DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

M.Tech VLSI & Embedded System Design

SCHEME

First Semester

Course No.	Subject	Scheme of studies periods per week			Total Credits
		L	T	P	
VED 101	VLSI Design	3	-	-	3
VED 102	Computer Aided Design of Digital Systems	3	-	-	3
VED 103	Embedded Systems	3	-	-	3
	Department Elective-1	3	-	-	3
	Department Elective-2	3	-	-	3
VED 104	Lab I Embedded System Design	-	-	2	1
VED 105	Lab II VLSI front end Design	-	-	2	1
VED 106	Seminar-1	-		2	1
VED 107	Minor Project-1 (Self Learning)	-	-	-	2
		15	-	6	20

Total Hours: 21 **Total Credits: 20**

Second Semester

Course No.	Subject	Scheme of studies periods per week			Total Credits
		L	T	P	
VED 201	VLSI Technology	3	-	-	3
VED 202	Testing of VLSI circuits	3	-	-	3
	Department Elective-3	3	-	-	3
	Department Elective-4	3	-	-	3
	Open Elective	3	-	-	3
VED 203	Lab III VLSI Back end Design	-	-	2	1
VED 204	Lab IV System Modelling	-	-	2	1
VED 205	Seminar-II	-	-	2	1
VED 206	Minor Project-2 (Self Learning)	-	-	2	2
		18	-	8	20

Total Hours: 23 **Cumulative Credits: 40**

Third Semester

Course No.	Subject	Scheme of studies periods per week L	T	P	Total Credits
VED 301	Dissertation Phase –I	-	-	40	**20**
Total Hours: 40	**Cumulative Credits: 60**		**Total Semester Credits**		**20**

Fourth Semester

Course No.	Subject	Scheme of studies periods per week L	T	P	Total Credits
VED 401	Dissertation Phase –II	-	-	40	**20**
Total Hours: 40	**Cumulative Credits: 80**		**Total Semester Credits**		**20**

List of Electives-Departmental		**List of Electives-Open**	
VED 501	Low power VLSI Design	VED 601	Optimization Techniques
VED 502	Digital System Design	VED 602	Fuzzy Computations
VED 503	Mixed Signal Design	VED 603	Neural Networks
VED 504	Design for Testability	VED 604	Queuing Theory
VED 505	Design of Semiconductor Memories	VED 605	Biomedical Signal Processing
VED 506	CMOS Active Filter Design	VED 606	Operation Research
VED 507	Design of Analog IC	VED 607	Internet of Things (IoT)
VED 508	CMOS RF Circuit Design	VED 608	Applied Machine Learning and Deep Learning
VED 509	Device Modeling and Simulation		
VED 510	Physical Design Automation		
VED 511	High VEDeed System Design		
VED 512	Electronic Packaging and Manufacturing		
VED 513	VLSI Design for signal processing		
VED 514	Nano Technology		
VED 515	Machine Learning for VLSI		
VED 516	Data compression and Cryptography		
VED 517	Research Methodology		
	NPTEL Course/ SWAYAM Course(s)		

Syllabus

First Semester

Name of Program	M.Tech. (VLSI)	Semester-I	Session 2020-21
Name of Course	Computational Techniques		
Course Code	MTH 513		
Core / Elective / Other	Core		

Prerequisite:	
1.	Knowledge of Engineering Mathematics upto B.Tech. level
Course Outcomes: At the end of the course, the student will be able to:	
CO1	Understand and interpret the concepts of linear algebra, integral equation and numerical analysis.
CO2	Understand the significance of digits in a numerical solution.
CO3	Compute the solution of high dimensional linear and non-linear homogeneous and non- homogeneous equations.
CO4	Distinguishbetween analytical and numerical solutions of their engineering problems.
CO5	Integrate higher dimension problems.
Description of Contents in brief:	
1.	Vector spaces, linear independence, bases and dimensions, eigenvalues, eigenvectors,characteristicspolynomial,norms,ortho-normalbases,innerproducts,singularvalue decompositions with different conditions (in polar),some theorems on linear operators.
2.	Interpolation and approximation by least squares and minimal error criteria. Interpolatoryquadrature rules, product integration, advanced methods for numerical integration.
3.	Approximate expansion methods, stability and convergence, compact operators and equations of the second kind, method of degenerate kernels for Fredholmequations, Nystrom method, analysis of methods for integral equations, general operator equations of the second kind.
4.	Methods of successive substitutions, generalized Newton method, minimization of functions.
List of Text Books:	
1.	Jain, M. K., Iyengar, S. R. K. and Jain, R. K., Numerical Methods for Scientific and Engineering Computation, New Age Pvt. Pub, New Delhi, 2003.
2.	Strang, G., Linear Algebra and its Applications, 4rd edition, Cengage LearningPvt Ltd, 2006.
3.	E. K. P. Chong and S. H. Zak, An Introduction to Optimization, 2nd edition, Wiley India Pvt. Ltd., 2010.
List of Reference Books:	

1.	Gerald, C. F. and Wheatly, P. O., Applied Numerical Analysis, 6th Edition, Wesley, 2004.
2.	Hoffman, K. and Kunze, R., Linear Algebra, 2nd edition, Pearson Education (Asia) Pvt. Ltd/ Prentice Hall of India 2004.
3.	Pant, J.C., Introduction to Optimization/Operations Research, Jain Brothers, New Delhi, 2nd edition, 2012.

URLs:

1.	https://nptel.ac.in/courses/111/105/111105112/

Lecture Plan (about 40-50 Lectures):

Lecture No.	**Topic**
1-2	Vector space, subspace, sum of subspaces
3-4	Linear combination, linear dependence and independence, basis, dimension and rank
5	Examples of infinite dimensional spaces, ordered bases and coordinates
6-7	Eigenvalues, eigenvectors and characteristics polynomial
8-10	Norm of a matrix, orthogonal and orthonormal vectors, GramSchmidt process for orthogonalisation
11-12	Inner Product Space: Inner product between two vectors, normed space
13	Singular value decompositions with different conditions (like polar)
14-15	Some theorems on linear operators: diagonalisation, Jordan canonical form
16-17	Interpolation: Finite difference operator and their relationships, difference tables, Newton interpolation
18-19	Bessel interpolation formulae, Divided differences, Lagrange interpolation
20-21	Newton’s divided difference interpolation
22-23	Least squares approximation and minimal error criteria
24-26	Numerical integration: Trapezoidal, Simpsons 1/3rd and 3/8th rules, quadrature rules, product integration
27-28	Advanced methods for numerical integration: Gauss Legendre 2-points and 3-points formulae
29	Approximate expansion methods
30	Stability and convergence
31-32	Integral Equation: Review of integral equation, compact operators and equations of the second kind
33-34	Method of degenerate kernels for Fredholmequations
35-36	General operator equations of the second kind
37-38	Nystrom method analysis of methods for integral equations
39-40	Methods of successive substitutions for integral equations
41-42	Generalized Newton method
43-44	Minimization of functions

Name of Program	M. Tech VED	Semester I	Year I
Name of Course	**VLSI Design**		
Course Code	VED 101		
Core / Elective / Other	Core		

Prerequisite:	
1.	Fundamentals of Basic electronics.
2.	Fundamentals of Digital electronics.
3.	Fundamentals of Micro-electronics.

Course Outcomes: After completion of the course, the students will be able to

CO1	Recall concepts of IC manufacturing and basics of CMOS technology, ASIC's, FPGAs, PLA & PAL
CO2	Outline physical design of logic gates, CMOS logic structure, power dissipation in CMOS, and also discuss about behavioral synthesis.
CO3	Explain locking Strategies, clock skew, timing issues, static and dynamic timing analysis
CO4	Explain CMOS Testing, manufacturing test principles, design strategies for chip and system level test techniques.
CO5	Illustrate basics of CMOS technology, ASIC's, FPGAs, PLA & PAL.

Description of Contents in brief:

Introduction to MOS Technology - CMOS fabrication. Basic Electrical Properties - NMOS Inverter, Zpu/Zpd ratio, CMOS Inverter, Regions of Operation, BiCMOS Inverters. Scaling - Scaling models and factors, scaling factors for various device parameters. MOS Circuits and logic design: Switching logic, gate logic, Two/Three input NMOS,CMOS&BiCMOS, NAND &NOR gates, CMOS logic structures - Pseudo nMOS, dynamic CMOS, clocked CMOS, CMOS domino, NP-domino logic, clocking strategies. Introduction of VLSI Design Methodologies -Design Description domains. System design and methods – CMOS design methods, CMOS design options. Layout design rules and Stick diagrams. Introduction to ASICDesign.

List of Text Books:	
1.	Basic VLSI Design Douglas A. Pucknell& Kamran Eshraghian.
2.	Principles of CMOS VLSI design Neil H.E. Weste& Kamran Eshraghian

List of Reference Books:	
1.	CMOS VLSI Design Harris, Weste, Banerjee
2.	CMOS Circuit design Jacob baker, Harry Wili& David Boyce
3.	Principles of CMOS VLSI design Neil H.E. Weste& Kamran Eshraghian
4.	Basic VLSI Design Douglas A. Pucknell& Kamran Eshraghian

Lecture Plan (about 40-50 Lectures):

Lecture No.	**Topic**
1.	Review of IC manufacturing.
2.	n-well and p-well process.
3.	CMOS Twin - Tub process.
4.	Integrated Circuit – An Overview.
5.	Introduction to MOS Technology.
6.	Basic Properties of MOS Circuits.
7.	Basic Electrical Properties - NMOS Inverter
8.	Pull-up to Pull-down ratio of nMOS inverter.
9.	Alternatives forms of Pull-up.
10.	CMOS Inverter
11.	Regions of Operation
12.	Power Dissipation in CMOS circuits
13.	Charge sharing and Latch-up problem.
14.	Scaling models and factors.
15.	Scaling factors for various device parameters
16.	Physical design of logic gates- Switches and Transmission gates.
17.	CMOS Circuit and Logic design.
18.	BiCMOS inverter
19.	BiCMOS NAND & NOR gates
20.	CMOS Logic Structures- Pseudo-nMOS logic.
21.	Dynamic CMOS logic.
22.	CMOS Domino logic.
23.	NP Domino logic.
24.	Clocking Strategies.
25.	Clock skew.
26.	Timing issues.
27.	Setup and Hold Time
28.	Static and Dynamic timing analysis.
29.	CMOS Design Methods.
30.	Behavioral Synthesis.
31.	Logic optimization.
32.	Design-Capture Tools.
33.	Chip Composition.
34.	Design Verification Tools.
35.	Network Isomorphism.
36.	Layout design rules
37.	Stick diagrams
38.	Introduction to ASIC Design.
39.	ASIC’s contd.
40.	Different types of ASIC’s
41.	PLA & PAL.
42.	FPGAs.

Name of Program	M.Tech VED	Semester I	Year I
Name of Course	**Computer Aided Design of Digital System**		
Course Code	VED 102		
Core / Elective / Other	Core		

Prerequisite:	
1.	Nil
Course Outcomes: After completion of the course, the students will be able to	
CO1	Apply CAD tools for modeling, design, test and verification of VLSI systems.
CO2	Explain various phases of CAD, including simulation, physical design and verification.
CO3	Demonstrate knowledge of computational algorithms and tools for CAD.
Description of Contents in brief:	
1.	Introduction to VLSI Methodologies, Design domains and actions. Design methods and technologies. VLSI design automation tools
2.	Structural and transistor level design algorithmic and system design algorithmic graph theory and computational complexities
3.	Tractable and intractable problems, general purpose methods for combinational optimization, Layout compaction
4.	Placement and partitioning, Floor planning concepts, Routing definition and Concept
5.	Simulation – general remarks on VLSI simulation, gate level modelling and simulation switch level modeling and simulation logic synthesis and verification, high level synthesis
List of Text Books:	
1.	S.H. Gerez, "Algorithms for VLSI Design Automation", 1998
2.	N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", 1999
3.	JA Bondy, USR Murty "Graph Theory With Applications" Elsevier Science Publishing Co. Inc , 1982
List of Reference Books:	
1.	Giovanni De Micheli ,"Synthesis And Optimization Of Digital Circuits".
URLs:	
1.	Nil

Lecture Plan (about 40-50 Lectures):

Lecture No.	Topic
1	Introduction and Review to VLSI Methodologies,
2	VLSI Physical Design Automation
3	Design and Fabrication of VLSI Devices,
4	Fabrication process and its impact on Physical Design
5	VLSI design automation tools
6	Graph Theory Fundamentals.
7	Graph theory Definitions
8	More definitions and problems
9	Data structures and basic algorithms –
10	Analysis of algorithms
11	Graph theory
12	Computational complexity of Graph Theory
13	Asymptotic Notations, Big O notation
14	Breadth first search
15	Depth first search
16	Maximum flow Algorithm
17	Some problems on Algorithms
18	Dijkstras Algorithm
19	Prims algorithm
20	Floyd Warshall Algorithm
21	Kruskal Algorithm
22	Longest path Algorithm
23	Liao Wong Algorithm
24	4 queens problem and Travelling Salesman problem
25	Bellman Ford Algorithm
26	Tractable and intractable problems.
27	Polynomial non polynomial algorithms
28	Optimization algorithms tarvelling salesman problem
29	Dynamic programming
30	Branch and bound concept and examples
31	Back tracking and all pair shortest path algorithm
32	Definition of partitioning-floor planning and
33	Pin assignment
34	Placement algorithm
35	Floor planning Algorithms
36	Routing algorithm (LEE algorithm)
37	Simulation – logic synthesis
38	High level synthesis compaction
39	Physical design automation of FPGAs, MCMS
40	VHDL-Verilog implementation of simple circuits using VHDL and Verilog

Name of Program	**M.TechVED**	**SemesterI**	**YearI**
Name of Course	**Embedded Systems**		
Course Code	VED 103		
Core / Elective / Other	Core		
Prerequisite:			
1	Programming with C		
2	Data Structures		
3	Microprocessors and Microcontrollers		
Course Outcomes: After completion of the course, the students will be able to			
CO1	Explain steps and complexities involved in the design of Embedded Systems		
CO2	Identify possible problems and their solutions in the software architecture for Embedded Systems.		
CO3	Interpret microcontroller implementation aspects with an example of industrial microcontroller		
Description of Contents in brief:			
1	Overview of Hardware Software Co-design and System Modeling		
2	Software Architectures, Interrupts and Shared Data Problem, Solutions		
3	Functions and usage of RTOS Primitives and structures		
4	PIC Microcontroller		
List of Text Books:			
1	System Design: A Unified Hardware/Software Introduction – by- Frank Vahid, Tony Givergis (John Wiley & Sons)		
2	An Embedded Software Primer – by - David Simon (Pearson)		
3	Design with PIC Microcontroller – by - John B Peatman (Pearson)		
List of Reference Books:			
1	Specification and Design of Embedded Systems – by – Gajski, Vahid, Narayan, Gong (Pearson)		
2	Introduction to Embedded Systems - A Cyber-Physical Systems Approach – by - E. A. Lee and S. A. Seshia, Second Edition, LeeSeshia.org, 2015		
URLs:			
1	https://ptolemy.berkeley.edu/books/leeseshia/lab/		
2	https://www.cs.ccu.edu.tw/~pahsiung/courses/soc/notes/SoC_Design_Flow_Tools_Codesign_2005_notes.pdf		
3	esd.cs.ucr.edu/toc.html#toc_ch7		
4	https://ptolemy.berkeley.edu/projects/embedded/research/hsc/		
Lecture Plan (about 40-50 Lectures):			
Lecture No.	**Topic**		

1.	Embedded Systems - Scope and definition
2.	Example of a complex ES, Processor technologies – Controller &Datapath variations
3	Overview of Hardware Software Codesign,
4	Design Space Exploration in H/w S/w Codesign (contd.)
5	ES Design Cycle, Modeling - Elevator Controller example – Representations and implementations
6	Modeling Behavior – Continuous Dynamics
7	Discrete Dynamics, Composition of State M/c
8	Concurrent models of computation
9	Example ES Design Problems and characteristics
10	Interrupts and Shared Data Problem, Solution
11	Shared data problem solution contd.
12	Shared data problem solution contd.
13	Software Architectures – RR, RRI
14	FQS
15	RTOS
16	RTOS Task structure, RTOS Data structure
17	Shared data problem and Semaphores
18	RTOS calls (Micrium OS)
19	RTOS primitives – Semaphores and their use
20	RTOS primitives – Semaphores and their use (contd.)
21	Queues and Examples
22	Queues and Examples (contd.)
23	Other RTOS Primitives
24	Embedded Software Development Tools
25	Models of Sensors and Actuators
26	Quantization, noise, distortion, Signal Conditioning
27	Sensors – Tilt, Acceleration, Position, Velocity
28	Sensors – Rotation, Sound, Others
29	Actuators – LEDs, Motor control
30	Memory Technologies and Hierarchy
31	Memory Models
32	I/O Hardware
33	Microcontroller families – Introduction
34	PIC microcontroller
35	PIC Memory Map and SFR
36	PIC instruction set
37	PIC programming examples
38	PIC program template
39	PIC program – table usage
40	PIC Interrupt Architecture
41	PIC program – Interrupt usage

Second Semester

Name of Program	M. Tech VED	Semester II	Year I

Name of Course	**VLSI Technology**
Course Code	VED 201
Core / Elective / Other	Department Elective

Prerequisite: After completion of the course, the students will be able to

1.	The students are well versed with the fundamentals of CMOS Design
2.	The students are well versed with the fundamental layout rules.

Course Outcomes: After completion of the course, the students will be able to

CO1	Illustrate mechanism of wafer preparation.
CO2	Explain working of various equipment for fabrication techniques.
CO3	Describe models of processes like epitaxy, diffusion, oxidation, etching and their dependence on various parameters.
CO4	Summarize various material deposition techniques and electronic/VLSI devices
CO5	Explain the fabrication process of IC technology.

Description of Contents in brief:

Introduction to VLSI Technology: Classification of ICs, features of ICs , monolithic and hybrid ICs. Crystal Growth and Wafer Preparation: silicon crystal growth from the melt, crystal orientations, various defects in crystal, wafer preparation and wafer specifications. Epitaxy: Epitaxy and its concepts, growth kinetics of epitaxy, vapour phase epitaxy, molecular beam epitaxy. Oxidation: Theory of growth of silicon dioxide layer, calculation of SiO2 thickness and oxidation kinetics. Lithography- Photolithography and pattern transfer, optical and electron photolithography, X-ray and ion beam lithography. photoresist, types of photoresist. Etching- dry & wet etching. Diffusion Process- Diffusion in solids, diffusion equation and diffusion mechanisms. Ion implantation- Implantation equipments, high energy implantation, scattering phenomenon, range of implanted ions, implantation damage, annealing. Metallization- Metallization applications, metallization choices, physical vapour deposition, patterning &problemsinmetallization.Thickandthinfilmdeposition.VLSIprocessintegration–NMOS, CMOS, BJT. Assembly techniques, packing of VLSI devices.

List of Text Books:

1.	S.K. Gandhi, “VLSI Fabrication Principles”, John Wiley Inc.
2.	S.M. Sze, “VLSI Technology”, McGraw Hill.

List of Reference Books:

1.	C.Y. Chang and S.M.Sze, “ULSI Technology”, McGraw Hill.
2.	James D. Plummer, “Silicon VLSI Technology: Fundamentals, Practice and Modeling”, Pearson Education.

Lecture Plan (about 40-50 Lectures):

Lecture No.	Topic
1.	Introduction to VLSI Technology: Classification of ICs.

2.	Features of ICs, monolithic and hybrid ICs.
3.	Refining of Silicon for Crystal Growth.
4.	Refining of Silicon for Crystal Growth contd.
5.	Wafer Preparation.
6.	Wafer Preparation contd.
7.	Crystal orientation.
8.	Defects in crystal.
9.	Epitaxy: Epitaxy and its concepts.
10.	Growth kinetics of epitaxy.
11.	Vapour phase epitaxy.
12.	Molecular beam epitaxy.
13.	Oxidation: Theory of growth of silicon dioxide layer.
14.	Calculation of SiO2 thickness.
15.	Oxidation kinetics.
16.	Lithography- Photolithography and pattern transfer.
17.	Optical photolithography
18.	Electron photolithography.
19.	X-ray and ion beam lithography.
20.	Types of photoresist.
21.	Etching- dry etching.
22.	Wet etching.
23.	Diffusion Process.
24.	Diffusion in solids.
25.	Diffusion equation and diffusion mechanisms.
26.	Diffusion equation and diffusion mechanisms contd.
27.	Implantation equipment.
28.	High energy implantation
29.	Scattering phenomenon
30.	Range theory of implanted ions.
31.	Implantation damage.
32.	Annealing.
33.	Metallization- Metallization applications
34.	Metallization choices.
35.	Physical vapour deposition.
36.	Patterning & problems in metallization.
37.	Thick film deposition.
38.	Thin film deposition.
39.	VLSI process integration – NMOS, CMOS, BJT.
40.	VLSI process integration – BJT.
41.	Assembly techniques.
42.	Packing of VLSI devices.

Name of Program	**M.Tech VED**	**Semester II**	**Year I**

Name of Course	**Testing of VLSI Circuits**
Course Code	VED 202
Core / Elective / Other	Core

Prerequisite:

1.	Digital System Design
2.	Probability, Probability Density Functions
3.	IC Design and Fabrication

Course Outcomes: After completion of the course, the students will be able to

CO1	Explain the need for VLSI chip testing and its complexity, implications for chip manufacturing industry
CO2	Recall the importance and operation of various Test Models for Chip manufacturing process
CO3	Interpret quantification of testing and understanding of search mechanisms to apply automatic test algorithms to industrial testing problems

Description of Contents in brief:

1.	Testing Philosophy, Yield, Defects, Test Economy
2.	Fault Models
3.	Fault Simulation Algorithms
4.	Testability Measures
5.	ATPG Algorithms, Exposure to Testing tools

List of Text Books:

1.	Essentials of Electronic Testing – by – M Bushnell, V D Agrawal (Springer)
2.	Viswani D. Agrawal Michael L. Bushnell, “Essentials of Electronic Testing for digital memory and mixed signal VLSI circuit”, Kluwer Academic Publications, 1999.

List of Reference Books:

1.	Alfred L. Crouch, “Design for test for digital ICs and embedded core systems”, PHI 1999.

URLs:

1.	Nil

Lecture Plan (about 40-50 Lectures):

Lecture No.	**Topic**
1.	Introduction to VLSI testing, Motivation, Scope
2.	Testing Philosophy, Yield Loss, Defect Level - Analogy with IC testing
3	VLSI Realization Process and FMA, Technology Trends affecting Testing
4	Types of testing, Types of tests,
5	Test specification and Test Plan
6, 7	Test Economics, Benefit-cost analysis

8	Yield, Defect level, Test data analysis
9	Fault modeling, levels of fault models,
10	Single stuck-at fault model
11	Fault equivalence and fault collapsing
12	Fault dominance, Examples for faults collapsing
13	Simulation for design verification
14	Simulation for test evaluation
15	Modeling Levels, Types of simulators
16, 17	Hierarchical connectivity, Gate level modeling
18	Signal states, Timing models
19, 20	Compiled code and Event-driven simulation
21	Serial and parallel fault simulation
22	Deductive fault simulation
23	Concurrent fault simulation
24	Roth’s TEST-DETECT Algorithm, Differential Fault Simulation
25	Statistical Methods - Fault Sampling
26	Introduction to SCOAP measures
27, 28	Combinational SCOAP Measures, Examples
29	Sequential SCOAP Measures – D FF
30	Problem solving based on SCOAP measures
31	High level Testability Measures, example
32	Representations for Comb. circuit test generation – BST, BDD, Algebra
33	ATPG Algorithms – RPG, Symbolic
34	ATPG algorithm – PSM
35	Redundancy identification, testing as a global problem
36	Definitions - ATPG algorithms in general and D-algorithm in particular
37	D-calculus and D-algorithm
38	Examples based on D- Algorithm
39	DFT Methods – Adhoc and Structured, Scan Design for Digital Logic
40	Exposure to Testing tools

List of Electives A

Name of Program	M. Tech VED	Semester II	Year I

Name of Course	**Low Power VLSI Design**
Course Code	VED 501
Core / Elective / Other	Core

Prerequisite:

1.	Linear Integrated Circuits
2.	VLSI Design EC

Course Outcomes: After completion of the course, the students will be able to

CO1	Explain source of power dissipation and its modeling and also power estimation at various design levels such as circuit, transistor and gate level.
CO2	Analysis of leakage power consumption in deep sub-micron technologies and power optimization techniques for combinatorial and sequential circuits
CO3	Design and analysis oflow power systems including case-studies on low power RAM circuits

Description of Contents in brief:

1.	Introduction to Low power CMOS VLSI design. Sources of power dissipation. Probabilistic Technique for signal Activity estimation. Estimation of gliching Power. Power dissipation in domino CMOS circuits. Charge sharing problem in dominocircuits.
2.	Leakage currents in DSM Technology. Leakage reduction techniques: process level and circuit level. Design time techniques
3.	Run time stand by techniques. Architecture level static voltage scaling techniques (pipelining and parallelism used for low power design).
4.	Voltage scaling with optimal transistor sizing, high level circuit transformation, Switched capacitance minimization techniques.
5.	Variation tolerant Design. Adiabetic Logic Circuits, Battery driven system design. Cad tools for lowpower. (softwaredesignforlowpower),Case studies(low powerstaticRAM architecture).

List of Text Books:

1.	Low Power CMOS VLSI Circuit Design Kaushik Roy, Sharat Prasad
2.	Practical Low Power Digital VLSI Design Gary Yeap

List of Reference Books:

1.	Low Power Design in Deep Sub-micron Electronics W. Nebel and J. Mermet, Kluwer

URLs:

1.	Nil

Lecture Plan (about 40-50 Lectures):

Lecture No.	Topic
1.	Introduction to VLSI design and modern era of Technology scaling
2.	Effects and fundamental of technology scaling
3.	Transistors in DSM technology, concepts and FinFets, etc.
4.	Introduction To low power Design
5.	Power dissipation & Charge sharing problem in domino CMOS circuits.
6.	Sources of Power Consumption
7.	Power Estimation: Probabilistic Technique for signal Activity estimation I
8.	Power Estimation: Probabilistic Technique for signal Activity estimation I
9.	Estimation of glitching Power
10.	Power dissipation in domino CMOS
11.	Power dissipation in CMOS gates
12.	Leakage currents in DSM
13.	Leakage Power dissipation in deep submicron technologies. I
14.	Leakage Power dissipation in deep submicron technologies. I
15.	Tutorial I
16.	Techniques for Leakage Power Reduction I
17.	Techniques for Leakage Power Reduction II
18.	Techniques for Leakage Power Reduction III
19.	Techniques for Leakage Power Reduction IV
20.	Techniques for Leakage Power Reduction V (Supply voltage scaling) & Self adjusting threshold scheme)
21.	Techniques for Leakage Power Reduction for minimizing switched capacitance I
22.	Techniques for Leakage Power Reduction for minimizing switched capacitance II
23.	Techniques for Leakage Power Reduction for minimizing switched capacitance III
24.	Techniques for Leakage Power Reduction for minimizing switched capacitance IV
25.	Techniques for Leakage Power Reduction for minimizing switched capacitance V
26.	Techniques for Leakage Power Reduction for minimizing switched capacitance VI
27.	Techniques for Leakage Power Reduction for minimizing switched capacitance VII
28.	Techniques for Leakage Power Reduction for minimizing switched capacitance VIII
29.	Tutorials
30.	Leakage reduction techniques, process level and circuit level techniques
31.	Design time leakage reduction technique
32.	Design time leakage reduction technique
33.	Run time standby leakage reduction techniques
34.	Run time standby leakage reduction techniques
35.	Run time standby leakage reduction techniques
36.	Run time Active leakage reduction techniques
37.	Variation tolerant Design.
38.	Adiabatic Logic Circuits
39.	Battery driven system design
40.	Cad tools for low power(software design for low power), Case studies (low power static RAM architecture).

Name of Program	**M.Tech. VED**	**Semester I/II**	**Year I**
Name of Course	**Digital System Design**		
Course Code	VE 502		
Core / Elective / Other	Department Elective		

Prerequisite:

1.	Digital Electronics

Course Outcomes: After completion of the course, the students will be able to

CO1	Analyze and synthesize synchronous and asynchronous sequential circuit designs.
CO 2	Explain concepts of ASM for digital circuit design and implementation in practical applications.
CO 3	Design digital system by using PLD's, PLA and PAL.
CO 4	Outline basic concepts of ASIC, CPLD and FPGA
CO 5	Impart an understanding of the basic concepts of digital system modeling

Description of Contents in brief:

Synchronous Sequential Logic Circuit Design: Introduction, Moore, Mealy and Mixed type Synchronous State Machines. Synchronous Counter Design, Hazards, Duality of sequential circuits, Different methods of minimization. Asynchronous Sequential logic design-Introduction, Primitive flow table and reduction, type of delays, Cycles and races, Excitation Map, Hazards, Essential hazards. Algorithmic State Machine, ASM charts, Design Procedure for ASMs. Fault Diagnosis in Sequential Circuits Introduction to programmable logic devices: PALs, PLDs, CPLDs and FPGAs. ASICs – Full custom, gate array based, standard cell based and Programmable ASICs, Antifuse, SRAM, EEPROM/ EPROM Technologies for ProgrammableASICs.

List of Text Books:

1.	CMOS Logic Circuit Design, Uyemura, John P., Springer
2.	VLSI Design, Shanthi, A. Kavitha, A., New Age International
3.	VLSI Design And Technology, Bose, D.N., New Age International

List of Reference Books:

1.	Donald D.Givone, "Digital Principles and Design", Tata McGraw-Hill
2.	M.Morris Mano, "Digital Design", 3rd edition, Pearson Education
3.	Charles H.Roth, Jr. "Fundamentals of Logic Design", 4th Edition, Jaico Publishing House

URLs:

1.	Nil

Lecture Plan (about 40-50 Lectures):	
Lecture No.	**Topic**
1.	Review of sequential circuits, Mealy-Moore Circuits
2.	Analysis of clocked synchronous sequential networks
3.	Modeling of clocked synchronous sequential network behavior
4.	State table reduction, state assignment
5.	Design of clocked synchronous sequential networks
6.	Numerical
7.	Structure and operation of Asynchronous sequential network
8.	Races in Asynchronous sequential networks
9.	Primitive flow table, reduction of input restricted flow tables
10.	Problems on reduction of input restricted flow tables
11.	General procedure to flow table reduction
12.	State assignment problem and transition table
13.	Design of Asynchronous sequential networks
14.	Static, dynamic and essential hazards
15.	Problems based on hazards in combinational networks
16.	Problems on synchronous and asynchronous networks
17.	Algorithmic state machines
18.	Examples on ASM charts
19.	ASM transition and excitation tables
20.	ASM realization using gates and multiplexers
21.	ASM realization using PLA, PLD's and PROMs
22.	Problems on ASM charts
23.	Introduction to CPLD" $ FPGA"s.
24.	Digital system modeling: Behavioral , structural and physical domains.
25.	Fault modeling.
26.	Fault modeling
27.	ASICs-introduction and its types
28.	Anti-fuse Technologies for Programmable ASICs.
29.	SRAM Technologies for Programmable ASICs.
30.	EEPROM/EPROM Technologies for Programmable ASICs.

Name of Program	M.Tech. VED	Semester I/II	Year I

Name of Course	**Mixed Signal Design**
Course Code	VED 503
Core / Elective / Other	Department Elective
Prerequisite:	
1.	Analog and Digital IC Design
Course Outcomes: After completion of the course, the students will be able to	
CO1	Outline design methodology for mixed signal IC design
CO2	Recall fundamentals of data converters and also optimize performance of converters
CO3	Analyze the design of ADC's
CO4	Design the CMOS digital circuits and implement its layout.
CO5	Design and analysis of Nyquist Rate A/D Converters.
Description of Contents in brief:	
Fundamental circuit techniques and design issues for mixed-signal integrated circuits. approximation ADCs, Dual slope ADCs, High-speed ADCs (e.g. flash ADC, pipeline ADC and related architectures), High-resolution ADCs (e.g. delta-sigma converters), Data converters – SNR, Noise shaping, Bandpass data converters, high speed data converters, , analog switches, comparators.	
List of Text Books:	
1.	R. Jacob Baker, John "CMOS: Mixed-Signal Circuit Design", Wiley & Sons Inc. , IEEE Press, 2nd Edition, 2009
2.	Rudy V. dePlassche. "CMOS Integrated ADCs and DACs", Springer, Indian edition
3.	Thomas H. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits", , Cambridge University Press, Second Edition, 2004.
List of Reference Books:	
1.	R. Jacob Baker, John "CMOS: Mixed-Signal Circuit Design", Wiley & Sons Inc. , IEEE Press, 2nd Edition, 2009
2.	Thomas H. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits", , Cambridge University Press, Second Edition, 2004.
URLs:	
1.	Nil

Lecture Plan (about 40-50 Lectures):

Lecture No.	Topic
1 -5	Fundamental circuit techniques and design issues for mixed-signal integrated circuits.
6 - 20	Basics ADC, Successive approximation ADCs, Flash ADC, folding-and-interpolation ADC, Pipeline ADC, Introduction/Characterization of DACs,

	various architectures of high speed DAC
21 - 30	Over sampled ADC: Working principle and architecture of a Sigma-delta ADC, multistage sigma-delta converters, Design of decimation filter.
31-40	VCO, Loop Filter, Charge pump, Precautionary measures for integrating analog and digital modules within an IC, floor planning and physical design of mixed signal IC design.

Name of Program	**M.Tech. VED**	**Semester I/II**	**Year I**
Name of Course	**Design for Testability**		
Course Code	VED 504		
Core / Elective / Other	Department Elective		
Prerequisite:			
1.	Digital Circuit Design		
2.	IC Design		
Course Outcomes: After completion of the course, the students will be able to			
CO1	Explain the testing methodology		
CO2	Build test systems		
CO3	Outline the requirements for BIST		
CO4	List error correction mechanisms		
CO5	Recall the benefits of BIST		
Description of Contents in brief:			
Review of Testing Process, Test Economics and Test Methods, Digital DFT and Scan Design – Scan Design Rules, Overheads of Scan Design, Built-In Self-Test – BIST Process, Pattern Generation, Device Level BIST, Boundary Scan Standards, BSDL,Analog Test Bus Standard, System Test and Core-based Design.			
List of Text Books:			
1.	Viswani D. Agrawal Michael L. Bushnell, “Essentials of Electronic Testing for digital memory and mixed signal VLSI circuit”, , Kluwer Academic Publications, 2000.		
2.	Alfred L. Crouch, “Design for test for digital ICs and embedded core systems”– PHI 1999		
3.	Stroud, “A Designer’s Guide to Built-in Self-Test”, Kluwer Academic Publishers, 2002		
4.	V. Agrawal and S.C. Seth, Test Generation for VLSI Chips, Computer Society Press.1989		
List of Reference Books:			
1.	Viswani D. Agrawal Michael L. Bushnell, “Essentials of Electronic Testing for digital memory and mixed signal VLSI circuit”, Kluwer Academic Publications, 2000.		
2.	Alfred L. Crouch, “Design for test for digital ICs and embedded core systems”– PHI 1999		
3.	Stroud, “A Designer’s Guide to Built-in Self-Test”, Kluwer Academic Publishers, 2002		
4.	V. Agrawal and S.C. Seth, Test Generation for VLSI Chips, Computer Society Press.1989		
URLs:			
1.	Nil		

Lecture Plan (about 40-50 Lectures):	
Lecture No.	**Topic**
1 – 5	Review of Testing Process, Test Economics and Test Methods
6 – 14	Digital DFT and Scan Design – Scan Design Rules, Overheads of Scan Design
15 – 25	Built-In Self-Test – BIST Process, Pattern Generation, Device Level BIST,
26- 35	Boundary Scan Standards, BSDL, Analog Test Bus Standard,
36 – 40	System Test and Core-based Design.

Name of Program	M.Tech. VED	Semester I/II	YearI
Name of Course	**Design of Semiconductor Memories**		
Course Code	VED 505		
Core / Elective / Other	Department Elective		

Prerequisite:	
1.	IC Design
2.	Semiconductor devices
Course Outcomes: After completion of the course, the students will be able to	
CO1	Identify the parts of Memories
CO2	Explain Semiconductor Memory architectures.
CO3	Solve fundamental problems in memory design
CO4	Develop novel circuit techniques for improving memory design
CO5	Relate the growing semiconductor market with memory
Description of Contents in brief:	
Random Access Memory Technologies, silicon on insulator (SOI) technology advanced SRAM architectures and technologies, application specific SRAMs, Dynamic Random Access Memories (DRAMs), Advanced DRAM designs and architecture – application specific DRAMs. Nonvolatile Memories, Memory fault modeling, testing and memory design for Testability and fault tolerance, Semiconductor memory reliability and radiation effects, advanced memory technologies and high-density memory packaging technologies, CD, Blueray disk.	
List of Text Books:	
1.	A.K Sharma, "Semiconductor Memories Technology, Testing and Reliability",1st Edition IEEE Press, 2003.
2.	Ashok K. Sharma, "Advanced Semiconductor Memories: Architectures, Designs, and Applications", 2nd Edition, John Wiley, 2009.
3.	Betty Prince, "Semiconductor Memories: A Handbook of Design, Manufacture and Application", 2nd Edition, John Wiley,1996.
4.	Luecke Mize Care, "Semiconductor Memory design & application", 1st Edition, Mc-Graw Hill, 1999
List of Reference Books:	
1.	A.K Sharma, "Semiconductor Memories Technology, Testing and Reliability",1st Edition IEEE Press, 2003.
2.	Ashok K. Sharma, "Advanced Semiconductor Memories: Architectures, Designs, and Applications", 2nd Edition, John Wiley, 2009.
3.	Gerald Luecke, "Semiconductor memory design and application", McGraw-Hill.
4.	Betty Prince, "Semiconductor Memories: A Handbook of Design, Manufacture and Application", 2nd Edition, John Wiley,1996.

5.	Luecke Mize Care, “Semiconductor Memory design & application”, 1st Edition, Mc-Graw Hill, 1999
URLs:	
1.	Nil

Lecture Plan (about 40-50 Lectures):

Lecture No.	**Topic**
1 – 10	Random Access Memory Technologies, silicon on insulator (SOI) technology advanced SRAM architectures and technologies, application specific SRAMs
11 – 20	Dynamic Random Access Memories (DRAMs), Advanced DRAM designs and architecture – application specific DRAMs.
21 – 28	Nonvolatile Memories, Memory fault modeling, testing and memory design for Testability and fault tolerance,
29 – 40	Semiconductor memory reliability and radiation effects, advanced memory technologies and high-density memory packaging technologies, CD, Blueray disk

<table>
<tr><td>Name of Program</td><td>M.Tech. VED</td><td>SemesterI/II</td><td>YearI</td></tr>
<tr><td>Name of Course</td><td colspan="3">CMOS Active Filter Design</td></tr>
<tr><td>Course Code</td><td colspan="3">VED 506</td></tr>
<tr><td>Core / Elective / Other</td><td colspan="3">Department Elective</td></tr>
<tr><td colspan="4">Prerequisite:</td></tr>
<tr><td>1.</td><td colspan="3">Signals and systems</td></tr>
<tr><td colspan="4">Course Outcomes: After completion of the course, the students will be able to</td></tr>
<tr><td>CO1</td><td colspan="3">Obtain in depth knowledge on signal processing system and Filters at mixed signal system</td></tr>
<tr><td>CO2</td><td colspan="3">Design filter Active- RC, MOSFET-C, Gm-C, Gm-Opamp-C</td></tr>
<tr><td>CO3</td><td colspan="3">Explain regarding the CMOS filter analysis and applications</td></tr>
<tr><td colspan="4">Description of Contents in brief:</td></tr>
<tr><td colspan="4">Introduction of Filters at mixed signal system, Analog filter, Filter approximation- Magnitude, Phase, group delay. Continuous-time, Discrete-time types of filters. Designing of filter Active-RC, MOSFET-C, Gm-C, Gm-Opamp-C, Switched-capacitor, switched-current filter. Noise in active RC filters, Adaptive Filters, Higher order filters and cascade, switched capacitor filters. Scattering parameter models, analysis and applications</td></tr>
<tr><td colspan="4">List of Text Books:</td></tr>
<tr><td>1.</td><td colspan="3">M. E. Van Valkenburg and Mac Elwyn Van Valkenburg, “Analog Filter Design” 1st Edition, Oxford University Press, 2000.</td></tr>
<tr><td>2.</td><td colspan="3">Lawrence P. Huelsman, “Active and passive analog filter design: an introduction, Volume 1”, 1st Edition, McGraw-Hill, 1993.</td></tr>
<tr><td>3.</td><td colspan="3">Electronic Filter Design Handbook by Arthur B. Williams, McGraw-Hill</td></tr>
<tr><td>4.</td><td colspan="3">C. Toumazou, F. J. Lidgey, “Analogue IC Design: The Current-Mode Approach” (IEEE Circuits and Systems Series)</td></tr>
<tr><td>5.</td><td colspan="3">Wai-Kai Chen, “The Circuits and Filters Handbook”, Second Edition, CRC Press</td></tr>
<tr><td colspan="4">List of Reference Books:</td></tr>
<tr><td>1.</td><td colspan="3">M. E. Van Valkenburg and Mac Elwyn Van Valkenburg, “Analog Filter Design” 1st Edition, Oxford University Press, 2000.</td></tr>
<tr><td>2.</td><td colspan="3">Lawrence P. Huelsman, “Active and passive analog filter design: an introduction, Volume 1”, 1st Edition, McGraw-Hill, 1993.</td></tr>
<tr><td>3.</td><td colspan="3">Arthur B. Williams, “Electronic Filter Design Handbook”, McGraw-Hill</td></tr>
<tr><td colspan="4">URLs:</td></tr>
<tr><td colspan="4">Lecture Plan (about 40-50 Lectures):</td></tr>
<tr><td>Lecture No.</td><td colspan="3">Topic</td></tr>
<tr><td>1 – 5</td><td colspan="3">Introduction of Filters at mixed signal system, Analog filter,</td></tr>
<tr><td>6 – 10</td><td colspan="3">Filter approximation- Magnitude, Phase, group delay. Continuous-time, Discrete-time types of filters.</td></tr>
</table>

11 – 20	Designing of filter Active- RC, MOSFET-C, Gm-C, Gm-Opamp-C
21 – 26	Switched-capacitor, switched-current filter. Noise in active RC filters,
27 – 33	Adaptive Filters, Higher order filters and cascade, switched capacitor filters.
34 – 38	Scattering parameter models, analysis and applications

Name of Program	M. Tech. VED	Semester I/II	YearI

Name of Course	**Design of Analog IC**
Course Code	VED 507
Core / Elective / Other	Department Elective

Prerequisite:

1.	Knowledge of MOS Transistors

Course Outcomes: After completion of the course, the students will be able to

CO1	Design and analysis of analog integrated circuits.
CO2	Optimize analog Integrated circuit designs
CO3	Explain various analog integrated circuits.

Description of Contents in brief:

1.	Design CMOS analog circuits.
2.	Noise and distortion in analog circuits
3.	Analyze and Design of analog IC
4.	Small and large signal modeling and analysis. Different Single stage and Differential mplifiers, Current Mirrors, operational amplifier, switch capacitor circuits
5.	Optimization and trade-offs involved in analog integrated circuit design

List of Text Books:

1.	BehzadRazavi, “Design of Analog CMOS Integrated Circuits” ,McGrawHill
2.	Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, and Robert G. Meyer , “Analysis and Design of Analog Integrated Circuit”, John Wiley & Sons
3.	Willy Sansen, “Analog Design Essentials”, Springer

List of Reference Books:

1.	David Johns & Ken Martin, Analog Integrated Circuit Design, Wiley-India,
2.	P. Allen & D. R. Holberg, CMOS Analog Circuit Design, Oxford Press,
3.	P. Gray, P. Hurst, S. Lewis, R. Meyer, Analysis and Design of Analog Integrated Circuits, Wiley-In

URLs:

1.	www.analogic.com
2.	www.anylogic.com/resources/books/free-simulation-book-and-modeling-tutorials
3.	www.electronicshub.org/cmos-technology

Lecture Plan (about 40-50 Lectures):

Lecture No.	Topic

1	Introduction to Analog VLSI
2	General Concepts of Analog IC Design
3	Performance parameter for analog design
4	Single-Stage Amplifier
5	Numerical on Common-Source Stage amplifier
6	Source Follower
7	Common-Gate Stage
8	Numerical on Common-Gate Stage amplifier
9	Cascode Stage and choice of Device Models
10	Single Ended and Differential Operation of Differential Amplifier
11	Basic Differential Pair
12	Common-Mode Response
13	Differential Pair with MOS Loads
14	Numerical on differential pair
15	Basic and Cascode Current Mirrors
16	Active Current Mirrors
17	General Consideration of Amplifiers
18	Common-Source Stage
19	Active load
20	Frequency response
21	Cascode Stage and Differential Pair
22	Characteristics and Types of Noise
23	Representation of Noise in Circuit
24	Noise in Single Stage Amplifier

25	Noise in Differential Pair and Noise Bandwidth
26	General Consideration and Feedback Topologies
27	Effect of Loading and Effect of Feedback on the Noise
28	Operational Amplifier Considerations and Types of Operational Amplifier
29	Compensation of Two-Stage Op Amps and Other Techniques
30	Gain Boosting
31	Common-Mode Feedback
32	Input Rate Limitation and Slew Rate
33	Power Supply Rejection and Noise in Op-Amp
34	Mutlipole System and Phase Margin
35	Frequency Consideration
36	Stability and frequency compensation
37	Introduction to Switched-Capacitor Circuits
38	Sampling Techniques
39	Switched-Capacitors Amplifiers
40	Switched-Capacitor common mode feedback
41	Numerical on Switched-Capacitors Amplifiers

Name of Program	**M. Tech. VED**	**Semester: I/II**	**Year: I**
Name of Course	**CMOS RF circuit Design**		
Course Code	VED 508		
Core / Elective / Other	Department Elective		

Prerequisite:	
1.	Knowledge of MOS Transistors
2.	Design of Analog CMOS circuit
Course Outcomes: After completion of the course, the students will be able to	
CO1	Explain principles and design concepts of CMOS Radio frequency circuits for wireless communication systems
CO2	Analyze CMOS Radio frequency circuits for communication systems
CO3	Design low noise amplifiers
Description of Contents in brief:	
1.	RF Transceiver system design concept
2.	Device Noise calculation and analysis
3.	low-noise amplifiers (LNA) designs,
4.	Power amplifier design
5.	Oscillators Ring , LC cross-coupled, Colpitts, Hartley, Voltage control oscillators
List of Text Books:	
1.	B. Razavi , “RF Microelectronics”, Prentice Hall of India
2.	R. Jacob Baker, H.W. Li and D.E. Boyce, “CMOS Circuit Design, Layout and Simulation ”,Prentice Hall of India
3.	Thomas H. Lee “Design of CMOS RF Integrated Circuits”, Cambridge University press
List of Reference Books:	
1.	Y.P. Tsividis, “Mixed Analog and Digital VLSI Devices and Technology”, McGraw Hill.
2.	P. Allen & D. R. Holberg, CMOS Analog Circuit Design, Oxford Press,
3.	P. Gray, P. Hurst, S. Lewis, R. Meyer, Analysis and Design of Analog Integrated Circuits, Wiley-In
URLs:	
1.	www.CMOScircuit.com
2.	www.anylogic.com/resources/books/free-simulation-book-and-modeling-tutorials
3.	www.electronicshub.org/cmos-technology

Lecture Plan (about 40-50 Lectures):

Lecture No.	Topic
1	Transceiver architecture
2	Transmitter and receiver design
3	MOS small signal model
4	MOS large signal model
5	Analysis of different types of noise in RF communication
6	Derivations on Thermal noise
7	Device noise
8	Flickernoise
9	Numericals on different types of noise in RF communication
10	Analysis of different capacitances in MOSFET
11	Passive devices
12	Uses of passive devices in RF circuit design
13	RF inductor design
14	MOS varactor design
15	Building block in RF systems
16	Oscillators in RF communication system
17	Common source amplifier
18	Ring oscillator design using single common source stage
19	Ring oscillator design using two common source stage
20	Ring oscillator design using multiple common source stage
21	Numericals on Ring oscillator

22	One port view of oscillator
23	LC oscillator
24	Conversion of series resistance to parallel
25	Cross coupled LC Oscillator design
26	Numericals on LC Oscillator
27	Cross coupled Oscillator
28	Numericals on Cross coupled Oscillator
29	Voltage Control Oscillator
30	VCO tuning range limitations
31	Numericals on VCO
32	Basics of LNA, important parameters
33	LNA design issues
34	LNA broadband topology
35	Noise cancelling LNA
36	Different configurations of differential LNA
37	Power amplifier basics
38	Design of power amplifier
39	Single ended and differential power amplifier
40	High efficiency power amplifier
41	Numericals on power amplifier

Name of Program	**M.Tech. VED**	**Semester I/II**	**Year I**
Name of Course	**Device Modeling and Simulation**		
Course Code	VED 509		
Core / Elective / Other	Department Elective		

Prerequisite:

1.	Design of Analog IC
2.	CMOS RF CIRCUIT DESIGN

Course Outcomes: After completion of the course, the students will be able to

CO1	Explain Ebers-Moll model and its characteristics
CO2	Analyze MOSFET parameters
CO3	Explain the importance of Current-voltage characteristics of Devices
CO4	Outline of numerical approach to 2D and 3D device models

Description of Contents in brief:

1.	Integrated circuits diodes and transistors; Current-voltage characteristics; Ebers-Moll model and transistors Gummel-Poon model of bipolar; current gain; Early effect and high level injection; 2-D effects. Modulation doped FETs, HEMTs; Hetero junctions and HBTs; microwave and optonic devices;
2.	Transient parameters; MOSFETs; analysis of MOSFET parameters; short channel and narrow width effects;
3.	Hot electron effects; MOSFET models; JFET and MESFETs;
4.	Modulation doped FETs, HEMTs; Heterojunctions and HBTs; microwave and optonic devices
5.	Outline of numerical approach to 2D and 3D device models; Introduction to device simulation programs.

List of Text Books:

1.	Nandita Das Gupta and Amitava Das Gupta, "Semiconductor Devices", PHI.
2.	S. M. Sze, "Physics of Semiconductor Devices", John Wiley & Sons.

List of Reference Books:

1.	Karl Hess, "Advanced Theory of Semiconductor Devices", IEEE Press

URLs:

1.	Nil

Lecture Plan (about 40-50 Lectures):

Lecture No.	**Topic**
1.	What is Integrated circuits with respects physical design ofDevice
2.	..........do..........
3.	..........do..........
4.	

5.	Physical design of Device diodes and transistors
6.	..........do..........
7.	..........do..........
8.	Current-voltage characteristics of Devices
9.	..........do..........
10.	..........do..........
11.	What is Ebers-Moll model and its characteristics
12.	..........do..........
13.	..........do..........
14.	What is EKV model with singe of MOSFET
15.	..........do..........
16	..........do..........
17	Gummel-Poon model of bipolar; current gain
18	..........do..........
19	..........do..........
20	..........do..........
21	..........do..........
22	Early effect and high level injection; 2-D effects. of device.
23	..........do..........
24	..........do..........
25	Modulation doped FETs
26	..........do..........
27	..........do..........
28	..........do..........
29	HEMTs; Heterojunctions and HBTs
30	..........do..........
31	..........do..........
32	..........do..........
33	microwave and optonic devices;
34	..........do..........
35	..........do..........
36	..........do..........
37	Transient parameters; MOSFETs; analysis of MOSFET parameters;
38	..........do..........
39	short channel and narrow width effects;
40	..........do..........
41	Hot electron effects; MOSFET models; JFET and MESFETs;
42	..........do..........
43	..........do..........
44	Modulation doped FETs, HEMTs; Heterojunctions and HBTs; microwave and optonic devices
45	..........do..........
46	Outline of numerical approach to 2D and 3D device models; Introduction to device simulation programs.
47	..........do..........

48	............................do..
49	............................do..
50	............................do..

Name of Program	**M. Tech. VED**	**Semester: I/II**	**Year: I**
Name of Course	**Physical Design Automation**		
Course Code	VED 510		
Core / Elective / Other	Department Elective		

Prerequisite:	
1.	VLSI Design
Course Outcomes: After completion of the course, the students will be able to	
CO1	Explain automation process of VLSI System design
CO2	Recall fundamentals for various physical design CAD tools.
CO3	Develop and enhance the existing algorithms and computational techniques for physical design process of VLSI systems
Description of Contents in brief:	
1.	The course introduces the basic design flow in VLSI physical design automation.
2.	Basic data structures and algorithms used for implementing
3.	Examples and assignments to understand the concepts involved in physical design automation and appreciate the main challenges therein
4.	Floor planning and Pin Assignment, Placement – problem formulation, partitioning based placement problems, Global routing – problem formulation Detailed Routing – multilayer routing algorithms, Over the cell routing and via minimization, Clock and power routing, PDA of FPGAs and MCMs.
List of Text Books:	
1.	N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic
2.	Sadiq M Sait, "VLSI Physical Design Automation: Theory and Practice
List of Reference Books:	
1.	Gerez, Sabih H., "Algorithms for VLSI Design Automation", John Wiley & Sons
2.	Drechsler, Rolf, "Evolutionary Algorithms for VLSI CAD" Springer Science & Business Media
3.	Trimberger, Stephen M., "An Introduction to CAD for VLSI", Springer Science & Business Media
URLs:	
1.	www.worldscientific.com › VLSI DESIGN AUTOMATION
2.	www.electronicshub.org/cmos-technology
Lecture Plan (about 40-50 Lectures):	

Lecture No.	Topic
1	Design Representation

2	VLSI Design cycle
3	VLSI Design Styles
4	VLSI Physical Design Automation (Part 1)
5	VLSI Physical Design Automation (Part 2)
6	Partitioning
7	Floor planning
8	Floor planning Algorithms
9	Pin Assignment
10	Placement (Part 1)
11	Placement (Part 2)
12	Grid Routing (Part 1)
13	Grid Routing (Part 2)
14	Global Routing (Part 1)
15	Global Routing (Part2)
16	Detailed Routing (Part 1)
17	Detailed Routing (Part 2)
18	Clock Design (Part 1)
19	Clock Design (Part 2)
20	Clock and Network synthesis
21	POWER AND GROUND ROUTING
22	Time Closure
23	Timing Driven Placement
24	Timing Driven Routing
25	Physical Synthesis (Part 1)
26	Performance-Driven Design Flow
27	Interconnect Modeling
28	Design Rule Check
29	Layout Compaction
30	Test Pattern Generation
31	Design for Testability
32	Boundary Scan Standard

33	Built-in Self-Test (Part 1)
34	Low Power VLSI Design
35	Techniques to Reduce Power
36	Gate Level Design for LowPower
37	Algorithmic Level Techniques for Low Power Design
38	PDA
39	FPGAs
40	MCMs

Name of Program	**M. Tech. VED**	**SemesterI/II**	**YearI**
Name of Course	**High Speed System Design**		
Course Code	VED 511		
Core / Elective / Other	Department Elective		

Prerequisite:	
1.	VLSI Technology
Course Outcomes: After completion of the course, the students will be able to	
CO1	Outline importance of High Speed VLSI Circuits Design
CO2	Explain high speed buses, radiated emissions and minimizing system noise
CO3	Recall knowledge of chip and wafer-level packaging and testability
Description of Contents in brief:	
1.	Basics of VLSI design for high speed processing
2.	Methods for logical efforts, logic styles, latching strategies and Interface techniques and related issues.
3.	Transmission line theory (basics), crosstalk effects; signal integrity: impact of packages, vias, traces, connectors; non-ideal return current paths, high frequency power delivery, simultaneous switching noise; system-level timing analysis and budgeting; methodologies for design of high speed buses; radiated emissions and minimizing system noise; Practical aspects of measurement at high frequencies.
4.	Printed Circuit Board - CAD tools for PCB design, Standard fabrication, Surface Mount Technology, Through Hole Technology, Process Control and Design challenges. Thermal Management, Heat transfer fundamentals, Thermal conductivity and resistance, Conduction, convection and radiation, Cooling requirements. Reliability - Basic concepts, Environmental interactions. Thermal mismatch and fatigue failures thermomechanicallyinducedelectricallyinducedchemicallyinduced.ElectricalTesting: System level electrical testing, Design for Testability basics.
5.	IC packaging - Requirements and properties; materials and substrates; wire-bonding; chip and wafer-level packaging; impact on reliability and testability.
List of Text Books:	
1.	Stephen H. Hall, Garrett W. Hall, James A. McCall ,"High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices", Wiley-IEEE Press

2.	Tummala, Rao R., "Fundamentals of Microsystems Packaging", McGraw Hill
3.	R.G. Kaduskar and V.B.Baru" ,Electronic Product design", Wiley India
List of Reference Books:	
1.	Chung-Kang Cheng, John Lillis, Shen Lin and Norman H. Chang, "Interconnect Analysis and Synthesis", A wileyInterscience Publication
2.	. Sung-Mo (Steve) Kang, Yusuf Leblebigi, "CMOS Digital integrated circuits analysis and design", by Tata Mcgraw-Hill, (2007).
URLs:	
1.	www.worldscientific.com ›high speed system design
2.	www.electronicshub.org/cmos-technology
Lecture Plan	

Lecture No.	Topic
1	Transmission line theory
2	Transmission line theory
3	Signal integrity: impact of packages
4	Vias, traces, connectors;
5	Non-ideal return current paths
6	High frequency power delivery
7	High frequency power delivery
8	Simultaneous switching noise
9	System-level timing analysis and budgeting
10	Methodologies for design of high speed buses
11	Radiated emissions and minimizing system noise
12	Practical aspects of measurement at high frequencies
13	CAD tools for PCB design
14	Standard fabrication
15	Surface Mount Technology
16	Through Hole Technology
17	Process Control and Design challenges
18	Thermal Management
19	Heat transfer fundamentals
20	Thermal conductivity and resistance
21	Conduction, convection and radiation
22	Cooling requirements

23	Environmental interactions
24	Thermal mismatch
25	Fatigue failures thermo mechanically induced electrically induced
26	Chemically induced
27	Electrical Testing:
28	Design for Testability basics
29	IC packaging - Requirements and properties
30	Materials and substrates
31	wire-bonding
32	Chip and wafer-level packaging
33	Impact on reliability
34	Impact on testability

Name of Program	M. Tech. VED	Semester I/II	YearI

Name of Course	**Optimization Techniques**
Course Code	VED 601
Core / Elective / Other	Open Elective
Prerequisite:	
1.	Fundamentals of Computing and Programming
Course Outcomes: After completion of the course, the students will be able to	
CO1	Apply classical optimization techniques and numerical methods of optimization
CO2	Explain the basics of different evolutionary algorithms.
CO3	Enumerate fundamentals of Integer programming technique and apply different techniques to solve various optimization problems arising from engineering areas.
Description of Contents in brief:	
1.	Enumerate the fundamental knowledge of Linear Programming and Dynamic Programming problems
2.	Learn classical optimization techniques and numerical methods of optimization.
3.	Know the basics of different evolutionary algorithms.
4.	Frame engineering minima maxima problems in the framework of optimization problems.
5.	Learn efficient computational procedures to solve optimization problems
List of Text Books:	
1.	Practical Optimization R. Fletcher.
2.	Nonlinear Programming, Theory and Algorithms, M.S.Bazara, H.D.SheraliandC.Shetty
3.	Optimization for Engineering Design by Kalyanmoy Deb, PHI Publishers
List of Reference Books:	
1.	Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers 3
2.	Operations Research by Hillar and Liberman, TMH Publishers
3.	Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers
URLs:	
1.	https://books.google.co.in/books/about/Advanced_Optimization_Techniques
2.	https://nptel.ac.in/content/storage2/courses/105108127/pdf/Module_1/M1L4slides.pdf
Lecture Plan (about 40-50 Lectures):	

Lecture No.	Topic
1	mathematical review for optimization

2	matrix factorizations
3	sets and sequences
4	convex sets and functions
5	linear programming
6	simplex method
7	Weierstrass' theorem
8	Karush Kuhn Tucker optimality conditions
9	Algorithms for optimization I
10	Algorithms for optimization II
11	Algorithms for optimization III
12	Algorithms for optimization IV
13	Algorithms for optimization V
14	Convergence
15	unconstrained optimization
16	Line search methods
17	method of multidimensional search I
18	method of multidimensional search II
19	Simplex algorithm
20	steepest descent methods I
21	steepest descent methods II
22	steepest descent methods III
23	Gradient Search Methods I
24	Gradient Search Methods II
25	Gradient Search Methods III

26	Newton's method
27	modifications to Newton's method
28	trust region methods I
29	trust region methods II
30	conjugate gradient methods I
31	conjugate gradient methods II
32	Constrained optimization
33	quasi-Newton's methods I
34	quasi-Newton's methods II
35	penalty and barrier function methods I
36	penalty and barrier function methods II
37	augmented Lagrangian methods
38	polynomial time algorithm for linear programming
39	successive linear programming
40	Successive quadratic programming.

Name of Program	M.Tech VED	Semester I/II	Year I

Name of Course	**Fuzzy Computations**
Course Code	VED 602
Core / Elective / Other	Open Elective

Prerequisite:	
1.	Elementary Set Theory
2.	Elementary Probability Theory
Course Outcomes: After completion of the course, the students will be able to	
CO1	Explain concepts of Fuzzy Set Theory and Fuzzy Logic.
CO2	Discuss about Fuzzy rule base systems and performance analysis
CO3	Formulate and solve various real life problems using concepts of Fuzzy logic.
Description of Contents in brief:	
1.	Classical Set and Fuzzy set Theory
2.	Classical and Fuzzy Relations
3.	Fuzzification and Defuzzification
4.	Development of Membership function
5.	Fuzzy Logic and Fuzzy Systems
6.	Decision Making with Fuzzy Information
7.	Fuzzy Classification
8.	Fuzzy Pattern Recognition
9.	Fuzzy Control Systems
10.	Miscellaneous Topics
List of Text Books:	
1.	Timothy J. Ross, Fuzzy Logic With Engineering Applications, 3rd ed. Wiley, 2010
2.	George J Klir / Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Pearson, 2015
3.	A.K. Bhargava, Fuzzy Set Theory Fuzzy Logic and their Applications, S.Chand and Comp, 2013
List of Reference Books:	
1.	LotfiA.Zadeh and Rafik A. Aliev, Fuzzy Logic theory and Applications, World Scientific, 2018.
2.	M.K. Hasan, Fuzzy Sets and Fuzzy Logic with Applications: Imprecision, Uncertainty and Vagueness, Scholar’s Press, 2019
3.	Hans-Jurgen Zimmermann, Practical Applications of Fuzzy Technologies (The Handbooks of Fuzzy Sets), 2012, Springer Science

URLs:	
1.	https://www.tutorialspoint.com › fuzzy_logic
2.	https://www.guru99.com/
3.	https://www.youtube.com/watch?v=a2i-lHS-c_I

Lecture Plan (about 40-50 Lectures):	
Lecture No.	**Topic**
1.	Introduction and historical aspects of Fuzzy set theory
2.	Classical set theory and Fuzzy set theory
3.	Fuzzy membership functions
4.	Fuzzy union, intersection and complement operations
5.	Graphical representations of Fuzzy operations
6.	Cartesian product and Fuzzy Relations
7.	Fuzzy Compositions
8.	Fuzzy equivalence Relations
9.	Value assignments for Fuzzy Relations
10.	Fuzzy Set elements and Properties
11.	Concepts of Fuzzification and Defuzzifications
13.	Methods of Defuzzification
14.	Alpha Cut for Crisp conversion
15.	Alpha Cut for Fuzzy Equivalence Relation
16.	Fuzzy Propositions
17.	Fuzzy Implications
18.	Concepts of Fuzzy Rule based Systems
19.	Mamdani Fuzzy Rule based Systems
20.	Sugeno (TSK) Fuzzy Rule based Systems
21.	Tsukamoto Fuzzy Rule based Systems
22.	Development of Fuzzy membership functions
23.	Intuition and Inference method
24.	Rank ordering and Neural network method
25.	Other methods for development of Fuzzy membership functions
26.	Fuzzy Decision Masking
27.	Fuzzy Ordering
28.	Nontransitive Ranking
29.	Preference and Consensus
30.	Multi objective Decision Making: Concepts and Requirements
31.	Multi objective Decision Making: Examples
32.	Multi objective Decision Making: Practical Applications
33.	Fuzzy Bayesian Decision Making: Concepts and requirements
34.	Fuzzy Bayesian Decision Making: Examples
35.	Decision Making Under Fuzzy States
36.	Fuzzy Classification
37.	Fuzzy Clustering
38.	Fuzzy C-Means Clustering
39.	Fuzzy C-Means Clustering (Cont.)

40.	Hard C-Means and Fuzzy C-Means Algorithms
41.	Fuzzy pattern Recognition
42.	Feature Analysis
43.	Single Sample Identification
44.	Multi Feature Pattern Recognition
45.	Fuzzy Extension Principles
46.	Approximate Methods of Fuzzy Extension
47.	Fuzzy control Systems
48.	Simple Fuzzy Logic Controllers
49.	Fuzzy Logic Controllers (Cont.)
50.	Industrial Applications

Name of Program	M.Tech. VED	Semester I/II	Year I

Name of Course	**Neural Networks**
Course Code	VED 603
Core / Elective / Other	Open Elective
Prerequisite:	
1.	Nil
Course Outcomes: After completion of the course, the students will be able to	
CO1	Outline concepts of Neural Networks.
CO2	Explain about various Neural Networks based systems
CO3	Formulate and solve various real life problems using concepts of ANN.
Description of Contents in brief:	
1.	Introduction to ANN
2.	Artificial Neurons architectures
3.	Learning Algorithms
4.	Neural Network Architectures
5.	Feed forward and Fee Back Neural Networks
6.	Self Organizing Feature Maps (SOM)
7.	Concepts of Machine Learning
8.	Convolutional Neural Networks
9.	Applications of CNN
10.	Miscellaneous Topics
List of Text Books:	
1.	Simon Haykin, " Neural Networks: A Comprehensive Foundations", MacMillan Publishing Company, 1994
2.	Satish Kumar, "Neural Networks: A Classroom Approach", McGraw Hill Education, 2004
3.	Mohamad Hassoun, "Fundamentals of Artificial Neural Networks", MIT Press, 2003
List of Reference Books:	
1.	Tariq Rashid, "Make Your Own Neural Network: A Gentle Journey Through theMathematics of Neural Networks" Kindle, 2016.
2.	Wolfgang Beer**, "**Applied Artificial Intelligence: Neural networks and deep learning with Python and Tensor Flow", Kindle, 2017**.**
3.	P.J. Braspenning, "Artificial Neural Networks: An Introduction to ANN Theory and Practice", Springer 1995.
URLs:	
1.	https://www.coursera.org/learn/neural-networks-deep-learning

2.	https://www.coursera.org/learn/machine-learning
3.	https://www.edx.org/learn/neural-network

Lecture Plan (about 40-50 Lectures):

Lecture No.	Topic
1.	Introduction and historical aspects of Neural Networks
2.	Components of biological Neurons
3.	Artificial Neuron Models
4.	Aggregation Functions
5.	Activation Functions
6.	Errors and error functions
7.	Concept and importance of learning rate
8.	Concepts of Learning methods
9.	Supervised Learning Methods
10.	Supervised Learning Methods (Cont.)
11.	Supervised Learning Methods (Cont.)
13.	Unsupervised Learning Methods
14.	Unsupervised Learning Methods (Cont.)
15.	Unsupervised Learning Methods (Cont.)
16.	Reinforcement Learning
17.	Neural network Architectures
18.	Feed Forward Neural Networks
19.	Feed Forward Neural Networks (cont.)
20.	Feed Forward Neural Networks (cont.)
21.	Radial basis Function Neural networks
22.	Radial basis Function Neural networks (Cont.)
23.	Radial basis Function Neural networks (Cont.)
24.	Recurrent Neural Networks
25.	Recurrent Neural Networks (Cont.)
26.	Recurrent Neural Networks (Cont.)
27.	Concepts of Hopfield Neural networks
28.	Hopfield Neural networks (Cont.)
29.	Electrical Equivalence of Hopfield network
30.	Energy function of Hopfield Network
31.	Weight calculation of Hopfield networks
32.	State updating and applications of Hopfield networks
33.	Adaptive Resonance Theory (ART)
34.	Adaptive Resonance Theory(Cont.)
35.	Self Organizing Feature Maps (SOM)
36.	Self Organizing Feature Maps (SOM) (Cont.)
37.	Boltzmann Machine
38.	Restricted Boltzmann Machine (RBM)
39.	Concepts of Deep Learning and Machine learning
40.	Convolutional Neural networks (CNN)
41.	Convolutional Neural networks (CNN) (Cont.)

42.	CNN for Image Processing
43.	Neural network Applications in Communication systems
44.	Neural network Applications in Image Processing
45.	Neural network Applications in Antenna Theory

Name of Program	M.Tech VED	SemesterI/II	Year I
Name of Course	**Queuing Theory**		
Course Code	VED 604		
Core / Elective / Other	Open Elective		

Prerequisite:	
1.	Some knowledge of basic statistical theory and probability
2.	Stochastic Models for Computer Science
Course Outcomes: After completion of the course, the students will be able	
CO1	Demonstrate computer system modeling and performance analysis.
CO2	Recall the basic probability tools and concepts of modeling such as Markov models and queuing theory.
CO3	Adapt necessary mathematical support and confidence to tackle real life problems.
Description of Contents in brief:	
1.	Queuing Models: Data Traffic Characteristic: Poisson process; Birth-Death Processes
2.	Chain Models; M/M/1Queues: Delay and Little's Formula; M/M/S/K Queues: Average Queue Length, Delay and Waiting Time, Blocking Probability; M/G/1 Queues-Imbedded Markov
3.	Pollaczek-Kinchin Transform Formula, Delay Formula Using Residual Service Time, Network of Queues and Jackson's Theorem Queuing Theory: Introduction, Queuing
4.	Markov Chains Elements of a Queuing System, Operating Characteristics of Queuing system, Probability distributions in Queuing system, Probability distributions in Queuing systems
5.	Distribution of arrivals, Distribution of Inter – arrival times, Distribution of Departures, Distribution of Service Times, classification of Queuing Models, Definition of transient and steady states, Poisson Queuing systems.
List of Text Books:	
1.	Kishor S. Trivedi, "Probability & Statistics with Reliability, Queuing, and Computer Science Applications", Prentice Hall of India Pvt. Ltd., 2000.
2.	Donald Gross , Carl M. Harris, "Fundamentals of Queuing Theory", Wiley Series in Probability and Statistics
List of Reference Books:	
1.	A.O. Allen, "Probability, Statistics and Queuing Theory with Computer Applications", Elsevier, 2nd edition, 2005
2.	2. H.A. Taha, "Operations Research", Pearson Education, Asia, 8th edition,2007

URLs:	
1.	https://arxiv.org/pdf/1307.2968.pdf

Lecture Plan (about 40-50 Lectures):

Lecture No.	**Topic**
1.	Queuing Models
2.	Poisson process
3.	Data Traffic Characteristic
4.	Birth-Death Processes
5.	Birth-Death Processes
6.	Birth-Death Processes
7.	Chain Models; M/M/1Queues
8.	Chain Models; M/M/1Queues
9.	Delay and Little's Formula
10.	Tutorial-1
11.	M/M/S/K Queues
12.	M/M/S/K Queues
13.	Average Queue Length
14.	Delay and Waiting Time
15.	Blocking Probability
16.	Tutorial-2
17.	M/G/1 Queues
18.	M/G/1 Queues
19.	Imbedded Markov
20.	Pollaczek-Kinchin Transform Formula
21.	Tutorial-3
22.	Delay Formula Using Residual Service Time
23.	Network of Queues
24.	Jackson's Theorem Queuing Theory
25.	Introduction, Queuing
26.	Introduction, Queuing
27.	MarkovChains Elements of a Queuing System
28.	Operating Characteristics of Queuing system
29.	Probability distributions in Queuing system
30.	Probability distributions in Queuing systems
31.	Tutorial-4
32.	Distribution of arrivals
33.	Distribution of Inter – arrival times
34.	Distribution of Departures
35.	Distribution of Service Times
36.	classification of Queuing Models
37.	Definition of transient and steady states

38.	Definition of transient and steady states
39.	Poisson Queuing systems
40.	Tutorial-5
41.	Tutorial-6

Name of Program	**M.Tech VED**	**Semester I/II**	**Year I**
Name of Course	**Biomedical Signal Processing**		
Course Code	VED605		
Core / Elective / Other	Open Elective		

Prerequisite:

1.	Digital Image Processing, Digital Signal Processing

Course Outcomes: After completion of the course, the students will be able to

CO1	Illustrate the major medical signal modelities and their acquisition systems.
CO2	Demonstrate the various signal processing techniques of medical signals.
CO3	Recall various medical signal analysis methods.
CO4	Illustrate signal processing algorithms for enhancement, de-noising, compression.
CO5	Develop domain specific medical signal classification models for computer aided diagnosis.

Description of Contents in brief:

1.	Introduction to biomedical Signals, Radiographic, Tomographic, Magnetic Resonance, Ultrasound and Microscopic Imaging. Image formats. Enhancement, Restoration, Segmentation and compression of medical Signals. Feature extraction and Statistical measurement based signal processing systems. Medical signal processing in frequency domain, Texture and shape based analysis. Object detection and extraction, Computer aided diagnostic techniques, Classification of medical signals.

List of Text Books:

1.	Biomedical Signal and ImageProcessing, KayvanNajarian, Robert Splinter, CRC Press,2016
2.	Medical Imaging Signals and Systems, Jerry L. Prince, Jonathan Links, 4th Edition, Pearson, 2015.

List of Reference Books:

1.	Biomedical Image Processing, Thomas M. Deserno, Springer Science & Business Media, 2011
2.	Biomedical Signal Analysis, Rangaraj M. Rangayyan, John Wiley and Sons, 2015
3.	Medical image processing, G.R. Sinha, BhagwatiCharan Patel, 1st Edition, PHI, 2014.
4.	Machine Learning, SaikatDutt, Subramanian Chandramouli, Amit Kumar Das, 1st Edition, Pearson, 2018.
5.	Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig, 3rd Edition, Pearson, 2015.

URLs:

1.	Nil

Lecture Plan (about 40-50 Lectures):

Lecture No.	**Topic**
1.	Review of Digital Image Processing
2.	Review of Digital Signal Processing
3.	Introduction to biomedical Signals

4.	Radiographic Images
5.	Radiographic Image Acquisition System
6.	Enhancement, Restoration, Segmentation and compression of medical Signals.
7.	Tomographic Images
8.	Tomographic Image Acquisition System
9.	Tomographic Image reconstruction
10.	Magnetic Resonance Images
11.	Magnetic Resonance Acquisition System
12.	Magnetic Resonance Reconstruction
13.	Ultrasound Images
14.	Ultrasound Image Acqusition System
15.	Medical Image formats I
16.	Medical Image formats II
17.	Enhancement of Medical signals
18.	Compression of Medical signals
19.	Denoising of Medical signals
20.	Statistical measurement based signal processing systems I
21.	Statistical measurement based signal processing systems II
22.	Feature extraction
23.	Medical signal processing in spatial domain I
24.	Medical signal processing in spatial domain II
25.	Medical signal processing in spatial domain III
26.	Medical signal processing in frequency domain I
27.	Medical signal processing in frequency domain II
28.	Medical signal processing in frequency domain III
29.	Texture based analysis I
30.	Texture based analysis II
31.	Shape based analysis I
32.	Shape based analysis II
33.	Object detection and extraction I
34.	Object detection and extraction II
35.	Computer aided diagnostic techniques I
36.	Computer aided diagnostic techniques II
37.	Computer aided diagnostic techniques III
38.	Classification of medical signals I
39.	Classification of medical signals II
40.	Classification of medical signals III

Name of Program	**M.Tech. VED**	**Semester I/II**	**YearI**

Name of Course	**Operation Research**
Course Code	VED 606
Core / Elective / Other	Open Elective

Prerequisite:

1.	Knowledge of basic engineering
2.	Understanding of research methodology

Course Outcomes: After completion of the course, the students will be able to

CO1	Describe characteristics and scope of Operation Research and formulate mathematical problems on Operation Research
CO2	Evaluate optimum solution using dynamic programming for different applications.
CO3	Devise appropriate queuing model for practical application

Description of Contents in brief:

1.	Operations Research and Linear Programming Problem
2.	Transportation and Assignment
3.	Queuing Theory and Inventory Control
4.	Replacement theory and Game Theory
5.	Decision Theory and Project Management

List of Text Books:

1.	Operations Research: An Introduction by HamdyTaha, Pearson
2.	Operations Research by R. Paneerselvam, Prentice Hall of India Pvt. Ltd
3.	Operations Research by H N wagner, Prentice hall.

List of Reference Books:

1.	Operations Research by A M Natarajan, P Balasubramani, A Tamilarasi, Pearson Education Inc
2.	Operations Research by P Mariappan, Pearson
3.	Optimization in Operations Research by Ronald Rardin, Pearson Education Inc.

URLs:

1.	https://www.pearson.com/us/higher-education/program/Taha-Operations-Research-An-Introduction-10th-Edition/PGM334070.html
2.	https://books.google.co.in/books/about/Operations_Research.html?id=PO61GwAACAAJ
3.	https://www.abebooks.com/first-edition/Operations-Research-A.M-Natarajan-Balasubramani-Tamilarasi/16381568544/bd

Lecture Plan (about 40-50 Lectures):

Lecture No.	**Topic**
1.	Operations Research: Origin of Operation Research
2.	Historical Standpoint, Methodology and Different Phases
3.	Characteristics, Scope and Application of Operations Research
4.	Linear Programming Problem: Introduction

5.	Requirement of LP and Basic Assumptions
6.	Formulation of LP and General Statement of LP
7.	Solution techniques of LP: Graphical Methods
8.	Analytical Methods: Simplex
9.	Big M and Two Phase
10.	Sensitivity Analysis
11.	Primal and Dual Problems
12.	Economic Interpretation
13.	Transportation and Assignment: Transportation Problems definition, Linear form
14.	Solution methods: North west corner method
15.	least cost method
16.	Vogel's approximation method
17.	Degeneracy in transportation
18.	Modified Distribution method
19.	Unbalanced problems and profit maximization problems
20.	Transshipment Problems
21.	Assignment Problems and Travelling sales man Problem
22.	Queuing Theory: Basis of Queuing theory, , ,
23.	elements of queuing theory and Kendall's Notation
24.	Operating characteristics of a queuing system
25.	Classification of Queuing models
26.	Preliminary examples of M/M/1:∞/FCFA
27.	Inventory Control: Inventory classification
28.	Different cost associated to Inventory and Economic order quantity
29.	Inventory models with deterministic demands and ABC analysis
30.	Replacement theory: Introduction, Replacement of capital equipment which depreciated with time
31.	replacement by alternative equipment
32.	Group and individual replacement policy
33.	Game Theory: Introduction, Characteristics of Game Theory
34.	Two Person and Zero sum games, Pure strategy
35.	Dominance theory and Mixed strategies (2x2, mx2)
36.	Algebraic and graphical methods.
37.	Decision Theory: Introduction, Decision under certainty
38.	Decision under risk
39.	Decision under uncertainty: Laplace criterion
40.	MaxiMin criterion, MiniMax criterion
41.	savage MiniMax regret criterion
42.	hurwicz criterion, Decision tree
43.	Project Management: Introduction to PERT and CPM
44.	Critical Path calculation
45.	float calculation and its importance
46.	Cost reduction by Crashing of activity.

Name of Program	**M. Tech. VED**	**Semester I/II**	**Year 1**
Name of Course	**Internet of Things (IoT)**		
Course Code	**VED 607**		
Core / Elective / Other	**Open Elective**		

Prerequisite:

1.	Computer Networks

Course Outcomes: After completion of the course, the students will be able to

CO1	Understand the basic concepts, architecture and applications of IoT.
CO2	Understand the fundamentals of sensors, actuators and IoT network.
CO3	Have a brief idea of the communication protocols for the IoT networks.
CO4	Understand the data analysis for IoT networks.
CO5	Identify the application areas of the IoTs.

Description of Contents in brief:

1.	Introduction to IoT: What is IoT, Impact of IoT, IoT Challenges. IoT network architecture & design: oneM2M, IoTWF, Core functional stack, Data management stack.
2.	'Things' in IoT: Sensors, Actuators, Smart objects, Basics of Sensor Networks.
3.	Communicating smart objects: Communication criteria, IoT access technologies- IEEE 802.15.4, IEEE 802.15.4e, IEEE 802.11ah, IEEE 1901.2a, NB-IoT. IoT Network Layer: IP as IoT network layer, 6LoWPAN, 6Lo, 6TiSCH, RPL. IoT Application Layer: IoT application transport methods, CoAP, MQTT.
4.	Data and Analytics for IoT: IoT Middleware, Data analytics for IoT, Big Data analytics tools and technology.
5.	IoT application case study: Smart City, Smart Grid, Smart Transportation, Smart Manufacturing, Smart Healthcare.

List of Text Books:

1.	D. Hanes, G. Salgueiro, P. Grossetete, R. Barton, J. Henry; IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, 1st Edition, Pearson India Pvt. Ltd., 2018.
2.	A. Bahga, V. Madisetti; Internet of Things: A Hands-on Approach, 1st Edition, Universities Press (India) Pvt. Ltd., 2015.

List of Reference Books:

1.	Y. Kanetkar, S. Korde; 21 Internet of Things (IOT) Experiments: Learn IoT, the programmer's way, 1st Edition, BPB Publications, 2018.

URLs:

1.	Nil

Lecture Plan (about 40-50 Lectures):

Lecture No.	**Topic**
1	Introduction to IoT:
2	Impact of IoT, IoT Challenges.
3	IoT network architecture & design: oneM2M
4	IoTWF
5	Core functional stack
6	Data management stack.

7	'Things' in IoT: Sensors,.
8	Actuators
9	Smart objects
10	Basics of Sensor Networks
11	Communicating smart objects: Communication criteria.
12	IoT access technologies- IEEE 802.15.4
13	IEEE 802.15.4e
14	, IEEE 802.11ah,
15	IEEE 1901.2a, NB-IoT
16-17	IoT Network Layer: IP as IoT network layer
18	6LoWPAN
19	6Lo, 6TiSCH,
20	RPL.
21-22	IoT Application Layer: IoT application transport methods
23	CoAP, MQTT.
24	Data analytics for IoT.
25-27	, Big Data analytics tools and technology
28-30	Data and Analytics for IoT: IoT Middleware
31-32	IoT application case study: Smart City
33-35	Case Study 2: Smart Grid.
36-38	Case Study 3: Smart Transportation
39	Case Study 4: Smart Manufacturing
40	Case Study 5 Smart Healthcare

Name of Program	M. Tech. (Communication Systems)	Semester I/II	Year 1

Name of Course	**Applied Machine Learning and Deep Learning**
Course Code	**CS 605**
Core / Elective / Other	**Elective**

Prerequisite:

1.	Basics of probability and statistical inference, and basics of machine learning (such as regression, classification, clustering).

Course Outcomes: After completion of the course, the students will be able to

CO1	Understand the advanced Machine learning algorithms
CO2	Outline the application of advanced machine learning in the design of physical layer techniques for wireless communications
CO3	Create the application of machine learning and deep learning in network design

Description of Contents in brief:

The objective of this course is to teach modern topics in machine learning. The course will deepen the student's knowledge of how to build computer systems that learn from experience. The course assumes basic knowledge of introductory machine learning, and a good background on probability and statistics, linear algebra, and optimization methods. We will cover modern topics such as learning theory, transfer learning, meta-learning, domain adaptation, self-adaptive learning algorithms, deep learning, Gaussian processes, and kernel methods. Students will read papers from main conferences in machine learning and will learn to identify novel ideas within the field.

List of Text Books:

1.	Deep Learning- Ian Goodfelllow, Yoshua Benjio, Aaron Courville, The MIT Press
2.	F. V. Jensen. "Bayesian Networks and Decision Graphs". Springer. 200

List of Reference Books:

1.	T. J. OShea, T. Erpek, and T. C. Clancy. Deep learning based MIMO communications.

URLs:

1.	Nil

Lecture Plan (about 40-45 Lectures):

Lecture No.	Topic
1-2	Introduction to Advanced Machine Learning Meta-Learning
3-4	Self-Adaptive Learning
5-6	Semi-Supervised Learning

7-8	Transfer Learning
9-10	Domain Adaptation
11-12	Active learning
13-14	Kernel Methods
15-16	Gaussian Processes
17-19	*Unsupervised Bayesian Modeling*
19-20	Inference Procedures
21-22	Introduction to deep learning, Optimization Techniques, Gradient Descent, Batch Optimization etc.
23-24	Introduction to Neural Network, Multilayer Perceptron, Back Propagation Learning
24-25	Unsupervised Learning with Deep Network, Autoencoders
26-27	Convolutional Neural Network, Building blocks of CNN, Transfer Learning
27-28	Revisiting Gradient Descent, Momentum Optimizer, RMSProp, Adam
29-30	Effective training in Deep Net- early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization
31-32	Recent Trends in Deep Learning Architectures, Residual Network, Skip Connection Network, Fully Connected CNN etc.
33-34	RNN Networks
35-38	LSTM Networks
39-40	Generative Modeling with DL, Variational Autoencoder, Generative Adversarial Network Revisiting Gradient Descent, Momentum Optimizer, RMSProp, Adam

Name of Program		**M. Tech. VED**	**SemesterI/II**	**Year I**
Name of Course		**Data Compression and Cryptography**		
Course Code		VED 516		
Core / Elective / Other		Department Elective		
Prerequisite:				
1.	Information Theory			
2.	Information Security			
3.	Network Security			
Course Outcomes: After completion of the course, the students will be able to				
CO1	Contrast compression techniques			
CO2	Explain mathematical models of compression techniques			
CO3	Illustrate decompressing techniques			
CO4	List various types of security attacks			
CO5	Distinguish various types of encryption techniques			
Description of Contents in brief:				
1.	Compression Techniques: Loss less compression, Lossy Compression, Measures of performance, Modeling and coding,			
2.	Mathematical Preliminaries for Lossless compression: A brief introduction to information theory, Models: Physical models, Probability models, Markov models, composite source model,			
3.	Coding: uniquely decodable codes, Prefix codes.			
4.	Introduction to security attacks, services and mechanism,			
5.	Classical encryption techniques- substitution ciphers and transposition ciphers, cryptanalysis, steganography, Stream and block ciphers.			
List of Text Books:				
1.	Khalid Sayood, “Introduction to Data Compression” , Morgan Kaufmann Publishers.			
2.	William Stallings, “Cryptography and Network Security: Principals and Practice”, Pearson Education.			
3.	Behrouz A. Forouzan, “Cryptography and Network Security”, TMH.			
List of Reference Books:				
1	V. .K. Jain ,“Cryptography and Network Security”			
2.	Bruce **“**Applied Cryptography: Protocols, Algorithms and Source Code in C 20th Edition, Kindle Edition **”**			
3.	Helen F. Gaines “Cryptanalysis: A Study of Ciphers and Their Solution”			
URLs:				
1.	https://nptel.ac.in/courses/106106221/			
2.	https://nptel.ac.in/courses/106105162/			

Lecture Plan (about 40-50 Lectures):	
Lecture No.	**Topic**
1.	Compression Techniques: Loss less compression
2.	Compression Techniques: Loss less compression continued
3.	Lossy Compression
4.	Lossy Compression continued
5.	Measures of performance
6.	Measures of Performance continued
7.	Modeling and coding
8.	Modeling and coding continued
9.	Mathematical Preliminaries for Lossless compression Models
10.	Mathematical Preliminaries for Lossless compression Models continued
11.	A brief introduction to information theory,
12.	A brief introduction to information theory continued
13.	Physical models
14.	Physical models continued
15.	Probability models
16.	Markov models
17.	Markov models continued
18.	composite source model
19.	composite source model continued
20.	Coding: uniquely
21.	Coding: uniquely continued
22.	decodable codes
23.	Prefix codes
24.	Prefix codes continued
25.	Introduction to security attacks
26.	Introduction to security attacks continued
27.	Security services
28.	Security services continued
29.	Security mechanism
30.	Security mechanism continued
31.	Classical encryption techniques- substitution ciphers
32.	Classical encryption techniques- substitution ciphers continued
33.	transposition ciphers
34.	transposition ciphers continued
35.	Cryptanalysis
36.	cryptanalysis continued
37.	Steganography
38.	Steganography continued
39.	Stream and block ciphers
40.	Stream and block ciphers continued

Name of Program	M.TECH VED	**Semester** II	**Year** I
Name of Course	Machine Learning for VLSI		
Course Code	VED 515		
Core / Elective / Other	Department Elective		

Prerequisite:	
1.	Statistics, Probability, Linear Algebra,
2.	Trigonometry, calculus
3.	Programming Languages - Python
Course Outcomes: After completion of the course student will be able to:	
CO1	Ability to understand concepts of machine learning and algorithm design.
CO2	Ability to apply machine learning and algorithm design concepts for analysis of problems
CO3	Ability to analyze and process datasets using machine learning techniques for extracting useful information
CO4	Ability to design and implement machine learning models for the given task.
CO5	Analyse different machine learning algorithms and describe machine learning in VLSI computer-aided design.
Description of Contents in brief:	
1.	Review of Probability Theory and Linear algebra, Mathematical Concepts Review - Central Tendency - Dispersion of Data -
2.	Descriptive Data Summaries - K-Nearest Neighbors Classifier - Bayes Classifiers - Classifier Performance Measures.
3.	Decision Tree - Ensemble Methods - Ordinary Least Squares - Artificial Neurons - Perceptron - Multi Layer Perceptron and Back Propagation -
4.	Hyperparameter Tuning - Cluster Analysis - Partitioning Methods - Hierarchical Methods - Density-Based Methods - Cluster Evaluation.
5.	Graphs - Definitions and Applications - Graph Connectivity - Graph Traversal - Testing Bipartiteness - Breadth - First Search - Directed Graphs
6.	Directed Acyclic Graphs Topological Ordering - Interval Scheduling - Optimal Caching - Shortest Paths - Minimum Spanning Tree - Clustering - Huffman Codes - Data Compression - Partitioning Problems - Graph Coloring.
List of Text Books:	
1.	Ethem Alpaydin, “Introduction to Machine Learning”, PHI, 2005
2.	Bishop, C. (2006). Pattern Recognition and Machine Learning. Berlin: Springer-Verlag.
3.	Jon Kleinberg, ÉvaTardos, Algorithm Design, Pearson, 2006.
List of Reference Books:	
1.	Mitchell Tom, “Machine learning”, New York, NY: McGraw-Hill, ISBN:9780070428072
2.	Bishop Christopher, “Neural Networks for Pattern Recognition”, New York, NY: Oxford University Press, ISBN: 9780198538646
3.	Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani “Introduction to Statistical Learning”, Springer, 2013.

4.	Elfadel, Ibrahim M., Duane S. Boning, and Xin Li, eds. Machine Learning in VLSI Computer-Aided Design. Springer, 2019.
5.	Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Second Edition, O'Reilly Media, 2019.
URLs:	
1.	https://youtu.be/xcVZkkxrEDk?si=AkDkQuV-T1pGXrKz
2.	https://youtu.be/_5OsLjSq0kQ?si=RjFsMmZIZTXAyQXb
3.	https://youtu.be/dUDOccxcl-E?si=NDVUeIzn-2aSXFba

Lecture Plan (about 40-50 Lectures):

Lecture No.	**Topic**
1 -3	Introduction: Aims and applications of machine learning, learning systems, various aspects of developing a learning system
4 - 6	Linear and Logistic Regression: Linear regression, Decision trees, overfitting
7 - 10	Instance based learning: Instance based learning, Feature reduction, Collaborative filtering-based recommendation
11 - 14	Bayesian learning: Probability and Bayes learning
15 - 17	Logistic Regression: Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM
18 - 20	Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network
21 - 25	Computational learning: Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning
26 - 30	Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture model
30 - 35	Machine Learning in VLSI Design: A Taxonomy for Machine Learning in VLSI Design
36 - 38	Machine Learning for Lithographic Process Models: Masks, and Physical Design, Yield Enhancements, Machine Learning based Aging Analysis
39 - 40	Machine Learning Hardware: Energy-Efficient Design of Advanced Machine Learning Hardware

Name of Program	M.TECH VED	**Semester** II	**Year** I
Name of Course	Nano Technology		
Course Code	VED 514		
Core / Elective / Other	Department Elective		

Prerequisite:	
1.	Semiconductor Devices and Physics
2.	Material Science and chemistry
3.	Bio- technology
Course Outcomes: After completion of the course student will be able to:	
CO 1	Impart the basic knowledge of Nano chemistry and synthetic methods involved in nanotechnology.
CO 2	Understand the basic principles and instrumentation of characterization techniques used in nanotechnology and its technological importance.
CO 3	Identify the materials, properties, syntheses and fabrication, characterization and applications in various fields.
CO 4	Enlighten the needs and utilization of nanomaterials in the various fields such as energy, water treatment process, Agriculture, medicine, engineering and textile industries.
CO 5	Apply the knowledge of Nanocomposites, Biodegradable polymer-based nanocomposites, Clay polymer nanocomposites.
Description of Contents in brief:	
1.	History of nano science, definition of nano meter, nano materials, nano technology. Classification of nano materials.
2.	Mechanical properties, electrical properties, dielectric properties, thermal properties, magnetic properties, opto electronic properties.
3.	X-Ray diffraction and Scherrer method, scanning electron microscopy, transmission electron microscopy, scanning probe microscopy, atomic force microscopy,
4.	Characterization of carbon allotropes, synthesis of diamond – nucleation of diamond, growth and morphology.
5.	Synthesis of bulk polycrystalline samples, growth of single crystals. Synthesis techniques for preparation of nano particle
6.	Applications in material science, biology and medicine, surface science, energy and environment. Applications of nano structured thin fins, applications of quantum dots.
List of Text Books:	
1.	Nano science and nano technology by M.S Ramachandra Rao, Shubra Singh, Wiley publishers.
2.	Nanotechnology: technology Revolution of 21st Century Rakesh Rathi (S. Chand & Company, New Delhi
3.	Nano Materials- A.K.Bandyopadhyay/ New Age Introdu
List of Reference Books:	
1.	Introduction to Nano Technology by Charles P. Poole, Jr., Frank J.Owens, Wiley publishers.
2.	Nanotechnology by Jermy J Ramsden, Elsevier publishers.
3.	Principles of Nanotechnology by Phani Kumar, Scitech
4.	Nanotechnology the Science of Small by M.A Shah, K.A Shah, Wiley Publishers.

5.	Introduction to Nanoscience, S. M. Lindsay (Oxford Press)
6.	Nano: The Essentials, T. Pradeep (Tata McGraw Hill)
URLs:	
1.	https://www.youtube.com/results?search_query=Characterization+of+Nanomaterials
2.	https://www.youtube.com/watch?v=qUEbxTkPIWI&list=PLbMVogVj5nJSl_2XmFjuRmvuAgCOZXUjv
3.	https://www.youtube.com/watch?v=4j5cMHVPStc

Lecture Plan (about 40-50 Lectures):

Lecture No.	**Topic**
1.	Nanotechnology, Nanotech Generation, Nanoscience,
2.	Classification of nano materials. Crystal symmetries, crystal directions, crystal planes. Band structure.
3.	Molecular nanotechnology, Nanostructured materials by self-assembly, Nanocrystals,
4.	Crystal symmetries, crystal directions, crystal planes. Band structure.
5.	Mechanical properties, electrical properties, dielectric properties, thermal properties,
6.	magnetic properties, opto electronic properties. Effect of size reduction on properties, electronic structure of nano materials.
7.	Synthesis of bulk polycrystalline samples, growth of single crystals.
8.	Synthesis techniques for preparation of nano particle – Bottom Up Approach – sol gel synthesis
9.	Synthesis techniques for preparation of nano particle – Bottom Up Approach – sol gel synthesis
10.	thin film growth, PVD and CVD; Top Down Approach – Ball milling, micro fabrication, lithography.
11.	thin film growth, PVD and CVD; Top Down Approach – Ball milling, micro fabrication, lithography.
12.	X-Ray diffraction and Scherrer method, scanning electron microscopy,
13.	X-Ray diffraction and Scherrer method, scanning electron microscopy,
14.	scanning probe microscopy, atomic force microscopy, piezoresponse microscopy, X-ray photoelectron spectroscopy,
15.	scanning probe microscopy, atomic force microscopy, piezoresponse microscopy, X-ray photoelectron spectroscopy,
16.	XANES and XAFS, angle resolved photoemission spectroscopy, diffuse reflectance spectra, photoluminescence spectra, Raman spectroscopy.
17.	XANES and XAFS, angle resolved photoemission spectroscopy, diffuse reflectance spectra, photoluminescence spectra, Raman spectroscopy.
18.	XANES and XAFS, angle resolved photoemission spectroscopy, diffuse reflectance spectra, photoluminescence spectra, Raman spectroscopy.
19.	Characterization of carbon allotropes, synthesis of diamond – nucleation of diamond, growth and morphology.
20.	Characterization of carbon allotropes, synthesis of diamond – nucleation of diamond, growth and morphology.
21.	Characterization of carbon allotropes, synthesis of diamond – nucleation of diamond, growth and morphology.
22.	Applications of nano crystalling diamond films, grapheme, applications of carbon nano tubes.
23.	Applications of nano crystalling diamond films, grapheme, applications of carbon

	nano tubes.
24.	Applications of nano crystalling diamond films, grapheme, applications of carbon nano tubes.
25.	Tools and Techniques, microscopy, Metrology, Simulation, Carbon Nanotube (CNT)
26.	Purification of CNTs, Dispersion, Scanning Probe Microscopes (SPM), Atomic Force Microscopy (AFM),
27.	Purification of CNTs, Dispersion, Scanning Probe Microscopes (SPM), Atomic Force Microscopy (AFM),
28.	Microlithography and MEMs, Electron beam lithography and focused ion bombardment.
29.	Applications in material science, biology and medicine,
30.	surface science, energy and environment.
31.	Identified potential applications, Expected benefits from nanotechnologies,
32.	Applications of nano structured thin fins, applications of quantum dots.
33.	Applications of nano structured thin fins, applications of quantum dots.
34.	Energy and Energy Efficiency, new energy producers, Medicine, security, Other Applications, Constructions.
35.	Energy and Energy Efficiency, new energy producers, Medicine, security, Other Applications, Constructions.
36.	Green materials, including biomaterials, biopolymers, bioplastics, and composites Nanotech Materials for Truly Sustainable Construction
37.	Green materials, including biomaterials, biopolymers, bioplastics, and composites Nanotech Materials for Truly Sustainable Construction
38.	Societal impact of nanotechnology,
39.	Social and ethical impact, Health and environmental impact,
40.	Risks with nanotechnology, Indian Scenario in nanotechnology

Name of Program	M.TECH VED	**Semester**III	**Year** II
Name of Course	VLSI Design for Signal Processing		
Course Code	VED 513		
Core / Elective / Other	**Department Elective**		

Prerequisite:	
1.	Undergraduate-level **knowledge of digital circuit design**
2.	Elementary DSP operations are sufficient for one to be able to attend the course.
Course Outcomes: After completion of the course student will be able to:	
CO1	Ability to modify the existing or new DSP architectures suitable for VLSI.
CO2	Understand the concepts of folding and unfolding algorithms and applications
CO3	Ability to implement fast convolution algorithms..
CO4	Low power design aspects of processors for signal processing and wireless applications
Description of Contents in brief:	
1.	Introduction to DSP: Typical DSP algorithms, DSP algorithms benefits, Representation of DSP algorithms Pipelining and Parallel Processing Introduction, Pipelining of FIR Digital filters, Parallel Processing, Pipelining and Parallel Processing for Low Power Retiming Introduction, Definitions and Properties, Solving System of Inequalities, Retiming Techniques
2.	Folding and Unfolding: Folding- Introduction, Folding Transform, Register minimization Techniques, Register minimization in folded architectures, folding of Multirate systems Unfolding- Introduction, An Algorithm for Unfolding, Properties of Unfolding, critical Path, Unfolding and Retiming, Applications of Unfolding
3.	Systolic Architecture Design: Introduction, Systolic Array Design Methodology, FIR Systolic Arrays, Selection of Scheduling Vector, Matrix Multiplication and 2D Systolic Array Design, Systolic Design for Space Representations contain Delays.
4.	Fast Convolution: Introduction – Cook-Toom Algorithm – Winogard algorithm – Iterated Convolution – Cyclic Convolution – Design of Fast Convolution algorithm by Inspection
5.	Digital lattice filter structures, bit level arithmetic, architecture, redundant arithmetic. Numerical strength reduction, synchronous, wave and asynchronous pipe lines, low power design. Low Power Design:Scaling Vs Power Consumption, Power Analysis, Power Reduction techniques, Power Estimation Approaches
List of Text Books:	
1.	VLSI Digital signal processing systems, design and implementation, Wiley, Inter Science
2.	Analog VLSI signal and information processing, McGraw HillPrentice Hall, 1985
3.	VLSI and Modern Signal Processing, Prentice Hall
List of Reference Books:	
1.	Digital Signal Processing for Multimedia Systems", Keshab K. Parhi and Takao Nishitani, Marcel Dekker.
2.	Pipelined Lattice and Wave Digital Recursive Filters", J. G. Chung and Keshab K. Parhi, Kluwer.
URLs:	
1.	https://matjournals.com/Journal-of-VLSI-Design-and-Signal-Processing.html

2.	[VLSI Signal Processing - Course (nptel.ac.in)]
3.	[VLSI Design Methodologies for Digital Signal Processing Architectures | SpringerLink]

Lecture Plan (about 40-50 Lectures):

Lecture No.	**Topic**
1.	Introduction to DSP: Typical DSP algorithms, benefits, Representation of DSP algorithms
2.	DSP algorithms
3.	Pipelining and Parallel Processing
4.	Introduction, Pipelining of FIR Digital filters
5.	Parallel Processing for Low Power Retiming
6.	Solving System of Inequalities
7.	Retiming Techniques
8.	Folding and Unfolding:, ,
9.	Folding- Introduction, Folding Transform, Register minimization Techniques
10.	Register minimization in folded architectures, folding of Multirate systems Unfolding
11.	Introduction, An Algorithm for Unfolding
12.	Properties of Unfolding, critical Path, Unfolding and Retiming,
13.	Applications of Unfolding
14.	Systolic Architecture Design
15.	Systolic Array Design Methodology
16.	FIR Systolic Arrays
17.	Selection of Scheduling Vector
18.	Matrix Multiplication and 2D Systolic
19.	Array Design, Systolic Design for Space Representations contain Delays
20.	Fast Convolution: Introduction
21.	Cook-Toom Algorithm
22.	Winogard algorithm
23.	Iterated Convolution
24.	Cyclic Convolution
25.	Design of Fast Convolution algorithm by Inspection
26-30	Digital lattice filter structures,
31.	bit level arithmetic, architecture, redundant arithmetic
32.	Numerical strength reduction
33.	synchronous, wave and asynchronous pipe lines
34.	low power design. Low Power Design
35-37	Scaling Vs Power Consumption
38.	Power Analysis
39.	Power Reduction techniques
40.	Power Estimation Approaches

Name of Program	M.TECH VED	**Semester** III	**Year** II

Name of Course	ELECTRONIC PACKAGING AND TESTING
Course Code	VED 512
Core / Elective / Other	Department Elective

Prerequisite:	
1.	Overview Of Electronic Systems Packaging
2.	Electrical Issues in Packaging
3.	PCB, Surface Mount Technology and Thermal Considerations
Course Outcomes: After completion of the course student will be able to:	
CO1	Functions of an Electronic Package, Packaging Hierarchy, IC packaging: MEMS packaging, consumer electronics packaging, medical electronics packaging, Trends.
CO2	Challenges, Driving Forces on Packaging Technology, Materials for Microelectronic packaging, Packaging Material Properties, Ceramics, Polymers, and Metals in Packaging, Material for high density interconnect substrates.
CO3	Electrical Issues of Systems Packaging, Signal Distribution, Power Distribution, Electromagnetic Interference, Transmission Lines, Clock Distribution, Noise Sources, Digital and RF Issues. Design Process Electrical Design: Interconnect Capacitance, Resistance and Inductance fundamentals; Packaging roadmaps - Hybrid circuits - Resistive, Capacitive and Inductive parasitics.
CO4	IC Assembly - Purpose, Requirements, Technologies, Wire bonding, Tape Automated Bonding, Flip Chip, Wafer Level Packaging, reliability, wafer level burn – in and test. Single chip packaging: functions, types, materials processes, properties, characteristics, trends. Multi chip packaging: types, design, comparison, trends. System – in - package (SIP); Passives: discrete, integrated, and embedded.
CO5	Printed Circuit Board: Anatomy, CAD tools for PCB design, Standard fabrication, Micro via Boards. Board Assembly: Surface Mount Technology, Through Hole Technology, Process Control and Design challenges. Thermal Management, Heat transfer fundamentals, Thermal conductivity and resistance, Conduction, convection and radiation – Cooling requirements
Description of Contents in brief:	
1.	Functions of an Electronic Package, Packaging Hierarchy, IC packaging: MEMS packaging, consumer electronics packaging, medical electronics packaging, Trends.
2.	Challenges, Driving Forces on Packaging Technology, Materials for Microelectronic packaging, Packaging Material Properties, Ceramics.
3.	Polymers, and Metals in Packaging, Material for high density interconnect substrates.
4.	Electrical Issues of Systems Packaging, Signal Distribution, Power Distribution, Electromagnetic Interference, Transmission Lines, Clock Distribution, Noise Sources, Digital and RF Issues.
5.	Design Process Electrical Design: Interconnect Capacitance, Resistance and Inductance fundamentals; Packaging roadmaps - Hybrid circuits - Resistive, Capacitive and Inductive parasitics.
6.	IC Assembly - Purpose, Requirements, Technologies, Wire bonding, Tape Automated Bonding, Flip Chip, Wafer Level Packaging, reliability, wafer level burn – in and test. Single chip packaging: functions, types, materials processes, properties, characteristics, trends.

7	Multi chip packaging: types, design, comparison, trends. System – in - package (SIP); Passives: discrete, integrated, and embedded.
8	Printed Circuit Board: Anatomy, CAD tools for PCB design, Standard fabrication, Micro via Boards. Board Assembly: Surface Mount Technology, Through Hole Technology, Process Control and Design challenges.
9	Thermal Management, Heat transfer fundamentals, Thermal conductivity and resistance, Conduction, convection and radiation – Cooling requirements.
List of Text Books:	
1.	Tummala, Rao R., Fundamentals of Microsystems Packaging, McGraw Hill, 2001.
2.	Blackwell (Ed), The electronic packaging handbook, CRC Press, 2000.
3.	Tummala, Rao R, Microelectronics packaging handbook, McGraw Hill, 2008.
List of Reference Books:	
1.	Bosshart, Printed Circuit Boards Design and Technology, TataMcGraw Hill, 1988.
2.	R.G. Kaduskar and V.B.Baru, Electronic Product design, Wiley India, 2011.
3.	R.S.Khandpur, Printed Circuit Board, Tata McGraw Hill, 2005.
4.	Recent literature in Electronic Packaging
5.	Michael L. Bushnell &Vishwani D. Agrawal,‖ Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits‖, Kluwer Academic Publishers.2000.
6.	M. Abramovici, M. A. Breuer, and A.D. Friedman, ―Digital System Testing and Testable Design‖, Computer Science Press,1990.
URLs:	
1.	http://class.ece.iastate.edu/ee230/
2.	http://inst.eecs.berkeley.edu/~ee130/archives.html
3.	http://class.ece.iastate.edu/ee330/

Lecture Plan (about 40-50 Lectures):

Lecture No.	Topic
1.	Functions of an Electronic Package.
2.	Packaging Hierarchy.
3.	IC packaging: MEMS packaging.
4.	Consumer electronics packaging.
5.	Medical electronics packaging, Trends.
6.	Challenges, Driving Forces on Packaging Technology.
7.	Materials for Microelectronic packaging.
8.	Packaging Material Properties, Ceramics.
9.	Polymers, and Metals in Packaging.
10.	Material for high density interconnect substrates.
11.	Electrical Issues of Systems Packaging.
12.	Signal Distribution, Power Distribution.
13.	Electromagnetic Interference, Transmission Lines.
14.	Clock Distribution, Noise Sources.
15.	Digital and RF Issues.
16.	Design Process Electrical Design: Interconnect Capacitance.
17.	Resistance and Inductance fundamentals.
18.	Packaging roadmaps - Hybrid circuits – Resistive.
19.	Capacitive and Inductive parasitics.
20.	IC Assembly - Purpose, Requirements.

21.	Technologies, Wire bonding, Tape Automated Bonding.
22.	Flip Chip, Wafer Level Packaging.
23.	Multi chip packaging: types.
24.	Design, comparison, trends.
25.	System – in - package (SIP).
26.	Passives: discrete, integrated.
27.	Embedded.
28.	Printed Circuit Board: Anatomy.
29.	CAD tools for PCB design.
30.	Standard fabrication.
31.	Micro via Boards. Board Assembly.
32.	Surface Mount Technology.
33.	Through Hole Technology.
34.	Process Control and Design challenges.
35.	Thermal Management,
36.	Heat transfer fundamentals.
37.	Thermal conductivity and resistance,
38.	Conduction.
39.	convection and radiation.
40.	Cooling requirements.