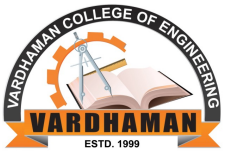

VARDHAMAN COLLEGE OF ENGINEERING

(AUTONOMOUS)

Affiliated to **JNTUH,** Approved by **AICTE,** Accredited by **NAAC** with **A++** Grade, **ISO 9001:2015** Certified

Kacharam, Shamshabad, Hyderabad - 501218, Telangana, India

www.vardhaman.org

CURRICULUM

For

Master of Technology

Digital Electronics and Communication Systems

Under

Choice Based Credit System (CBCS)

M. Tech. - Regular Two Year PG Program

(For batches admitted from the Academic Year 2022 - 2023)

October 2022

M. Tech – Digital Electronics and Communication Systems

Regulations: VCE-R22

College Vision:

- **To be a pioneer institute and leader in engineering education to address societal needs through education and practice.**

College Mission:

- **To adopt innovative student centric learning methods.**
- **To enhance professional and entrepreneurial skills through industry institute interaction.**
- **To train the students to meet dynamic needs of the society.**
- **To promote research and continuing education.**

Department Vision:

- To produce competent engineers with social responsibility to address the global challenges in the field of Electronics and Communication Engineering.

Department Mission:

- Promote active learning strategies to facilitate student centric learning.
- Provide self learning capabilities to enhance employability and entrepreneurial skills.
- Inculcate human values and ethics to make learners sensitive towards societal issues.
- Strengthen core competencies among the learners through experiential curriculum.

Program Educational Objectives(PEOs):

- **PEO1: Graduates will continue perpetual learning to contribute new knowledge and apply innovatively in an appropriate context within the field of VLSI and Communication systems.**

- **PEO2: Graduates will have the ability to identify potential problems to pursue research in multidisciplinary domains.**

- **PEO3: Graduates will demonstrate their leadership qualities to address professional, ethical and societal issues.**

Program Outcomes(POs):

- **PO1: An ability to independently carry out research/investigation and development work to solve practical problems.**
- **PO2: An ability to write and present a substantial technical report/document.**
- **PO3: An ability to demonstrate a degree of mastery over the area of VLSI and communication systems.**
- **PO4:An ability to create novel designs by applying in-depth knowledge to meet the challenges in the communication domain.**
- **PO5: An ability to integrate multiple sub-systems to develop VLSI System-on-Chip and optimize its performance.**

Programme Curriculum Structure
M. Tech – Digital Electronics and Communication Systems

Regulations: VCE-R22

I Year I Semester								
#	Course Code	Title of the Course	Hours per Week and Credit			Assessment Marks		
			L	P	C	CIE	SEE	Total
1	B6401	RTL Simulation and Synthesis with PLDs	3	0	3	40	60	100
2	B6402	Advanced Communications and Networks	3	0	3	40	60	100
3		Professional Elective - I	3	0	3	40	60	100
4		Professional Elective - II	3	0	3	40	60	100
5	B6403	RTL Simulation and Synthesis with PLDs Laboratory	0	4	2	40	60	100
6	B6404	Advanced Communications Laboratory	0	4	2	40	60	100
7	B6001	Research Methodology and IPR	2	0	2	40	60	100
Total			14	08	18	280	420	700
Audit Courses (Non-Credit)								
8		Audit Course-I	2	0	0	-	100	100

I Year II Semester								
#	Course Code	Title of the Course	Hours per Week and Credit			Assessment Marks		
			L	P	C	CIE	SEE	Total
1	B6405	Analog and Digital CMOS VLSI Design	3	0	3	40	60	100
2	B6406	Advanced Digital Signal Processing	3	0	3	40	60	100
3		Professional Elective - III	3	0	3	40	60	100
4		Professional Elective - IV	3	0	3	40	60	100
5	B6407	Analog and Digital CMOS VLSI Design Laboratory	0	4	2	40	60	100
6	B6408	Advanced Digital Signal Processing Laboratory	0	4	2	40	60	100
7	B6441	Mini -Project	0	4	2	100	-	100
Total			12	12	18	340	360	700
Audit Courses (Non-Credit)								
8		Audit Course-II	2	0	0	-	100	100

Programme Curriculum Structure
M. Tech – Digital Electronics and Communication Systems

Regulations: VCE-R22

II Year I Semester								
#	Course Code	Title of the Course	Hours per Week and Credit			Assessment Marks		
			L	P	C	CIE	SEE	Total
1		Professional Elective -V	3	0	3	40	60	100
2		Open Elective	3	0	3	40	60	100
3	B6442	Dissertation Work Review - II	0	12	6	100	-	100
Total			06	12	12	180	120	300

II Year II Semester								
#	Course Code	Title of the Course	Hours per Week and Credit			Assessment Marks		
			L	P	C	CIE	SEE	Total
1	B6443	Dissertation Work Review - III	0	12	06	100	-	100
2	B6444	Dissertation Viva-Voce	0	28	14	-	100	100
Total			0	40	20	100	100	200

Programme Curriculum Structure
M. Tech – Digital Electronics and Communication Systems

Regulations: VCE-R22

List of Professional Electives

Professional Elective - I	
Course Code	**Title of the Course**
B6451	Ad-hoc and Wireless Sensor Networks
B6452	Cognitive Radio Networks
B6453	Next Generation Mobile Networks

Professional Elective - II	
Course Code	**Title of the Course**
B6454	Low power VLSI Design
B6455	Scripting Languages for VLSI Design Automation
B6456	Machine Learning for Hardware Design

Professional Elective - III	
Course Code	**Title of the Course**
B6457	Coding Theory and Techniques
B6458	MIMO Systems
B6459	Communication Protocols for IoT

Professional Elective - IV	
Course Code	**Title of the Course**
B6460	System Verilog for Verification
B6461	VLSI Physical Design Automation
B6462	High Speed VLSI Design

Professional Elective - V	
Course Code	**Title of the Course**
B6463	Detection and Estimation Theory
B6464	Speech Processing
B6465	Deep Learning for Computer Vision

Programme Curriculum Structure
M. Tech – Digital Electronics and Communication Systems

Regulations: VCE-R22

Audit Courses		
#	Course Code	Title of the Course
1	B6091	Disaster Management
2	B6092	Value Education
3	B6093	Constitution of India
4	B6094	Stress Management by Yoga
5	B6095	Personality Development through Life Enlightenment Skills
6	B6096	Pedagogy Studies

Open Electives		
#	Course Code	Title of the Course
1	B6081	Business Analytics
2	B6082	Waste to Energy
3	B6083	Operations Research
4	B6084	IoT and Applications
5	B6085	Cyber Security
6	B6086	Mobile Cloud Computing

I YEAR I SEMESTER

Course Structure

B6401 - RTL Simulation and Synthesis With PLDS

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

In digital circuit design, register-transfer level (RTL) is a design abstraction which models a synchronous digital circuit in terms of the flow of digital signals between hardware registers, and the logical operations performed on those signals. ASIC design is a methodology of cost and size reduction of an electronic circuit, product or system through miniaturization and integration of individual components and their functionality into a single element. Static timing analysis (STA) is a method of validating the timing performance of a design by checking all possible paths for timing violations. A Programmable Logic Device is an individual, programmable electronic chip which can be used as an element to build digital circuits that can be reconfigured.

Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6401.1 Apply digital design procedure for the development of complex arithmetic logic
B6401.2 Develop the digital circuit by utilizing the different modeling strategies in Verilog HDL
B6401.3 Analyze the hardware feasibility for the advanced Digital Systems using PLDs
B6401.4 Examine the Timing Analysis in different levels of abstractions of digital design
B6401.5 Evaluate the performance of the digital circuits with reconfigurable FPGA and ASIC

3. Course Syllabus

Verilog HDL : Importance of HDLs, Lexical Conventions of Verilog HDL Gate level modeling: Built in primitive gates, switches, gate delays Data flow modeling: Continuous and implicit continuous assignment, delays Behavioural modeling: Procedural constructs, Control and repetition Statements, delays, function and tasks.

Digital Design: Design of BCD Adder, State graphs for control circuits, shift and add multiplier, Binary divider, FSM and SM Charts: Finite state diagram, Implementation of

sequence detector using FSM, State machine charts, Derivation of SM Charts, Realization of SM Chart, Implementation of Binary Multiplier.

ASIC: Types of ASICs, ASIC Design flow, Trade off issues at System Level-Optimization with regard to speed, area and power, asynchronous and low power system design. ASIC physical design: ASIC floor planning, Placement and Routing, physical design issues, System Partitioning, Power Dissipation, Partitioning Methods.

Static Timing Analysis : Introduction, STA Concept: CMOS Logic Design, Modeling of CMOS Cells, Switching Waveform, Propagation Delay, Slew of a Waveform, Skew between Signals, Timing Arcs and Unateness, Min and Max Timing Paths, Clock Domains, Operating Conditions.

Digital Design using PLD's: ROM, PLA, PAL- Registered PAL's, Configurable PAL's, GAL. CPLDs: Features, programming and applications using complex programmable logic devices. FPGAs: Field Programmable gate arrays Logic blocks, routing architecture, design flow.

4. Books and Materials

Text Books:

1. Verilog HDL, A Guide to Digital Design and Synthesis Samir Palnitkar, 2nd Edition, 2003
2. Fundamentals of Logic Design, Charles H. Roth, 5th Edition. Cengage Learning, 2010
3. Michael John Sebastian Smith, "Application-Specific Integrated Circuits", VLSI Design Series, Addison Wesley Longman
4. J. Bhasker, Rakesh Chadha, "Static Timing Analysis for Nanometer Designs A Practical Approach , Springer Science+Business Media, LLC 2009.
5. Bob Zeidman, "Designing with FPGAs & CPLDs", CMP Books, 2002.

Reference Books:

1. Donald D Givone, "Digital Principles and Design", TMH, 2016
2. Data Sheets for CPLD & FPGA Architectures, 1996.
3. Richard S. Sandige, "Modern Digital Design", MGH, International Editions, 1990
4. Charles H. Roth, Jr. Lizy Kurian John ByeongKil Lee "Digital Systems Design Using Verilog", Cengage Learning 2016

Course Structure

B6402 - Advanced Communications and Networks

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

This Course is to expose the students to the most recent technological developments in Wireless communication systems. This course covers various propagation effects and propagation models used in mobile communication. This course deals with various methodologies to improve the received signal quality and synchronization in mobile communication. The course analyze networking architecture, design issues for wireless link.

Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6402.1 Learn to model radio signal propagation issues and its impact on communication system performance.
B6402.2 Describe the fundamentals of OFDM and synchronization, pilot insertion in OFDM transmission .
B6402.3 Examine channel modeling and propagation in MIMO, multi-user communications, MIMO-OFDM.
B6402.4 Analyze networking architecture, design issues and infrastructure for wireless link.
B6402.5 Describe the architecture of wireless LAN and broadband Wireless MANs/IEEE 802.16.

3. Course Syllabus

Spread Spectrum Communications: Spreading sequences- Properties of Spreading Sequences, Pseudo- noise sequence, Gold sequences, Kasami sequences, Walsh Sequences, Orthogonal Variable Spreading Factor Sequences, Barker Sequence, Complementary Codes. **Direct Sequence Spread Spectrum:** DS-CDMA Model, Conventional receiver, Rake Receiver, Synchronization in CDMA, Power Control, Soft handoff, Multiuser detection – Optimum multiuser detector, Liner multiuser detection.

Orthogonal Frequency Division Multiplexing: Basic Principles of Orthogonality, Single vs Multicarrier Systems, OFDM Block Diagram and Its Explanation, OFDM Signal

Mathematical Representation, Selection parameter for Modulation, Pulse shaping in OFDM Signal and Spectral Efficiency, Window in OFDM Signal and Spectrum, Synchronization in OFDM, Pilot Insert in OFDM Transmission and Channel Estimation, Amplitude Limitations in OFDM, FFT Point Selection Constraints in OFDM, CDMA vs OFDM, Hybrid OFDM.

MIMO Systems: Introduction, Space Diversity and System Based on Space Diversity, Smart Antenna system and MIMO, MIMO Based System Architecture, MIMO Exploits Multipath, Space – Time Processing, Antenna Consideration for MIMO, MIMO Channel Modelling, MIMO Channel Measurement, MIMO Channel Capacity, Cyclic Delay Diversity (CDD), Space Time Coding, Advantages and Applications of MIMO in Present Context, MIMO Applications in 3G Wireless System and Beyond, MIMO-OFDM.

Wireless LANs/IEEE 802.11x: Introduction to IEEE802.11x Technologies, Evolution of wireless LANs, IEEE 802.11 Design Issues, IEEE 802.11 Services, IEEE 802.11 MAC Layer operations, IEEE 802.11 Layer1, IEEE 802.11 a/b/g Higher Rate Standards, Wireless LAN Security, Computing Wireless Technologies, Typical WLAN Hardware.

Wireless PANs/IEEE 802.15x: Introduction to IEEE 802.15x Technologies: Wireless PAN Applications and Architecture, IEEE 802.15.1 Physical Layer Details, Bluetooth Link Controllers Basics, Bluetooth Link Controllers Operational States, IEEE 802.15.1 Protocols and Host Control Interface. Evaluation of IEEE 802.15 Standards. Broad Band Wireless MANs/IEEE 802.16x: Introduction to WMAN/IEEE 802.16x Technology, IEEE 802.16 Wireless MANs, IEEE 802.16 MAC Layer Details, IEEE 802.16 Physical Layer Details, IEEE 802.16 Physical Layer Details for 2-11 GHz, IEEE 802.16 Common System Operations.

4. Books and Materials

Text Books:

1. Gary J. Mullett, "Introduction to Wireless Telecommunications Systems and Networks", CENGAGE
2. Upena Dalal, "Wireless Communication", Oxford University Press, 2009

Reference Books:

1. Ke-Lin Du & M N S Swamy, "Wireless Communication System", Cambridge University Press, 2010
2. Gottapu Sasibhusan Rao, "Mobile Cellular Communication", PEARSON.

Course Structure

B6403 - RTL Simulation and Synthesis with PLDs Laboratory

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
0	4	0	56	2	40	60	100

1. Course Description

Course Overview

This laboratory course aims at developing digital systems using different modeling styles of Verilog HDL. The VLSI Design flow methodology is accomplished using EDA tools like Xilinx, Cadence, Mentor Graphics. etc. The real time validation and feasibility check for advanced circuits such as UART, USART, PCI, arbiter, Transforms, memory units are verified using FPGA device

Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6403.1 Conduct experiments using EDA tool to demonstrate the constructs of Verilog HDL
B6403.2 Design various combinational and sequential circuits using HDL
B6403.3 Apply digital design procedure for Memories, Communication, DSP applications
B6403.4 Analyze the digital system using reconfigurable FPGA
B6403.5 Build a prototype for real time applications with FPGA

3. Course Syllabus

1. Verilog implementation of
   i) 8:1 Mux/Demux,
   ii) Full Adder, 8-bit Magnitude comparator,
   iii) 3-bit Synchronous Counters
   iv) Parity generator
2. Sequence generator/detectors, Synchronous FSM – Mealy and Moore machines
3. Vending machines - Traffic Light controller, ATM, elevator control.
4. PCI Bus & arbiter and downloading on FPGA
5. UART/ USART implementation in Verilog
6. Realization of single port SRAM in Verilog
7. Verilog implementation of Arithmetic circuits like serial adder/ subtractor, parallel adder/ subtractor, serial/parallel multiplier

8. Discrete Fourier transform/Fast Fourier Transform algorithm in Verilog

4. Laboratory Equipment/Software/Tools Required

1. Cadence
2. Xilinx

5. Books and Materials

Text Books:

1. Verilog HDL, A Guide to Digital Design and Synthesis Samir Palnitkar, 2nd Edition, 2003.
2. Fundamentals of Logic Design, Charles H. Roth, 5th Edition. Cengage Learning, 2010.
3. Michael John Sebastian Smith, "Application-Specific Integrated Circuits", VLSI Design Series, Addison Wesley Longman.
4. J. Bhasker, Rakesh Chadha, "Static Timing Analysis for Nanometer Designs A Practical Approach , Springer Science+Business Media, LLC 2009.
5. Bob Zeidman, "Designing with FPGAs & CPLDs", CMP Books, 2002.

Reference Books:

1. Donald D Givone, "Digital principles and Design", TMH, 2016
2. Data Sheets for CPLD & FPGA architectures, 1996.
3. Richard S. Sandige, "Modern Digital Design", MGH, International Editions, 1990
4. Charles H. Roth, Jr. Lizy Kurian John ByeongKil Lee "Digital Systems Design Using Verilog", Cengage Learning 2016

Course Structure

B6404 - Advanced Communications Laboratory

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
0	4	0	56	2	40	60	100

1. Course Description

Course Overview

Wireless communications technology is one of the most rapidly growing disciplines and is experiencing unprecedented market growth. The laboratory experience can play an important role in motivating students and stimulating their interest in a specific discipline such as wireless communication systems. This course describe the various GSM AT Commands their use and developing new application using it. It also covers Understanding of 3G/4G Communication System and CDMA System with features like; transmission of voice and video calls.

Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6404.1 Analyze the radio channel characteristics and the cellular principle .
B6404.2 Analyze the Transmitter and Receiver section in mobile handset and measure frequency band signal.
B6404.3 Analyze 3G and 4G communication system by means of various AT commands .
B6404.4 Develop Real time Application by make use of Software Radio.
B6404.5 Examine the CDMA concept using DSSS kit.

3. Course Syllabus

1. To study transmitters and receiver section in mobile handset and measure frequency bandsignal and GMSK modulating signal.
2. Analysis of relation between bit rate, symbol rate and chip rate.
3. To study various GSM AT Commands their use and developing new application using it.Understating of 3G Communication System with features like; transmission of voice and SMS by AT Commands.
4. Analyze the AT Commands of 4G LTE Smart Phone.
5. Study of DSSS technique for CDMA, observe effect of variation of types of PN codes, chip rate, spreading factor, processing gain on performance

6. Bit Error Rate Measurement of DSSS CDMA.
7. Analyze the Simple Transmitter and Receiver Section of USRP.
8. To study and analyze frequency modulation technique in time and frequency domain using SDR kit.
9. To study and analyze Phase modulation technique in time and frequency domain using SDR kit.
10. Study of GSM handset for various signaling and fault insertion techniques (Major GSMhandset sections: clock, SIM card, charging, LCD module, Keyboard, User interface).

4. Laboratory Equipment/Software/Tools Required

1. DSSS KIT

5. Books and Materials

Text Books:

1. Gary J. Mullett, "Introduction to Wireless Telecommunications Systems and Networks", CENGAGE.
2. Upena Dalal, "Wireless Communication", Oxford University Press, 2009.

Reference Books:

1. Ke-Lin Du & M N S Swamy, "Wireless Communication System", Cambridge University Press, 2010.
2. Gottapu Sasibhusan Rao, "Mobile Cellular Communication", PEARSON.

Course Structure

B6001 - Research Methodology and IPR

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
2	0	28	0	2	40	60	100

1. Course Description

Course Overview

Research is an art of scientific investigation. Research is an original contribution to the existing stock of knowledge making for its advancement. It is the pursuit of truth with the help of study, observation, comparison and experiment. This course will help students to understand about the research process, tools, importance of ethics. Students can learn about the law of patent and copyrights and knowledge on IPR (Intellectual Property rights)

Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

2. Course Outcomes (COs)

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

B6001.1. Identify an appropriate research problem in their suitable domain.
B6001.2. Construct a well-structured research paper and scientific presentations.
B6001.3. Express the importance of research ethics in scientific community.
B6001.4. Explore on various component of IPR and process of filing.
B6001.5. Gain knowledge on patents and copyrights.

3. Course Syllabus

Research Problem: Scope and objectives, Selection criteria, Research Problems, Research Approaches, Data collection, Data analysis, Ethics, Instrumentation, Interpretation.

Literature Studies: Effective literature studies, Types of literature review, Process and Purpose, Survey, Critical analysis, classification and comparison, case study, identifying the knowledge gap and propose a action plan.

Technical Writing: Effective Report/Article/Thesis writing, tools required, documentation using suitable application (Word, LaTeX, Pages), data representation using graphs, bar diagrams, pi-charts, preparation of manuscript, plagiarism, presentation of research work, Abstract and Conclusion.

Research proposal: Problem defining, national and international Scenario of proposed research, key factors, cost and contingencies, preparing timeline for research plan, funding agencies, collaboration, product and patent development.

Patent Rights and IPR: Process of Patenting and Development, Copyright, Trademark, Licensing and transfer of technology, Patent information and databases, New Developments in IPR, Administration of Patent System, Trade Secret, Copyright Infringement.

4. Books and Materials

Text Books:

1. C.R. Kothari, Gaurav Garg, Research Methodology : Methods And Techniques, New Age International Publishers; 4th edition, 2019
2. P Suganda Devi, Research Methodology: A Handbook for Beginners, Notion Press; 1st edition, 2017
3. Brad Sherman and Lionel Bently, Intellectual Property Law, Oxford University Press, 4th edition, 2014

I YEAR II SEMESTER

Course Structure

B6405 - Analog and Digital CMOS VLSI Design

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

This course serves as a brief overview of the topic of Analog and Digital CMOS VLSI design. It is a high-level view of what VLSI design is all about and discusses the requirements for a designer in this field. Silicon models of information and different functions, implemented in analog and digital CMOS integrated circuits. This course focuses on structured design, scalability, parallelism, low-power consumption, and robustness to process variations. Topics include Combinational logic, Sequential logic, Single Stage Amplifier, Passive and active current mirrors, and Frequency response of CS stage.

Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6405.1 Analyze the electrical characteristics of analog and digital circuits using MOSFETs

B6405.2 Solve engineering problems for feasible and optimal solutions in analog and digital circuits

B6405.3 Design fully compensated OpAmp against process, supply and temperature variations

B6405.4 Identify suitable types of the current mirrors and frequency response of the CS stage using MOSFETs to design efficient system as per the specifications

B6405.5 Analyze the physical design flow of different combinational and sequential logic circuits

3. Course Syllabus

Quality Metrics of a Digital Design: Cost, Functionality, Robustness, Power, Energy Consumption, Wire: Interconnect Parameters, Electrical Wire Models. CMOS Inverter - Static CMOS inverter, Switching threshold and noise margin concepts, Dynamic behavior, Dynamic Power consumption, Static Consumption, Stick diagram and Layout.

Physical Design Flow: Floor planning, Placement, Routing, CTS, Power analysis and IR drop, ESD protection. **Combinational Logic** - Static CMOS design, Logic effort, Rationed

logic, Pass transistor logic, Dynamic logic, Speed and power dissipation in dynamic logic, Cascading dynamic gates, CMOS transmission gate logic.

Sequential Logic: Static latches and registers, Bi-stability principle, MUX based latches, Master-Slave edge-triggered register, Static SR flip-flops, Dynamic latches and registers, Concept of pipelining, Pulse registers, Non-bistable sequential circuit.

Single Stage Amplifier: CS stage with resistance load, Divide connected load, Current source load, Triode load, CS stage with source degeneration, Source follower, Common gate stage, Cascode stage, Choice of device models. Differential Amplifiers - Basic difference pair, Common mode response, Differential pair with MOS loads, Gilbert cell.

Passive and Active Current Mirrors: Basic current mirrors, Cascade mirrors, Active current mirrors. Frequency response of CS stage - Source follower, Common gate stage, Cascode stage and difference pair, Operational amplifiers - One stage OP-AMP, Two stage OP-AMP, Gain boosting, Common mode feedback, Slew rate, PSRR, Compensation of two stage OP-AMP.

4. Books and Materials

Text Books:

1. J P Rabaey, A P Chandrakasan, B Nikolic, "Digital Integrated Circuits: A Design Perspective", Prentice Hall Electronics and VLSI Series, 2nd Edition.
2. Baker, Li, Boyce, "CMOS Circuit Design, Layout, and Simulation", Wiley, 2nd Edition.
3. Behzad Razavi , "Design of Analog CMOS Integrated Circuits", TMH, 2007.
4. K.Lal Kishore, V.S.V. Prabhakar, "VLSI Design", I.K. International Publishing House Pvt. Ltd., 2009.

Reference Books:

1. Phillip E. Allen and Douglas R. Holberg, "CMOS Analog Circuit Design", Oxford, 3rd Edition.
2. R J Baker, "CMOS Circuit Design, Layout and Simulation", IEEE Inc., 2008.
3. Kang, S. and Leblebici, Y., "CMOS Digital Integrated Circuits, Analysis and Design", TMH, 3rd Edition
4. Pucknell, D.A. and Eshraghian, K., "Basic VLSI Design", PHI, 3rd Edition.

Course Structure

B6406 - Advanced Digital Signal Processing

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

The course includes a review of the linear constant-coefficient system properties covered in an undergraduate DSP course, and then examines a variety of multi rate filter structures, time-varying and adaptive systems, fast algorithms, and other topics like applications on adaptive filters using different algorithms like LMS and RLS which are relevant to the research areas of the students. In this course power spectrum estimation is discussed in detail using parametric and non-parametric methods.

Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6406.1 Interpret design of FIR and IIR digital filters along with realization techniques.
B6406.2 Apply multi rate signal processing techniques to design poly phase filters, QMF, digital filter banks etc.
B6406.3 Design and analyze linear prediction filters and solution to normal equations.
B6406.4 Analyze adaptive filters and its applications using various algorithms.
B6406.5 Estimate the various power spectrum techniques using parametric and non-parametric methods.

3. Course Syllabus

Overview of DSP: Overview of DSP, Characterization in time and frequency, FFT Algorithms, Digital filter design and structures: Basic FIR/IIR filter design & structures, design techniques of linear phase FIR filters, IIR filters by impulse in variance, bi-linear transformation, FIR/IIR Cascaded lattice structures, parallel realization of IIR.

Multi Rate DSP: Multi rate DSP, Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, QMF, digital filter banks, Applications in sub band coding.

Linear Prediction & Optimum Linear Filters: Linear prediction & optimum linear filters, stationary random process, forward-backward linear prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.

Adaptive Filters: Adaptive Filters, Applications, Gradient Adaptive Lattice, Minimum mean square criterion, LMS algorithm, Recursive Least Square algorithm

Estimation of Spectra from Finite: Duration observations of Signals. Non parametric methods for power spectrum estimation, parametric methods for power spectrum estimation, minimum-variance spectral estimation, Eigen analysis algorithms for spectrum estimation.

4. Books and Materials

Text Books:

1. J.G.Proakis and D.G.Manolakis "Digital signal processing: Principles, Algorithm and Applications", 4th Edition, Prentice Hall, 2007.
2. N. J. Fliege, "Multirate Digital Signal Processing: Multirate Systems -Filter Banks –Wavelets", 1st Edition, John Wiley and Sons Ltd, 1999

Reference Books:

1. Bruce W. Suter, "Multirate and Wavelet Signal Processing", 1st Edition, Academic Press,1997.
2. M. H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley & SonsInc., 2002.

Course Structure

B6407 -Analog and Digital CMOS VLSI Design Laboratory

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
0	4	0	56	2	40	60	100

1. Course Description

Course Overview

This laboratory course provides an insight into the design and analysis of various Analog and Digital CMOS VLSI circuits. The students will gain knowledge on amplifiers, current mirrors, combinational circuits, sequential circuits, memory circuits. The analysis of these circuits in terms of process variations, low power consumption, area using EDA tools like cadence, mentor graphics, ngspice will help the students in design and implementation of real time applications.

Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6407.1 Design the practical amplifiers, small systems and their design parameter trade-offs
B6407.2 Experiment with various analog and digital CMOS VLSI circuits to achieve the high performance in real time applications
B6407.3 Design the various VLSI circuits for given specifications using EDA tools
B6407.4 Design the VLSI circuits suited for wide range of applications
B6407.5 Solve problems in logic verification and timing calculation of digital circuits

3. Course Syllabus

1. MOS Device Characterization and parametric analysis
2. Common Source Amplifier
3. Common Source Amplifier with source degeneration
4. Cascode amplifier
5. Simple current mirror
6. Cascode current mirror.
7. Wilson current mirror.
8. Full Adder
9. RS-Latch
10. Clock Divider

11. JK-Flip Flop
12. Synchronous Counter
13. Asynchronous Counter
14. Static RAM Cell

4. Laboratory Equipment/Software/Tools Required

1. Cadence

5. Books and Materials

Text Books:

1. J P Rabaey, A P Chandrakasan, B Nikolic, "Digital Integrated Circuits: A Design Perspective", Prentice Hall Electronics and VLSI Series, 2nd Edition.
2. Baker, Li, Boyce, "CMOS Circuit Design, Layout, and Simulation", Wiley, 2nd Edition.
3. Behzad Razavi , "Design of Analog CMOS Integrated Circuits", TMH, 2007.
4. K.Lal Kishore, V.S.V. Prabhakar, "VLSI Design", I.K. International Publishing House Pvt. Ltd., 2009.

Reference Books:

1. Phillip E. Allen and Douglas R. Holberg, "CMOS Analog Circuit Design", Oxford, 3rd Edition.
2. R J Baker, "CMOS Circuit Design, Layout and Simulation", IEEE Inc., 2008.
3. Kang, S. and Leblebici, Y., "CMOS Digital Integrated Circuits, Analysis and Design", TMH, 3rd Edition
4. Pucknell, D.A. and Eshraghian, K., "Basic VLSI Design", PHI, 3rd Edition.

Course Structure

B6408 - Advanced Digital Signal Processing Laboratory

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
0	4	0	56	2	40	60	100

1. Course Description

Course Overview

The course describes how to solve simple problems in the areas of communications and signal processing in a MATLAB environment. The course provide practical experience of signal and image processing implementation in preparation for the project. The course will be composed of programming sessions and course assignments covering discrete time signal analysis, communications and image processing. Experiments cover fundamental concepts of digital signal processing like sampling and aliasing, quantization in A/D conversion and in internal arithmetic operations, digital filter design and implementation, signal generation, spectrum estimation and fast transforms, sampling-rate conversion and multi-rate processing. Application experiments address a selection of multi-media and digital communications problems.

Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6408.1 Analyze the properties of discrete-time systems to compute the linear convolution and correlations of discrete-time sequences

B6408.2 Evaluate the discrete Fourier transform (DFT) of a sequence to compute the linear convolution of two sequences.

B6408.3 Design and Implement the FIR and IIR digital filters for the given specifications.

B6408.4 Examine the Multirate Digital Signal Process Approaches.

B6408.5 Analyze the various power spectrum techniques to calculate the Power Spectral Density

3. Course Syllabus

1. Calculation of auto correlation and cross correlation
2. Butterworth lowpass and highpass filter design
3. Chebychev type I, II filter design
4. FIR filter design
5. Estimating the cost of filter
6. Decimation and interpolation using rationale factors

7. Wiener filter design
8. Linear prediction filter design
9. Adaptive filter design for noise cancellation
10. Estimation of power spectral density
11. Estimation of PSD using parametric method
12. Estimation of PSD using non-parametric method
13. Stability using Hurwitz Routh criteria

4. Laboratory Equipment/Software/Tools Required

1. MATLAB

5. Books and Materials

Text Books:

1. J.G.Proakis and D.G.Manolakis "Digital signal processing: Principles, Algorithm and Applications", 4th Edition, Prentice Hall, 2007.
2. N. J. Fliege, "Multirate Digital Signal Processing: Multirate Systems -Filter Banks –Wavelets", 1st Edition, John Wiley and Sons Ltd, 1999

Reference Books:

1. Bruce W. Suter, "Multirate and Wavelet Signal Processing", 1st Edition, Academic Press,1997.
2. M. H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley & SonsInc., 2002.

Professional Electives

Course Structure

B6451 - Ad-hoc and Wireless Sensor Networks

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

This course will provide students with an understanding of wireless adhoc and sensor networks enable them to recognize the wide range of applicability of these networks and provide them with an understanding of the major design issues including topics such as protocol mechanisms and resource constraints..

Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

2. Course Outcomes (COs)

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

B6451.1 Explain the Fundamental Concepts and applications of ad hoc and wireless sensor networks..
B6451.2 Analyze the operation and the performance of MAC layer protocols of Adhoc wireless networks.
B6451.3 Describe the routing protocols for Adhoc wireless network.
B6451.4 To Know the design, operation and the performance of transport layer protocol of Adhoc wireless networks.
B6451.5 Discuss the sensor network Architecture and will be able to distinguish between protocols used in Adhoc wireless network and wireless sensor networks.

3. Course Syllabus

Wireless LANs and PANs : Introduction, Fundamentals of WLANS, IEEE 802.11 Standards, HIPERLAN Standard, Bluetooth, Home RF. AD HOC WIRELESS NETWORKS: Introduction, Issues in Ad Hoc Wireless Networks.

MAC Protocols : Introduction, Issues in Designing a MAC protocol for Ad Hoc Wireless Networks, Design goals of a MAC Protocol for Ad Hoc Wireless Networks, Classifications of MAC Protocols, Contention - Based Protocols, Contention - Based Protocols with reservation Mechanisms, Contention – Based MAC Protocols with Scheduling Mechanisms, MAC Protocols that use Directional Antennas, Other MAC Protocols.

Routing Protocols : Introduction, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classification of Routing Protocols, Table –Driven Routing Protocols, On – Demand Routing Protocols, Hybrid Routing Protocols, Routing Protocols with Efficient Flooding Mechanisms, Hierarchical Routing Protocols, Power – Aware Routing Protocols.

Transport Layer Protocols : Introduction, Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks, Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks, Classification of Transport Layer Solutions, TCP Over Ad Hoc Wireless Networks, Other Transport Layer Protocol for Ad Hoc Wireless Networks.

Sensor Network Architecture: Introduction, Sensor Network Architecture, Data Dissemination, Data Gathering, MAC Protocols for Sensor Networks, Location Discovery, Quality of a Sensor Network, Evolving Standards, Other Issues.

4. Books and Materials

Text Books:

1. Ad Hoc Wireless Networks: Architectures and Protocols - C. Siva Ram Murthy and B. S. Manoj, 2004, PHI.
2. Wireless Ad- hoc and Sensor Networks: Protocols, Performance and Control - Jagannathan Sarangapani, CRC Press.

Reference Books:

1. Ad- Hoc Mobile Wireless Networks: Protocols & Systems, C. K. Toh, 1st Ed. Pearson Education.
2. Wireless Sensor Networks - C. S. Raghavendra, Krishna M. Sivalingam, 2004, Springer.

Course Structure

B6452 - Cognitive Radio Networks

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

The Course describes the basics of the software defined radio. This Course provides Comprehensive coverage of hardware and software architecture of software defined radio. course interpret the design and implementation algorithms for cognitive radio spectrum sensing and dynamic spectrum access. Course deals with the design of the wireless networks based on the cognitive radios

Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6452.1 Understand the basics of SDR and how it evolves from Software Defined Radio to Cognitive Radio
B6452.2 Interpret the basics of various spectrum sensing techniques and Algorithms
B6452.3 Recognize the concepts of cooperative spectrum sensing and handoff process
B6452.4 Describe the issues regarding dynamic spectrum access, the radio-resource management
B6452.5 Describe the issues regarding dynamic spectrum access, the radio-resource management

3. Course Syllabus

Introduction to Cognitive Radios : Digital dividend, Cognitive Radio (CR) architecture, functions of cognitive radio, Dynamic Spectrum Access (DSA), components of cognitive radio, spectrum sensing, spectrum analysis and decision, potential applications of cognitive radio.

Spectrum Sensing : Spectrum sensing, detection of spectrum holes (TVWS), collaborative sensing, geo-location database and spectrum sharing business models (spectrum of commons, real time secondary spectrum market).

Optimization Techniques of Dynamic Spectrum Allocation: Linear programming, convex programming, non-linear programming, integer programming, dynamic programming,

stochastic programming.

Dynamic Spectrum Access and Management : Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

Spectrum Trading : Introduction to spectrum trading, classification to spectrum trading, radio resource pricing, brief discussion on economics theories in DSA (utility, auction theory), classification of auctions (single auctions, double auctions, concurrent, sequential)

4. Books and Materials

Text Books:

1. Kwang-Cheng Chen, Ramjee Prasad, "Cognitive Radio Networks", John Wiley & Sons Ltd., 2009.
2. Huseyin Arslan, "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems", Springer, 2007.

Reference Books:

1. Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, 2009.
2. Bruce Fette, "Cognitive Radio Technology", Elsevier, 2nd Edition, 2009.
3. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, "Optimizing Wireless Communication Systems" Springer, 2009.
4. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.

Course Structure

B6453 - Next Generation Mobile Networks

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

This course gives a comprehensive overview of the current state of the 5G landscape, covering everything from the most likely use cases, to a wide range of technology options and potential 5G system architectures, to spectrum issues. This course explain the architecture, Beam forming and hardware technologies for mm W communication.

Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

2. Course Outcomes (COs)

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

B6453.1 Describe and explain the evolution of 5G, system concepts and physical architecture.
B6453.2 llustrate the fundamentals, resource allocation and transceiver algorithms for Massive MIMO
B6453.3 Explain the architecture, Beam forming and hardware technologies for mmW communications
B6453.4 Compare and explain various radio access technologies for 5G networks.
B6453.5 Describe the requirements and fundamental techniques for Machine Type Communications(MTC) and D2D Communication.

3. Course Syllabus

Introduction and Roadmap to 5G : Historical trend and evolution of LTE technology to beyond 4G – Key building blocks of 5G – 5G use cases and System Concepts – The 5G Architecture – IoT: relation to 5G.

RF Front End For 5G: Millimeter Wave Communications: Hardware technologies for mmW systems – Architecture and Mobility – Massive MIMO: Resource allocation and transceiver algorithms for massive MIMO - Fundamentals of baseband and RF implementations in massive MIMO – Beamforming.

5G Waveforms and Channel Modules: 5G Radio Access Technologies: Design principles - Multi-carrier with filtering - Non orthogonal Multiple Access - Radio access for dense

deployments – Radio Access for V2X Communication - Radio access for massive machine-type communication - 5G wireless propagation channel models: Modelling requirements and scenarios - The METIS channel models.

Networking in 5G: Coordinated multi-point transmission in 5G: Joint Transmission CoMP enablers - Distributed cooperative transmission - JT CoMP with advanced receivers - Relaying and network coding in 5G: Multi-flow wireless backhauling - Bufferaided relaying.

Evaluation of 5G and 5G Applications : Machine-type communications: Fundamental techniques for MTC - Massive MTC - Ultra-reliable low-latency MTC - Device-to-device (D2D) communications - Multi-hop D2D communications - Multi-operator D2D communication - Simulation methodology: Evaluation methodology – Calibration - New challenges in the 5G modelling.

4. Books and Materials

Text Books:

1. Jonathan rodriguez, - Fundamentals of 5G mobile networks, John Wiley & Sons, Ltd, 2015

Reference Books:

1. Wei Xiang, Kan Zheng, Xuemin (Sherman) Shen, - 5G Mobile Communications, Springer, 2017.
2. Afif Osseiran, Jose F. Monserrat and Patrick Marsch, - 5G Mobile and Wireless Communications Technology, Cambridge University Press, 2016.

Course Structure

B6454 - Low Power VLSI Design

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

This course introduces various strategies and methodologies for designing low power circuit. It describes the many issues facing designers at architectural, logic, circuit and device levels and presents some of the techniques that have been proposed to overcome these difficulties. This course is a dynamic research area driven by battery–powered portable computing and wireless communications products. It has become critical to the continued progress of high–performance and reliable microelectronic systems. The course addresses the concepts, principles and techniques to reduce the power in VLSI systems.

Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6454.1 Identify the sources of power dissipation in digital IC systems
B6454.2 Examine the impact of power on system performance and reliability
B6454.3 Analyze the sources of leakage power dissipation and reduction techniques
B6454.4 Inspect the issues in VLSI systems, specific to the deep-submicron silicon technologies
B6454.5 Analyze the power optimization and trade-off techniques in digital circuits

3. Course Syllabus

Physics of Power Dissipation in CMOS : Introduction, sources of power dissipation, designing for low power. Physics of power dissipation in MOSFET devices-MIS structure, long channel and sub-micron MOSFET, Gate induced Drain leakage, Power dissipation in CMOS-Short circuit dissipation, dynamic dissipation, and load capacitance. Low Power VLSI Design Limits -Principles of Low power design, hierarchy of limits, fundamental limits, material, device, circuit and system limits.

Statistical Techniques : Estimating Average Power in Combinational and sequential circuits, Monte-carlo based estimation of glitching power, power estimation using input vector compaction. **Software Design for Low Power :**Introduction, sources of software power

dissipation, software power estimation and optimization.

Design of Low Power Circuits : Transistor and Gate Sizing : Sizing an Inverter Chain, Transistor and Gate Sizing for Dynamic Power Reduction, Transistor Sizing for Leakage Power Reduction - Network Restructuring and Reorganization : Transistor Network Restructuring, Transistor Network Partitioning and Reorganization - Special Latches and Flip-flops : Self-gating Flip-flop, Combinational Flip-flop, Double Edge Triggered Flip-flop.

Design and Test of Low Voltage CMOS Circuits : - Introduction, circuit design styles, leakage current in deep sub - micrometer transistors, device design issues, minimizing short channel effect, low voltage circuit design techniques using reverse Vgs, multiple threshold voltages, multiple supply voltages

Special Techniques : Power Reduction in Clock Networks, CMOS Floating Node, Low Power Bus, Delay Balancing, Low Power Techniques for SRAM. Advanced Techniques - Adiabatic Computation, Pass Transistor Logic Synthesis, Asynchronous Circuits

4. Books and Materials

Text Books:

1. Kaushik Roy, Sharat C. Prasad (2000), Low-Power CMOS VLSI Circuit Design, Wiley India, New Delhi.
2. Gary Yeap (1998), Practical Low Power Digital VLSI Design, Springer Science+Business Media New York.

Reference Books:

1. Anantha P. Chandrakasan, Robert W. Brodersen (1998), Low - Power CMOS Design, IEEE Press, USA.
2. Christian Piguet (2006), Low-Power CMOS Circuits: Technology, Logic Design and CAD Tools, CRC Taylor & Francis, USA.

Course Structure

B6455 - Scripting Languages for VLSI Design Automation

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

A scripting language is a programming language for a runtime system that automates the execution of tasks that would otherwise be performed individually by a human operator. Scripting languages are usually interpreted at runtime rather than compiled. The spectrum of scripting languages ranges from small to large, and from highly domain-specific language to general-purpose programming languages. A language may start as small and highly domain-specific and later develop into a portable and general-purpose language; conversely, a general-purpose language may later develop special domain-specific dialects.

Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

2. Course Outcomes (COs)

B6455.1 Apply the suitable commands to work in LINUX environment.
B6455.2 Identify the strengths and weakness of various scripting language for solving a given problem.
B6455.3 Develop the TCL & TK scripts for automation.
B6455.4 Design Scripting applications using python tuples, dictionaries and lists.
B6455.5 Make use of Python language fundamentals to implement required scripts.

3. Course Syllabus

LINUX Basics : Introduction to Linux, File System of Linux, General usage of Linux Kernel and Basic Commands, Linux users and group, Permissions for file, directory and users, Searching a file and directory, zipping and unzipping concepts.

PERL Basics : History and Concepts of PERL - Scalar Data - Arrays and List Data - Control structures – Hashes - Basics I/O - Regular Expressions – Functions - Miscellaneous control structures - Formats.

Advanced Topics in PERL : Directory access - File and Directory manipulation - Process Management - Packages and Modules.

TCL Basics : An Overview of TCL and Tk -Tcl Language syntax – Variables – Expressions – Lists - Control flow– procedures - Errors and exceptions - String manipulations. Advanced Topics in TCL Accessing files- Processes. Applications - Controlling Tools - Basics of Tk.

Python Basics : Introduction to Python – Using Python interpreter – Control flow Tools – Data structures –Modules. Advanced Topics in Python - Input and Output – Errors and Exceptions – Classes – Brief tour on standard library.

4. Books and Materials

Text Books:

1. Richard Petersen, "Linux: The Complete Reference, 6th Edition", McGraw-Hill, 2007.
2. Guido van Rossum Fred L. Drake, Jr., editor, "Python Tutorial Release 3.2.3", 2012.
3. Larry Wall, Tom Christiansen, John Orwant, "Programming PERL", Oreilly Publications, Fourth Edition, 2012.

Reference Books:

1. John K. Ousterhout, Ken Jones, "Tcl and the Tk Toolkit", Pearson Education, Second Edition, 2010

Course Structure

B6456 -Machine Learning for Hardware Design

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

This course deals with building hardware designs for machine learning systems using state-of-the art platforms like FPGAs. It emphasizes to develop low power and high speed hardware architectures for machine learning.

Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6456.1 Interpret the basics of Deep Neural Networks
B6456.2 Analyze the metrics for hardware design
B6456.3 Apply the hardware design methods to Machine Learning or Deep Neural Networks model Analyze different hardware level techniques to apply them for Neural networks
B6456.4 Analyze different hardware level techniques to apply them for Neural networks
B6456.5 Estimate the challenges in designing efficient hardware for DNN models

3. Course Syllabus

Overview of Deep Neural Networks : Introduction to ML and Deep Neural Networks (DNNs), Need of DNNs for hardware design, Connections within a layer and between layers, Popular types of layers- CONV layer, FC layer, Non-linearity, Pooling and Unpooling, Normalization, Convolutional Neural

Key Metrics and Design Objectives : Accuracy, throughput and latency, energy efficiency and power consumption, hardware cost, flexibility, scalability, interplay between different metrics. Kernel Computation- matrix multiplication, optimizing performance, computation transform optimizations.

Designing DNN Accelerators : data reuse- temporal reuse, spatial reuse, techniques to reduce reuse distance, dataflEvaluation Metrics, DNN hardware design considerations,

architectural techniques for exploiting ows, dataflow taxonomy, dataflows for cross-layer processing.

Software and Co-Design Optimization : Resource Requirements of State-of-the-Art Neural Networks, Pruning and Sparsity, Weight Sharing, Compact Network Architectures, Hardware–Software Co-design, Bit-Precision, Systolic Arrays. Hardware-Level Techniques - Dataflows and Architectures for Accelerators, Hardware Friendly Strategies for Deep CNN Accelerators, Memory-Efficient Architectures, Hardware Architectural Techniques for Leveraging Sparsity in Neural Networks.

Error Resilience Analysis : DNN-Specific Approximations for Low-Power Accelerators, Energy-Efficient Hardware Accelerator Design Methodology for Neural Networks, Efficient Machine Learning Architectures: Challenges and the Way Forward-Optimizing Memory vs. Computations, Neuromorphic Computing, Accuracy vs. Energy Trade-off, Adaptability, (Re-)configurability, and Scalability, Run-Time Evolutionary Algorithms for Designing and Optimizing DNN Architectures.

4. Books and Materials

Text Books:

1. S.H. Gerez, "Algorithms for VLSI Design Automation", John Wiley & Sons, 1999.
2. Giovanni De Michele "Synthesis and optimization of digital circuits", Mc Graw Hill, 1994.

Reference Books:

1. Soha Hassoun and Tsutomu Sasao "Logic Synthesis and verification", Kluwer Academic Publisher, 2003.
2. Sherwani "An Introduction to Physical VLSI Design", Prentice Hall of India, 2004.

Course Structure

B6457 - Coding Theory and Techniques

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

Error control coding is an indispensible part of any digital communication system. This course focus on theory of liner block codes and convolutional codes, their encoding and decoding techniques as well as their applications in real world scenarios starting from simple repetition codes, Hamming codes, Reed Muller codes, low density parity check codes, and turbo codes.

Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6457.1 To know the measurement of information and errors.
B6457.2 Obtain knowledge in designing Linear Block Codes and Cyclic codes.
B6457.3 Construct tree and trellies diagrams for convolution codes.
B6457.4 Describe the concatenated convolutional codes .
B6457.5 Design the Turbo codes and Space time codes and also their applications

3. Course Syllabus

Coding for Reliable Digital Transmission and Storage: Mathematical model of Information, A Logarithmic Measure of Information, Average and Mutual Information and Entropy, Types of Errors, Error Control Strategies. Linear Block Codes - Introduction to Linear Block Codes, Syndrome and Error Detection, Minimum Distance of a Block code, Error-Detecting and Error-correcting Capabilities of a Block code, Standard array and Syndrome Decoding, Probability of an undetected error for Linear Codes over a BSC, Hamming Codes. Applications of Block codes for Error control in data storage system

Cyclic Codes: Description, Generator and Parity-check Matrices, Encoding, Syndrome Computation and Error Detection, Decoding, Cyclic Hamming Codes, Shortened cyclic codes, Error-trapping decoding for cyclic codes, Majority logic decoding for cyclic codes.

Convolutional Codes: Encoding of Convolutional Codes, Structural and Distance Properties, maximum likelihood decoding, Sequential decoding, Majority- logic decoding of Convolution codes. Application of Viterbi Decoding and Sequential Decoding, Applications of Convolutional codes in ARQ system

Turbo Codes: LDPC Codes- Codes based on sparse graphs, Decoding for binary erasure channel, Log-likelihood algebra, Brief propagation, Product codes, Iterative decoding of product codes, Concatenated convolutional codes- Parallel concatenation, The UMTS Turbo code, Serial concatenation, Parallel concatenation, Turbo decoding.

Space-Time Codes : Introduction, Digital modulation schemes, Diversity, Orthogonal space- Time Block codes, Alamouti's schemes, Extension to more than Two Transmit Antennas, Spatial Multiplexing: General Concept, Iterative APP Preprocessing and Per-layer Decoding, Linear Multilayer Detection, Original BLAST Detection, QL Decomposition and Interface Cancellation.

4. Books and Materials

Text Books:

1. Error Control Coding- Fundamentals and Applications –Shu Lin, Daniel J. Costello, Jr,Prentice Hall, Inc
2. Error Correcting Coding Theory-Man Young Rhee, McGraw-Hill, 1989.

Reference Books:

1. Digital Communications-Fundamental and Application - Bernard Sklar, PE.
2. Digital Communications- John G. Proakis, 5^{th} Edition. TMH, 2008.
3. Error Correction Coding – Mathematical Methods and Algorithms – Todd K. Moon, WileyIndia, 2006.
4. Information Theory, Coding and Cryptography – Ranjan Bose, 2^{nd} Edition, TMH, 2009.

Course Structure

B6458 - MIMO Systems

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

Digital communication using multiple-input–multiple output (MIMO), sometimes called a "volume-to-volume" wireless link, has recently emerged as one of the most significant technical breakthroughs in modern communications. The technology figures prominently on the list of recent technical advances with a chance of resolving the bottleneck of traffic capacity in future Internet-intensive wireless networks. This course covers various diversity techniques, capacity models and coding techniques for MIMO communication systems.

Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

2. Course Outcomes (COs)

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

B6458.1 Examine channel modeling and propagation, MIMO receivers, MIMO for multi-carrier systems, multi-user communications, multi-user MIMO.
B6458.2 Examine the performance of Communication system with multiple antennas at Transmitter and/or Receiver under various fading environments
B6458.3 Analyze the capacity of MIMO systems for ergodic and non-ergodic channel models
B6458.4 Apply the various space-time codes to achieve spatial diversity.
B6458.5 Utilize the iterative decoding algorithms to decode Concatenated codes for AWGN channel of MIMO system.

3. Course Syllabus

MIMO Systems : Overview of MIMO Communications - What is MIMO, History of MIMO, Smart antennas vs MIMO, Single user and multi user MIMO, Introduction to Spatial Diversity, Introduction to Spatial multiplexing.

Fading Channels and Diversity Techniques : Wireless channels – Error/Outage probability over fading channels – Diversity techniques – Channel coding as a means of time diversity – Multiple antennas in wireless communications.

Capacity and Information Rates of MIMO Channels : Capacity and Information rates of noisy, AWGN and fading channels – Capacity of MIMO channels – Capacity of non-coherent MIMO channels – Constrained signaling for MIMO communications.

Space-Time Block and Trellis Codes : Transmit diversity with two antennas: The Alamouti scheme –Orthogonal. and Quasi-orthogonal space-time block codes – Linear dispersion codes – Generic space-time trellis codes – Basic space-time code design principles – Representation of space-time trellis codes for PSK constellation – Performance analysis for space-time trellis codes – Comparison of space-time block and trellis codes.

Concatenated Codes and Iterative Decoding : Development of concatenated codes – Concatenated codes for AWGN and MIMO channels – Turbo coded modulation for MIMO channels – Concatenated space-time block coding.

4. Books and Materials

Text Books:

1. Tolga M. Duman and Ali Ghrayeb, "Coding for MIMO Communication Systems", John Wiley & Sons, West Sussex, England, 2007.
2. Jerry. R. Hampton, "Introduction to MIMO Communications", CAMBRIDGE University Press 2014.

Reference Books:

1. E.G. Larsson and P. Stoica, "Space-Time Block Coding for Wireless Communications", Cambridge University Press, 2003.
2. M. Janakiraman, "Space-Time Codes and MIMO systems", Artech House, 2004.

Course Structure

B6459 - Communication Protocols for IoT

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

The course introduces you to advance concepts and design methodologies to design IoT systems architecture and developing IoT applications for communication domain. It also exposes participants to communication technologies and legacy protocols as well as newly developed IoT specific application and physical layer protocols. The course covers Security Protocol in great detail with set of packages which makes it obvious choice as a leading IoT Technology

Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6459.1 Identify the architecture of Internet of Things and connected world.
B6459.2 Determine the Real-World Design and Technical Design constraints
B6459.3 Analyze the Network layer Protocol and data link layer.
B6459.4 Understand and apply various protocols for design of IoT systems.
B6459.5 Understand IoT related Security Protocols.

3. Course Syllabus

Introduction : IoT architecture outline, standards - IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics.

IoT Reference Architecture : Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant Architectural views. Real-World Design Constraints- Introduction, Technical Design constraints.

IoT Data Link Layer and Network Layer Protocols : PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, ZWave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4,IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP.

IoT Transport and Session Layer Protocols : Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT.

IoT Service Layer Protocols and Security Protocols : Service Layer -one M2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC802.15.4, 6LowPAN, RPL, Application Layer.

4. Books and Materials

Text Books:

1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications, 2016.
2. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle,"From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence",1st Edition, Academic Press, 2015.

Reference Books:

1. Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer, 2016.
2. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.

Course Structure

B6460 - System Verilog for Verification

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

SystemVerilog, standardized as IEEE 1800, is a hardware description and hardware verification language used to model, design, simulate, test and implement electronic systems. SystemVerilog is based on Verilog and some extensions, and since 2008 Verilog is now part of the same IEEE standard. It is commonly used in the semiconductor and electronic design industry as an evolution of Verilog. In order to verify that the HDL is correct, there is a need for a language with more features in object-oriented programing that will support complicated testing procedures and is often called a Hardware Verification Language. SystemVerilog is an extension of Verilog with many such verification features that allow engineers to verify the design using complex testbench structures and random stimuli in simulation.

Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

2. Course Outcomes (COs)

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

B6460.1 Create reusable verification environment using Universal Verification Methodology.
B6460.2 Analyze the use of procedural statements and routines in testbench design with system verilog
B6460.3 Apply OOP concepts in designing testbench with system verilog.
B6460.4 Apply randomization concepts in designing testbench to generate all combinations of test cases
B6460.5 Make use of Assertions and functional coverage to meet all specifications

3. Course Syllabus

Verification Techniques : Introduction to Verification - Testing Vs Verification - Verification Technologies – Functional Verification- Code coverage – Functional coverage. Testbench – Linear Testbench - Linear Random Testbench - Self-checking Testbench – Regression - RTL Formal Verification. Basic OOP - OOP Terminology, Creating Object, object deallocation, copying objects, static variables, Global variables, Inheritance, Polymorphism.

System Verilog – Data Types & Procedural Statements : Introduction to SystemVerilog – Literal values-data Types – Arrays – Array methods – Creating new types with typedef – user defined structures – Enumerated types – attributes - operators – expressions - Procedural statements and control flow - Processes in SystemVerilog – Task and functions – Routine arguments – Returning from a routine.

Connecting Testbench and Design : Program, Interface, Stimulus timing, Module interactions, Connecting together, Development of self-checking test environment – Generator, Transactor, Driver, Monitor, Checker, Scoreboard

Randomization, Assertion and Coverage : Randomization in systemVerilog, Constraints, Functional coverage, cross coverage, cover groups, Assertions.

Universal Verification Methodology : Introduction to UVM - Verification components - Transaction level modeling. UVM – Verification Environments - Developing reusable verification components - Using Verification components – Developing reusable verification environment – Register classes.

4. Books and Materials

Text Books:

1. Christian B Spear, "System Verilog for Verification: A guide to learning the Testbench language features", Springer publications, 3rd Edition, 2012.
2. Ray Salmei, "The UVM Primer: A Step-by-Step Introduction to the Universal Verification Methodology" Boston Light Press; 1st Edition, 2013,

Reference Books:

1. Vanessa R. Copper, "Getting started with UVM: A Beginner's Guide", Verilab Publishing, 1st Edition, 2013.
2. JanickBergeron, "Writing Testbenches using System Verilog" Synopsys Inc., Springer Publications, 2006

Course Structure

B6461 - VLSI Physical Design Automation

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

This course provides the concepts of design optimization algorithms and their application to physical design automation. This course enables students to decompose large mapping problem into pieces, including logic optimization with partitioning, placement and routing. The course focuses on the algorithms for the VLSI Physical Design automation. To understand the influence of the algorithms in the design of VLSI ICs using advanced optimization techniques. To utilize EDA tools in the development of VLSI Physical Design Automation Algorithms. To Formulate CAD design problems using algorithmic methods.

Course Pre/co-requisites

This course has no specific prerequisite and corequisite

2. Course Outcomes (COs)

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

B6461.1 Analyze Physical Design Process such as partitioning, Floor planning, Placement and Routing, simulation and synthesis for VLSI circuits.
B6461.2 Develop automation algorithms for partitioning, floor planning, placement and routing
B6461.3 Analyze circuits using both analytical and CAD tools
B6461.4 Solve the performance issues in circuit layout.
B6461.5 Formulate CAD design problems using algorithmic methods.

3. Course Syllabus

Introduction to VLSI Physical Design Automation : VLSI Design Cycle, New Trends in VLSI Design Cycle, Physical Design Cycle, New Trends in Physical Design Cycle, Design Styles, System Packaging Styles, Historical Perspectives, Existing Design Tools

Performance issues in circuit layout : Delay Models, Timing-Driven Placement, Timing-Driven Routing, Via Minimization, Power Minimization.

Placement: Problem Formulation, Classification of Placement Algorithms, Simulation Based Placement Algorithms, Partitioning Based Placement Algorithms, Other Placement Algo-

rithms, Performance Driven Placement.

Timing-Driven Placement Global Routing : Problem Formulation, Classification of Global Routing, Maze Routing Algorithms, Line-Probe Algorithms, Shortest Path Based Algorithms, Steiner Tree based Algorithms, Integer Programming Based Approach, Performance Driven Routing.

Placement : Over the Cell Routing Via Minimization, Clock and Power Routing, Physical Design Automation of FPGAs.

4. Books and Materials

Text Books:

1. Naveed A. Sherwani "Algorithms for VLSI Physical Design Automation", 3rd Edition, Kluwer Academic Publishers.
2. M. Sarrafzadeh, C. K. Wong, "An Introduction to VLSI Physical Design", The McGraw-HillCompanies, Inc.

Reference Books:

1. Charles J. alpert, Dinesh p. Mehta, Sachin S. Sapatnekar "Handbook of Algorithms for Physical design Automation", CRC Press.
2. Andrew B. Kahng, Jens Lienig Igor L. Markov, Jin Hu, "VLSI Physical Design: From Graph Partitioning to Timing Closure", Springer.
3. Sadiq M Sait Habib Youssef, "VLSI Physical Design Automation Theory and Practice", World Scientific.
4. Sung Kyu Lim, "Practical Problems in VLSI Physical Design Automation", Springer.

Course Structure

B6462 - High Speed VLSI Design

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

This course introduces various strategies and methodologies for high speed systems. It describes multiple issues which are facedby designers at architectural, logic, circuit and device levels. It also presents various techniques being proposed to overcome the difficulties in hierarchical design. The methods of clock distribution and clock generation are also discussed for the design of high–performance and reliable microelectronic systems. The course addresses the concepts, principles and techniques for high speed in VLSI design.

Course Pre/co-requisites

The course has no specific prerequisite and corequisite

2. Course Outcomes (COs)

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

B6462.1 Explore the circuits and techniques involved in high speed VLSI design
B6462.2 Make use of various logic styles to design high speed VLSI circuits
B6462.3 Analyze design-driven performance variability, storage element designs and related issues
B6462.4 Apply various chip interface techniques for high speed circuits
B6462.5 Apply clocking styles for high speed VLSI circuits

3. Course Syllabus

Clocked Logic Styles: Introduction, Single-Rail Domino Logic Styles, Dual-Rail Domino Structures, Latched Domino Structures, Clocked pass Gate Logic. Non Clocked Logic Styles, Static CMOS, DCVS Logic, Non-Clocked pass Gate Families, Adiabatic logic

Circuit Design Margin and Design Variability: Introduction, Process Induced Variations, Design Induced Variations, Application Induced Variations, Noise

Latching Strategies : Introduction, Basic Latch Design, Latching Differential Logic, Race Free Latches for Pre-charged Logic, Asynchronous Latch Techniques

Interface Techniques: Introduction, Signaling Standards, Chip-to-Chip Communication Networks, ESD Protection, Driver design techniques, receiver design techniques

Clocking Styles: Introduction, Clock Jitter, Clock Skew, Clock Generation, Clock Distribution, Asynchronous Clocking Techniques

4. Books and Materials

Text Books:

1. Kerry Bernstein, Keith M. Carrig & et Al., "High Speed CMOS Design Styles", Kluwer Academic Publishers, 2002.

Reference Books:

1. Howard Johnson & Martin Graham, "High Speed Digital Design" A Handbook of Black Magic, Prentice Hall PTR, 1993.
2. William S. Dally & John W. Poulton, "Digital Systems Engineering", Cambridge University Press, 1998.
3. Masakazu Shoji, "High Speed Digital Circuits", Addison Wesley Publishing Company, 1996

Course Structure

B6463 - Detection and Estimation Theory

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

Signal detection and estimation is the area of study that deals with the processing of information-bearing signals for the purpose of extracting information from them. Applications of the theory of signal detection and estimation are in many areas, such as communications, automatic control, radar/ sonar, speech and image processing and medical signal processing. In general, detection and estimation applications involve making inferences from observations that are distorted or corrupted in some manner. As the information that one wishes to extract from such observation is unknown to the observer, it is useful to cast detection and estimation problems in a probabilistic framework in which unknown behavior is assumed to be random.

Course Pre/co-requisites

The course has no specific prerequisite and corequisite

2. Course Outcomes (COs)

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

B6463.1 Analyze the various random processes for discrete linear models.
B6463.2 Apply the concept of probability for detection theory methods.
B6463.3 Differentiate between the linear and nonlinear minimum mean squared error estimators.
B6463.4 Understand the basic estimation methods and filters
B6463.5 Measure the statistical parameters for random processes

3. Course Syllabus

Random Processes: Discrete Linear Models, Markov Sequences and Processes, Point Processes, and Gaussian Processes.

Detection Theory: Basic Detection Problem, Maximum A posteriori Decision Rule, Minimum Probability of Error Classifier, Bayes Decision Rule, Multiple-Class Problem (Bayes)-minimum probability error with and without equal a priori probabilities, Neyman-Pearson Classifier, General Calculation of Probability of Error, General Gaussian Problem, Composite Hypotheses.

Linear Minimum Mean-Square Error Filtering: Linear Minimum Mean Squared Error Estimators, Nonlinear Minimum Mean Squared Error Estimators. Innovations, Digital Wiener Filters with Stored Data, Real-time Digital Wiener Filters, Kalman Filters.

Statistics: Measurements, Nonparametric Estimators of Probability Distribution and Density Functions, Point Estimators of Parameters, Measures of the Quality of Estimators, Introduction to Interval Estimates, Distribution of Estimators, Tests of Hypotheses, Simple Linear Regression, Multiple Linear Regression.

Estimating the Parameters of Random Processes from Data: Tests for Stationarity and Ergodicity, Model-free Estimation, Model-based Estimation of Autocorrelation Functions, Power Special Density Functions.

4. Books and Materials

Text Books:

1. Random Signals: Detection, Estimation and Data Analysis – K. Sam Shanmugan & A.M. Breipohl, Wiley India Pvt. Ltd, 2011.
2. Random Processes: Filtering, Estimation and Detection – Lonnie C. Ludeman, Wiley India Pvt. Ltd., 2010.

Reference Books:

1. Fundamentals of Statistical Signal Processing: Volume I Estimation Theory– Steven. M. Kay, Prentice Hall, USA, 1998
2. Introduction to Statistical Signal Processing with Applications – Srinath, Rajasekaran, Viswanathan, 2003, PHI.
3. Statistical Signal Processing: Detection, Estimation and Time Series Analysis – Louis L. Scharf, 1991, Addison Wesley.
4. Signal Processing: Discrete Spectral Analysis – Detection & Estimation – Mischa Schwartz, Leonard Shaw, 1975, Mc Graw Hill.

Course Structure

B6464 - Speech Processing

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

Speech Processing offers a practical and theoretical understanding of how human speech can be processed by computers. It covers Fundamentals of Digital speech Processing, Time domain models for speech processing, linear predictive coding analysis, Homomorphic speech processing, Automatic speech and Speaker Recognition. The course involves practical concepts also where the student will build working speech recognition systems, build their own synthetic voice and build a complete telephone spoken dialog system. This work will be based on existing toolkits. Details of algorithms, techniques and limitations of state of the art speech systems will also be presented. This course is designed for students wishing understand how to process real data for real applications, applying statistical and machine learning techniques and algorithms as well as working with limitations in the technology.

Course Pre/co-requisites

This course has no specific prerequisite and corequisite.

2. Course Outcomes (COs)

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

B6464.1 Interpret an electrical equivalent of Speech Production system.
B6464.2 Calculate LPC coefficients that can be used to Synthesize or compress the speech
B6464.3 Design a Homomorphic vocoder for coding and decoding of speech
B6464.4 Generate the speech and can design an isolated word recognition system using HMM
B6464.5 Analyze the features for Automatic speaker recognition and classification system

3. Course Syllabus

Fundamentals of Digital Speech Processing : Anatomy & Physiology of Speech Organs, The process of Speech Production, Acoustic Phonetics, Articulatory Phonetics, The Acoustic Theory of Speech Production- Uniform lossless tube model, effect of losses in vocal tract, effect of radiation at lips, Digital models for speech signals.

Time Domain Models for Speech Processing : Introduction- Window considerations, Short time energy and average magnitude Short time average zero crossing rate, Speech Vs Silence discrimination using energy and zero crossing, Pitch period estimation using a parallel processing approach, The short time autocorrelation function, The short time average magnitude difference function, Pitch period estimation using the autocorrelation function.

Linear Predictive Coding (LPC) Analysis : Basic principles of Linear Predictive Analysis: The Autocorrelation Method, The Covariance Method, Solution of LPC Equations: Cholesky Decomposition Solution for Covariance Method, Durbin's Recursive Solution for the Autocorrelation Equations, Comparison between the Methods of Solution of the LPC Analysis Equations, Applications of LPC Parameters: Pitch Detection using LPC Parameters, Formant Analysis using LPC Pa Homomorphic Speech Processing

Homomorphic Speech Processing : Introduction, Homomorphic Systems for Convolution: Properties of the Complex Cepstrum, Computational Considerations, The Complex Cepstrum of Speech, Pitch Detection, Formant Estimation, The Homomorphic Vocoder. Speech Enhancement: Nature of interfering sounds, Speech enhancement techniques: Single Microphone Approach : spectral subtraction, Enhancement by re-synthesis, Comb filter, Wiener filter, Multi microphone Approach.

Automatic Speech & Speaker Recognition : Basic pattern recognition approaches, Parametric representation of speech, Evaluating the similarity of speech patterns, Isolated digit Recognition System, Continuous digit Recognition System. Hidden Markov Model (HMM) for Speech: Hidden Markov Model (HMM) for speech recognition, Viterbi algorithm, Training and testing using HMMS. Speaker Recognition: Recognition techniques, Features that distinguish speakers, Speaker Recognition Systems: Speaker Verification System, Speaker Identification System.

4. Books and Materials

Text Books:

1. L.R. Rabiner and S. W. Schafer, "Digital Processing of Speech Signals", Pearson Education.
2. Douglas O'Shaughnessy, "Speech Communications: Human & Machine", 2nd Edition., Wiley India, 2000.
3. L.R Rabinar and R W Jhaung, "Digital Processing of Speech Signals", 1978, Pearson Education.

Reference Books:

1. Thomas F. Quateri, "Discrete Time Speech Signal Processing: Principles and Practice",

1st Edition., PE.

2. Ben Gold & Nelson Morgan, "Speech & Audio Signal Processing", 1st Edition, Wiley.

Course Structure

B6465 - Deep Learning for Computer Vision

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

Course Overview This course focuses on the application of Deep Learning in the field of Computer Vision. The automatic analysis and understanding of images and videos, an area called Computer Vision,occupy significant importance in applications including security, healthcare, entertainment, mobility,etc. The recent success of deep learning methods has revolutionized the field of computer vision,making new developments increasingly closer to deployment that benefits end users.

Course Pre/co-requisites

This course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6465.1 Understand the basic knowledge, theories, and methods in computer vision
B6465.2 Thoroughly Understanding the fundamentals of Deep Learning
B6465.3 Identify the deep learning algorithms which are more appropriate for various types of learning tasks in multiple domains.
B6465.4 Implement deep learning algorithms and solve real-world problems
B6465.5 Design and develop practical and innovative computer vision applications using Deep Generative Models.

3. Course Syllabus

Recognition in Computer Vision : Introduction to Image Formation,Capture, and Representation; Linear Filtering, Correlation, Convolution, **Visual Features and Representations:** Edge, Blobs, Corner Detection; Scale Space and ScaleSelection; SIFT, SURF; HoG, LBP. **Visual Matching :** Bag-of-words, Vector of locally aggregated descriptors(VLAD); Random Sample Consensus(RANSAC), Hough transform; Pyramid Matching; Optical flow.

Deep Learning Review : Review of Deep Learning, Multi-layer Perceptrons, Backpropagation, Convolutional Neural Networks (CNNs): Introduction to CNNs; Evolution of CNN Architectures:AlexNet, ZFNet, VGG, InceptionNets, ResNets, DenseNets.

CNNs for Recognition, Verification, Detection, Segmentation : CNNs for Recognition andVerification (Siamese Networks, Triplet Loss, Contrastive Loss, Ranking Loss); CNNs forDetection: Background of Object Detection, R-CNN, Fast R-CNN, Faster R-CNN, YOLO, SSD,RetinaNet; CNNs for Segmentation: FCN, SegNet, U-Net, Mask-RCNN.

Deep Generative Models: Review of (Popular) Deep Generative Models: GANs, VAEs; OtherGenerative Models: PixelRNNs, NADE, Normalizing Flows, etc.

Variants and Applications of Generative Models in Vision : Variants: CycleGANs,Progressive GANs, StackGANs, Pix2Pix.Applications: Image Editing,Inpainting, Superresolution, 3D Object Generation.

4. Books and Materials

Text Books:

1. Ian Goodfellow, YoshuaBengio, Aaron Courville (2016), Deep Learning, the MIT Press, London.
2. Mohamed Elgendy (2020), Deep Learning for Vision Systems, Manning Publications, Shelter Island.

Reference Books:

1. Richard Szeliski (2022), Computer Vision Algorithms and Applications, Springer International Publishing.
2. AurélienGéron (2019), Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, O'Reilly, 2nd Edition.

Audit Courses

Course Structure

B6091 – Disaster Management

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

The course has been framed with an intention to provide a general concept in the dimensions of disasters caused by nature beyond human control as well as the disasters and environmental hazards induced by human activities with emphasis on Natural disaster, Man-made disaster, vulnerability and risks of disasters, Disaster Management Mechanism, Capacity Building and disaster coping Strategies and Disaster management planning.

Course Pre/co-requisites

The course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6091.1 Identify concepts, hazards and vulnerabilities of different types of disasters.
B6091.2 Examine the components of disaster management mechanism.
B6091.3 Select suitable capacity building framework for disaster management.
B6091.4 Interpret various disaster coping strategies.
B6091.5 Develop Strategies for disaster management planning.

3. Course Syllabus

Introduction: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. **Disaster Prone Areas in India:** Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

Disaster Preparedness and Management: Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

Risk Assessment Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

Disaster Mitigation: Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

4. Books and Materials

Text Books:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep Et. Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi.
3. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep &Deep Publication Pvt. Ltd., New Delhi

Course Structure

B6092 – Value Education

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

The present education system does not prepare students well for dealing with life. Primarily, it prepares them for profession or jobs. It concentrates on providing "How to do" rather than "What to do" or "Why to do?". This course will be helpful for students to develop critical ability, commitment and courage in real life problems. Students will learn about happiness, character development, self control, honesty, time management.

Course Pre/co-requisites

The course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6092.1 Identify the importance of value based living for character development.
B6092.2 Emerge as responsible citizens with clear conviction to practice values and ethics in life.
B6092.3 Interpret their role in nation building for a better tomorrow .
B6092.4 Develop a sense of commitment and decision making capability.

3. Course Syllabus

Values and Self - Development: Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgments.

Importance of Cultivation of Values: Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truth fullness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature Discipline.

Personality and Behavior Development: Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness.

Achieving Happiness: Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for

truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

Character and Competence: Holy Books vs Blind faith. Self-Management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, and Studying effectively.

4. Books and Materials

Text Books:

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi.
2. David N. Aspin, Judith D. Chapman, "Values Education and Lifelong Learning: Principles, Policies, Programmes" Springer, 2007

Course Structure

B6093 – Constitution of India

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

This course enables the students to understand the constitution of India as the Supreme law of India. The student will also gain knowledge about the parliament of India and how it functions. This course will survey the basic structure and operative dimensions of the Indian constitution. It will explore various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian constitution.

Course Pre/co-requisites

The course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6093.1 Identify the important components of Indian Constitution.
B6093.2 Explore the basics of Constitutional right in various domains .
B6093.3 Illustrate the evolution of Indian Constitution.
B6093.4 Analyze the Administrative process in India from grass-root level.
B6093.5 Relate the basic concepts of democracy, liberty, equality, secular and justice.

3. Course Syllabus

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working), **Philosophy of the Indian Constitution:** Preamble, Salient Features.

Contours of Constitutional Rights & Duties: Fundamental Rights Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualification, Powers and Functions.

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

4. Books and Materials

Text Books:

1. The Constitution of India, 1950 (Bare Act), Government Publication
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015

Reference Books:

1. M. P. Jain, Indian Constitution Law, 7th Edition., Lexis Nexis, 2014
2. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015

Course Structure

B6094 - Stress Management by Yoga

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

Stress has been determined to be a key factor of illness and disease. Prolonged stress in any person can lead to negative thinking, depression and worse. The course is based on managing stress by practice of yogic principles that are proven to be highly effective and easy to learn. In this course the students will learn about different types of yoga practices, Meditation, Yoga asanas, Pranayama for stress, anger and fear management.

Course Pre/co-requisites

The course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6094.1 Make use of yoga for stress management in educational environments.
B6094.2 Improve emotional intelligence to better deal with stress.
B6094.3 Develop flexibility through participation in yoga.
B6094.4 Learn methods of performing asanas, pranayama, mudras and bandhas.
B6094.5 Practice meditation for holistic living.

3. Course Syllabus

Meaning and Definition of Stress: Eutress, Distress, Anticipatory Anxiety, Intense Anxiety and Depression. Necessity of Stress Management, Concept of Stress according to Yoga.

Introduction to Yoga: Definition and Meaning of Yoga, Historical Perceptive on yoga – yoga before the time of Patanjali (Indus valley civilization, Vedas, Brahmnas, Upanishads, Epics, Puranas).

Schools of Yoga: Eight Limbs of Yoga: Yama, Niyama, Asana, Pranayama, Pratyahara, Dharana, Dhyana & Samathi. General principles of practicing Asana, Pranay- ama, Meditation, Kriyas Bandhas and Mudra.

Essentials of yoga practices: Prayer, Disciplines in Yogic Practices, Place & Timing, Diet & Schedule for Yoga Practitioner. Obstacles in the Path of Yoga Practice, Sequence for yogic

practices, Different between yogic & non yogic system of exercise. Do's and donts during Yoga

Personality development by yoga: Yoga and development of Social qualities of personality, Co-operation, Simplicity, Tolerance, Social adjustments, Yoga and personal efficiency. Improvement of personal efficiency through yoga.

4. Books and Materials

Text Books:

1. Wasmer Linda Andrews, Stress Control For Peace of Mind, Barnes & Noble Publisher, 2005
2. H.R. Nagendra, and R. Nagarathana, Yoga practices for anxiety & depression. Bangalore: Swami Sukhabodhanandha Yoga Prakashana 2004.

Reference Books:

1. BKS Iyengar, The Art of Yoga. New Delhi: Harper Collins Publishers, 2003.

Course Structure

B6095 - Personality Development through Life Enlightenment Skills

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

The course aims to provide a basic awareness about the significance of Life Enlightenment skills in all-round development of personality. Personality development boosts confidence level in students and help them achieve high esteem. In this course the holistic development of personality in students will be done by practicing some basic Veres of Srimad Bhagavath Geetha by explaiing the true meaning of Wisdom, Pride, Virtue, Happiness, Pain.

Course Pre/co-requisites

The course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6095.1 Create Holistic development of personality.
B6095.2 Exercise the role model in the Bhagavath Geetha by practicing it.
B6095.3 Develop a sense of spirituality and heart fullness in mind and body.
B6095.4 Demonstrate knowledge of beliefs and values to continuing personal reflection and reassessment.

3. Course Syllabus

Neetisatakam - Holistic Development of Personality:

Verses- 19, 20, 21,22 (Wisdom)

Verses- 29, 31, 32 (Pride & Heroism)

Verses- 26, 28, 63, 65 (Virtue)

Do's and Dont's

Verses- 52, 53, 59 (Dont's)

Verses- 71, 73, 75, 78 (Do's)

Approach to Day to Day Work and Duties:

Chapter 2: Verses 41, 47,48

Chapter 3: Verses 13, 21, 27, 35

Chapter 6: Verses 5,13,17, 23, 35

Chapter 18: Verses 45, 46, 48.

Statements of basic knowledge :

Chapter 2: Verses 56, 62, 68

Chapter 12: Verses 13, 14, 15, 16,17, 18

Personality of Role Model

Chapter 2: Verses 17

Chapter 3: Verses 36,37,42

Chapter 4: Verses 18, 38,39

Chapter 18: Verses 37,38,63

4. Books and Materials

Text Books:

1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata.

Reference Books:

1. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Samskrit Sansthanam, New Delhi.

Course Structure

B6096 - Pedagogy Studies

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

Pedagogy is the relationship between learning techniques and culture. It requires meaningful classroom interactions between educators and learners. The objective of this course is to help students build on prior learning and develop skills and attitudes. Furthermore it can improve the quality of your teaching and the way students learn, helping them gain a deeper grasp of fundamental material.

Course Pre/co-requisites

The course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6096.1 Develop a positive attitude towards life and teaching profession
B6096.2 Critically analyze the classroom teaching, learning and behavior.
B6096.3 Compare the teaching and learning practices in educational institutes in the past decade.
B6096.4 Summarize the aspects of effective teaching process.

3. Course Syllabus

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology. Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.

Thematic Overview: Pedagogical practices in formal and informal classrooms in developing countries, Curriculum development, Teacher education.

Evidence on the Effectiveness of Pedagogical Practices : Quality assessment of included studies, How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?. Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

Professional Development: Alignment with classroom practices and followup support. Peer support, Support from the head teacher and the community. Curriculum and assessment. Barriers to learning: limited resources and large class sizes.

Research Gaps and Future Directions: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment. Dissemination and research impact.

4. Books and Materials

Text Books:

1. Ackers J, Hardman F (2001) Classroom Interaction in Kenyan Primary Schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular Reform in Schools: The Importance of Evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher Training in Ghana - does it count? Multi-site Teacher Education Research Project (MUSTER) Country Report 1. London: DFID.

Reference Books:

1. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving Teaching and Learning of Basic Maths and Reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
2. Alexander RJ (2001) Culture and Pedagogy: International Comparisons in Primary Education. Oxford and Boston: Blackwell.
3. Chavan M (2003) Read India: A mass scale, rapid, 'Learning to Read' campaign.

Open Electives

Course Structure

B6081 - Business Analytics

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

This course addresses the scope of business analytics, process and tools used to get competitive advantages of business analytics. It covers the forecasting techniques to predict the given data for various decision making. Apart from prediction it also establishes the relationship between the given data to formulate the strategies for business decisions.

Course Pre/co-requisites

This course has no specific prerequisite and co-requisite.

2. Course Outcomes (COs)

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

B6081.1	Demonstrate knowledge of data analytics.
B6081.2	Demonstrate the ability of think critically in making decisions based on data and deep analytics.
B6081.3	Demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making,
B6081.4	Demonstrate the ability to translate data into clear, actionable insights.

3. Course Syllabus

Theory

Business analytics and Statistical Tools: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

Forecasting Techniques and Monte Carlo Simulation and Risk Analysis: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model,Overbooking Model, Cash Budget Model.

Decision Analysis and recent trends: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

4. Books and Materials

Text Books:

1. Varshney & Maheswari , Business analytics Principles, Concepts, and Applications, Marc J. Schniederjans, Dara G.Schniederjans, Christopher M. Starkey, 1st Ed., Pearson FT Press, 2014
2. Jamesh R Evans, Business Analytics, Global Edtion, Pearson Higher Education & Professional Group, 2020

Course Structure

B6082 - Waste to Energy

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

The course deals with the production of energy from different types of wastes through thermal, biological and chemical routes. This course provides insights into waste management options by reducing the waste destined for disposal and encouraging the use of waste as a resource for alternate energy production. This course is explores Biomass Pyrolysis, Biomass gasification, Biomass combustions and Bio energy systems.

Course Pre/co-requisites

The course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6082.1 Classify different waste material produces from all sources.
B6082.2 Analyze Bio energy systems resources, process and application.
B6082.3 Apply emerging methods for Bio mass Pyrolysis, gasification and combustion to improve the efficiency.
B6082.4 Analyze different case studies for understanding success and failure of waste to energy technologies.

3. Course Syllabus

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers - Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs,

fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

4. Books and Materials

Text Books:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.

Reference Books:

1. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Course Structure

B6083 - Operations Research

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

The courses in Operational Research offer a unique blend of traditional coursework, practical skills, and real-world problem-solving experience designed to position students for success in today's competitive world. This course covers Linear Programming, Non-Linear Programming Problem, Mathematical Models and problems.

Course Pre/co-requisites

Industrial Management concepts

2. Course Outcomes (COs)

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

B6083.1 Gain knowledge in concepts and techniques of Operations Research.
B6083.2 Determine the optimal solution for Linear Programming problems.
B6083.3 Formulate and obtain the optimal solution for non- Linear Programming problems.
B6083.4 Solve to get optimal solution using queuing and inventory models .
B6083.5 Determine solution for non- Linear Programming problems using dynamic programming

3. Course Syllabus

Linear Programming Problem & Its Application I: Introduction, Formulation of LPP. Slack Variable, Surplus Variable and Artificial Variables. Standard Form and Matrix Form. Concept of Duality. Graphical Method. Simplex Method. Big - M method & Two - Phase Method. Problems of Degeneracy.

Linear Programming Problem & Its Application II: Parametric Programming introduction . Types of Linear Variations. Graphical and Analytical Sensitivity Analysis.

Non-Linear Programming Problem I: Introduction, Formulation and Graphical Method, Kuhn-Tucker Conditions, Quadratic Programming Problems by Wolfe's and Beale's Method.

Non-Linear Programming Problem II: Geometric programming introduction and analytical methods , Fractional programming introduction and analytical methods, Dynamic

programming introduction and analytical methods.

General Mathematical Models: Sequencing - n Jobs and m Machines, Inventory Control - introduction and its analytical methods. Single server queuing model.

4. Books and Materials

Text Books:

1. S.D. Sharma, Operations Research Theory, Methods and Applications, 18th Edition, Kedarnath Ramnath Publishers, Delhi 2017
2. H.A. Taha, Operations Research- An Introduction,8th Edition PHI, 2008.
3. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.

Reference Books:

1. J.C. Pant, Introduction to Optimization: Operations Research, 7th Edition,Jain Brothers, Delhi, 2008.
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009.
3. Pannerselvam, Operations Research:2nd Edition, Prentice Hall of India 2010.
4. Harvey M Wagner, Principles of Operations Research:2nd Edition, Prentice Hall of India 2010.

Course Structure

B6084 - IoT and Applications

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

The course introduces you to advance concepts and design methodologies to design IoT systems and developing IoT applications programming languages and tools optimized for IoT domain. The course covers python languages in great detail with set of packages which makes it obvious choice as a leading IoT language. It also exposes participants to communication technologies and legacy protocols as well as newly developed IoT specific application and physical layer protocols. The course covers Cloud based service in great detail with set of packages which makes it obvious choice as a leading IoT Technology.

Course Pre/co-requisites

The course has no specific prerequisite and co-requisite

2. Course Outcomes (COs)

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

B6084.1 Identify the basic Architecture of IoT and its characteristics
B6084.2 Determine the most appropriate IoT Devices and communication system management
B6084.3 Utilize Python standard libraries for implementing various IoT Applications
B6084.4 Analyze the appropriate protocol for establishing communication between various IoT Devices
B6084.5 Analyze cloud infrastructure, services, APIs and architectures of commercial and industrial cloud platforms

3. Course Syllabus

Introduction to Internet Of Things : Introduction, Definition & Characteristics of IoT,Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies, IoT Levels & Deployment Templates DOMAIN SPECIFIC IOTS - Introduction, Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health & Lifestyle.

IoT , M2M and IoT System Management with NETCONF-YANG : Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT IoT System Management with NETCONF-YANG - Need for IoT Systems Management, Simple Network Management

Protocol (SNMP), Network Operator Requirements, NETCONF, YANG, IoT Systems Management with NETCONF-YANG.

IoT Platforms Design Methodology : IoT Platforms Design Methodology - Introduction, IoT Design Methodology, Case Study on IoT System for Weather Monitoring, Motivation for Using Python IoT SYSTEMS - LOGICAL DESIGN USING PYTHON - Introduction, Installing Python, Python Data Types & Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/Time Operations, Classes,Python Packages of Interest for IoT.

IoT Physical Devices & Endpoints : What is an IoT Device, Exemplary Device: Raspberry Pi, About the Board, Linux on Raspberry Pi, Raspberry Pi Interface, Programming Raspberry Pi with Python, Other IoT Devices IoT PHYSICAL SERVERS & CLOUD OFFERINGS - Introduction to Cloud Storage Models & Communication APIs, WAMP - AutoBahn for IoT, Xively Cloud for IoT, Python Web Application Framework,Designing a RESTful Web API, Amazon Web Services for IoT, SkyNet IoT Messaging Platform.

Case Studies Illustrating IoT Design : What is an IoT Device, Exemplary Device: Raspberry Pi, About the Board, Linux on Raspberry Pi, Raspberry Pi Interface, Programming Raspberry Pi with Python, Other IoT Devices IoT PHYSICAL SERVERS & CLOUD OFFERINGS - Introduction to Cloud Storage Models & Communication APIs, WAMP - AutoBahn for IoT, Xively Cloud for IoT, Python Web Application Framework,Designing a RESTful Web API, Amazon Web Services for IoT, SkyNet IoT Messaging Platform.

4. Books and Materials

Text Books:

1. Arshdeep Bahga,Vijay Madisetti(2015), "Internet of Things A Hands-On Approach", University Press, India.
2. Jain, R.K. and Iyengar, S.R.K., Advanced Engineering Mathematics, 3rd Edition, Narosa Publishing House, 2011

Course Structure

B6085 - Cyber Security

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

This course drawing upon a wealth of experience from academia, industry, and government service, Cyber Security details and dissects, in current organizational cyber security policy issues on a global scale—taking great care to educate students on the history and current approaches to the security of cyberspace. It includes thorough descriptions of Cyber Offences, Cyber Crime, tools and methods used in Cyber Crime. It also delves into organizational implementation issues, and equips students with descriptions of the positive and negative impact of specific policy choices.

Course Pre/co-requisites

The course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6085.1 Demonstrate the basics of cybercrime in computer, networked device or a network.
B6085.2 Identify various cyber offences in real time.
B6085.3 Identify the different attacks in cybercrime.
B6085.4 Use various methods and tools to control cybercrimes and cyber offences.
B6085.5 Examine how to protect organizations from intruders, attackers and cyber criminals.

3. Course Syllabus

Introduction to Cybercrime: Introduction, Cybercrime, and Information Security, who are Cybercriminals, Classifications of Cybercrimes. The legal Perspectives and Indian Perspective, Cybercrime and the Indian ITA 2000, A Global Perspective on Cybercrimes.

Cyber Offenses: How Criminals Plan Them: Introduction, How Criminals plan the Attacks, Social Engineering, Cyber stalking, Cyber cafe and Cybercrimes. Botnets: The Fuel for Cybercrime, Attack Vector, and Cloud Computing.

Cybercrime: Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing

Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Organizational Security Policies and Measures in Mobile Computing Era, Laptops.

Tools and Methods: Introduction, Proxy Servers and Anonymizers, Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Trojan Horse and Backdoors, Steganography, DoS and DDoS attacks, SQL Injection, Buffer Overflow.

Cyber Security: Organizational Implications Introduction, Cost of Cybercrimes and IPR issues, Web threats for Organizations, Security and Privacy Implications. Social media marketing: Security Risks and Perils for Organizations, Social Computing and the associated challenges for Organizations.

4. Books and Materials

Text Books:

1. Nina Godbole and Sunil Belapure., Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, 1st Edition, Wiley INDIA. 2011.

Reference Books:

1. James Graham, Richard Howard and Ryan Otson., Cyber Security Essentials, 1st Edition, CRC Press, 2011.
2. Chwan-Hwa(John) Wu,J.David Irwin., Introduction to Cyber Security, , 1st Edition, CRC Press T&F Group, 2013.
3. Richard A. Clarke, Robert Knake., Cyberwar: The Next Threat to National Security & What to Do About It, Ecco, 2010.

Course Structure

B6086 - Mobile Cloud Computing

Hours Per Week		Hours Per Semester		Credits	Assessment Marks		
L	P	L	P	C	CIE	SEE	Total
3	0	42	0	3	40	60	100

1. Course Description

Course Overview

This Course provides a comprehensive overview of how to integrate cloud and mobile technology. It is an emerging field and this course explores how distributed resources can be shared by mobile users in different ways and issues arising there from. This course also provides understanding of Architecture, Applications of Mobile Cloud Computing along with Offloading concept and Resource allocation techniques. This also introduces concept called Green Mobile Computing and also discusses about the security issues in Mobile Cloud Computing. This course enables the student to choose as research area of interest.

Course Pre/co-requisites

The course has no specific prerequisite and co requisite.

2. Course Outcomes (COs)

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

B6086.1 Identify the architecture, issues and applications in mobile cloud computing.
B6086.2 Make use of remote cloud and offloading techniques for storage and computation.
B6086.3 Choose a resource allocation method in mobile cloud computing.
B6086.4 Use green mobile computing for an energy efficient mobile network.
B6086.5 Identify the trust and privacy requirements in a mobile cloud computing environment.

3. Course Syllabus

Mobile Cloud Computing: : Introduction to cloud computing, Basic cloud architecture, Motivation to MCC, Architecture, Platform and Technologies, Mobile Augmentation approaches, Issues of Mobile Cloud Computing, Advantages and Applications of Mobile Cloud Computing.

Offloading in Mobile Cloud Computing: Introduction, Offloading Decision, Types of Offloading, offloading in CC and MCC: Similarities and Differences, Adaptive Computation offloading from Mobile Devices, Cloud Path selection for Offloading, Mobile Data Offloading Using Opportunistic Communication, Three-Tier Architecture of Mobile Cloud Computing,

Requirements of Data Offloading, Performance Analysis of Offloading Techniques, Multi-Cloud Offloading in Mobile Cloud Computing Environment.

Resource Allocation in MCC: Introduction, Significance of Resource Allocation, Resource-Allocation Strategies- Semi-Markov Decision Process (SMDP), Task Scheduling Using Activity-Based Costing Algorithm, Resource Allocation Using Middleware, Energy-Aware Resource Allocation, Resource Allocation in MCC Using Entropy-Based FIFO Method, Auction Mechanism for Resource Allocation in MCC.

Green Mobile Computing: Introduction, Green Mobile Computing, Green Mobile Network, Green Cloud Computing, Green Mobile Cloud Computing, Green Mobile Devices Using Mobile Cloud Computing, Green Femtocell Using MCC.

Privacy and Security in MCC: Introduction, Security Levels, Security Issues. Trust in MCC: Introduction, Properties, Components, types of Trust, Trust Issues, and Trust Establishment.

4. Books and Materials

Text Books:

1. Debashis De., Mobile Cloud Computing-Architectures, Algorithms and Applications, CRC Press, Taylor and Fransis group, 2016.

Reference Books:

1. Frank H.P. Fitzek and Marcos D. Katz., Mobile Clouds: Exploiting Distributed Resources in Wireless, Mobile and Social Networks, 1st Edition, WILEY publications, 2014.
2. Valentino Lee, Heather Schneider, and Robbie Schell., Mobile Applications: Architecture, Design, and Development, Prentice Hall, 2004.