

DR. A.P.J. ABDUL KALAM TECHNICAL
UNIVERSITY, UTTAR PRADESH, LUCKNOW



EVALUATION SCHEME & SYLLABUS

FOR

B. TECH. THIRD YEAR

Electronics Engineering (VLSI Design and Technology)

AS PER

AICTE MODEL CURRICULUM & NEP2020

[Effective from the Session: 2025-26]

ELECTRONICS AND COMMUNICATION ENGINEERING

B.Tech. V Semester

Electronics Engineering (VLSI Design and Technology)

S. No.	Subject Code	Subject	Type	Category	Periods			Sessional Component		Sessional (SW) (TS/PS)	End Semester Examination (ESE)	Total SW+ESE	Credit
					L	T	P	CT	TA				
1	BEC501	Integrated Circuits	T	PC	3	1	0	20	10	30	70	100	4
2	BEC502	Microprocessor & Microcontroller	T	PC	3	1	0	20	10	30	70	100	4
3	BEC503	Digital Signal Processing	T	PC	3	1	0	20	10	30	70	100	4
4	----	Department Elective-I	T	PC	3	0	0	20	10	30	70	100	3
5	----	Department Elective-II	T	PC	3	0	0	20	10	30	70	100	3
6	BEC551	Integrated Circuits Lab	P	PC	0	0	2		50	50	50	100	1
7	BEC552	Microprocessor & Microcontroller Lab	P	PC	0	0	2		50	50	50	100	1
8	BEC553	Digital Signal Processing Lab	P	PC	0	0	2		50	50	50	100	1
9	BEC-554	Mini Project/Internship **	P	PC	0	0	2		50	50		50	1
10	BNC501 / BNC502	Constitution of India, Law and Engineering / Indian Tradition, Culture and Society	T	VA	2	0	0	20	10	30	70	100	NC
		Total										850	22
**The Mini Project or Internship (4weeks) conducted during summer break after IV Semester and will be assessed during Vth Semester.													

Course Code

Course Title

Department Elective-I

BEC-051	IoT – Architecture, Communication, Technology & its applications
BEC-053	Intelligent Systems and Robotics
BEC-054	VLSI Technology
BVL-051	Digital Integrated Circuit Design

Department Elective-II

BVL-052	Low Power VLSI Design
BVL-053	Analog Integrated Circuit Design
BEC-056	Bio-Medical Signal Processing
BEC-058	CMOS Analog VLSI Design

ELECTRONICS AND COMMUNICATION ENGINEERING

B.Tech. VI Semester

Electronics Engineering (VLSI Design and Technology)

S. No.	Subject Code	Subject	Type	Category	Periods			Sessional Component		Sessional (SW) (TS/PS)	End Semester Examination (ESE)	Total SW+ESE	Credit
					L	T	P	CT	TA				
1	BVL601	Digital Design with FPGA	T	PC	3	1	0	20	10	30	70	100	4
2	BVL602	Physical Design for VLSI Circuits	T	PC	3	1	0	20	10	30	70	100	4
3	BVL603	VLSI Circuit Testing and Testability	T	PC	3	1	0	20	10	30	70	100	4
4	----	Department Elective–III	T	PC	3	0	0	20	10	30	70	100	3
5		Open Elective-I	T	PC	3	0	0	20	10	30	70	100	3
6	BVL651	Digital Design with FPGA Lab	P	PC	0	0	2		50	50	50	100	1
7	BVL652	Physical Design for VLSI Circuits Lab	P	PC	0	0	2		50	50	50	100	1
8	BEC653	Elective Lab	P	PC	0	0	2		50	50	50	100	1
9	BNC601 / BNC602	Constitution of India, Law and Engineering / Indian Tradition, Culture and Society	T	VA	2	0	0	20	10	30	70	100	NC
		Total										800	21

Course Code

Course Title

Department Elective-III

BVL-061	Fundamentals of Nanoelectronics
BVL-062	Drone Technology
BEC-063	CMOS Digital Design Techniques
BEC-064	Microcontrollers and Sensors for IoT Applications

Course Code

Elective Lab

BEC-653A	CMOS Digital Design Lab
BEC-653B	CAD (Computer-Aided Design) for Electronics Lab
BEC-653C	Microcontrollers and Sensors for IoT Applications Lab

**B.Tech 3rd Year
V Semester
Syllabus**

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC -501	INTEGRATED CIRCUITS	3L:1T:0P	4 Credits
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Unit	Topics	Lectures
I	The 741 IC Op-Amp: General operational amplifier stages (bias circuit, the input stage, the second stage, the output stage, short circuit protection circuitry), device parameters, DC and AC analysis of input stage, second stage and output stage, gain, frequency response of 741, a simplified model, slew rate, relationship between f_t and slew rate.	8
II	Linear Applications of IC Op-Amps: Op-Amp based V-I and I-V converters, instrumentation amplifier, generalized impedance converter, simulation of inductors. Active Analog filters: Sallen Key second order filter, Designing of second order lowpass and high pass Butterworth filter, Introduction to band pass and band stop filter, all pass active filters, KHN Filters. Introduction to design of higher order filters.	8
III	Frequency Compensation & Nonlinearity: Frequency Compensation, Compensation of two stage Op-Amps, Slewing in two stage Op-Amp. Nonlinearity of Differential Circuits, Effect of Negative feedback on Nonlinearity. Non-Linear Applications of IC Op-Amps: Basic Log–Anti Log amplifiers using diode and BJT, temperature compensated Log-Anti Log amplifiers using diode, peak detectors, sample and hold circuits. Op-amp as a comparator and zero crossing detector, astable multivibrator & monostable multivibrator. Generation of triangular waveforms, analog multipliers and their applications.	4 8
IV	Digital Integrated Circuit Design: An overview, CMOS logic gate circuit's basic structure, CMOS realization of inverters, AND, OR, NAND and NOR gates. Latches and Flip flops: the latch, CMOS implementation of SR flip-flops, a simpler CMOS implementation of the clocked SR flip-flop, CMOS implementation of J-K flip- flops, D flip-flop circuits.	6
V	Integrated Circuit Timer: Timer IC 555 pin and functional block diagram, Monostable and Astable multivibrator using the 555 IC. Voltage Controlled Oscillator: VCO IC 566 pin and functional block diagram and applications. Phase Locked Loop (PLL): Basic principle of PLL, block diagram, working, Ex-OR gates and multipliers as phase detectors, applications of PLL.	6

Text Book:

1. Microelectronic Circuits, Sedra and Smith, 7th Edition, Oxford, 2017.
2. Behzad Razavi: Design of Analog CMOS Integrated Circuits, TMH

Reference Books:

1. Gayakwad: Op-Amps and Linear Integrated Circuits, 4th Edition Prentice Hall of India, 2002.
2. Franco, Analog Circuit Design: Discrete & Integrated, TMH, 1st Edition.
3. Salivahnan, Electronics Devices and Circuits, TMH, 3rd Edition, 2015
4. Millman and Halkias: Integrated Electronics, TMH, 2nd Edition, 2010

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Explain complete internal analysis of Op-Amp 741-IC.
2. Examine and design Op-Amp based circuits and basic components of ICs such as various types of filters.
3. Implement the concept of Op-Amp to design Op-Amp based non-linear applications and wave-shaping circuits.
4. Analyse and design basic digital IC circuits using CMOS technology.
5. Describe the functioning of application specific ICs such as 555 timer, VCO IC 566 and PLL.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-502	MICROPROCESSOR & MICROCONTROLLER	3L:1T:0P	4 Credits
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Unit	Topics	Lectures
I	Introduction to Microprocessor: Microprocessor architecture and its operations, Memory, Input & output devices, The 8085 MPU- architecture, Pins and signals, Timing Diagrams, Logic devices for interfacing, Memory interfacing, Interfacing output displays, Interfacing input devices, Memory mapped I/O.	8
II	Basic Programming concepts: Flow chart symbols, Data Transfer operations, Arithmetic operations, Logic Operations, Branch operation, writing assembly language programs, Programming techniques: looping, counting and indexing. Additional data transfer and 16-bit arithmetic instruction, Logic operation: rotate, compare, counter and time delays, 8085 Interrupts.	8
III	16-bit Microprocessors (8086): Architecture, Pin Description, Physical address, segmentation, memory organization, Addressing modes. Peripheral Devices: 8237 DMA Controller, 8255 programmable peripheral interface, 8253/8254 programmable timer/counter, 8259 programmable interrupt controller, 8251 USART and RS232C.	8
IV	8051 Microcontroller Basics: Inside the Computer, Microcontrollers and Embedded Processors, Block Diagram of 8051, PSW and Flag Bits, 8051 Register Banks and Stack, Internal Memory Organization of 8051, IO Port Usage in 8051, Types of Special Function Registers and their uses in 8051, Pins Of 8051. Memory Address Decoding, 8031/51 Interfacing with External ROM And RAM. 8051 Addressing Modes.	8
V	Assembly programming and instruction of 8051: Introduction to 8051 assembly programming, Assembling and running an 8051 program, Data types and Assembler directives, Arithmetic, logic instructions and programs, Jump, loop and call instructions, IO port programming. Programming 8051 Timers. Serial Port Programming, Interrupts Programming, Interfacing: LCD & Keyboard Interfacing, ADC, DAC & Sensor Interfacing, External Memory Interface, Stepper Motor and Waveform generation.	8

Text Books:

1. Ramesh Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 6th Edition, Penram International Publication (India) Pvt. Ltd., 2013
2. D. V. Hall: Microprocessors Interfacing, TMH 3rd Edition,
3. Mazidi Ali Muhammad, Mazidi Gillispie Janice, and McKinlay Rolin D., "The 8051 Microcontroller and Embedded Systems using Assembly and C", Pearson, 2nd Edition, 2006

Reference Books:

1. Kenneth L. Short, "Microprocessors and programmed Logic", 2nd Ed, Pearson Education Inc., 2003
2. Barry B. Brey, "The Intel Microprocessors, 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium-Pro Processor, Pentium-II, Pentium-III, Pentium-IV, Architecture, Programming & Interfacing", Eighth Edition, Pearson Prentice Hall, 2009.
3. Shah Satish, "8051 Microcontrollers MCS 51 Family and its variants", Oxford, 2010

Course Outcomes: At the end of this course students will demonstrate the ability to

1. Demonstrate the basic architecture of 8085.
2. Illustrate the programming model of microprocessors & write program using 8085 microprocessors.
3. Demonstrate the basics of 8086 Microprocessor and interface different external Peripheral Devices like timer, USART etc. with Microprocessor (8085/8086).
4. Compare Microprocessors & Microcontrollers, and comprehend the architecture of 8051 microcontroller.
5. Illustrate the programming model of 8051 and implement them to design projects on real time problems.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-503	DIGITAL SIGNAL PROCESSING	3L:1T:0P	4 Credits
Unit	Topics	Lectures	
I	Introduction to Digital Signal Processing: Basic elements of digital signal processing, advantages and disadvantages of digital signal processing, Technology used for DSP. Realization of Digital Systems: Introduction- basic building blocks to represent a digital system, recursive and non-recursive systems, basic structures of a digital system: Canonic and Non-Canonic structures. IIR Filter Realization: Direct form, cascade realization, parallel form realization, Ladder structures- continued fraction expansion of $H(z)$, example of continued fraction, realization of a ladder structure, design examples. FIR Filter Realization: Direct, Cascade, FIR Linear Phase Realization and design examples.	8	
II	Infinite Impulse Response Digital (IIR) Filter Design: Introduction to Filters, Impulse Invariant Transformation, Bi-Linear Transformation, All- Pole Analog Filters: Butterworth and Chebyshev, Design of Digital Butterworth and Chebyshev Filters, Frequency Transformations.	8	
III	Finite Impulse Response Filter (FIR) Design: Windowing and the Rectangular Window, Gibb's phenomenon, Other Commonly Used Windows (Hamming, Hanning, Bartlett, Blackmann, Kaiser), Examples of Filter Designs Using Windows. Finite Word length effects in digital filters: Coefficient quantization error, Quantization noise – truncation and rounding, Limit cycle oscillations-dead band effects.	8	
IV	DFT & FFT: Definitions, Properties of the DFT, Circular Convolution, Linear Convolution using Circular Convolution, Decimation in Time (DIT) Algorithm, Decimation in Frequency (DIF) Algorithm.	8	
V	Multirate Digital Signal Processing (MDSP): Introduction, Decimation, Interpolation, Sampling rate conversion: Single and Multistage, applications of MDSP- Sub-band Coding of Speech signals, Quadrature mirror filters, Advantages of MDSP.	8	

Text Books:

1. John G Prokias, Dimitris G Manolakis, Digital Signal Processing. Pearson, 4th Edition, 2007
2. Johnny R. Johnson, Digital Signal Processing, PHI Learning Pvt Ltd., 2009.
3. S. Salivahanan, A. Vallavaraj, Digital Signal Processing, TMH, 4th Edition 2017.

Reference Books:

1. Oppenheim & Schaffer, Digital Signal Processing. Pearson Education 2015
2. S.K. Mitra, 'Digital Signal Processing–A Computer Based Approach, TMH, 4th Edition.
3. Digital Signal Processing-a computer-based approach by S. K. Mitra, McGraw Hill.
4. Digital Signal Processing by A. Anand kumar, PHI learning PVT. Ltd.
5. Digital Signal Processing - a modern introduction by Ashok Ambardar, Cengage learning.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Design and describe different types of realizations of digital systems (IIR and FIR) and their utilities.
2. Select design parameters of analog IIR digital filters (Butterworth and Chebyshev filters) and implement various methods such as impulse invariant transformation and bilinear transformation of conversion of analog to digital filters.
3. Design FIR filter using various types of window functions.
4. Define the principle of discrete Fourier transform & its various properties and concept of circular and linear convolution. Also, students will be able to define and implement FFT i.e. a fast computation method of DFT.
5. Define the concept of decimation and interpolation. Also, they will be able to implement it in various practical applications.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-051	IoT – ARCHITECTURE, COMMUNICATION, TECHNOLOGY & ITS APPLICATIONS	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	Introduction to IoTs: Understanding IoT's fundamentals and Significance, Definition and Characteristics of IoT, Elements of an IoT ecosystem, Sensors, Actuators, Data Management, Overview of Governance, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization.	8
II	IoT Architecture: Software defined networks, Network function virtualization, Difference between SDN and NFV for IoT, IoT Open-source architecture (OIC) - OIC Architecture & Design principles, IoT Devices and deployment models - IoTivity: An Open Source IoT stack, Overview - IoTivity stack architecture, Resource model and Abstraction.	8
III	IoT Communication Protocols: Protocol Standardization for IoT, M2M and WSN Protocols, Issues with IoT Standardization, SCADA and RFID Protocols, Unified Data Standards – Protocols, Short, Medium and Long-Range Wireless Connectivity, Wired Connectivity, IOT Networking – Networking Architecture, Networking Protocols, IoT Devices Application-Level Protocols.	8
IV	Interfacing With Physical Devices: Introduction to Arduino and Raspberry Pi- Installation, Interfaces (Serial, SPI, I2C), Introduction to the Arduino environment, the Arduino board, the Arduino IDE, and the Arduino compatible shields together with their libraries. Interfacing Hardware with the Raspberry Pi, Raspberry Pi Remote Access, Communication with devices through the pins of the Raspberry Pi, Range of sensors interfacing such as voltage sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors and others.	8
V	IoT Applications: Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT for Oil and Gas Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.	8

Text Books:

1. Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, November 2013, John Wiley and Sons.
2. Zach Shelby, Carsten Bormann, “6LoWPAN: The Wireless Embedded Internet”, John Wiley and Sons.
3. Simon Monk, “Programming the Raspberry Pi: Getting Started with Python”, January 2012, McGraw Hill Professional.

Reference Books:

1. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, Apress Publications, 2013.
2. Dr. Ovidiu Vermesan, Dr. Peter Friess “Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems”, River Publishers.
3. Donald Norris, “The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and Beagle Bone Black”, McGraw Hill, 2015.
4. Eben Upton and Gareth Halfacree, “Raspberry Pi User Guide”, August 2016, 4th edition, John Wiley & Sons

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Understand the fundamentals of IoT's.
2. Understand the vision of IoT's from a global context.
3. Building State of the art architecture in IoT.
4. Interface mechanism of different Sensors, Gateways, and other external Devices with microcontroller board
5. Application of IoT in Industrial and Commercial Building Automation.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC -053	INTELLIGENT SYSTEMS AND ROBOTICS	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	System Modeling: Biological and Cognitive Paradigms for Robot Design, Declarative-Procedural-Reflexive Hierarchy for Decision-Making and Control, Articulated Robots, Joint-Link (Denavit - Hartenberg) Transformations, Mobile Ground Robots, Uninhabited Air Vehicles, Intelligent Agents.	8
II	Control System Principles: Open- and Closed-Loop Control, Time-domain and Frequency-domain Analysis, Optimality and Constraints, Stability and Performance, Adaptation, Control Actuation, Closed-form and Probabilistic Path Planning.	8
III	Computing, Measurement, State, and Parameter Estimation: Sensors and Sensing, Formal and Fuzzy Logic, Turing Machines and Concepts of Machine Learning, Analog and Digital Systems, Probability and Error Models, Sensor-Based Estimation, Extended Kalman and Particle Filters, Simultaneous Location and Mapping (SAM).	8
IV	Decision-Making and Machine Learning: Decision Trees, Bayesian Belief Networks, Classification of Data Sets, Task Planning for Individual and Multiple Agents.	8
V	Numerical Methods for Evaluation and Search: Monte Carlo Simulation, Genetic Algorithms, Simulated Annealing, Particle Swarm Optimization, Production Systems, Forward Chaining, Backward Chaining, Training and Implementation of Network Architectures, Feed-Forward Networks, Associative Networks, Cerebellar Model Articulation Controller, Deep-Learning Algorithms.	8

Text Books:

1. H. Asada and J.-J. Slotine, Robot Analysis and Control, J. Wiley & Sons, 1986.
2. C. Asfahl, Robots and Manufacturing Automation, J. Wiley & Sons, 1992.
3. D. Auslander, J. Ridgely, and J. Ringgenberg, Control Software for Mechanical Systems, Prentice-Hall, 2002.
4. G. Bekey, Autonomous Robots, MIT Press, 2005.
5. Albus, J. I., and Meystel, A. M., Engineering of Mind, J. Wiley & Sons, 2001.
6. P. Antsaklis and K. Passino, An Introduction to Intelligent and Autonomous Control, Kluwer, 1993.

Reference Books:

1. J. Craig, Introduction to Robotics Mechanics and Control, Pearson, 2018
2. R. Dorf, Robotics and Automated Manufacturing, Reston (Prentice-Hall), 1983
3. D. Goldberg, Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley, 1989.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Apply the concept of Open- and Closed-Loop Control.
2. Apply Fourier to understand Time-domain and Frequency-domain Analysis
3. Apply the fundamental concepts of Closed-form and Probabilistic Path Planning
4. Analyze Formal and Fuzzy Logic.
5. Analyze Simultaneous Location and Mapping (SAM).

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC 054	VLSI TECHNOLOGY	3L:0T:0P	3 Credits
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Unit	Topic	Lectures
I	Introduction To IC Technology: SSI, MSI, LSI, VLSI Integrated Circuits. Crystal Growth and Wafer Preparation: Electronic Grade Silicon, Czochralski Crystal Growth, Silicon Shaping, Processing Considerations. Wafer Cleaning Technology - Basic Concepts, Wet cleaning, Dry cleaning	8
II	Epitaxy: Vapor-Phase Epitaxy, Molecular Beam Epitaxy, Silicon on Insulators, Epitaxial Evaluation. Oxidation: Growth Kinetics, Thin Oxides, Oxidation Techniques and Systems, Oxides Properties.	8
III	Lithography: Optical Lithography, Electron beam lithography, Photo masks, Wet Chemical Etching. Dielectric and Polysilicon Film Deposition: Deposition Processes of Polysilicon, Silicon Dioxide, Silicon Nitride.	8
IV	Diffusion: Models of diffusion in solids, Fick's 1-Dimensional diffusion equation, Diffusion of Impurities in Silicon and Silicon Dioxide, Diffusion Equations, Diffusion Profiles, Diffusion Furnace, Solid, Liquid and Gaseous Sources, Ion-Implantation: Ion-Implantation Technique, Range Theory, Implantation Equipment.	8
V	Metallization: Metallization Application, Metallization Choices, Physical Vapor Deposition, Vacuum Deposition, Sputtering Apparatus. Packaging of VLSI devices: Package Types, Packaging Design Consideration, VLSI Assembly Technologies, Package Fabrication Technologies, CMOS fabrication steps.	8

Text Book:

1. S. M. Sze, "VLSI Technology", McGraw Hill Publication, 2nd Edition 2017
2. S.K. Ghandhi, "VLSI Fabrication Principles", Willy-India Pvt. Ltd, 2008

Reference Books:

1. J. D. Plummer, M. D. Deal and Peter B. Griffin, "Silicon VLSI Technology: Fundamentals, Practice and Modeling", Pearson Education Publication, 2009
2. Stephen A. Campbell, "Fabrication Engineering at the Micro and Nano scale", Oxford University Press, 2013

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Interpret the basics of crystal growth, wafer preparation and wafer cleaning.
2. Evaluate the process of Epitaxy and oxidation.
3. Differentiate the lithography, etching and deposition process.
4. Analyze the process of diffusion and ion implantation
5. Express the basic process involved in metallization and packaging.

ELECTRONICS AND COMMUNICATION ENGINEERING

BVL 051	DIGITAL INTEGRATED CIRCUIT DESIGN	3L:0T:0P	3 Credits
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Unit	Topic	Lectures
I	Fundamentals of Synthesis and Digital Design Flow Introduction to ASIC and FPGA Design Flow: RTL-to-GDSII flow, Role of synthesis in digital design Basics of Hardware Description Languages (HDLs): Verilog vs. VHDL for synthesis, RTL coding styles for efficient synthesis.	8
II	Introduction to Logic Synthesis: Definition and purpose of synthesis, Technology-independent vs. technology-dependent optimizations, Synthesis tools overview (Cadence Genus)	8
III	Static Timing Analysis (STA) Basics: Fundamentals of Timing Analysis: Setup time, hold time, propagation delay, Clock period, clock skew, and clock jitter.	8
IV	Timing Paths: Types of Timing Paths in a Digital Circuit: Data path, clock path, asynchronous paths, Critical path analysis. Timing Models and STA Basics: Transition time, cell delay, net delay, Wire-load models, parasitic extraction	8
V	Introduction to STA, Introduction to Functional Verification, Functional Verification using Conformal LEC Tool, Pre & Post Synthesis Analysis. Introduction to Power Analysis.	8

Text Books:

1. Digital Integrated Circuit Design: From VLSI Architectures to CMOS Fabrication, Hubert Kaeslin, Cambridge University Press, 2008.
2. Verilog HDL: A Guide to Digital Design and Synthesis, Samir Palnitkar, Pearson, 2nd Edition, 2003.

Reference Books:

1. Introduction to VLSI Design Flow, Sneh Saurabh, Cambridge University Press 2023.
2. The Designer's Guide to VHDL, Peter J. Ashenden, Morgan Kaufmann, 3rd Edition, 2008.

COURSE OUTCOME: After completion of the course student will be able to:

1. Explain the digital design flow, including RTL-to-GDSII, and the importance of synthesis in ASIC/FPGA design.
2. Write efficient RTL code in Verilog/VHDL and apply synthesis optimizations.
3. Perform Static Timing Analysis (STA) by understanding timing parameters and constraints.
4. Apply functional verification methods and use tools such as Conformal LEC for equivalence checking.

ELECTRONICS AND COMMUNICATION ENGINEERING

BVL -052	LOW POWER VLSI DESIGN	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	POWER DISSIPATION IN CMOS: Sources of power dissipation – Physics of power dissipation in MOSFET devices: The MIS structure, long channel MOSFET, Submicron MOSFET, gate induced drain leakage– Power dissipation in CMOS: short circuit dissipation, dynamic dissipation, load capacitance– Low power VLSI design: Limits – principles of low power design.	8
II	DESIGN OF LOW POWER CIRCUITS: Transistor and Gate Sizing: Sizing an Inverter Chain, Transistor and Gate Sizing for Dynamic Power Reduction, Transistor Sizing for Leakage Power Reduction - Network Restructuring and Reorganization: Transistor Network Restructuring, Transistor Network Partitioning and Reorganization - Special Latches and Flip-flops: Self-gating Flip-flop, Varieties of Boolean Functions, Adjustable Device Threshold Voltage.	8
III	SYNTHESIS FOR LOW POWER: Behavioral Level Transforms, Logic Level Optimization for Low power, Circuit Level Optimization	8
IV	LOW POWER STATIC RAM ARCHITECTURES: Organization of a static RAM, MOS Static RAM Memory cell, Banked organization of SRAMs, Reducing voltage swings on bit lines, Reducing power in write driver circuits, Reducing power in sense amplifier circuits, method for achieving low core voltages from a single supply.	8
V	DESIGN AND TEST OF LOW VOLTAGE CMOS CIRCUITS: Circuit Design style, Leakage current in deep submicrometer transistors, Deep submicrometer device design issues, Low voltage circuit design techniques, Designing deep submicrometer ICs with elevated intrinsic leakage, multiple supply voltages.	8

Text Book:

1. K. Roy and S. C. Prasad, Low Power CMOS VLSI Circuit Design, John Wiley and Sons, 3 rd Edition, 2009.
2. Jan Rabaey, Low Power Design Essentials, Springer Publications, 1 st Edition, 2009.

Reference Books:

1. Chandrakasan and R. Brodersen, Low-Power CMOS Design, IEEE Press, 1 st Edition, 1995.
2. Chandrakasan, Bowhill, and Fox, Design of High-Performance Microprocessors, IEEE Press, 1st Edition, 2000.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Able to understand basics of Power Dissipation.
2. Able to learn low power circuit design
3. Able to learn circuit level optimization.
4. Able to acquire knowledge on SRAM.
5. Able to design low power circuit at submicron level.

ELECTRONICS AND COMMUNICATION ENGINEERING

BVL -053	ANALOG INTEGRATED CIRCUIT DESIGN	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	Introduction to System Design and Verification Fundamentals of System Design: Introduction to system-on-chip (SoC) and embedded system design, Hardware/software co-design principles, Model-based design and virtual prototyping. Verification Challenges and Methodologies: Importance of verification in digital system design, Directed vs. constrained-random verification, Coverage-driven verification (functional, code, FSM, toggle coverage)	8
II	Introduction to Full Custom IC Design Flow, Cadence Solutions for Custom IC Design, MOSFET Characterization, Schematic Capture using Virtuoso Schematic Editor, Symbol Creation. Testbench Creation using Virtuoso Schematic Editor, Functional Simulation using Spectre, Delay Estimation, Power estimation, Monte-Carlo.	8
III	Introduction to IC Physical Design Flow, Cadence EDA tools for PD Flow., Functional Simulation using Incisive tool, Coverage analysis using IMC tool, Introduction to TCL Scripting, RTL Synthesis using Genus Synthesis Solution.	8
IV	Layout Design using Virtuoso Layout Editor, Physical Verification which includes DRC & LVS, Parasitic Extraction using Quantus, Post Layout Simulation, Generation of GDSII.	8
V	Physical Implementation using Innovus that includes- Floor Planning, Power Planning, Placement, CTS, Routing, Timing Analysis using Power Analysis, Parasitic Extraction, Generation of GDSII	8

Text Books:

1. System Verilog for Verification: A Guide to Learning the Testbench Language Features, Chris Spear & Greg Tumbush, Springer, 2nd Edition, 2012.
2. N.A.Sherwani , “Algorithms for VLSI Physical Design Automation”, (3/e), Kluwer,1999.
3. CMOS: Circuit Design, Layout, and Simulation, R. Jacob Baker, Wiley-IEEE, 3rd Edition, 2010

Reference Books:

1. UVM Primer: A Step-by-Step Introduction to the Universal Verification Methodology, Mark Glasser, Boston Light Press, 2014.
2. The Complete Formal Verification Guide, Sasan Iman & Sunita Joshi – Synopsys Press, 2004.
3. Andrew B. Kahng, Jens Lienig, Igor L. Markov, JinHu, VLSI Physical Design: From Graph Partitioning to Timing Closure, Springer, 2011.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Understand system-level design methodologies and their role in IC design.
2. Develop and simulate custom IC schematics using Cadence Virtuoso.
3. Perform functional verification and analyze coverage using Incisive and IMC tools.
4. Implement IC physical design flow, including synthesis, layout design, and parasitic extraction.
5. Implement physical implementation steps, including floor planning, power planning, placement, routing, and GDSII generation.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-056	BIO-MEDICAL SIGNAL PROCESSING	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	Introduction to Bio-Medical Signals: Classification, Acquisition and Difficulties during Acquisition. Basics of Electrocardiography, Electroencephalography, Electromyography & electro-retinography Role of Computers in the Analysis, Processing, Monitoring & Control, and image reconstruction in bio-medical field.	8
II	ECG: Measurement of Amplitude and Time Intervals, QRS Detection (Different Methods), ST Segment Analysis, Removal of Baseline Wander and Power line Interferences, Arrhythmia Analysis, Portable Arrhythmia Monitors.	8
III	Data Reduction: Turning Point algorithm, AZTEC Algorithm, Fan Algorithm, Huffman and Modified Huffman Coding, Run Length Coding.	8
IV	EEG: Neurological Signal Processing, EEG characteristic, linear prediction theory, Sleep EEG, Dynamics of Sleep/Wake transition. Study of pattern of brain waves, Epilepsy-Transition, detection and Estimation. EEG Analysis By Spectral Estimation: The Bt Method, Periodogram, Maximum Entropy Method & AR Method, Moving Average Method. The ARMA Methods, Maximum Likelihood Method.	8
V	EP Estimation: by Signal Averaging, Adaptive Filtering: - General Structures of Adaptive filters, LMS Adaptive Filter, Adaptive Noise Cancelling, Wavelet Detection: - Introduction, Detection by Structural features, Matched Filtering, Adaptive Wavelet Detection, Detection of Overlapping Wavelets.	8

Text Books:

1. Willis J. Tomkin, "Biomedical Digital Signal Processing", PHI.
2. D. C. Reddy, "Biomedical Signal Processing", McGraw Hill
3. Crommwell, Weibel and Pfeifer, "Biomedical Instrumentation and Measurement", PHI

Reference Books:

1. Arnon Cohen, "Biomedical Signal Processing (volume-I)", Licrc Press.
2. Rangaraj M. Rangayyan, "Biomedical Signal Analysis A Case Study Approach", John Wiley and Sons Inc.
3. John G. Webster, "Medical instrumentation Application and Design", John Wiley & Sons Inc.

Course Outcomes: At the end of this course students will able to

1. To understand the basics of biomedical signals.
2. Analyses of ECG signals.
3. To Analyze the data reduction techniques.
4. Analyses of EEG signals.
5. To understand the advance techniques of signal processing

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-058	CMOS ANALOG VLSI DESIGN	3L:0T:0P	3 CREDITS
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Unit	Topics	Lectures
I	Introduction to MOS: MOS device models and short channel effects MOSFET level 1 and level 2 models, threshold voltage model, MOSFET basics, Single stage amplifiers, Basic concept, Common source stage: with resistive load, with diode connected load, with current-source load, with triode load, with source degeneration Source follower (common-drain) and common gate with various loads.	8
II	Scheme and Implementation: basic current mirrors, cascode current mirrors and active current mirrors with large and small signal analysis, CMOS amplifier Frequency response: Miller effect, common source (CS), common gate (CG), common drain (CD) stages.	8
III	Noise: types of noise, significance of flicker and thermal. Analysis and representation of noise in single stage amplifiers: CG, CS, CD (source follower) and cascode stage and noise in differential pairs. Feedback: Feedback topologies (voltage-voltage, current-voltage, voltage-current, current-voltage) and the noise and the loading effect analysis.	8
IV	Design of the CMOS Operational Amplifiers: One-stage opamps and two stage opamps, Gain boosting techniques, folded cascode, telescopic amplifier and common mode feedback (CMFB) amplifier, Design of high speed and high gain amplifiers.	8
V	Stability and Frequency Compensation: Specification analysis, multi-pole system, three stage opamp, phase margin Frequency compensation, pole-zero doublet analysis, Analog layout techniques, Design rule check (DRC), layout versus schematic (LVS) and antenna effects.	8

Text Book:

3. Design of Analog CMOS Integrated Circuits” by Behzad Razavi, McGraw Hill Education.
4. “CMOS Analog Circuit Design” by Phillip Allen and Douglas R. Holberg, OUP USA; Third Edition.

Reference Books:

1. “Operation and Modeling of the MOS Transistor” by Yannis Tsividis, Oxford University Press; 2nd edition.
2. “Microelectronic Circuits-Theory & Applications” by A.S. Sedra and K.C. Smith, Adapted by A.N. Chandorkar, 6th Edition, Oxford, 2013.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Analyze the basics concepts of MOSFET and modelling of single stage amplifiers.
2. Illustrate the various current mirror structures and layout techniques.
3. Analyze the different types of noise in MOSFET based amplifiers.
4. Illustrate designing of CMOS based operational amplifiers.
5. Analyze the stability analysis in MOSFET based amplifiers and oscillators.

BEC-551	INTEGRATED CIRCUITS LAB	0L:0T:2P	1 Credit
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SUGGESTIVE LIST OF EXPERIMENTS:

1. Design the following using Op-Amp: *(Through Virtual Lab Link 1)*
 - a) A unity gain amplifier.
 - b) An inverting amplifier with a gain of “A”.
 - c) A non-inverting amplifier with a gain of “A”
2. Study and design Log and antilog amplifiers.
3. Voltage to current and current to voltage convertors.
4. Second order filters using operational amplifier for: *(Through Virtual Lab Link 1)*
 - a) Low pass filter of cutoff frequency 1 KHz.
 - b) High pass filter of frequency 12 KHz.
5. Realization of Band pass filter with unit gain of pass band from 1 KHz to 12 KHz.
6. Study and design voltage comparator and zero crossing detectors.
7. Function generator using operational amplifier (sine, triangular & square wave).
8. Design and construct astable multivibrator using IC 555 and
 - a) Plot the output waveform
 - b) Measure the frequency of oscillation *(Through Virtual Lab Link 2)*
9. Design and construct a monostable multivibrator using IC 555 and
 - a) Plot the output waveform
 - b) Measure the time delay *(Through Virtual Lab Link 2)*
10. Implement Schmitt Trigger Circuit using IC 555. *(Through Virtual Lab Link 2)*
11. Implement voltage-controlled oscillator using IC566 and plot the waveform. *(Through Virtual Lab Link 2)*
12. Study and design ramp generator using IC 566.

Virtual Lab Link:

1. <http://vlabs.iitkgp.ernet.in/be/exp17/index.html>
2. <http://hecoep.vlabs.ac.in/Experiment8/Theory.html?domain=ElectronicsandCommunications&lab=Hybrid%20Electronics%20Lab>

Available on: <http://www.vlab.co.in/broad-area-electronics-and-communications>

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Design different non-linear applications of operational amplifiers such as log, antilog amplifiers and voltage comparators.
2. Explain and design different linear applications of operational amplifiers such as filters.
3. Demonstrate the function of waveforms generator using op-Amp.
4. Construct multivibrator and oscillator circuits using IC555 and IC566 and perform measurements of frequency and time.
5. Design and practically demonstrate the applications based on IC555 and IC566.

BEC-552	MICROPROCESSOR & MICROCONTROLLER LAB	0L:0T:2P	1 Credit
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SUGGESTIVE LIST OF EXPERIMENTS:

1. Write a program using 8085 Microprocessor for Decimal, Hexadecimal addition and subtraction of two Numbers. **(Through Virtual Lab Link).**
2. Write a program using 8085 Microprocessor for addition and subtraction of two BCD numbers.
3. **(Through Virtual Lab Link).**
4. To perform multiplication and division of two 8 bit numbers using 8085. **(Through Virtual Lab Link).**
5. To find the largest and smallest number in an array of data using 8085 instruction set.
6. To write a program using 8086 to arrange an array of data in ascending and descending order.
7. **(Through Virtual Lab Link).**
8. To convert given Hexadecimal number into its equivalent ASCII number and vice versa using 8086 instruction set.
9. To convert given Hexadecimal number into its equivalent BCD number and vice versa using 8086 instruction set.
10. To interface 8253 programmable interval timer and verify the operation of 8253 in six different modes.
11. To write a program to initiate 8251 and to check the transmission and reception of character.
12. Serial communication between two 8085 through RS-232 C port.
13. Write a program of Flashing LED connected to port 1 of the 8051 Micro Controller
14. Write a program to generate 10 kHz square wave using 8051.
15. Write a program to show the use of INT0 and INT1 of 8051.
16. Write a program for temperature & to display on intelligent LCD display.

Virtual Lab Link: http://vlabs.iitb.ac.in/vlabs-dev/labs_local/microprocessor/labs/explist.php

Available on: <http://www.vlab.co.in/broad-area-electronics-and-communications>

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Use techniques, skills, modern engineering tools, instrumentation and software/hardware appropriately to list and demonstrate arithmetic and logical operations on 8-bit data using microprocessor 8085.
2. Examine 8085 & 8086 microprocessor and its interfacing with peripheral devices.
3. State various conversion techniques using 8085 & 8086 and generate waveforms using 8085.
4. Implement programming concept of 8051 Microcontroller.
5. Design concepts to Interface peripheral devices with Microcontroller so as to design Microcontroller based projects.

BEC-553	DIGITAL SIGNAL PROCESSING LAB	0L:0T:2P	1 Credit
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SUGGESTIVE LIST OF EXPERIMENTS:

1. Introduction to MATLAB and or Open Source Software, Scilab (Using Spoken Tutorial MOOCs).
2. Write a Program for the generation of basic signals such as unit impulse, unit step, ramp, exponential, sinusoidal and cosine.
3. Implement IIR Butterworth analog Low Pass for a 4 KHz cut off frequency.
4. Verify Blackman and Hamming windowing techniques.
5. Evaluate 4-point DFT of and IDFT of $x(n) = 1, 0 \leq n \leq 3; 0$ elsewhere.
6. Verify Linear convolution of two sequences using FFT
7. Verify Circular Convolution of two sequences using FFT.
8. To verify FFT as sample interpolator.
9. To implement Tone Generation.
10. To implement floating point arithmetic.
11. To study about DSP Processors and architecture of TMS320C6713 DSP processor.
12. **VIRTUAL Lab by NME-ICT available at: (*Through Virtual Lab*)**
 - a) Study of Discrete Fourier Transform (DFT) and its inverse.
 - b) Study of FIR filter design using window method: Lowpass and highpass filter.
 - c) Study of FIR filter design using window method: Bandpass and Bandstop filter.
 - d) Study of Infinite Impulse Response (IIR) filter.

Virtual Lab Link: [http://vlabs.iitkgp.ernet.in/dsp/index.html#
http://vlabs.iitkgp.ernet.in/dsp/](http://vlabs.iitkgp.ernet.in/dsp/index.html#http://vlabs.iitkgp.ernet.in/dsp/)

Available on: <http://www.vlab.co.in/broad-area-electronics-and-communications>

Spoken Tutorial (MOOCs):

Spoken Tutorial MOOCs, ' Course on Scilab', IIT Bombay (<http://spoken-tutorial.org/>)

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Create and visualize various discrete/digital signals using MATLAB/Scilab.
2. Implement and test the basic operations of Signal processing.
3. Examine and analyse the spectral parameters of window functions.
4. Design IIR and FIR filters for band pass, band stop, low pass and high pass filters.
5. Design the signal processing algorithms using MATLAB/Scilab.

**B.Tech 3rd Year
VI Semester
Syllabus**

ELECTRONICS AND COMMUNICATION ENGINEERING

BVL 601	DIGITAL DESIGN WITH FPGA	3L:1T:0P	4 Credits
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Unit	Topics	Lectures
I	DIGITAL SYSTEM OVERVIEW Review of Combinational Circuits: Adder, Subtractor, Code converter, Decoder, Encoder, Multiplexer, Demultiplexer Review of Sequential Circuits: Flip flops, Shift Registers, Synchronous Counter, Ripple Counter, MOD Counter, Ring Counter, Johnson Counter	8
II	INTRODUCTION TO VHDL VHDL Invariants, VHDL Design units, VHDL Programming Paradigm, Standard Models in VHDL Architectures, VHDL Operators, FSM Design using VHDL, Structural Modelling Using VHDL, Data Objects, Looping Constructs	8
III	STANDARD DIGITAL CIRCUITS IN VHDL Design of D Flip Flop, 8-bit Shift Register, Synchronous Up/Down Counter; Design of parallel adder/subtractor with accumulator, Serial Adder with Accumulator, Design of Binary Multiplier and Binary Divider.	8
IV	INTRODUCTION TO FPGA AND ITS ARCHITECTURE Types of Programmable Logic Devices: PLA, PAL, CPLD. FPGA Design flow, Applications of FPGA, FPGA Architecture,	8
V	DIGITAL SYSTEM DESIGN USING FPGA Programming Technologies, Introduction to FPGA development environments (Vivado, Xilinx), features of commercially available Xilinx / Vivado FPGAs. Design and Synthesis of basic circuits such as logic gates, adder, subtractor, decoder, multiplexer. Flipflops, counter using Xilinx /Vivado FPGA.	8

Text Books:

1. Digital Design (4th Edition) by M. Morris R. Mano Michael D. Ciletti
2. Cem Unsalan, Bora Tar. Digital System Design with FPGA: Implementation using Verilog and VHDL. McGrawHill, First Edition.
3. John V. Old Field, Richrad C. Dorf, Field Programmable Gate Arrays, Wiley, 2008.
4. Bhasker, Jayaram. "A VHDL primer." (1995).
5. Wolf, W., FPGA-based System Design, PH/Pearson, (2004) Cheap ed.

Reference Books:

1. Douglas L.Perry, VHDL: "Programming by Example", McGraw-Hill, 2002.
2. Simon Monk. Programming FPGAs Getting Started with Verilog. McGrawHill, First Edition.

Course Outcomes: At the end of this course students will demonstrate the ability:

1. Review the concept of combinational and sequential digital circuit
2. Implement digital circuits using hardware description language
3. Understand FPGA design flow.
4. Understand FPGA Architectures and advanced technologies
5. Implementing Digital Systems on FPGAs using VHDL

ELECTRONICS AND COMMUNICATION ENGINEERING

BVL 602	PHYSICAL DESIGN FOR VLSI CIRCUITS	3L:1T:0P	4 Credits
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Unit	Topics	Lectures
I	Introduction: VLSI Design flow, Physical Design Cycle, VLSI Design Styles, Common EDA Terminology. Partitioning – Problem formulation, Classification of Partitioning algorithms, Kernighan-Lin Algorithm, Simulated Annealing, Fiduccia-Mattheyses (FM) Algorithm.	8
II	Floor Planning – Problem formulation, Classification of floor planning algorithms, constraint-based floor planning, Rectangular Dualization, Pin Assignment – Problem formulation, Classification of pin assignment algorithms, General and channel Pin assignments.	8
III	Placement – Problem formulation, Placement algorithms: standard cell placement, timing-driven placement, Classification of placement algorithms, Partitioning based placement algorithms. Power planning and IR drop considerations	8
IV	Clock Tree Synthesis (CTS) and Routing Clock distribution challenges: skew, latency, and insertion delay, CTS methodologies: H-tree, X-tree, and balanced clock trees, Clock gating. Global routing and detailed routing techniques, Routing constraints: DRC, wire load models, parasitic extraction	8
V	Timing and Power Analysis Static Timing Analysis (STA): setup and hold analysis, Timing closure challenges and optimization techniques Power analysis: dynamic, leakage, IR drop, and power grid design	8

Text Books:

1. N.A.Sherwani , “Algorithms for VLSI Physical Design Automation”, (3/e), Kluwer,1999.
2. Andrew B. Kahng, Jens Lienig, Igor L. Markov, JinHu, VLSI Physical Design: From Graph Partitioning to Timing Closure, Springer, 2011.

Reference Books:

1. H. Yosuff and S.M. Sait, VLSI Physical Design Automation – Theory and Practice, Cambridge India, 2010.
2. Khosrow Golshan, “Physical Design Essentials-An ASIC Design Implementation Perspective” Springer New York, NY, 2007. DOI: <https://doi.org/10.1007/978-0-387-46115-1>.
3. S.H. Gerez, “Algorithms for VLSI Design Automation”, John Wiley ,1998.
4. Sung Kyu Lim, Practical Problems in VLSI Physical Design Automation, Springer India, 2011.

Course Outcomes: At the end of this course students will demonstrate the ability:

1. Understood the physical design flow and different VLSI design styles.
2. Apply partitioning in a given circuit.
3. Design and optimized floorplans of a circuit.
4. Optimize placements on the silicon chip and perform complex routing using algorithms.
5. Design clock trees to distribute the clock signals on the chip while satisfying various constraints like clock skew and wire length.

ELECTRONICS AND COMMUNICATION ENGINEERING

BVL 603	VLSI CIRCUIT TESTING AND TESTABILITY	3L:1T:0P	4 Credits
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Unit	Topics	Lectures
I	Faults in Digital Circuits: Fault modelling, fault detection, redundancy, equivalence, fault location, fault dominance. Stuck at faults, bridging faults, stuck open faults, Transient faults, Permanent faults.	8
II	Testing and Testability of Combinational Circuits Test generation basics, test generation algorithms, path sensitization, Boolean difference, D-algorithm, PODEM, Testable combinational logic circuit design.	8
III	Testing and Testability of Sequential Circuits Testing of sequential circuits as iterative combinational circuits, State table verification, Test generation based on circuit structure, Design of testable sequential circuits, Ad Hoc design rules, Scan path technique (scan design), Partial scan, Boundary scan	8
IV	Memory, Delay, Fault AND IDDQ Testing Testable memory design, RAM fault models, test algorithms for RAMs, Delay faults, Delay test, IDDQ testing, limitations of IDDQ Testing	8
V	Design for testability: controllability and observability, Random test generation, transition count testing, signature analysis, syndrome testable design, RMC, Level sensitive scans design, BIST: LSSD on-chip self-test, BILBO, BIDCO.	8

Text Books:

1. P. K. Lala, "Digital Circuit Testing and Testability", Academic Press.
2. M.L. Bushnell and V.D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers.

Reference Books:

1. N.K. Jha and S.G. Gupta, "Testing of Digital Systems", Cambridge University Press.
2. Zainalabe Navabi, "Digital System Test and Testable Design: Using HDL Models and Architectures", Springer.

Course Outcomes: At the end of this course students will demonstrate the ability:

1. Understand the concepts of digital testing and Fault models.
2. Apply fault equivalence and dominance collapsing.
3. Apply fault simulation algorithms on digital circuits.
4. Understand and analyze combinational ATPG algorithms.
5. Design testable combinational & sequential circuits.

ELECTRONICS AND COMMUNICATION ENGINEERING

BVL-061	FUNDAMENTALS OF NANO ELECTRONICS	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	Overview of basic Nano electronics , Nano technology and its architectures, Basics of Quantum Mechanics: Schrodinger equation, density of states of electrons in nanostructures; Electron transport in nanostructures: Electrons in quantum wells, quantum wires and quantum dots	8
II	Materials for Nanoelectronics Semiconductors, Crystal lattices: bonding in crystals, Electron energy bands, 2D materials for Semiconductor: Carbon nano-materials: nanotubes and fullerenes	8
III	Introduction to methods of fabrication of Nano-layers, different approaches, physical vapour deposition, chemical vapour deposition, Formation of Silicon Dioxide- dry and wet oxidation methods. Fabrication of Nano particle- grinding with iron balls, soil gel techniques: oil in water techniques.	8
IV	Introduction to characterization of nanostructures, tools used for of Nanomaterials characterization, electron microscope, X-Ray Diffraction analysis, UV Spectroscopy, Scanning Electron Microscopy (SEM).	8
V	Some Nanostructure Devices: MOSFET structures, Heterojunctions, Tunnel junction and applications of tunneling, Resonant-tunneling diodes; Field-effect transistors, Introduction to MEMS/NEMS	8

Text Books:

1. G.W. Hanson, Fundamentals of Nano electronics, Pearson, 2009.
2. W. Ranier, Nano electronics and Information Technology, Wiley-VCH, 2003.
3. K.E. Drexler, Nano systems, Wiley, 1992.
4. K. Gosser, P. Glosekotter, J. Dienstuhl, Nanoelectronics and nanosystems, Springer 2004.

Reference Books:

1. C.P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003
2. Supriyo Dutta, Quantum Transport- Atom to transistor, Cambridge, 2013.
3. WR Fahrner – Springe, Nano Terchnology and Nano Electronics – Materials, devices and measurement Techniques.
4. Nanotubes and nanowires by C.N.R. Rao and A. Govindaraj, RSC Publishing.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Understand basic concepts of Nano-electronic devices and Nano technology.
2. Understand various aspects of Nano components and material.
3. Understand fabrication processes involved in making Nano-electronic components
4. Understand different characterization techniques for Nano devices
5. 5. Study of some Nano electronic structure device

ELECTRONICS AND COMMUNICATION ENGINEERING

BVL-062	DRONE TECHNOLOGY	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	Flight Dynamics of Aerial Vehicles: Definitions of Drone, UAV, RPA, Quadcopters -Basic Components and Categories – Principles of Flight - Flight Maneuvers – Airframes - Creating a Frame: Materials, Different Frame Shapes – Building Airframes - Flight dynamics - Applications - Future potential - Comparison with other aerial vehicles.	8
II	Hardware Anatomy of a Quadcopter: Power Train – Propellers, Motors- Total Lift - Electronic Speed Controllers– Flight Battery –Radio transmitter and receiver – Flight Controller – GPS, Compass, Camera Assembling for Quadcopter – Connectors, Mounting of Propellers and Powering up.	8
III	Introduction to Satellite Communication: Key Flight Safety Rules - Preflight Checklist and Flight Log Information – Flight Instructions - Repair and Maintenance: Crash analysis, Common issues, Voltage testing. Test and troubleshoot the Flight Controller Board (FCB), Electronic Speed Controller (ESC), and its associated peripherals.	8
IV	Real World Applications and Case Studies: Beneficial Drones, Aerial Photography, Mapping and Surveying, Precision Agriculture, Search and Rescue, Infrastructure Inspection, and Conservation. Case Studies: Agriculture Weed Classification, Microdrone Surveillances.	8
V	Drone Technology: 1. Familiarization with Drone Parts. 2. Assembling the Drone. 3. Preparation for Drone for Flight, making a flight plan, and basic drone flight training. 4. Debugging and repairing the drone. 5. Operation of a Drone for Different Applications.	8

Text Books:

1. Reg Austin “Unmanned Aircraft Systems UAV design, development and deployment”, Wiley, 2010.
2. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.
3. Kimon P. Valavanis, “Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy”, Springer, 2007..

Reference Books:

1. Paul G Fahlstrom, Thomas J Gleason, “Introduction to UAV Systems”, UAV Systems, Inc, 1998
2. Dr. Armand J. Chaput, “Design of Unmanned Air Vehicle Systems”, Lockheed Martin Aeronautics.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Apply the concept of Flight dynamics for building a Quadcopter.
2. Assemble and Program the Quadcopter.
3. Perform Testing and Control operations on the Quadcopter.
4. Implement a Quadcopter for real-world applications.
5. Design and Develop the Drone.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-063	CMOS DIGITAL DESIGN TECHNIQUES	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	VLSI design flow, VLSI design style, introduction to the basic fabrication processes (wafer preparation, oxidation, diffusion, etching, metallization and lithography, etc.), Fabrication process Flow: basic Steps, the CMOS n-well Process. Metal oxide semiconductor (MOS) structure, Types of MOSFET: Enhancement and Depletion. Structure and operation of MOS transistor.	8
II	Threshold voltage equation and energy band diagram of MOSFET, controlling of threshold voltage, MOSFET current – Voltage Characteristics. Transconductance, Drain conduction. Aspect ratio, process parameters, second order effects, MOS small signal and Large signal model, MOS capacitances. Stick diagram rules for nMOS and CMOS technology, lambda based and micron-based design rules. Layout design for CMOS inverter	8
III	Analysis of different types of inverter circuit, CMOS inverter, transfer characteristic, calculation of propagation delay, rise time, fall time, noise margin and power dissipation for CMOS Inverter. Effect of threshold voltage and supply voltage on Delay and power dissipation. Limitations of CMOS in NANO scale circuit design.	8
IV	CMOS logic, Complex Logic Circuits, pseudo NMOS logic, pass transistor logic, Transmission Gate logic and Dynamic logic circuit design. Designing of Combinational logic circuit using CMOS and analysis of various design parameters.	8
V	Sequential MOS Logic circuits, SR Latched circuits, clocked latch and Flip Flop Circuits, CMOS D latch and Edge Triggered Flip Flop, Design of the Schmitt trigger circuit, Dynamic random access and Static random access memory cell design and analysis, Sense amplifier and row and column decoder circuit.	8

Text Books:

1. Sung-mo Kang and Yusuf Leblebici, CMOS Digital Integrated Circuit analysis and Design, Tata McGraw-Hill, 3/e.
2. R. Jacob Baker, Harry W. Li and David E. Boyce, CMOS Circuit design, layout and Simulation, PHI, IEEE press, Series Edition,

Reference Books:

1. Yuan Taur and Tak H. Ning, Fundamentals of Modern VLSI Devices, Cambridge university Press, Special Edition, 1998
2. Neil H.E. Weste and Kamran Esharhian, Principal of CMOS VLSI design, PHI, 2/e
3. Jan M. Rabaey, Digital Integrated Circuit, PHI, 2/e

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Understand the static and dynamic behavior of MOSFETs (Metal Oxide Semiconductor Field Effect Transistors) and the secondary effects of the MOS transistor model.
2. To be aware about the trends in semiconductor technology, and how it impacts scaling and its effect on device density, speed and power consumption.
3. To understand MOS transistor as a switch and its capacitance.
4. Student will be able to design digital systems using MOS circuits (Static and Switching characteristics of inverters)
5. Understand the concept behind ASIC (Application Specific Integrated Circuits) design and the different implementation approaches used in industry.

ELECTRONICS AND COMMUNICATION ENGINEERING

BEC-064	MICROCONTROLLERS AND SENSORS FOR IOT APPLICATIONS	3L:0T:0P	3 Credits
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Unit	Topics	Lectures
I	Fundamentals of IOT: Introduction to IoT, IoT Design Methodology, Design Principles for Connected Devices: Calm and Ambient Technology, Internet Communications overview, IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing.	8
II	Data Acquisition with IOT Devices: Prototyping embedded devices: Sensors and Actuators, Electronics and Power Components, Working mechanism of range of sensors and data acquisition, Data processing and analysis, Wireless Data transmission, IoT Point to point communication technology, IoT Communication Patterns, Selection of Wireless technologies (6LoWPAN, Zigbee, WIFI, BLE, NFC, LORA, Li-Fi, Widi).	8
III	MSP430 Microcontrollers: Functional Block diagram, Addressing modes, Instruction Set, Examples, Reflections on the CPU and Instruction Set, DPR for M.Tech IoT and Sensor Systems 2022 19 Exceptions, Clock system. Development: Development Environment, Access to the Microcontroller for Programming and Debugging, Demonstration Boards, Examples. Functions, Interrupts, and Low-Power Modes. Functions and Subroutines, Interrupts, ISR, Low-Power Modes of Operation.	8
IV	Sensor Interfacing and Applications: Sensors interfacing: Sensors interfacing techniques-Port Programming, ADC, SPI thermometer, I2C thermometer, PWM generation and demodulation, DTH11Cloud interfacing: Interfacing and data logging with cloud: Thing speak. IoT's Applications – Smart Farming: Smart Greenhouse, Drones for pesticides, Smart Energy Meters, Home automation, Smart Grid and Solar Energy Harvesting, Intelligent Parking, IoT for Healthcare, and weather analysis.	8
V	Security and Privacy in IoT: The problem- “Identity of Things”, Device On-Boarding, Symmetric Encryption Standards: Symmetric Encryption (DES, AES 128), Hashing, Authentication, CCMP Authentication and Encryption protocol, Non-Symmetric Encryption Standards: Diffie Hellman (principle, Man in the Middle attack), RSA, Digital Signature and Authentication.	8

Text Books:

1. A Beginner's Guide to Internet of Things Security: Attacks, Applications, B.B. Gupta, Aakansha Tiwari, CRC Press, Taylor and Francis Group, 2020.
2. Donald Norris, “The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and BeagleBone Black”, McGraw Hill, 2015.
3. John H. Davies, “MSP430 Microcontroller Basics”, 2011, 2nd ed., Newnes publishing, New York.

Reference Books:

1. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015.
2. A First Course in Fuzzy and Neural Control by Nguyen, Prasad, Walker, and Walker. CRC 2003.
3. Jacob Fraden, “Hand Book of Modern Sensors: physics, Designs and Applications”, 2014, 4th ed., Springer, New York.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Introduction to IoTs enabled technologies.
2. Analyze the mechanism of Data Acquisition and processing.
3. Understand data classification, process of big data technology, user roles and Detects myths in big data
4. Analyze software and management tools for Industrial applications of IoTs
5. Understand the Real-World design constraints and challenges.

BVL 651	DIGITAL DESIGN WITH FPGA LAB	0L:0T:2P	1 Credits
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SUGGESTIVE LIST OF EXPERIMENTS:

1. Simulate all gates using VHDL.
2. Design and simulate Half adder and Full adder using VHDL.
3. Design and simulate Multiplexer and Demultiplexer using VHDL.
4. Design and simulate Encoder and Decoder using VHDL.
5. Simulate Flip flops using VHDL.
6. Implement shift register using VHDL.
7. FPGA implementation of Flip flops.
8. FPGA implementation of shift register.
9. Design and implement 4-bit Synchronous and Asynchronous Counters on FPGA
10. Implement Binary Multiplier using FPGA

Course Outcomes: At the end of this course students will demonstrate the ability:

1. Design and simulate basic logic gates and arithmetic circuits using VHDL.
2. Design and simulate multiplexers, encoders, and decoders using VHDL.
3. Implement sequential logic circuits such as flip-flops and shift registers using VHDL.
4. Implement and test sequential and arithmetic circuits on FPGA hardware.
5. Demonstrate the ability to integrate and debug VHDL code in FPGA-based digital design workflows.

BVL 652	PHYSICAL DESIGN FOR VLSI CIRCUITS LAB	0L:0T:2P	1 Credits
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SUGGESTIVE LIST OF EXPERIMENTS:

1. Perform RTL synthesis to generate a gate-level netlist from Verilog or VHDL code.
2. Make Floorplan of a Digital Design Block
3. Carry out standard cell and macro placement to optimize area and performance.
4. Power Planning: Creation of Power Rings and Straps
5. Design and analyze a clock tree structure to minimize skew and meet timing constraints.
6. Perform global and detailed routing to complete interconnections between placed cells.
7. Perform static timing analysis to verify setup and hold timing violations.
8. Parasitic Extraction and RC Delay Estimation
9. Conduct Design Rule Check (DRC) and Layout Versus Schematic (LVS) Verification.
10. Generate the final GDSII file for fabrication-ready layout submission.

Course Outcomes: At the end of this course students will demonstrate the ability:

1. Apply physical design concepts to synthesize RTL code into a gate-level netlist.
2. Perform floor planning, placement, and power planning for digital integrated circuits.
3. Implement clock tree synthesis and routing while analyzing clock skew and congestion.
4. Evaluate the timing, power, and parasitic effects in VLSI layouts through STA and extraction techniques.
5. Validate physical designs through DRC, LVS, and generate final GDSII layouts for fabrication readiness.

BEC-653A	CMOS DIGITAL DESIGN LAB	0L:0T:2P	1 Credit
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SUGGESTIVE LIST OF EXPERIMENTS:

1. Design and analyze the parameters of CMOS inverter using simulation.
2. Design and Simulate 4-bit adder in structural and behavioral modeling VHDL.
3. Design and Simulate State machine using VHDL.
4. Design and Simulate ALU using Packages and user defined datatype.
5. Design and Simulate Linear Feedback Shift Register
6. Design and simulate any combinational circuit using domino CMOS logic.
7. Design and simulate 2:1 mux using CMOS transmission gate.
8. Design and simulate decade counter using VHDL.
9. Design and simulate ripple counter using VHDL.
10. Design and simulate shift register using VHDL.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Understand the static and dynamic behavior of MOSFETs (Metal Oxide Semiconductor Field Effect Transistors) and the secondary effects of the MOS transistor model.
2. To be aware about the trends in semiconductor technology, and how it impacts scaling and its effect on device density, speed and power consumption.
3. To understand MOS transistor as a switch and its capacitance.
4. Student will be able to design digital systems using MOS circuits (Static and Switching characteristics of inverters)
5. Understand the concept behind ASIC (Application Specific Integrated Circuits) design and the different implementation approaches used in industry.

BEC-653B	CAD (COMPUTER-AIDED DESIGN) FOR ELECTRONICS LAB	0L:0T:2P	1 Credit
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SUGGESTIVE LIST OF EXPERIMENTS:

Part A

PSPICE Experiments:

1. (a) Transient Analysis of BJT inverter using step input.(b) DC Analysis (VTC) of BJT inverter
2. (a) Transient Analysis of NMOS inverter using step input.
(b) Transient Analysis of NMOS inverter using pulse input.
(c) DC Analysis (VTC) of NMOS inverter.
3. (a) Analysis of CMOS inverter using step input.
(b) Transient Analysis of CMOS inverter using step input with parameters.
(c) Transient Analysis of CMOS inverter using pulse input.
(d) Transient Analysis of CMOS inverter using pulse input with parameters.
(e) DC Analysis (VTC) of CMOS inverter with and without parameters.
4. Transient & DC Analysis of NAND Gate using CMOS inverter.
5. Transient Analysis of NOR Gate inverter and implementation of XOR gate using NOR gate
6. To design and perform transient analysis of D latch using CMOS inverter.
7. To design and perform the transient analysis of SR latch circuit using CMOS inverter.
8. To design and perform the transient analysis of CMOS transmission gate.
9. Analysis of frequency response of Common Source amplifiers.
10. Analysis of frequency response of Source Follower amplifiers

Part B :

HDL (using VHDL **program module** & verilog **Module**)

VHDL PROGRAMS

1. Design and Simulation of Full Adder using VHDL **program module**
2. Design and Simulation of 4x1 MUX using VHDL **program module**
3. Design and Simulation of BCD to Excess-3 code using VHDL **program module**
4. Design and Simulation of 3 to 8 decoder using VHDL **program module**
5. Design and Simulation of JK Flip-flop using VHDL **program module**
6. Design and Simulation of CMOS Inverter using **verilog Module**

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Design and analyze the performance of different type of inverters.
2. Design and analyze the performance of the basic logic gates using CMOS inverter circuit.
3. Design and analyze the performance of the memory based digital circuits using CMOS inverter circuit.
4. Analyze the performance of the different configuration of MOS amplifier circuits.

BEC-653C	MICROCONTROLLERS AND SENSORS FOR IOT APPLICATIONS LAB	0L:0T:2P	1 Credit
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SUGGESTIVE LIST OF EXPERIMENTS:

1. Write a program on Arduino/Raspberry Pi to upload various data of different sensors onto things peak cloud.
2. Write a program to create TCP server on Arduino/Raspberry Pi and respond with relevant data of sensor to TCP client when requested.
3. Analysis IoT Data Logging using Beagle Board.
4. Indoor Air Quality Analysis using ESP32 & Byte beam Cloud.
5. Collect sensor data from Arduino/ESP32 and Raspberry Pi and analysis onto MATLAB.
6. Analysis of ESP32 UART Communication and RS232 TTL serial communication.
7. Analysis of data received from multiple boards at a time. (Many to one mapping)
8. Perform LED Blinking operation using MSP 430 GPIOs.
9. Configure the PWM module of the MSPEXP430FR5969 Launchpad to control the brightness of LED.
10. PWM based DC Motor Speed Control using MSP430 GPIOs.

Course Outcomes: At the end of this course students will demonstrate the ability to:

1. Introduction to IoTs enabled technologies.
2. Analyze the mechanism of Data Acquisition and processing.
3. Understand data classification, process of big data technology, user roles and Detects myths in big data
4. Analyze software and management tools for Industrial applications of IoTs
5. Understand the Real-World design constraints and challenges.