction; General Approach to Combinational Logic Design; Introduction to Digital Integrated Circuits; Decoders; Encoders; Digital Multiplexers; Binary Comparators; Array Multipliers; Tristate Buffers. Sequential: Latches; Flip- Flops; Counters-Ring counter and Johnson Counter.

UNIT 2 SYNCHRONOUS SEQUENTIAL NETWORKS 9 Hrs.

Structure and Operation of Synchronous Sequential Networks: Moore model, Mealy model-Analysis of Clocked Synchronous Sequential Networks (CSSN); Transition equations, Transition tables, Excitation tables, State Tables, State diagrams - Modelling of CSSN behaviour: Serial binary adder as a mealy and Moore network, Sequence recogniser.

UNIT 3 CSSN TABLE REDUCTION TECHNIQUES AND ASM 9 Hrs.

State Table Reduction–Implication Table for determining equivalent states of the table, Obtaining Equivalence Classes of states, Constructing the minimum state table –State Assignment, Unused states Algorithmic state Machines–ASM Charts - ASM blocks, ASM chart for mod-N binary counter – Relationship between state diagram and ASM charts - ASM Chart for a sequence recogniser- ASM Chart for binary multiplier.

UNIT 4 ASYNCHRONOUS SEQUENTIAL NETWORKS 9 Hrs.

Structure and Operation of Asynchronous Sequential Networks (Fundamental and Pulse Mode); Analysis of Asynchronous Sequential Networks (ASN); Design of ASN; Primitive Flow Table; Flow Table Reduction; Races in ASC–Static and Dynamic Hazards; Essential Hazards.

UNIT 5 PROGRAMMABLE LOGIC DEVICES AND FPGA 9 Hrs.

Programmable Logic Array (PLA), Programmable Array Logic (PAL), Structure of standard PLD's; Complex PLD's (CPLD) -System Design using PLD's; Design of Combinational and Sequential Circuits using PLD's; Introduction to Field Programmable Gate Arrays - FPGA Programming.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Design combinational digital circuits for given specifications.
CO2 - Design Sequential digital circuits for given specifications.
CO3 - Apply state table reduction techniques for optimization of digital circuits.
CO4 - Apply ASM chart for designing sequential logic systems.
CO5 - Implement digital circuits using PLDs.
CO6 - Implement digital circuits using FPGAs.

TEXT / REFERENCE BOOKS

1. Donald G.Givone, Digital principles and Design, Tata McGraw Hill, 2nd Edition, reprint, 2012.
2. John MYarbrough, Digital Logic applications and Design, Thomson Learning, 2010 reprint.
3. Charles H. Roth, Jr. and Larry L. Kinney, "Fundamentals of Logic Design", 6th Edition, Cengage Learning, 2012.
4. Richard F. Tinder, "Engineering Digital Design", 2nd Edition Revised, Academic Press, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB5103	MICROCONTROLLERS (For AE and Embedded &IoT)	L	T	P	EL	Credits	Total Marks
		3	0	0	1	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To learn the internal architecture of ARM CortexM3/M4 core.
- To study about different communication protocols.
- Discuss in detail about peripheral interfacing with MCUs.
- To learn STM32 cubeMX IDE for ARM Cortex M3 /M4 processors.
- To learn API level coding with STM32fxxxboards.

UNIT 1 INTRODUCTION TO MICROCONTROLLER 9 Hrs.

Microprocessors and Microcontrollers – CISC and RISC - Fundamentals of Assembly language Programming – Instruction to Assembler – C Programming for Microcontrollers – Compiler and IDE.

UNIT 2 INTRODUCTION TO ARM CORTEX-M 9 Hrs.

Introduction to various versions of ARM Cortex M series - Debugging Features -Thumb Instruction Set - Memory Management - Comparison of various Cortex-M microcontrollers: LPC2148, STM32 series.

UNIT 3 CORTEX M4 CORE 9 Hrs.

Cortex M4 Architecture – Features – CPU Registers, Operating Modes - Instruction set – Addressing modes – I/O Programming - Vector Table.

UNIT 4 CORTEX M4 MICROCONTROLLER 9 Hrs.

STM32F3/4 Series Microcontrollers - Timers and Counters – Interrupts /Exception Handling - Phase Locked Loops – Communication Protocols - I2C, SPI, USB, CAN and LIN

UNIT 5 STM32F3/4 SERIES PROGRAMMING 9 Hrs.

Introduction to Cortex M4 microcontroller boards – GPIO, Timers, EEPROM, ADC, PWM, SPI and I2C interface programming with STM32cube IDE.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1 - Choose appropriate microcontrollers or processor core for different applications.
CO2 - Demonstrate Host/Target Development build tools for Embedded System development.
CO3 - Design circuits with ARM cortex-M family microcontrollers.
CO4 - Analyze the performance of various communication protocols.
CO5 - Develop Embedded System applications using STM microcontrollers.
CO6 - Demonstrate Hardware Abstraction Layer based microcontroller peripheral programming.

TEXT/ REFERENCE BOOKS

1. Joseph Yiu, “The Definitive Guide to the ARM Cortex-M3”, Newnes, 2nd Edition, 2009.
2. Mark Fisher, “ARM Cortex M4 Cookbook, Packt Publishing, 2016.
3. Lyla B. Das, “Architecture, Programming, and Interfacing of Low-power Processors-ARM 7, Cortex-M”, Cengage, 1st Edition, 2017.
4. Steve Furber, ARM System-on-Chip Architecture” Pearson, 2nd Edition, 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

S35PB11	ANALOG INTEGRATED CIRCUIT DESIGN	L	T	P	EL	Credits	Total Marks
		2	0	2	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To understand the concepts of small signal models of BJTs and MOSFETs.
- To identify the design and analysis of single stage and multistage amplifier.
- Be familiar the performance of operational amplifier.
- To focus on analog multiplier.
- Be familiar with the Analog Design.

UNIT 1 INTEGRATED CIRCUIT BJT AND MOSFET MODELING 9 Hrs.

Small signal models of BJTs and MOSFETs, short channel effects and scaling, and its impact on small signal parameters, biasing and operating regimes, parasitic elements, Frequency response of BJTs and MOSFETs.

UNIT 2 SINGLE AND MULTISTAGE AMPLIFIERS 9 Hrs.

Small signal single stage amplifier such as Common Emitter stage, Common source stage, Source follower, Common gate stage, Cascode stage configurations and properties, multistage amplifier stages such as Darlington and cascade configurations, Small signal analysis of differential amplifiers, Balanced differential amplifiers.

UNIT 3 CURRENT MIRRORS AND LOADS 9 Hrs.

Basic current mirrors, cascode current mirrors, active current mirrors, current mirror configurations, current matching considerations, active load configurations, Miller effect, voltage references, supply independent biasing, temperature independent references, input bias current.

UNIT 4 OPERATIONAL AMPLIFIERS 9 Hrs.

Concept of negative feedback, Effect of loading in feedback networks, Operational amplifier performance parameters, analysis of the simple op amp, Two-stage Op Amps, Input range limitations, Gain boosting, slew rate, power supply rejection, design considerations of integrated op-amps, Statistical characteristics of noise, noise in single stage amplifiers, noise in differential amplifiers, noise figure and noise temperature.

UNIT 5 ANALOG MULTIPLIER AND IC DESIGN 9 Hrs.

Bipolar analog multiplier, simple emitter coupled multiplier, a complete analog multiplier, Gilbert multiplier, Analysis of four quadrant and variable trans conductance multiplier, Low Power Analog Design, Introduction to Switched Capacitor Circuits, Analog Layout Considerations and Packaging Issues.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze the characteristics of various small signal models of BJT and MOSFETs.
CO2 - Analyze the performance of single stage and multistage amplifiers.
CO3 - Design current mirrors circuits for given specifications.
CO4 - Analyze the performance of Operational amplifiers in closed loop and open loop configurations.
CO5 - Design analog multiplier circuits using BJT and MOSFETs.
CO6 - Design various filters using switched capacitor circuit techniques.

TEXT / REFERENCE BOOKS

1. Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, "Analysis and Design of Analog Integrated Circuits", 5th Edition, Wiley, 2009.
2. Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, Tata McGraw Hill, 2012
3. Willey M.C. Sansen, “Analog design essentials”, Springer, 2014.
4. Grebene, “Bipolar and MOS Analog Integrated circuit design”, John Wiley & Sons, Inc., 2015.
5. Phillip E.Allen, Douglas R.Holberg, “CMOS Analog Circuit Design”, 2nd Edition, Oxford University Press, 2012.
6. P.E.Allen and D.R.Holberg, "CMOS Analog Circuit Design", Oxford University Press, 2011.

S35BLH11	SOFTWARE FOR EMBEDDED SYSTEMS (For AE and Embedded & IoT)	L	T	P	EL	Credits	Total Marks
		3	0	2	0	4	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- Introduce the students to the issues and challenges in developing software for embedded systems.
- Educate the students in formal modeling, design and development methodologies.
- Expose the students to software tools and techniques used in the development process.

UNIT 1 EMBEDDED PROGRAMMING 9 Hrs.

C and Assembly - Programming Style - Declarations and Expressions - Arrays, Qualifiers and Reading Numbers - Decision and Control Statements - Programming Process - More Control Statements - Variable Scope and Functions - C Preprocessor - Advanced Types - Simple Pointers – Experiment Debugging and Optimization of C Programs.

UNIT 2 C PROGRAMMING TOOLCHAIN IN LINUX 9 Hrs.

C preprocessor - Stages of Compilation - Introduction to GCC - Debugging with GDB - The Make utility - GNU Configure and Build System - GNU Binary utilities - Profiling - using gprof -Memory Leak Detection with val grind - Introduction to GNU C Library – Develop Embedded C programs in Linux platforms.

UNIT 3 EMBEDDED C AND EMBEDDED OS 9 Hrs.

Adding Structure to 'C' Code: Object oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism - Creating loop timeouts - Creating hardware timeouts. Basis of embedded OS, Introduction to sEOS, Using Timer 0 and Timer 1, Portability issue- Creating real-time applications using sEOS.

UNIT 4 MODEL BASED DESIGN OF EMBEDDED SYSTEMS 9 Hrs.

System-level design methodologies - UML basics, Object state behavior - UML state charts - Role of scenarios in the definition of behavior - Timing diagrams - Sequence diagrams - Event hierarchies - types and strategies of operations - Architectural design in UML - threads in UML- Develop UML model for Real World Problems.

UNIT 5 EMBEDDED JAVA 9 Hrs.

Introduction to Embedded Java and J2ME – Smart Card basics – Java card technology overview – Java card objects – Java card applets – working with APDUs – Web Technology for Embedded Systems- Smart Programming using Javacard tool chain.

Max. 45Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Develop Assembly and C programs for 8-bit microcontrollers.
CO2 - Analyze Embedded C programs and debug the software faults.
CO3 - Apply embedded C programming tool chain available in Linux platforms.
CO4 - Develop applications with sEOS embedded operating system.
CO5 - Apply UML based modeling in design of embedded applications.
CO6 - Develop embedded applications with Embedded Java and J2ME tool chain.

TEXT / REFERENCE BOOKS

1. Steve Oualline, 'Practical C Programming 3rd Edition', O'Reilly Media, Inc, 2016.
2. Hassan Gomma, "Designing concurrent, distributed, and real time applications with UML", 2nd Edition, Pearson Education, 2012.
3. Michael J Pont, "Embedded C", Pearson Education, 2017.
4. Zhiqun Chen, 'Java Card Technology for Smart Cards: Architecture and Programmer's Guide', Addison-Wesley Professional, 2020.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 20 Questions - MCQs	**20 Marks**
PART B: Practical Laboratory	**80 Marks**

SISB9101	RESEARCH METHODOLOGY AND IPR (For AE and Embedded & IoT)	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To provide an insight into the techniques of research.
- To learn the requisites of writing a research report.
- To impart knowledge on formulation of research problem, research methodology, ethics involved in doing research and importance of IPR protection.

UNIT 1 RESEARCH PREPARATION AND PLANNING 9 Hrs.

Objectives of research – Understanding research and its goals, Critical thinking, Techniques for generating research topics. Topic selection and justification. Techniques involved in designing a questionnaire – Methods of scientific enquiry – Formulation of hypotheses and testing of the same – Development of a research proposal.

UNIT 2 RESEARCH RESOURCES 9 Hrs.

Sources of information. Literature search. World Wide Web, Online data bases – search tools. Citation in dices – Principles underlying impact factor – Literature review – Case studies, review articles and Meta analysis – Role of the librarian. Ethical and moral issues in Research, Plagiarism, tools to avoid plagiarism.

UNIT-3 ACADEMIC WRITING AND PRESENTATION 9 Hrs.

Proposal submission for funding agencies, Elements of Style. Organization of proposals, Basic knowledge of funding agencies, Research report writing, Communication skills, Tailoring the presentation to the target audience – Oral presentations, Poster preparations, Submission of research articles for Publication in Reputed journal, Thesis writing and Research report writing. Elements of excellent presentation: preparation, visual and delivery, oral communication skills and oral defense.

UNIT 4 DATA COLLECTION, ANALYSIS AND INFERENCE 9 Hrs.

Basic statistical distributions and their applications. Sample size determination and sampling techniques. Large sample tests and small sample tests.

UNIT 5 INTELLECTUAL PROPERTY RIGHTS 9 Hrs.

Nature of Intellectual Property: Patents, Designs, Trade Mark and Copyright. Process of Patenting and Development: technological research, innovation, patenting & development. Procedure for grants of patents, Patenting under PCT. Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO 1 - Understand the important basics of research and Intellectual Property Rights
CO 2 - Write research problem formulations through various methods of literature survey
CO 3 - Analyze research related information and Follow research ethics
CO 4 - Correlate the results of any research article with other published results. Write a review article in the field of engineering
CO 5- Differentiate patents, copyrights, trademark and designs.
CO 6 - Apply the process for IPR protection

TEXT / REFERENCE BOOKS

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.
5. James C. Van Horne, Standford University, Financial Management and Policy, Prentice Hall.
6. James R. McGuigan, R. Charles Moyer, Frederick H. deB. Harris, Managerial economics – applications, strategy and Tactics, Cengage learning, India.
7. Philip Kotler, Marketing management Pearson Education, India.
8. Modern Production / Operations Management, Elwood S. Buffa & RakeshSarin, Wiley India.
9. Ronald R. Sims, Organizational success through effective human resources Management, Quorum books, London.
10. Ganesan R, Research Methodology for Engineers, MJP Publishers, Chennai. 2011.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB6101	Microcontroller Programming Lab (For AE and Embedded & IoT)	L	T	P	EL	Credits	Total Marks
		0	0	6	0	2	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To learn C programming of Microcontrollers
- To understand the basics of STM32cube IDE and Eclipse IDE
- To learn interfacing of ARM Cortex-M series microcontrollers with Peripherals

SUGGESTED LIST OF EXPERIMENTS

1. GPIO Programming of 8-bit and 16-bit Microcontrollers
2. GPIO Programming of Cortex-M Microcontrollers (LED blinking, Potentiometer, Switch),
3. Timer/Counter Programming.
4. ADC Interface (Polling and Interrupt).
5. Interfacing with DC, Stepper and Servo Motors.
6. PWM Interfacing.
7. UART, SPI, I2C protocols.
8. USB and CAN protocols.
9. Interfacing with Wi-Fi, Bluetooth and BLE Modems.
10. Interfacing with TFT and LED displays.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 - Apply Assemblers, Compilers and Debuggers tool chain for programming Microcontrollers.
CO2 - Develop Host/Target Development environment using build tools for Embedded Systems.
CO3 - Design 8-bit and 16-bit microcontroller based circuits.
CO4 - Demonstrate Embedded C programming through examples.
CO5 - Design ARM Cortex-M microcontroller based circuits.
CO6 - Develop programs for ARM microcontroller based applications.

SECB5201	CMOS CIRCUIT DESIGN	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To learn the basics of MOS transistors.
- To learn the fundamental concepts of CMOS devices and characteristics.
- To learn about different CMOS logic circuits.

UNIT 1 CMOS AND MOS TRANSISTOR 9 Hrs.

CMOS technology n-well p-well process- Twin tub - Silicon on insulator - CMOS process enhancements - Interconnect - Circuit elements - Latch up - Latch up prevention techniques - Threshold voltage equation and second order effects-MOS models-small signal AC characteristics.

UNIT 2 ELECTRICAL PROPERTIES OF MOS TRANSISTOR 9 Hrs.

CMOS AND NMOS inverters, Inverter ratio, Static and Dynamic characteristics-Power consumption - Static Dissipation- Dynamic Dissipation -Energy and Energy delay parameter-combinational logic implementation using NMOS and CMOS - Design rules-Stick diagram and Layout design, NAND-NAND, NOR- NOR, and AOI Logic.

UNIT 3 CMOS CIRCUIT AND LOGIC DESIGN 9 Hrs.

CMOS logic design- Typical CMOS NAND and NOR delays-Transistor sizing-CMOS logic structures-Complementary logic BICMOS logic- Pseudo NMOS logic-Dynamic CMOS logic-Clocked CMOS logic-Pre charge domino CMOS logic-Pass transistor logic-CMOS domino logic-NP domino logic-Cascade voltage switch logic-Source follower pull up logic(SFPL)- Clocking strategies- I/O structures.

UNIT 4 CMOS TESTING 9 Hrs.

Need for testing-Manufacturing test principles, Fault models, observability, controllability, fault coverage, automatic test pattern generation, Delay fault Testing, Statistical fault analysis, Fault sampling-Design strategies for test-Chip level Test Techniques, System level test techniques-Layout design for improved testability.

UNIT 5 CMOS SUBSYSTEM DESIGN 9 Hrs.

Data path operations, Addition/subtraction, Parity generations, Comparators, Zero/one detectors, Binary Counters, Implementation of ALU functions with an adder-carry look-ahead adder- Multiplication Array-Radix-n-Wallace tree and Serial parallel Multiplication, Pipelined multiplier array, Design of 4 bit Shifters-Memory Architectures and Memory control circuits - FSM, PLA Control Implementation.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze the performance of different small signal models of MOSFET.
CO2 - Evaluate the characteristics of different MOS inverters.
CO3 - Design CMOS based logic circuits for given specifications.
CO4 - Evaluate the performance of CMOS circuits with different testing methodologies.
CO5 - Design subsystems for arithmetic and logic units.
CO6 - Design memory circuits using CMOS devices.

TEXT / REFERENCE BOOKS

1. Jan M. Rabaey, “Digital integrated circuits”, 2nd Edition, PHI Limited, 2016.
2. Douglas A Pucknell, “Basic VLSI design”, PHI Limited, 2008.
3. E. Fabricious, “Introduction to VLSI design”, McGraw Hill Limited, 2012.
4. Neil Weste, “Principles of CMOS VLSI design”, Addison Wesley, 2014.
5. Amar Mukherjee, "Introduction to nMOS and CMOS VLSI system design", Prentice Hall, USA, 2014.
6. Wayne Wolf, "Modern VLSI Design: Systems on Silicon", 3rd Edition, Pearson Education Indian Reprint, New Delhi, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SECB5202	REAL TIME OPERATING SYSTEMS (For AE and Embedded & IoT)	L	T	P	EL	Credits	Total Marks
		3	0	0	1	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To learn about the fundamental difference between general purpose and real time operating systems.
- To learn about the scheduling algorithms used in RTOS.
- To learn about the porting and configuration of RTOS to different hardware targets.
- To learn programming with RTOS.

UNIT 1 INTRODUCTION AND INTERNALS 9 Hrs.

Introduction to Real-Time Systems, Classification of real time systems, Difference between GPOS and RTOS- Real Time Kernels - RTOS Architecture- Features of RTOS- POSIX-RT standard.

UNIT 2 PERFORMANCE METRICS AND SCHEDULING ALGORITHMS 9 Hrs.

Performance Metrics of RTOS, Task Specifications-Task state - Real Time Scheduling algorithms: Cyclic executive, Rate monotonic, IRIS and Least laxity scheduling- Schedulability Analysis.

UNIT 3 RESOURCE SHARING FOR REAL TIME TASKS 9 Hrs.

Resource sharing among tasks- Priority inversion Problem- Priority inheritance and Priority ceiling Protocols – Features of commercial and open source real time operating systems:Vxworks, QNX, Micrium OS, RT Linux and FreeRTOS.

UNIT 4 APPLICATION PROGRAMMING USING RTOS 9 Hrs.

Task synchronization using semaphores, Intertask communication: message queues and pipes, Remote procedure call- Timers and Interrupts-Memory management and I/O management.

UNIT 5 RTOS IMAGE BUILDING FOR DIFFERENT TARGET PLATFORMS 9Hrs.

Porting of RTOS, Configuring RTOS for minimizing RAM consumption and increasing Throughput-Building RTOS Image for Target platforms.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze the hardware and software issues in real-time computing

CO2 - Demonstrate real-time scheduling and schedulability analysis of priority-driven scheduling algorithms.

CO3 - Analyze the situation of fault occurrence and provide feasible solutions accordingly.

CO4 - Demonstrate porting of RTOS to embedded hardware target platforms.

CO5 - Develop real-time applications using RTOS software.

CO6 - Attain improved employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

TEXT/REFERENCE BOOKS

1. Jane W. S Liu, “Real Time Systems” Pearson Higher Education,3rd Edition, 2010.
2. Raj Kamal, “Embedded Systems- Architecture, Programming and Design” Tata McGraw Hill,2nd Edition, 2014.
3. Jean J. Labrosse, “Micro C/OS-II : The real time kernel” CMP Books, 2nd Edition,2015.
4. Warren Gay, “Beginning STM32: Developing with Free RTOS”, Apress, 1st Edition, 2018.
5. Richard Barry, Mastering the Free RTOS: Real Time Kernel”, Real Time Engineers Ltd, 1st Edition, 2016.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

S35BLH21	REAL TIME SIGNAL AND COLOR IMAGE PROCESSING (FOR AE and Embedded & IoT)	L	T	P	EL	Credits	Total Marks
		3	0	2	0	4	100

COURSE OBJECTIVES

- To introduce the principles of optimum filters such as Wiener and Kalman filters.
- To introduce the principles of adaptive filters and their applications to communication engineering.
- To introduce the concepts of multi-resolution analysis.

UNIT 1 DESIGN OF OPTIMUM FILTERS 9 Hrs.

Wiener filters - FIR Wiener filter - discrete Wiener Hopf equation, Applications - filtering, linear prediction. IIR Wiener filter - causal and non-causal filters. Recursive estimators - discrete Kalman filter applications.

UNIT 2 DESIGN OF ADAPTIVE FILTERS 9 Hrs.

Principles and properties of adaptive filters - FIR adaptive filters.Adaptive algorithms - steepest descent algorithm, the LMS algorithm - convergence. Applications of adaptive filtering - noise cancellation, channel equalization - Design and Analysis of Various Filters using Matlab.

UNIT 3 APPLICATIONS OF WAVELETS 9 Hrs.

Short-time Fourier transform - Heisenberg uncertainty principle. Principles of multi-resolution analysis - sub-band coding, the continuous and discrete wavelet transform - properties. Applications of wavelet transform - noise reduction, image compression – Demonstration of Wavelet's applications in Signal and Image Processing using Matlab.

UNIT 4 COLOR IMAGE PROCESSING 9 Hrs.

Color Models and Spaces- RGB and CMYK Spaces, Scalar Processing of Color Images- Vector Processing of Color Images- Noise Removal using Vector Filters-Vector Edge Detection- Color Filter Arrays and Demosaicking- Color Image Processing using Matlab.

UNIT 5 3D IMAGE VISUALIZATION 9 Hrs.

Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Image processing in 3D, Measurements on 3D images- Experimentation of 3D image processing using Matlab.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Apply optimum filters appropriately for a given communication application.
CO2 - Design appropriate adaptive algorithm for processing non-stationary signals.
CO3 - Analyse wavelet transforms for signal and image processing based applications.
CO4 - Demonstrate filtering of color images.
CO5 - Perform vector operations on color images.
CO6 - Develop Matlab code signal and image processing applications.

TEXT / REFERENCE BOOKS

1. Monson H. Hayes, "Statistical digital signal processing and modeling", John Wiley and Sons Inc. New York, Indian reprint 2008.
2. P. P. Vaidyanathan, "Multirate systems and filter banks", Prentice Hall Inc. 1993
3. Andreas Koschan, MongiAbidi. Digital color image processing, John Wiley and Sons, 2008.
4. Gaurav Sharma (Ed). Digital color imaging handbook, CRC Press, 2003.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 20 Questions - MCQs	**20 Marks**
PART B: Practical Laboratory	**80 Marks**

S35BPB21	STRATEGIES IN INDUSTRY 5.0 (For AE and Embedded & IoT)	L	T	P	EL	Credits	Total Marks
		2	0	2	0	3	100

Pre requisite: Nil **Co - requisite: Nil**

COURSE OBJECTIVES

- To acquaint with the digital transformation of Industry 5.0.
- To recognize the power of industry to achieve societal goals beyond jobs and growth.
- To understand the design of personalized electronics products.
- To focus on methods of interaction between humans and machines in virtual reality.
- To develop the concept of augmented reality in electronics manufacturing beyond automation and optimization.

UNIT 1 INDUSTRY 5.0 9 Hrs.

Evolution from Industry 1.0 to 5.0, Introduction to Industry 5.0, Globalization and Emerging Issues, LEAN Production Systems, Smart and Connected Business Perspective, Smart Factories, Healthcare and Human computer interactions, Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Big Data and Advanced Analysis.

UNIT 2 DIGITAL TRANSFORMATION TO INDUSTRY 5.0 9 Hrs.

Digital Transformation, Introduction to Digital Transformation, Digital business transformation, Causes of disruption and transformation, Digital transformation myths and realities, Digital transformation across various industries, Retail industry, Urban Development, e-Governance and the public sector, Insurance industry, Healthcare, Food, Manufacturing, Disaster Control, Elements of Society 5.0, Data Driven to Society, Humanity Vs Society 5.0.

UNIT 3 SMART WORLD 9 Hrs.

Introduction: Sensing & actuation, Communication, Electronics in Smart city, 5G Technology, Communication protocols, Integration of Sensors in Robots and Artificial Intelligence, Human-Machine Interaction, Industrial IoT- Application Domains: Healthcare, Power Plants, Inventory Management & Quality Control, Plant Safety and Security (Including AR and VR safety applications), Facility Management., Intellectual Property Rights- Case Studies - Milk Processing and Packaging Industries.

UNIT 4 CYBER SECURITY IN INDUSTRY 5.0 9 Hrs.

Introduction to Cyber Physical Systems (CPS), Architecture of CPS, Data science and technology for CPS, Prototypes of CPS, Emerging applications in CPS including social space, crowd sourcing, Networking systems for CPS applications, Wearable cyber physical systems and applications, Domain applications of CPS: Agriculture, Infrastructure, Disaster management, Energy, Intellectual Property Rights (IPR).

UNIT 5 AR/VR IN INDUSTRY 5.0 9 Hrs.

Unity, Basics of Unity, Understanding different panels in Unity, Moving, rotating & scaling Game objects in Unity, Game Panel in Unity, Physics in Unity, Increasing the light intensity, Adding colors to Game object, Adding textures to Game object, Parent and child Game objects in Unity. Case Studies- Development of AR/VR Models in Unity.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Identify the digital transformation power of Industry 5.0 to achieve societal goals beyond jobs and growth.

CO2 - Analyze the effectiveness of various enhanced production models in electronics.

CO3 - Implement various electronics manufacturing technologies of augmented reality beyond automation and optimization.

CO4 - Design suitable sensors for smart world real time applications with virtual reality experience

CO5 - Evaluate the performance of various cyber physical systems.

CO6 - Create personalized electronics products combining the various industry 5.0 Applications with deep knowledge on Intellectual Property Rights.

TEXT / REFERENCE BOOKS

1. S. Misra, A. Mukherjee, and A. Roy, Introduction to IoT, Cambridge University Press, 2020.
2. S. Misra, C. Roy, and A. Mukherjee, Introduction to Industrial Internet of Things and Industry, CRC Press, 2020.
3. Klaus Schwab, “Fourth Industrial Revolution”, Random House USA Inc, New York, USA, 2017.
4. Oliver Grunow, SMART FACTORY AND INDUSTRY 4.0. The current state of Application Technologies, Studylab Publications, 2016.
5. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
6. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
7. Grigore C. Burdea, Philippe Coiffet , Virtual Reality Technology, Wiley 2016.

SECB6201	VLSI PROGRAMMING LAB	L	T	P	EL	Credits	Total Marks
		0	0	6	0	2	100

Pre requisite: Nil **Co - requisite: Nil**

COURSE OBJECTIVES

- To learn Hardware Descriptive Language (Verilog).
- To learn the fundamental principles of VLSI circuit design in digital and analog domain.
- To familiarize fusing of logical modules on FPGAs.
- To provide hands on design experience with professional design (EDA) platforms.

SUGGESTED LIST OF EXPERIMENTS

1) Model Parameter extraction for MOSFET
2) NMOS and PMOS characteristics
3) Inverter characteristics
4) Layout of resistors, capacitors, transistors and inverter
5) 1-bit Shift Register
6) Design of Digital logic cells
7) Design of Adders, multipliers, Ring Oscillator.
8) Sequential circuit design
9) Combinations circuits design.
10) ALU Design

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze the characteristics of CMOS circuits using advanced EDA tool sets.
CO2 - Develop Layout design for discrete components and MOSFET circuits.
CO3 - Analyze the physical design performance of different CMOS logic circuits.
CO4 - Develop HDL code for given hardware specifications.
CO5 - Develop test bench programs for analyzing performance of digital circuits.
CO6 - Implement digital logic circuits in FPGA platforms.

SECB5301	ARTIFICIAL INTELLIGENCE AND DATA SCIENCE	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co - requisite: Nil**

COURSE OBJECTIVES

- To understand the basic principles and concepts of Artificial Intelligence and Data Science.
- To gain knowledge of various machine learning algorithms and their applications.
- To develop skills in data preprocessing, feature engineering, and model evaluation.
- To explore ethical considerations and challenges associated with AI and Data Science applications.

UNIT 1 INTRODUCTION TO AI AND DATA SCIENCE 9 Hrs.

Overview of AI and Data Science- Historical perspective and key milestones -AI Agents and Environments-Structure of Agents - Searching for solutions -Parameters to evaluate performance of problem solving - Heuristic functions - Data Acquisition - Sources of acquiring the data - Internal systems and External systems.

UNIT 2 PROBABILITY, STATISTICS, AND DATA PREPROCESSING 9 Hrs.

Probability theory - Probability Space - Events - Axiomatic approach to Probability - Conditional Probability - Independent Events -Descriptive statistics - Statistical inference - Population, sample-parameter and statistic-characteristics of a good estimator – Consistency-Invariance property of Consistent estimator, Sufficient condition for consistency Data preprocessing-Data cleaning- Data integration - Data Reduction - Feature Generation and Feature Selection- Wrappers.

UNIT 3 SUPERVISED LEARNING ALGORITHMS 9 Hrs.

Linear regression - Logistic regression- Decision trees and ensemble methods- Support Vector Machines (SVM)- Neural networks - Training and its types-Single layer Perceptron-Back Propagation Networks - Introduction to Deep learning Networks - Convolution Neural Networks.

UNIT 4 UNSUPERVISED LEARNING AND EVALUATION 9 Hrs.

Clustering algorithms - k-means, hierarchical clustering - Dimensionality reduction techniques- PCA, t-SNE - Model evaluation metrics – Cross validation techniques.

UNIT 5 ADVANCED TOPICS AND ETHICAL CONSIDERATIONS 9 Hrs.

Natural Language Processing (NLP) - Time Series Analysis and Forecasting - Multivariate Data Analysis-Reinforcement Learning - Ethical considerations in AI and Data Science - privacy, bias and responsible AI.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students are able to

CO1 - Analyze the software and hardware requirements to work with AI Algorithms.
CO2 - Simulate given problem scenario using appropriate AI libraries.
CO3 - Develop AI programming solutions for given problem scenario.
CO4 - Implement deep learning algorithms and solve real-world problems.
CO5 - Implement AI based edge computing solutions using GPUs.
CO6 - Analyze the performance of various ML algorithms for a specific application.

TEXT/REFERENCE BOOKS

1. Norvig, P., Russell, S. J., Artificial Intelligence: A Modern Approach. United Kingdom, Pearson, 2021.
2. Géron A. ,Hands-on machine learning with Scikit-Learn, Keras, and Tensor Flow, O'Reilly Media, Inc., 2022.
3. Cosma Rohilla Shalizi, Advanced Data Analysis from an Elementary Point of View, 2015.
4. Ian Good fellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.
5. Marc S. Paolella, Fundamental statistical inference: A computational approach, Wiley, 2018
6. Andreas Muller, Introduction to Machine Learning with Python: A Guide for Data Scientists, Shroff/O'Reilly; 1st Edition, 2016.
7. Andriy Burkov, The Hundred-Page Machine Learning Book, Publisher: Andriy Burkov, 1stEdition, 2019.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

S35BPB31	GRAPHICAL PROGRAMMING LANGUAGES (For AE and Embedded & IoT)	L	T	P	EL	Credits	Total Marks
		2	0	2	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To become familiar with the main features of the Python for Data Science applications.
- To enable the student on how to approach for solving Engineering problems using simulation tools.
- To prepare the students to use Python and LabVIEW in their project works.
- To provide a foundation in use of Python and LabVIEW softwares for real time applications.

UNIT 1 PYTHON FOR DATA SCIENCE 9 Hrs.

Introduction to Python, Datatypes in Python- Primitive Data Types, Core Type- LIST, Tuple, Dictionary, Array, Sets, Loops in Python, Conditional Statements in Python, Function.

UNIT 2 NUMPY AND PANDAS 9 Hrs.

Numpy- Introduction to Numpy, Creating different arrays using Numpy, Array Functions and Methods, Different Mathematical Functions, Different Matrix Operations, Random Numbers, Generate Numbers between a range.

Pandas-Introduction to Pandas (Series), Creating Series using Pandas, Different Series Attributes, Series vs List, Series Operations, Series from CSV File, Different Functions in Series, Different Sorting Algorithms in Series, Extracting Values from Series, .value_counts() method, .apply() methods.

UNIT 3 DATAFRAME AND DATA VISUALIZATION 9 Hrs.

Dataframe: Creating Dataframe, Dataframe different functions, Dataframe manipulation, Dropping with Null Values, Filling Null Values, Different Sorting Algorithms in Dataframe, Filtering Data in Dataframe, Retrieve Row Values using loc and iloc in Pandas, Delete Rows or Columns in Pandas.

Data Visualization-Introduction to Matplotlib, Installing Matplotlib in Python, Drawing 2D Graphs, Line Plot Graph, Bar Plot Graph, Scatter Plot Graph, Drawing Sub plot.

UNIT 4 INTRODUCTION TO LABVIEW 9 Hrs.

Introduction to Virtual Instrumentation- advantages- architecture of a Virtual Instrument-block diagram-front panel-VIs, loading and saving Vis-debugging techniques- creating sub Vis- loops and Charts-arrays-clusters and graphs.

UNIT 5 STRUCTURES, GRAPHS, FILE I/O AND DATA ACQUISITION 9 Hrs.

Shift registers-Case structure- Sequence structures-Formula node- Expression node-Math Script –Data Acquisition using LabVIEW - Case study :myDAQ Audio Equalizer.

Max.45Hrs.

COURSE OUTCOMES

On completion of the course, students are able to

CO1 - Apply Panda and NumPy libraries for data processing applications.
CO2 - Develop python code for different data handling and storage methods..
CO3 - Create VI models in LabVIEW for arithmetic and logic operations.
CO4 - Develop VI programs using various data structures.
CO5 - Perform real-time data acquisition using NI DAQ Modules.
CO6 - Create LabVIEW programs for audio and signal processing applications.

TEXT / REFERENCE BOOKS

1. Jake VanderPlas, " Python Data Science Handbook: Essential Tools for Working with Data" 2016.
2. Andreas Muller, " Introduction to Machine Learning with Python: A Guide for Data Scientists" 2016.
3. Jeffrey Travis, Jim Kring, " Labview for Everyone: Graphical Programming Made Easy and Fun", 3rd Edition, 2009
4. www.ni.com.

SECB6301	ARTIFICIAL INTELLIGENCE LAB	L	T	P	EL	Credits	Total Marks
		0	0	6	0	2	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To provide skills for designing and analyzing AI based algorithms.
- To enable students to work on various AI tools.
- To provide skills to work towards solution of real life problems using AI.

SUGGESTED LIST OF EXPERIMENTS

1. Data preprocessing and annotation and creation of datasets.
3. Learn existing datasets and Treebanks.
4. Implementation of searching techniques in AI.
5. Implementation of Knowledge representation schemes.
6. Natural language processing tool development.
7. Application of Machine learning algorithms.
8. Application of Classification and clustering problem.
9. Working on parallel algorithms.
10. Experiments using scientific distributions used in python for Data Science - Numpy, scify, pandas, etc.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze the software and hardware requirements to work with AI Algorithms.
CO2 - Simulate given problem scenario using appropriate AI libraries.
CO3 - Develop AI programming solutions for given problem scenario.
CO4 - Implement deep learning algorithms and solve real-world problems
CO5 - Implement AI based edge computing solutions using GPUs.
CO6 - Analyze the performance of various ML algorithms for a specific application.

SECB7001	ADVANCED ASIC DESIGN	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To understand the basic concepts of ASIC design flow.
- To acquire the knowledge about memory architectures and back end of VLSI design.
- To learn the fundamentals and recent advancements of SOC and NOC.

UNIT 1 INTRODUCTION TO ASICS, CMOS LOGIC AND ASIC LIBRARY DESIGN 9 Hrs.

Types of ASICs - Design Flow - CMOS transistors, CMOS design rules - Combinational Logic Cell – Sequential logic cell - Data path logic cell - transistors as resistors - transistor parasitic capacitance - Logical effort - Library cell design - Library architecture.

UNIT 2 PROGRAMMABLE LOGIC CELLS AND I/O CELLS 9 Hrs.

Anti fuse – static RAM – EPROM and EEPROM technology – PREP bench marks – Actel ACT – Xilinx LCA– Altera FLEX – Altera MAX DC & AC inputs and outputs – Clock and power inputs – Xilinx I/O blocks-Actel ACT – Xilinx LCA – Xilinx EPLD. – Altera MAX 5000 and 7000 – Altera MAX 9000 Altera FLEX.

UNIT 3 FLOOR PLANNING, PLACEMENT AND ROUTING 9 Hrs.

System partition - FPGA partitioning - partitioning methods - floor planning - placement - physical design flow - global routing - detailed routing - special routing - circuit extraction - DRC.

UNIT 4 SOC FUNDAMENTALS, SOFTWARE AND ENERGY MANAGEMENT 9 Hrs.

Essential issues of SoC design – A SoC for Digital still camera – multimedia IP development: Image and video Codecs. SoC embedded software – energy management techniques for SoC design.

UNIT 5 NOC DESIGN 9 Hrs.

Practical Design of NoC, NoC Topology-Analysis Methodology, Energy Exploration, NoC Protocol Design, Low-Power Design for NoC: Low-Power Signaling, On-Chip Serialization, Low-Power Clocking, Low-Power Channel Coding, Low-Power Switch, Low-Power Network on Chip Protocol.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Design sequential and combinational logic cells in line with CMOS design rules.
CO2 - Analyze the performance characteristics of logic cells and data paths.
CO3 - Implement ASIC design flows with Altera and Xilinx FPGAs.
CO4 - Analyze the performance of various routing and floor planning techniques.
CO5 - Develop a SoC architecture for given application requirement.
CO6 - Develop system level model of NoC for given real world problem.

TEXT / REFERENCE BOOKS

1. M.J.S. Smith, “Application Specific Integrated Circuits”, Addison Wesley Longman Inc., 2012.
2. Youn-Long, Steve Lin, “Essential Issues of SoC Design: Designing Complex Systems- On-Chip”, Springer, 2016.
3. Wolf Wayne, “FPGA Based System Design”, Pearson Education India, 2014.
4. Axel Jantsch, HannuTenhunen, “Network on chips”, Kluwer Academic Publishers, 2013.
5. Hoi-junyoo, Kangmin Lee, Jun Kyoung Kim, “Low power NoC for high performance SoC design”, CRC Press, 2018.
6. Vijay K. Madisetti, Chonlameth Arpikanondt, “A Platform-Centric Approach to System- on- Chip (SOC) Design”, Springer, 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7002	ADVANCED DIGITAL CONTROL SYSTEM	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To impart knowledge on various types of controllers.
- To provide advanced understanding of adaptive principles.
- To understand the basic digital control systems and their relationship to continuous systems.
- To understand of controller design methods based on z-plane.

UNIT 1 PRINCIPLES OF CONTROLLERS 9 Hrs.

Review of frequency and time response analysis and specification of control system, need for controller, continuous time compensation, continuous time PI, PD, PID controllers, Digital PID Controllers - Sampling and holding – Sample and hold devices – D/A and A/D conversion – observability.

UNIT 2 DESIGN USING TRANSFORM AND STATE SPACE TECHNIQUES 9 Hrs.

Reconstruction – Z transform – Inverse Z transform – Properties – Pulse transfer function and state variable approach – Review of controllability, Methods of discretization – Comparison – Direct design – Frequency response methods – State space design – Pole assignment – Optimal control – State estimation in the presence of noise – Effect of delays.

UNIT 3 COMPUTER BASED CONTROL 9 Hrs.

Selection of processors – Mechanization of control algorithms – PID control laws -Predictor merits and demerits – Application to temperature control – Control of electric drives – Data communication for control.

UNIT 4 PRACTICAL ASPECTS OF DIGITAL CONTROL ALGORITHMS 9 Hrs.

Algorithm development of PID control algorithms-Software implementation- Implementation using microprocessors and microcontrollers-Finite word length effects-, Choice of data acquisition systems-Microcontroller based temperature control systems-Microcontroller based motor speed control systems.

UNIT 5 QUANTIZATION EFFECTS AND SAMPLE RATE SELECTION 9 Hrs.

Analysis of round off error – Parameter round off – Limit cycles and dither – Sampling theorem limit – Time response and smoothness – Sensitivity to parameter variations – Measurement of noise – Anti-aliasing filter – Multirate sampling.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students will be able to

CO1 - Analyze the performance of different categories of controllers.
CO2 - Design an appropriate digital controller using transform techniques.
CO3 - Implement computer based digital control systems for given application.
CO4 - Develop digital algorithms for PID controllers.
CO5 - Evaluate the quantization effects in a digital control system.
CO6 - Analyze the performance of multirate sampling in digital control systems.

TEXT / REFERENCE BOOKS

1. Ogata K., "Discrete Time Control Systems", PHI, 2012.
2. Gopal M., “Digital control Engineering", Wiley Eastern Ltd., 2015
3. Franklin G.F. David Powell J. Michael Workman, “Digital control of Dynamic Systems”, 3rdEdition, Addison Wesley, 2012.
4. Paul Katz, “Digital control using Microprocessors”, Prentice Hall International, 2010.
5. Forsythe and W.Goodall. R.N., “Digital Control”, McMillan,2008.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7003	ADVANCED RF SYSTEM DESIGN	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To understand the issues in RF design.
- To learn the fundamental concepts in designing amplifiers, oscillators, mixers.
- To learn about different RF microwave antennas.
- To design RF circuits and systems.

UNIT 1 RF DESIGN ISSUES 9 Hrs.

Electromagnetic spectrum- Importance of RF design -Design and performance issues - Wireless system and markets- wireless system components-, RF behaviour of passive components, chip-Components and circuit board considerations, scattering parameters, smith chart and applications.

UNIT 2 RF AMPLIFIER DESIGN 9 Hrs.

Bilateral RF amplifier design for maximum small-signal gain- Multistage amplifiers - Stability considerations- Design for maximum linear power output - Output match considerations - Noise in RF circuits- Two-port noise parameter definitions - Available gain design technique- Low-noise amplifier design - considerations- Design of a single-ended and balanced LNA.

UNIT 3 RF OSCILLATORS AND MIXERS DESIGN 9 **Hrs.**

Two-port and One-port oscillator design approach-Transistor oscillator configurations - Characterizing oscillator phase noise- Colpitts crystal oscillator design - Voltage-controlled oscillator-Mixers and frequency multipliers - Single ended and balanced mixer- Double- balanced mixer- Harmonic components in mixers -Transistor mixer design.

UNIT 4 RF AND MICROWAVE ANTENNAS DESIGN 9 Hrs.

Basic Antenna parameters - Design Calculations of Rectangular Patch Antenna, circular patch Antenna-Microstrip antenna arrays-Fractal antennas-Smart Antennas.

UNIT 5 RF RECEIVER DESIGN 9 Hrs.

Receiver Architectures-Dynamic range-Frequency conversion and filtering-Examples of practical receivers-FM broadcast receiver- Digital cellular receiver-Millimetre wave point to point radio receiver-Direct conversion GSM receiver - Software- defined radio-Transceiver issues associated with software-defined radio.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students are able to

CO1 - Design RF amplifiers for given specifications.
CO2 - Design RF Oscillators for given frequency range.
CO3 - Analyze the performance of different types of mixer circuits in terms of noise level and harmonics.
CO4 - Design Microstrip patch antenna for given frequency band and gain.
CO5 - Evaluate the effect of noise in RF circuits.
CO6 - Develop suitable receiver architecture of real time applications.

TEXT / REFERENCE BOOKS

1. Reinhold Ludwig and Powel Bretchko, "RF Circuit Design – Theory and Applications", Pearson Education Asia, 1st Edition, 2010.
2. Rowan Gilmore, Les Besser, "Practical RF Circuit Design for Modern Wireless Systems -Active Circuits and Systems", Volume II, Artech House, Boston, London, 2013.
3. David M Pozar, "Microwave and RF design of wireless systems", John Wiley & Sons Inc., 2018.
4. Mathew M. Radmanesh, "Radio Frequency & Microwave Electronics", Pearson Education Asia, 2nd Edition, 2014.
5. Kraus J.D., Marhefka R.J., Khan A.S., "Antennas for all applications", Tata McGraw Hill, 3rd Edition2016.
6. Balanis A., "Antenna theory Analysis and Design", John Wiley and Sons, New York, 3rd Edition, 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7004	ADVANCED ROBOTICS AND AUTOMATION	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To introduce the functional elements of a ROBOT.
- To understand the concept of kinematics.
- To comprehend the concepts of robot arm dynamics.
- To study and analyze various assembly and inspection procedures.
- To illustrate the applications of Robot in different fields.

UNIT 1 INTRODUCTION 9 Hrs.

Geometric configuration of robots - Asimov's laws of robotics - work volume. Need for Automation - types of automation - fixed, programmable and flexible automation. Manipulators - drive systems - internal and external sensors - end effectors - control systems - robot programming languages and applications - Introduction to robotic vision system.

UNIT 2 ROBOT ARM KINEMATICS 9 Hrs.

Direct and Inverse Kinematics - rotation matrices - composite rotation matrices - Euler angle representation -homogeneous transformation –Denavit Hattenberg representation and various arm configurations.

UNIT 3 ROBOT ARM DYNAMICS 9 Hrs.

Lagrange - Euler formulation, joint velocities - kinetic energy - potential energy and motion equations – generalized D'Alembert equations of motion.

UNIT 4 ROBOT APPLICATONS 9 Hrs.

Material Transfer & Machine Loading / Unloading. General Consideration in robot material handling transfer applications – Machine loading and unloading. Processing Operations, Spot welding – Continuous arc welding - spray coating – other processing operations using robots.

UNIT 5 UNDERWATER ROBOTICS AND HUMANOIDS 9 Hrs.

Robotics in Water - Basics Representation of Underwater Robot - Types and Classification of Underwater Robotics - Underwater Manipulators - Introduction to Hydraulics on Underwater Vehicles - Applications of Underwater Vehicles. Humanoids**-** Wheeled and legged, Arm movement, Motion capture/Learning from demonstration, Human activity recognition using vision, touch, sound and tactile sensing.

Max.45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze the performance of different arm configurations.
CO2 - Apply kinematics techniques to control the movement of robotic arm.
CO3 - Evaluate different robot models based on manipulator Dynamics.
CO4 - Develop robotic manipulator for given real life problems.
CO5 - Choose appropriate type of actuator for the design of robots to solve real world problems.
CO6 - Assess different robot sensor systems for underwater and humanoid robots.

TEXT / REFERENCE BOOKS

1. JohnJ.Craig, "Introduction to Robotics Mechanics and Control", 3rdEdition, Pearson Education, 2015.
2. AshitavaGhoshal, "Robotics-Fundamental Concepts and Analysis", Oxford University Press, 6th Edition, 2015.
3. Deb S R. and Deb S., "Robotics Technology and Flexible Automation", Tata McGraw Hill Education Pvt. Ltd., 2014.
4. Saha S.K., "Introduction to Robotics", Tata McGraw Hill Education Pvt. Ltd., 2018.
5. K.S.Fu, R.C.Gonzalez, CSG. Lee, "Robotics control, sensing, vision and Intelligence", McGraw Hill Education Pvt. Ltd., 2013.
6. Richard D. Klafter, Thomas A. Chmielewski, Michael Negin, "Robotics Engineering: An Integrated Approach", PHI Learning, New Delhi, 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7005	AUTOMOTIVE EMBEDDED SYSTEMS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVE

- To introduce the potential of automotive systems in industries.
- To understand Automotive Sensory Systems.
- To analyze the importance of automotive control in system design.

UNIT 1 INTRODUCTION 9 Hrs.

Automotive Systems Overview :Automotive Vehicle Technology, Overview of Vehicle Categories, Various Vehicle Sub Systems like Chassis, Body, Driveline, Engine technology, Fuelling technology, vehicle Emission, Brakes, Suspension, Emission, Doors, Dashboard instruments, Wiring Harness, Safety & Security , Comfort &Infotainment, Communication & Lighting, Future Trends in Automotive Embedded Systems : Hybrid Vehicles, Electric Vehicles.

UNIT 2 AUTOMOTIVE PROTOCOLS 9 Hrs.

Need for Protocol, Automotive Protocols: LIN, CAN, KWP2000 & J1939, Flex Ray, Protocol- Calibration and Diagnostics tools for networking of electronic systems like ECU Software and Testing Tools, ECU Calibration Tools, Vehicle Network Simulation. Advanced Trends in Automotive Electronics: AUTOSAR Architecture.

UNIT 3 EMBEDDED COMMUNICATION 9 Hrs.

Automotive Communication Systems: Characteristics and Constraints - In-Car Embedded Networks- Middleware Layer- Open Issues for Automotive Communication Systems.

UNIT 4 AUTOMOTIVE ARCHITECTURE DESCRIPTION LANGUAGE 9 Hrs.

Engineering Information Challenges - State of Practice - ADL as a Solution- Existing ADL Approaches.

UNIT 5 TESTING, AND TIMING ANALYSIS 9 Hrs.

Testing Automotive Control Software- Testing and Monitoring of FlexRay-Based Applications- Timing Analysis of CAN-Based Automotive Communication Systems.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze the market potential in automotive systems.
CO2 - Analyze the various automotive protocols for given application
CO3 - Demonstrate embedded communication with CAN Networks.
CO4 - Develop automotive description language for various existing ADL approaches
CO5 - Development testing and timing analysis for CAN based communication system
CO6 - Develop automotive embedded system for real time applications.

TEXT BOOKS / REFERENCES

1. Nicolas Navet, Francoise Simonot -Lion ”Automotive Embedded system”, CRC Press, Taylor and Francis group, 2013.
2. Robert Bosch GmbH, “Bosch Automotive Electrics and Automotive Electronics – Systems and Components, Networking and Hybrid Drive”, 5th Edition, Springer Vieweg, 2017.
3. William Ribbens, “Understanding Automotive Electronics – An Engineering Perspective”, 7th Edition, Butterworth Heinemann, 2012.
4. V.A.W. Hillier and David R. Rogers, “Hillier’s Fundamentals of Motor Vehicle Technology”, Book 3 – Chassis and Body Electronics, 5th Edition, Nelson Thornes Ltd, 2012.
5. Tom Denton, “Automobile Electrical and Electronic Systems”, 4th Edition, Routledge, 2015.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7006	CLOUD COMPUTING (AE and Embedded & IoT)	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVE

- To have a knowledge on basics of cloud.
- To provide students basic understanding and virtualization.
- To discuss some scenarios of clouds in organizations.

UNIT 1 CLOUD COMPUTING 9 Hrs.

Origins of Cloud computing – Cloud components - Essential characteristics – On-demand self- service, Broad network access, Location independent resource pooling ,Rapid elasticity , Measured service, Comparing cloud providers with traditional IT service providers, Roots of cloud computing.

UNIT 2 CLOUD INSIGHTS 9 Hrs.

Architectural influences – High-performance computing, Utility and Enterprise grid computing, Cloud scenarios – Benefits: scalability ,simplicity ,vendors ,security, Limitations – Sensitive information - Application development- security level of third party - security benefits, Regularity issues: Government policies.

UNIT 3 CLOUD ARCHITECTURE- LAYERS AND MODELS 9 Hrs.

Layers in cloud architecture, Software as a Service (SaaS), features of SaaS and benefits, Platform as a Service (PaaS), features of PaaS and benefits, Infrastructure as a Service (IaaS), features of IaaS and benefits, Service providers, challenges and risks in cloud adoption.

Cloud deployment model: Public clouds – Private clouds – Community clouds - Hybrid clouds - Advantages of Cloud computing.

UNIT 4 CLOUD SIMULATORS- CLOUDSIM AND GREENCLOUD 9 Hrs.

Introduction to Simulator, understanding CloudSim simulator, CloudSim Architecture(User code, CloudSim, GridSim, SimJava) Understanding Working platform for CloudSim, Introduction to Green Cloud.

UNIT 5 INTRODUCTION TO VMWARE SIMULATOR 9 Hrs.

Basics of VMWare, advantages of VMware virtualization, using Vmware workstation, creating virtual machines-understanding virtual machines, create a new virtual machine on local host, cloning virtual machines, virtualize a physical machine, starting and stopping a virtual machine.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Articulate the main concepts, key technologies, strengths, and limitations of cloud computing
CO2 - Analyze the core issues of cloud computing such as security, privacy, and interoperability.
CO3 - Develop applications basedon public cloud and private cloud architectures.
CO4 - Demonstrate how storage and virtualization is carried out in the cloud platform.
CO5 - Create virtual machine based applications for real world problems.
CO6 - Apply the fundamental principles of multi-tier web applications and services in a cloud environment.

TEXT / REFERENCE BOOKS

1. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Rittinghouse, JohnW., and James F. Ransome, “Cloud Computing: Implementation, Management and Security”, CRC Press, 2017.
3. RajkumarBuyya, Christian Vecchiola, S. ThamaraiSelvi, “Mastering Cloud Computing”, Tata McGraw Hill, 2013.
4. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing -A Practical Approach”, Tata Mcgraw Hill, 2015.
5. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)”, O'Reilly, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7007	COMPUTER VISION AND DEEP LEARNING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To review image processing techniques for computer vision.
- To understand shape and region analysis, Hough Transform and its applications to detect lines, circles, ellipses.
- To understand Visualization and Convolution Neural Networks for computer vision.
- To understand the concept of Recurrent Neural Networks.
- To understand the concept of Attention and Deep Generative Models.

UNIT 1 INTRODUCTION TO COMPUTER VISION 9 Hrs.

Introduction to Image Formation, Capture and Representation; Linear Filtering, Thresholding, Correlation, Convolution, Edge, Blobs, Corner Detection; Scale Space and Scale Selection; SIFT, SURF; HoG, LBP.

UNIT 2 VISUAL MATCHING 8 Hrs.

Bag-of-words, VLAD; RANSAC, Hough transform; Pyramid Matching; Optical Flow.

UNIT 3 VISUALIZATION AND CONVOLUTION NEURAL NETWORKS (CNNs) 10 Hrs.

Review of Deep Learning, Multi-layer Perceptrons, Backpropagation, Introduction to CNNs; Evolution of CNN Architectures: AlexNet, ZFNet, VGG, InceptionNets, ResNets, DenseNets, Visualization of Kernels; Backprop-to-image/Deconvolution Methods; Deep Dream, Hallucination, Neural Style Transfer; CAM, and Grad-CAM.

UNIT 4 RECURRENT NEURAL NETWORKS (RNNs) 9 Hrs.

RNNs; CNN + RNN Models for Video Understanding: Spatio-temporal Models, Action/Activity Recognition.

UNIT 5 ATTENTION AND DEEP GENERATIVE MODELS 9 Hrs.

Introduction to Attention Models in Vision; Vision and Language: Image Captioning, Visual QA, Visual Dialog; Spatial Transformers; Transformer Networks, Deep Generative Models: GANs, VAEs, PixelRNNs, NADE, Normalizing Flows.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

- **CO1 -** Apply basic Image processing techniques to a specific image.
- **CO2 -** Apply visual matching techniques to extract features from the image.
- **CO3 -** Develop CNN architecture for computer vision applications.
- **CO4 -** Develop RNN model for video processing.
- **CO5 -** Develop Attention model for computer vision applications.
- **CO6 -** Choose appropriate Deep generative model for a specific application.

TEXT / REFERENCE BOOKS

1. E.R. Davies, “Computer & Machine Vision”, Fourth Edition, Academic Press, 2012.
2. R. Szeliski, “Computer Vision: Algorithms and Applications”, Springer 2011.
3. Simon J.D. Prince, “Computer Vision: Models, Learning and Inference”, Cambridge University Press, 2012.
4. Mark Nixon and Alberto S. Aquado, “Feature Extraction & Image Processing for Computer Vision”, 3rd Edition, Academic Press, 2012.
5. Ian Goodfelllow, YoshuaBenjio, Aaron Courville, Deep Learning, The MIT Press,2016.
6. S.Kevin Zhou, Hayit Greenspan, DinggangShen , Deep Learning for Medical Image Analysis, ELESVIER, Academic Press ,2017.
7. Mark Jenkinson, Michael Chappell, “Introduction to Neuroimageing Analysis”, OXFORD University Press,2018.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7008	CONTEMPORARY WIRELESS AND MOBILE COMMUNICATIONS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To understand the basics of 5G and Beyond Wireless communication
- To study about the key technologies and enablers of 5G and beyond communication systems.
- To learn about channel models used in contemporary wireless communication system.
- To learn 5G techniques such as massive MIMO, mmWave, NOMA, etc.

UNIT 1 EVOLUTION OF MOBILE WIRELESS TECHNOLOGIES 9 Hrs.

Evolution of cellular systems- requirements, goals, and vision of the next generation wireless communication systems - Fading, digital modulations and performance metrics.

UNIT 2 5G TECHNOLOGIES 9 Hrs.

Small cells: capacity of small cell networks - Interference management, D2D architecture for Spectrum efficiency- Massive MIMO: Point-to-point MIMO, Virtual MIMO (relaying), MIMO Challenges and propagation channel model - mmWave: Applications and radiowave propagation.

UNIT 3 MULTIPLE ACCESS TECHNIQUES FOR 5G AND BEYOND 9 Hrs.

Orthogonal frequency division multiplexing (OFDM), filter banks, Generalized Frequency Division Multiplexing (GFDM), Orthogonal Time Frequency Space (OTFS), Non-orthogonal multiple access (NOMA) – Beamforming Techniques.

UNIT 4 6G ENABLING TECHNOLOGIES 9 Hrs.

Wireless energy harvesting: Energy-rate trade-off, Simultaneous wireless information and power transfer (SWIPT), time-switching, power splitting Wireless energy harvesting - Visible light communication - Intelligent reflecting surface (IRS) - Extremely Large Aperture Massive MIMO.

UNIT 5 MACHINE LEARNING IN WIRELESS COMMUNICATION 9 Hrs.

Channel modeling, Channel Estimation using Machine learning - Spectrum sensing, Spectrum Sharing and Resource allocation in NOMA, mmWave massive MIMO using Machine learning.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Distinguish and understand the major cellular communication standards and wireless communications networks.

CO2 - Apply the 5G techniques e.g. massive MIMO. Mm Wave etc. for the design of communication systems.

CO3 - Evaluate performance of various modulation techniques used in wireless systems.

CO4 - Analyze different multiplexing techniques such as OFDM, NOMA etc.

CO5 - Apply machine learning techniques in wireless communications.

TEXT / REFERENCE BOOKS

1. R. Vannithamby and S. Talwar, Towards 5G: Applications, Requirements and Candidate Technologies., John Willey & Sons, West Sussex, 2017.
2. Manish, M., Devendra, G., Pattanayak, P., Ha, N., 5G and Beyond Wireless Systems PHY Layer Perspective, Springer Series in Wireless Technology.
3. T. S. Rappaport, R. W. Heath Jr., R. C. Daniels, and J. M. Murdock,, Millimeter Wave Wireless Communication., Pearson Education, 2015.
4. M. Vaezi, Z. Ding, and H. V. Poor, Multiple Access techniques for 5G Wireless Networks and Beyond., Springer Nature, Switzerland, 2019.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7009	CYBER PHYSICAL SYSTEMS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To study the basic concepts, requirements, principles, and techniques in emerging cyberphysical systems.
- To provide students hands-on experience in prototyping a cyber-physical system.
- To address real-world problems through Cyber Physical Systems.
- To develop an exposition of the challenges in implementing a cyber-physical system from a computational perspective.
- To provide students of different disciplinary background with necessary knowledge to understand the fundamentals of cyber physical systems.

UNIT 1 COMPUTATIONAL FOUNDATION AND DESIGN OF CYBER PHYSICAL SYSTEM **9 Hrs.**

Cyber Physical Systems in Real world, Basic Principle of Cyber Physical Systems, Industry 4.0, IIoT, Cyber Physical Systems Design Recommendations, CPS system requirements, Cyber Physical System Applications Case study of Cyber Physical Systems.

UNIT 2 CYBER PHYSICAL SYSTEM PLATFORMS **9 Hrs.**

Hardware platforms for Cyber Physical Systems (Sensors/Actuators, Microprocessor/Microcontrollers), Wireless Technologies for Cyber Physical Systems.

UNIT 3 MODELS AND DYNAMICS BEHAVIOURS **9 Hrs.**

Continuous Dynamics, Discrete dynamics and Hybrid Systems.

UNIT 4 CONCURRENT MODELS OF COMPUTATION **9 Hrs.**

Structure of Models, Synchronous Reactive models, Dataflow models of computation, Timed models of computation.

UNIT 5 SECURITY AND PRIVACY IN CYBER PHYSICAL SYSTEMS **9 Hrs.**

Security and Privacy Issues in CPS, Local Network Security for CPS, Internet-Wide Secure Communication, Security and Privacy for Cloud-Interconnected CPSs, Case Study: Cybersecurity in Digital Manufacturing/Industry 4.0.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO 1 - Choose the necessary components for Cyber Physical Systems.
CO 2 - Develop difference interface methods to interact with Cyber Physical System.
CO 3 - Apply appropriate communication protocols for CPS for given application.
CO 4 - Analyze the different architectures of Cyber Physical System
CO 5 - Develop different models for Cyber-physical systems.
CO 6 - Analyze common methods used to secure cyber-physical systems.

TEXT / REFERENCE BOOKS

1. Principles of Cyber Physical Systems, Rajeev Alur, MIT Press, 2015
2. E. A. Lee, SanjitSeshia , "Introduction to Embedded Systems – A Cyber–Physical Systems Approach", Second Edition, MIT Press, 2017, ISBN: 978-0-262-53381-2
3. Guido Dartmann, Houbing song, Ankeschmeink, “Big data analytics for Cyber Physical System”, Elsevier, 2019
4. Houbing song, Danda B Rawat, Sabina Jeschke, Christian Brecher, “Cyber Physical Systems Foundations, Principles and Applications”, Elsevier, 2017
5. Chong Li, MeikangQiu, “Reinforcement Learning for Cyber Physical Systems with Cyber Securities Case Studies”, CRC press, 2019

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7010	CYBER SECURITY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To analyze the basics of cyber security.
- To determine the cybercrimes and security.
- To examine the attacks and threats related to cyber security.
- To analyze the concepts of intrusion detection and prevention.
- To apply the concepts for various real time systems.
- To build cyber security system for real time applications.

UNIT 1 INTRODUCTION TO CYBER SECURITY 9 Hrs.

Introduction – Need for Security – Security Approaches – Principles of Security – Components – Balancing Security & Access – Cyber Security –Impact of Internet – CIA Triad;– Need for Cyber Security – Cybercriminals — A Global Perspective on Cyber Crimes; Cyber Laws – The Indian IT Act – Cybercrime and Punishment.

UNIT 2 CYBER CRIMES AND CYBER SECURITY 9 Hrs.

Cyber Crime and Information Security – History of Cyber Crime-classifications of Cyber Crimes – Reason for Cyber Crime -Tools and Methods –Password Cracking, Key loggers, Spywares, SQL Injection – Network Access Control – Cloud Security – Web Security – Wireless Security.

UNIT 3 ATTACKS AND COUNTERMEASURES 9 Hrs.

Malicious Attack Threats and Vulnerabilities: Scope of Cyber-Attacks – Security Breach – Types of Malicious Attacks – Malicious Software – Common Attack Vectors – Social engineering Attack – Wireless Network Attack – Web Application Attack – Attack Tools – Countermeasures.

UNIT 4 INTRUSION DETECTION AND PREVENTION 9 Hrs.

Host Based Intrusion Detection – Network Based Intrusion Detection – Distributed or Hybrid Intrusion Detection – Intrusion Detection Exchange Format – Honeypots. Firewalls- Types of Firewalls- Firewall location and configuration- Intrusion Prevention systems- Example -Unified Threat Management Products.

UNIT 5 CYBER SECURITY-CASE STUDIES 9 Hrs.

Smartphone security- social media and basic Windows security- secure password and Wi-Fi security- Online Banking, Credit Card and UPI Security- Micro ATM, e-wallet and Point of Sale (POS) Security.

Max 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO 1 - Analyze the basics of cyber security concepts
CO 2 - Analyze various cybercrimes and cyber security.
CO 3 - Interpret threats, attacks and countermeasures of cyber security
CO 4 - Investigate Intrusion detection and prevention systems
CO 5 - Apply the concepts for cyber security in IoT applications
CO 6 - Develop real time applications for cyber security.

TEXT / REFERENCE BOOKS

1. Anand Shinde, “Introduction to Cyber Security Guide to the World of Cyber Security”, Notion Press, 2021.
2. Nina Godbole, SunitBelapure, “Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives”, Wiley Publishers, 2011.
3. B. Sullivan, V. Liu, and M. Howard, “Web Application Security”, A B Guide. New York: McGraw-Hill Education, 2011.
4. Cyber Crime Impact in the New Millennium, by R. C Mishra ,Auther Press. Edition 2010.
5. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd. (First Edition, 2011).
6. Henry A. Oliver , Security in the Digital Age: Social Media Security Threats and Vulnerabilities, Create Space Independent Publishing Platform. (Pearson , 13th November, 2001).
7. B.B.Gupta,D.P.Agrawal,HaoxiangWang,ComputerandCyberSecurity:Principles,Algorithm, Applications, and Perspectives, CRC Press, 2018.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7011	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To provide an understanding of Electromagnetic Interference (EMI)/Electromagnetic Compatibility (EMC) methodology and concepts.
- To become familiar with specifications, standards and measurements of EMI.
- To learn EMI filter design and other mitigating solutions.
- To understand circuit board layout and mechanical packaging considerations for EMI/EMC compliant designs.

UNIT 1 EMI ENVIRONMENT 9 Hrs.

Introduction to EMI/EMC-Basics of electro Magnetic interference (EMI) Fundamentals of electromagnetic compatibility (EMC)-Radiation hazards Transients and other EMI sources Electrostatics discharge (ESD) Phenomena and effects, Transient phenomena and suppression -Tempest- Lightning.

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UNIT 2 EMI COUPLING 9 Hrs.

EMI coupling modes - CM and DM -EMI from apparatus and circuits: Introduction-Electromagnetic emission-Appliances- noise from relays and switches-nonlinearities in circuits-Passive inter modulation-Cross talk in transmission lines - Transmission in power supply lines-Electromagnetic interference.

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UNIT 3 EMI SPECIFICATION / STANDARDS AND MEASUREMENTS 9 Hrs.

Units of specification - civilian standards and military standards. Basics of EMI measurements-EMI measurement tools-TEM cell-measurement using TEM cell-Reverberating chamber-GTEM cell-Anechoic chamber-Open area test site-RF absorbers- conducted interference measurements-conducted EMI from equipment-Experimental setup for measuring conducted EMI- Measurement of DM interferences.

UNIT 4 EMI CONTROL TECHNIQUES 9 Hrs.

Shielding technique-Filter techniques-Grounding techniques-Bonding techniques-Cable connectors and components- Isolation transformer-Transient suppressor- EMI gasket- Opto-Isolator.

UNIT 5 EMC DESIGN OF PCB 9 Hrs.

Designing for EMC: Introduction - Different techniques involved in designing for EMC-EMC guide lines for PCB designs- EMC design guide line for audio and control circuit design, RF design, power supply design-Mother board designs and propagation delay- Trace routing, Impedance control, decoupling, Zoning and grounding

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students are able to

CO1 - Analyse the effect of radiation hazards from RF equipment.
CO2 - Evaluate the level of noise interference from electrical appliances.
CO3 - Apply different EMI control techniques in the design of RF systems.
CO4 - Analyse the protocols set by IEEE standards for EMI/EMC.
CO5 - Apply appropriate EMI measurement techniques for product validation.
CO6 - Apply EMC guidelines in the design of printed circuit boards for various applications.

TEXT / REFERENCE BOOKS

1. Clayton Paul, “Introduction to Electromagnetic Compatibility”, Wiley Interscience, 2016.
2. V Prasad Kodali, “Engineering Electromagnetic Compatibility”, IEEE Press, Newyork, 2011.
3. Henry W. Ott, “Electromagnetic Compatibility Engineering”, John Wiley & Sons Inc, Newyork, 2013.
4. Daryl Gerke and William Kimmel, “EDN’s Designer’s Guide to Electromagnetic Compatibility”, Elsevier Science & Technology Books, 2012.
5. Kenneth L Kaiser, “The Electromagnetic Compatibility Handbook”, CRC Press 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7012	HIGH PERFORMANCE NETWORKS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To develop a comprehensive understanding of high speed networks and multimedia networking.
- To study the concepts of applications related to high speed networks.
- To learn about different types of high speed Ethernet communication networks.
- To review about high performance wireless networks.
- To know about the high speed optical networks and the concepts of FTTH.

UNIT 1 BASICS OF HIGH SPEED NETWORKS AND APPLICATIONS 9 Hrs.

Traffic characteristics and QoS- Network services: connection oriented, connection less services – High performance network – Network elements – network mechanisms – high speed applications- peer to peer file distribution – scalability of p2p services-bit torrent- video streaming and content distribution networks – Internet video- HTTP Streaming- case study: Netflix, YouTube.

UNIT 2 DATA NETWORK AND COMMUNICATION PROTOCOLS 9 Hrs.

Switched communication networks- Circuit switching concepts-Packet Switch Networks – Frame Relay Networks – Congestion in data network and internets – Communication protocol architectures.

UNIT 3 HIGH SPEED ETHERNETS 9 Hrs.

Traditional Ethernet- High speed Ethernet: IEEE 802.3 (FAST ETHERNET)- Gigabit Ethernet- 10Gps Ethernet- configuration – 100 Gps Ethernet- Configuration for massive blade server site- Multilane distribution for 100Gps Ethernet- IEEE 802.1Q VLAN standard- configuration of VLAN.

UNIT 4 HIGH SPEED WLANS 9 Hrs.

Wireless LANs – Configuration – single cell, multiple cell- IEEE 802.11 standards- Terminology- Architecture- Services- MAC- Protocol architecture- MAC frame format- IEEE 802.11 a, b and g standards- comparison – Gigabit Wi-Fi.

UNIT 5 HIGH SPEED OPTICAL NETWORKS 9 Hrs.

Optical networks- Management and services- IP and optical integrated networks- Migration scenario- network configuration- resource allocation concepts- DOFSR- DOFSR network- Demands on high speed optical networks- packet switching in optical network- All optical packet switching- FTTH- Concepts- Architecture- Applications.

Max 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Appraise the elements of high speed networks and their relevant applications.
CO2 - Analyse the functional metrics of high speed networks.
CO3 - Apprehend different types of switching related to high speed operations.
CO4 - Evaluate the performance of various types of high speed Ethernets.
CO5 - Analayse the IEEE standards pertaining to high speed wireless data communications.
CO6 - Evaluate the performance of optical networks.

TEXT / REFERENCE BOOKS

1. J.F.Kurose & K.W.Ross, "Computer Networking: A top down approach featuring the internet", 7th Edition, Pearson, 2017.
2. Walrand.J.Varatya, "High performance communication network", 2nd Edition, 2010, Morgan Kauffman Publishers Ltd., Reprint 2015.
3. William Stallings, "Data and Computer communications", 10th Edition, Pearson, 2014.
4. Hans W. Barz, Gregory A. Bassett, "Multimedia Networks Protocols, Design and Applications", Wiley, 2016.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7013	LOW POWER VLSI DESIGN (For AE & VLSI)	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To categorize the sources of power dissipation.
- To analyze the types of low power design analysis.
- To apply Low power VLSI design Techniques and methodologies in System design.

UNIT 1 INTRODUCTION TO LOW POWER VLSI DESIGN 9 Hrs.

Introduction- Need for Low power VLSI design– Charging and Discharging Capacitance- Short circuit current in CMOS–CMOS leakage current- Static current- Principles of Low power design- Low power figure of Merits.

UNIT 2 POWER ANALYSIS METHODS 9 Hrs.

Simulation power analysis - SPICE circuit analysis - Discrete Transistor Modeling and analysis-Gate Level Logic simulation - Architecture level analysis - Data Correlation analysis in DSP systems - Monte Carlo Simulation – Random Logic signal Probability Power analysis techniques- Signal entropy.

UNIT 3 GATING AND ENCODING TECHNIQUES 9 Hrs.

Transistor and gate sizing-Network Restructuring and Reorganization- special latches and Flip flops-Low power digital cell library-Gate Reorganization-Signal Gating–Logic Encoding-State Machine encoding- Pre-Computation Logic.

UNIT 4 SPECIAL TECHNIQUES 9 Hrs.

Special Techniques- Power reduction in clock networks- CMOS floating node -Low power Bus -Delay Balancing- Low power techniques for SRAM- Architecture and system- Power and performance management - Switching activity reduction - Parallel Architecture – Flow graph transformation.

UNIT 5 ADVANCED TECHNIQUES 9 Hrs.

Advanced techniques- Adiabatic Computation- Pass transistor Logic synthesis -Asynchronous circuits – Software Design for Low power- Sources of software power dissipation- Software power optimization.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO 1 - Apply the basic concepts of Low power Designs by expressions
CO 2 - Analysis of Parameters such Power, Delay and Power Delay product
CO 3 - Evaluate the Gating and Encoding Techniques
CO 4 - Determine the features of Special Low Power Techniques
CO 5 - Analyze the Advanced Low Power Techniques for System design
CO 6 - Derive the Low Power design for VLSI applications

TEXT / REFERENCE BOOKS

1. GaryYeap, "Practical Low Power Digital VLSI design", Kluwer Academic Publishers, 2012.
2. Sharat Prasad and Koushik Roy, "Low power CMOS VLSI Circuit design", John Wiley Publications, 2014.
3. KiatSeng Yeo &Kaushik Roy, "Low voltage, Low power VLSI subsystems", McGraw Hill, 2009.
4. Meloberti Franco, "Analog design for CMOS VLSI systems", Kluwer Academic Publishers, 2013.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7014	MACHINE LEARNING ALGORITHMS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To focus on the construction and study of algorithms that can learn from data.
- To emphasize on the logical, knowledge-based approach.
- To introduce students to the basic concepts and techniques of Machine Learning.
- To develop skills of using recent machine learning software for solving practical problems.
- To gain experience of doing independent study and research.

UNIT 1 SUPERVISED LEARNING 9 Hrs.

Decision Trees: ID3, Classification and Regression Trees, Regression: Linear Regression, Multiple Linear Regression, Logistic Regression, Neural Networks: Introduction, Perceptron, Multilayer Perceptron, Support vector machines: Linear and Non-Linear, Kernel Functions, K-Nearest Neighbours.

UNIT 2 ENSEMBLE LEARNING 9 Hrs.

Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting: Adaboost and Stacking.

UNIT 3 UNSUPERVISED LEARNING 9 Hrs.

Introduction to clustering, Hierarchical: AGNES, DIANA, Partitional: K-means clustering, K-Mode Clustering, Expectation Maximization, Gaussian Mixture Models.

UNIT 4 PROBABILISTIC LEARNING 9 Hrs.

Bayesian Learning, Bayes Optimal Classifier, Naıve Bayes Classifier, Bayesian Belief Networks Learning Association Rules: Mining Frequent Patterns - basic concepts -Apriori algorithm, FP- Growth algorithm, Association based Decision Trees.

UNIT 5 MACHINE LEARNING IN PRACTICE 9 Hrs.

Design, Analysis and Evaluation of Machine Learning Experiments, Other Issues: Handling imbalanced data sets.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Choose appropriate learning techniques for classification, regression and clustering problems.
CO2 - Analyse the strengths and weaknesses of popular machine learning approaches.
CO3 - Analyse validity of machine learning approaches for different scenarios.
CO4 - Apply suitable model parameters for different machine learning techniques to achieve optimum
CO5 - performance.
CO6 - Develop ML algorithms for real world problems
CO7 - Evaluate the performance of probalistic learning and deterministic learning.

TEXT / REFERENCE BOOKS

1. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press,2014.
2. Tom Mitchell, “Machine Learning”, McGraw Hill, 2013.
3. ShaiShalev-Shwartz and Shai Ben-David, “Understanding Machine Learning: From Theory to Algorithms”, Cambridge University Press, 2014.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7015	MULTIDIMENSIONAL IMAGE PROCESSING	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To comprehend the concepts of digital image processing.
- To acquire knowledge about image preprocessing.
- To study the various 2D transforms and their applications to image processing.
- To study the various techniques involved in tomographic imaging and to understand the concept of 3D visualization.

UNIT 1 DIGITAL IMAGE FUNDAMENTALS 9 Hrs.

Elements of Visual Perception; Image Sensing and Acquisition; Image Sampling and Quantization; Basic Relationships between Pixels; Monochromatic Vision Models; Colour Vision Models; Colour Fundamentals; Colour Models; Conversion of Colour Models; Colour Transformations.

UNIT 2 IMAGE PREPROCESSING 9 Hrs.

Introduction; Point Processing – Image Negatives, Log transformations, Power Law Transformations, Piecewise-Linear Transformation Functions; Arithmetic/Logic Operations – Image Subtraction, Image Averaging; Histogram Processing – Histogram Equalization, Histogram Matching.

UNIT 3 2D TRANSFORMS 9 Hrs.

2D Orthogonal, 2D Unitary Transform, Introduction to 2D Discrete Fourier Transform , Discrete Cosine Transform, Discrete Sine Transform, Welsh- Hadamard Transform, Haar Transform, Slant Transform, Singular Value Decomposition, Karhunen- Loeve Transforms.

UNIT 4 TOMOGRAPHIC IMAGING 9 Hrs.

More than two dimensions, Volume imaging vs. sections, Basics of reconstruction, Algebraic reconstruction methods, Maximum entropy , Defects in reconstructed images, Beam hardening, Imaging geometries, Three-dimensional tomography, High-resolution tomography.

UNIT 5 3D VISUALIZATION 9 Hrs.

Sources of 3D data, Serial sections, Optical sectioning, Sequential removal, Stereo measurement, 3D data sets, Slicing the data set, Arbitrary section planes, Volumetric display ,Stereo viewing ,Special display hardware, Ray tracing Reflection , Surfaces, Multiply connected surfaces, Image processing in 3D, Measurements on 3D images.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 - Apply different image preprocessing techniques to convert the source image to required quality and format.
CO2 - Apply frequency domain transform techniques for image feature extraction.
CO3 - Apply two dimentional transform techniques for image analysis.
CO4 - Apply the concepts of tomographic imaging.
CO5 - Analyse the reliability of images acquired with tomography techniques.
CO6 - Apply the techniques of 3D images image processing for real world applications.

TEXT / REFERENCE BOOKS

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", 3rdEdition, Pearson Education Inc., Reprint, 2020.
2. John C. Russ, "The Image Processing Handbook", 6thEdition, CRC Press, Taylor & Francis Group, 2011.
3. Geoff Dougherty, “Digital Image Processing for Medical Applications”, Cambridge University Press, 2009.
4. William K. Pratt, "Digital Image Processing", 4thEdition, John Wiley & Sons Inc., 2007.
5. Anil K. Jain, "Fundamentals of Digital Image Processing", PHI Learning Private Limited, New Delhi, 2012.
6. Bernd Jähne, "Digital Image Processing", 5thRevised and Extended Edition, Springer, 2010.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7016	NANO ELECTRONICS AND SENSORS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To understand the basic concepts of Nano electronics and Nano sensors.
- To acquire the knowledge of advancements in MOSFET Devices.
- To learn the basic concepts of Carbon Nanotubes.
- To be familiar with the Applications of Nano sensors.

UNIT 1 FUNDAMENTALS OF NANOELECTRONICS 9 Hrs.

Spintronics – quantum cellular automata – quantum computing – DNA computer; performance of information processing systems;- basic binary operations, measure of performance processing capability of biological neurons–performance estimation for the human brain. Ultimate computation: - power dissipation limit – dissipation in reversible computation – the ultimate computer.

UNIT 2 SILICON MOSFETS AND QUANTUM TRANSPORT DEVICES 9 Hrs.

Silicon MOSFETS - Novel materials and alternate concepts:- fundamentals of MOSFET Devices- scaling rules –silicon- dioxide based gate dielectrics – metal gates – junctions & contacts–advanced MOSFET concepts-Quantum transport devices based on resonant tunneling:- Electron tunneling – resonant tunneling diodes–resonant tunneling devices; Single electron devices for logic applications:- Single electron devices – applications of single electron devices to logic circuits.

UNIT 3 CARBONNANOTUBES 9 Hrs.

Carbon Nanotube: Fullerenes–types of nanotubes–formation of nanotubes–assemblies–purification of carbon nanotubes – electronic properties – synthesis of carbon nanotubes – carbon nanotube interconnects–carbon nanotube FETs–nanotube for memory applications.

UNIT 4 INTRODUCTION TONANOSENSORS 9 Hrs.

Fundamentals of Nano sensors: Micro and nano-sensors, Fundamentals of sensors, biosensor, micro fluids, MEMS and NEMS, Packaging and characterization of sensors, Method of packaging at zero level, dye level and first level Sensors.

UNIT 5 NANO SENSORS ANDITS APPLICATIONS 9 Hrs.

Nanoparticles and Micro–organism- Biosensors- Bio receptors and their properties - Biochips- Integrated nano sensor networks for detection and response- DNA based biosensors and diagnostics- Natural nano composite systems; spider silk, bones, shells – Nano materials in bone substitutes and dentistry – Implants and Prosthesis – Tissue Engineering – Neuroscience -Neuro-electronic Interfaces–Nano sensors in Diagnosis–Drug delivery – Cancer therapy and Other therapeutic applications.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Analyze the limitations of MOSFETs at sub-micron dimensions.
CO2 - Analyze the characteristics of quantum devices.
CO3 - Develop carbon nanotubes for required specifications.
CO4 - Analyze the different packaging techniques deployed in nano electronic device.
CO5 - Develop nano bio sensors using nanoparticles.
CO6 - Evaluate the performance characteristics of nano sensors.

TEXT / REFERENCE BOOKS

1. Rainer Waser, "Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices", Wiley, VCH, 2013.
2. Meixner H., "Sensors: Micro &Nanosensors, Sensor Market trends", Wiley, VCH, 2005.
3. Neelina H. Malsch, “Biomedical Nanotechnology”, CRC Press, 2015.
4. Raguse, "Nanotechnology: Basic Science and Emerging Technologies", Chapman & Hall/CRC, 2012.
5. T.Pradeep, "NANO: The Essentials – Understanding Nanoscience and Nanotechnology", TMH, 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB7017	RF MEMS AND ITS APPLICATIONS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To learn MEMS fabrication techniques and various transducers.
- To understand the deposition techniques and different sensing devices.
- To explore Micro stereo lithography techniques in polymer MEMS.
- To discuss the characteristics of MEMS inductors and capacitors.
- To study and explore MEMS switches.

UNIT 1 MEMS AND FABRICATION TECHNIQUES 9 Hrs.

Micro fabrications for MEMS -Surface micromachining of silicon -Wafer bonding for MEMS-LIGA process-Electromechanical transducers-Piezoelectric transducers – Electrostrictive transducers – Magnetostrictive transducers –Electrostatic actuators- Electromagnetic transducers - Electrodynamics transducers- Electro thermal actuators.

UNIT 2 MICRO SENSING 9 Hrs.

Piezoresistive sensing - Capacitive sensing - Piezoelectric sensing - Resonant sensing - Surface acoustic wave sensors. Semiconductors : Electrical and chemical properties-Growth and deposition, Thin films for MEMS and their deposition techniques -Oxide film formation by thermal oxidation -Deposition of silicon dioxide and silicon nitride - Polysilicon film deposition -Ferroelectric thin films.

UNIT 3 MICRO STEREO LITHOGRAPHY 9 Hrs.

Materials for polymer MEMS: Classification of polymers -UV radiation curing –SU-8 for polymer MEMS. Micro stereo lithography for polymer MEMS –Scanning method - Two-photon Micro stereo lithography Surface micromachining of polymer MEMS -Projection method -Polymeric MEMS architecture with silicon, metal and ceramics.

UNIT 4 MEMS INDUCTORS AND CAPACITORS 9 Hrs.

MEMS inductors : Self-inductance and mutual inductance - Micro machined inductors - Effect of inductor layout - Reduction of stray capacitance of planar inductors-Approaches for improving the quality factor - Folded inductors - Modeling and design issues of planar inductors MEMS capacitors: MEMS gap-tuning capacitors - MEMS area-tuning capacitors - Dielectric tunable capacitors.

UNIT 5 SWITCHES AND APPLICATIONS 9 Hrs.

Switch parameters- Basics of switching - Mechanical switches-Electronic switches- - Mechanical RF switches - PIN diode RF switches- Electrostatic switching - Mercury contact switches -Magnetic switching- Electromagnetic switching - Thermal switching. Dynamics of the switch operation: -Switching time and dynamic response - Threshold voltage. MEMS switch design, modeling and evaluation. Introduction to Optical MEMS-Micro-machined antenna, Gyros and Bio-MEMS. MEMS software introduction: COMSOL.

Max 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 - Design MEMS based passive components such as resistors and capacitors.
CO2 - Analyze different thin film deposition techniques used in MEMS devices.
CO3 - Analyze the characteristics of different sensing devices.
CO4 - Demonstrate Micro stereolithography techniques in polymer MEMS.
CO5 - Analyze the properties of MEMS inductors and capacitors.
CO6 - Design MEMS switches and antennas.

TEXT / REFERENCE BOOKS

1. Vijay K.Varadan, Vinoy.K.J and Jose.K.A, “RF MEMS and Their Applications”, Reprint, JoWiley & Sons, 2009.
2. Gabriel M. Rebeiz, “RF MEMS: Theory, Design, and Technology”, Wiley, 2013.
3. Hector J. De Los Santos, “Introduction to Micro electromechanical Microwave Systems”,2nd Edition, Artech House, 2014.
4. Jacopo Iannacci, “Practical Guide to RF-MEMS”, John Wiley & Sons, 2017.
5. Nadim Maluf, Kirt Williams, "Introduction to Micro electromechanical Systems Engineering", Artech House, 2018.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice	**30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks	**70 Marks**

SECB7018	TIME FREQUENCY ANALYSIS	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To provide fundamental concepts of time-frequency analysis techniques converging to the subject of wavelet.
- Transforms.
- To understand multi-resolution analysis.
- To understand the Continuous and Discrete wavelets, and its applications.
- To understand different non stationary signal processing Techniques.

UNIT 1 INTRODUCTION TO TIME FREQUENCY ANALYSIS 9 Hrs.

Introduction to time frequency analysis- Basic definitions and concepts-Continuous time Fourier series and Fourier transform. -Discrete-Time Fourier Series Discrete-Time Fourier Transform Discrete Fourier Transform & Periodogram-Bandwidth Equation Instantaneous Frequency Analytic Signals Multicomponent Signals.

UNIT 2 BASES FOR TIME-FREQUENCY ANALYSIS STFT 9 Hrs.

Duration-Bandwidth Principle – Band width equation and Instantaneous frequency-Requirements of time frequency analysis techniques-STFT: Definition and Interpretations- Uncertainty Principle, Localization/Isolation in time and frequency- General Properties - Theorem and need for joint time-frequency Analysis- Concept of non-stationary signals- STFT: Application.

UNIT 3 WIGNER VILLE DISTRIBUTION 9 Hrs.

WVD: Definition and Interpretations - Properties of WVD- Discrete WVD- Pseudo and smoothed WVD-Cohen's class - Connections with Spectrogram -WVD: Application

UNIT 4 WAVELET TRANSFORM 9 Hrs.

CWT: Definition and Interpretations –Scale to frequency- Computational aspects of wavelets CWT -TFA and Filtering Perspective- Scalogram- Scaling Function –Wavelets- CWT: Application -DWT: Definition and Interpretations- Orthonormal Bases and Multi resolution Approximation- Wavelet filter and fast DWT algorithm-Wavelets for DWT-Applications of wavelets

UNIT 5 HILBER HUANG TRANSFORM 9 Hrs.

The Hilbert-Huang transform- The empirical mode decomposition method (the sifting process)- The Hilbert spectral analysis- Confidence limit- Statistical significance of IMFs- Mathematical problems related to the HHT- EMD Equivalent Filter Banks.- Denoising and detrending with EMD.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, students are able to

CO1 - Apply Fourier transform techniques to find spectrum of signals.
CO2 - Apply Short Time Fourier Transforms to extract frequency and time information in stationary signals.
CO3 - Apply the concept of Wigner Ville Distribution in analysis of real-time signals.
CO4 - Analyze the performance of CWT and DWT in signal analysis.
CO5 - Solve real world problems using the concept of HHT principle.
CO6 - Apply the concept of Time frequency Analysis for Non stationary signal processing

applications.

TEXT / REFERENCE BOOKS

1. S. Mallat, "A Wavelet Tour of Signal Processing", Academic Press, 3rdEdition, 2014.
2. L. Cohen, “Time-frequency analysis”, Prentice Hall, 2015.
3. B. Boashash, "Time-Frequency Signal Analysis and Processing: A Comprehensive Reference", Elsevier Science, 2018.
4. R.M. Rao and A.S. Bopardikar, "Wavelet Transforms: Introduction to Theory & Applications", Prentice Hall, 2017.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**

SECB5203	IoT COMMUNICATION	L	T	P	EL	Credits	Total Marks
		3	0	0	0	3	100

Pre requisite: Nil **Co requisite: Nil**

COURSE OBJECTIVES

- To Understand the Architectural Overview of IoT
- To Understand the IoT Reference Architecture and Real World Design Constraints
- To Understand the various IoT Protocols

UNIT 1 OVERVIEW OF IoT 9 Hrs.

IoT Architectural Overview– Standards considerations - IoT Technology Fundamentals - Devices and gateways - Business processes in IoT - Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management.

UNIT 2 REFERENCE ARCHITECTURE 9 Hrs.

IoT Reference Architecture- Functional View, Information View, Deployment and Operational View - Real-World Design Constraints - Data representation and visualization, Interaction and remote control.

UNIT 3 IoT DATA LINK LAYER & NETWORK LAYER PROTOCOLS 9 Hrs.

PHY/MAC Layer - 3GPP MTC, IEEE 802.11, IEEE 802.15 - Wireless HART, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer - IPv4, IPv6, 6LoWPAN, DHCP, ICMP, RPL, CORPL and CARP.

UNIT 4 TRANSPORT & SESSION LAYER PROTOCOLS 9 Hrs.

Transport Layer - TCP, MPTCP, UDP, DCCP, SCTP, TLS - Session Layer-HTTP, CoAP, XMPP, AMQP and MQTT.

UNIT 5 SERVICE LAYER PROTOCOLS & SECURITY 9 Hrs.

Service Layer – one M2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4, 6LoWPAN and RPL – Overview of Application Layer.

Max. 45 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO 1 - Choose appropriate hardware components for implementation of IoT applications.
CO 2 - Analyze various IoT Application layer Protocols.
CO 3 - Implement IoT-based systems for real-world problem
CO 4 - Demonstrate state of the art methodologies in data representation and analysis.
CO 5 - Apply appropriate IP based protocols and Authentication Protocols for IoT communication.
CO 6 - Analyze security issues in IoT Communication.

TEXT / REFERENCE BOOKS

1. David Hanes, Patrick Grossetete , Robert Barton , Jerome Henry, "IoT Fundamental Networking Technologies, Protocols, and Use Cases for the Internet of Things", First Edition, Pearson Education,2017.
2. Rolando Herrero,"Fundamentals of IoT Communication Technologies"Springer,2022.
3. Simone Cirani ,Gianluigi Ferrari, Marco Picone, Luca Veltri,"Internet of Things: Architectures,
Protocols and Standards",Wiley,2018.
4. Adrian McEwen and Hakim Cassimally, “Designing Internet of Things”, Wiley, 1st Edition, 2013.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs.**

PART A: 5 Questions of 6 marks each - No choice **30 Marks**
PART B: 2 Questions from each unit of internal choice, each carrying 14 marks **70 Marks**