PANDIT DEENDAYAL PETROLEUM UNIVERSITY, GANDHINAGAR
SCHOOL OF TECHNOLOGY

COURSE STRUCTURE FOR B TECH IN INFORMATION & COMMUNICATION TECHNONLOGY													
Semester VII			**B Tech in Information & Communication Technology**										
Sr. No.	**Course/Lab Code**	**Course/Lab Name**	**Teaching Scheme**					**Examination Scheme**					
								Theory			**Practical**		**Total**
			L	**T**	**P**	**C**	**Hrs/ Wk**	**CE**	**MS**	**ES**	**CE**	**ES**	**Marks**
1	19IC401T	Digital VLSI Circuits and HDL	4	0	0	4	4	25	25	50	-	-	100
2	18CP305T	Information Security	3	0	0	3	3	25	25	50	-	-	100
3	19CP402T	Machine Learning	4	0	0	4	4	25	25	50	-	-	100
4	19IC402P	Mini Project	0	0	14	7	14				There will be three reviews (30 %, 30 %, 40 %)		100
5	19XX40X	Elective III	3	0	0	3	3	25	25	50	-	-	100
6	19XX40X	Elective IV	3	0	0	3	3	25	25	50	-	-	100
8	19IC401P	Digital VLSI Circuits and HDL LAB	0	0	2	1	2	-	-	-	25	25	50
		Total	17	0	16	25	33						650

CE- Continuous Evaluation, MS-Mid Semester; ES – End Semester Exam

The department may offer electives from below basket, based on availability of expertise/faculty

Subject Code	**Elective III & IV**	**Credit**	**L-T-P**	**Category**
19CP405	Cloud Computing	3	3-0-0	Computing System
19CP406	Advanced Operating System	3	3-0-0	Computing System
19IC403	Image Processing	3	3-0-0	Communication and Signal Processing
19CP407	Data Compression	3	3-0-0	Communication and Signal Processing

19CP408	Biometrics	3	3-0-0	Security
19IC404	Fundamentals of Remote Sensing	3	3-0-0	Communication and Signal Processing
19IC405	Computer Vision	3	3-0-0	Communication and Signal Processing
19CP409	Big Data Analytics	3	3-0-0	Data Science
19CP4010	Software Testing Methodologies	3	3-0-0	Computing System
19IC406	Vehicular Networks	3	3-0-0	Communication and Signal Processing
19IC407	Statistical Signal Processing	3	3-0-0	Communication and Signal Processing
19IC408	Cognitive & Software Defined Radio	3	3-0-0	Communication and Signal Processing
19IC409	Theory of Automata and Computation	3	3-0-0	Computing System
19CP403	Internet of Things	3	3-0-0	Computing System
19IC4010	ICT for Energy Sector	3	3-0-0	Application
19CP4012	Human Computer Interaction	3	3-0-0	Application
19IC4011	Statistical Pattern Recognition	3	3-0-0	Data Science
19CP4013	Information Retrieval System	3	3-0-0	Data Science
19CP4014	Blockchain Technology	3	3-0-0	Security
19CP4015	Green Computing	3	3-0-0	Application
19IC4012	Advanced Communication Systems	3	3-0-0	Communication and Signal Processing

Course Code: 19IC401T					Course Name: Digital VLSI Circuits and HDL			
Teaching Scheme					Examination Scheme			
					Theory			Total
L	T	P	C	Hrs/Wk	Continuous Evaluation	Mid Semester	End Semester	Marks
4	0	0	4	4	25	25	50	100

Prerequisites: Embedded Systems, Computer Organization

Learning objectives:

- To understand the concepts related to design and performance/power analysis of digital CMOS VLSI circuits/gates
- To be able to simulate and characterize digital CMOS VLSI circuits/gates in CAD tools
- To be able to model and simulate digital gates and RTL blocks using Verilog Hardware Description Language (HDL)

Unit wise allocation of course content

UNIT 1 (10 L)

Introduction to CMOS VLSI

Trends in VLSI/Semiconductor industry, related to technology (Moore's) scaling; ITRS Roadmap; Investigation of semiconductor devices inherent in the MOSFET: Drain-Body and Source-Body PN junctions, Metal-semiconductor contacts, MOS Capacitor; IV characteristics of P-channel and N-channel planar MOSFETs; Non-ideal effects: Sub-threshold leakage, junction leakage, gate leakage, mobility degradation, velocity saturations, body-effect, etc.; Basic steps of CMOS fabrication process/technology

UNIT 2 (16 L)

Design of Digital CMOS VLSI Standard and Compound Gates

Static CMOS inverter and its VTC characteristics; Resistive Load NMOS inverter and its VTC characteristics; Pseudo NMOS inverter and its VTC characteristics; Design and transistor sizing of standard gates (NAND, NOR, EXOR, tri-state INV) and compound gates. RC modelling and Elmore delay analysis of gates (pattern dependent delay analysis); Sutherland Logical effort method of delay estimation and sizing of cascaded paths/gates; Static and dynamic Power of gates; Euler Diagram/Paths for layout of gates, stick diagram, Lambda rules (DRC) and layouts of gates

UNIT 3 (16 L)

CMOS Logic Styles

Pass-transistor tree based logic gates (and similar other logic styles – CPL, transmission gates, DPL, etc.); Pseudo-NMOS logic; CVLS logic; Dynamic logic (domino, NP domino, Zipper)

Introduction to Verilog Hardware Description Language (HDL)

Types of modelling: Gate-level modelling, Data-flow modelling; Behavioural modelling; Basic constructs and syntax of Verilog language, related to hierarchical and modular modelling; Concept of test-bench and incorporating delays in test-bench; Verilog implementation of combinational blocks: decoders, encoders, multiplexor, de-multiplexor, priority encoder, arithmetic-logic unit (ALU), etc, using Gate-level modelling, Data-flow modelling, Behavioural modelling; Analysing results of UUT through waveforms

UNIT 4 (10 L)

Verilog implementation of sequencing elements (latch and flip-flops) using behavioural modelling; Verilog implementation of sequential circuits: counters (with parallel load, up/down); universal shift-registers; Moore Finite State Machine; RTL/pipelined processing, etc. Verilog implementation of memories: Register bank (structural modelling), single and multi-ported behavioural memories, etc.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 54Hrs
Tutorial: 00Hrs
Approximate Total: 54Hrs

Texts and References:

1. CMOS VLSI design: A circuits and systems perspective, 3rd or 4th Edition, Pearson Education, by Neil Weste, David Harris, Ayan Banerjee.
2. CMOS Digital Integrated Circuits, 3rd Edition, Mcgraw Hill Education, by Sung-Mo Kang, Yusuf Leblebici
3. Semiconductor Device Fundamentals, 1st Edition, Pearson Education, by Robert F. Pierret
4. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, 2nd Edition, Prentice Hall
5. Stephen Brown, and Zvonko Vrsaniec, Fundamentals of Digital Logic with Verilog Design, 2nd Edition, McGraw Hill

Course Outcomes (COs):

At the end of this course students will be able to:

1. Understand the basics of semiconductor devices inherent inside the MOSFET, and the IV characteristics and regions of operation of the MOSFET.
2. Understand the design, simulation and (performance / power) analysis aspects of digital CMOS VLSI standard and compound gates, and various logic styles.
3. Understand the modeling and simulation of digital combinational circuits and sequential circuits, using Hardware Description Language (HDL).
4. Analyze behavioral model of sequencing elements.

19IC401T Digital VLSI Circuits and HDL

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
19IC401T.1	3	3	2	3	3	1	1	1	1	1	1	2	2	2	3
19IC401T.2	3	3	2	3	3	1	1	1	1	1	1	2	2	2	3
19IC401T.3	3	3	2	3	3	1	1	1	1	1	1	2	2	2	3
19IC401T.4	3	3	2	3	3	1	1	1	1	1	1	2	2	2	3
19IC401T	3.00	3.00	2.00	3.00	3.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	3.00

Constituent COs in Assessment: 19IC401T Digital VLSI Circuits and HDL

Assessment	19IC401T.1	19IC401T.2	19IC401T.3	19IC401T.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19IC401P					Course Name: Digital VLSI Circuits and HDL LAB		
Teaching Scheme					Examination Scheme		
					Practical		Total
L	T	P	C	Hrs/Wk	Continuous Evaluation	End Semester	Marks
0	0	2	1	2	25	25	50

Prerequisites: Embedded Systems, Computer Organization

Learning objectives:

- To understand the concepts related to design and performance/power analysis of digital CMOS VLSI circuits/gates
- To be able to simulate and characterize digital CMOS VLSI circuits in CAD tools
- To be able to model digital gates and RTL blocks using Verilog Hardware Description Language (HDL)

List of Experiments:

1. SPICE simulation of NMOSFET and PMOSFET (understanding the IV characteristics)
2. SPICE simulation and analysis of static CMOS inverter (understanding VTC and noise margins); and related layout (DRC, VLS, and RC extraction) in CAD tool
3. SPICE simulation and analysis of (static CMOS) standard gates (NAND, NOR, EXOR, tri-state)
4. SPICE simulation, analysis and comparison of various CMOS logic styles based gates
5. SPICE simulation and analysis of latch and flip-flop
6. Verilog HDL implementation of basic digital combinational circuits (decoder, MUX, etc)
7. Verilog HDL implementation of arithmetic-logic unit (ALU)
8. Verilog HDL implementation of basic digital sequential circuits (counters, registers, etc)
9. Verilog HDL implementation of register file
10. Verilog HDL implementation of memories
11. Verilog HDL implementation of Moore Finite State Machine (FSM)
12. Verilog HDL implementation of RTL/pipelined system

Texts and References:

1. CMOS VLSI design: A circuits and systems perspective, 3rd or 4th Edition, Pearson Education, by Neil Weste, David Harris, Ayan Banerjee.
2. CMOS Digital Integrated Circuits, 3rd Edition, Mcgraw Hill Education, by Sung-Mo Kang, Yusuf Leblebici
3. Semiconductor Device Fundamentals, 1st Edition, Pearson Education, by Robert F. Pierret
4. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, 2nd Edition, Prentice Hall
5. Stephen Brown, and Zvonko Vrsaniec, Fundamentals of Digital Logic with Verilog Design, 2nd Edition, McGraw Hill

Course Outcomes (COs):

At the end of this course students will be able to :

1. Understand the use of CAD tools (SPICE tool for transistor-level design/simulation and layout-level tool)
2. Understand the design and analysis (through simulations) aspects of digital CMOS VLSI

standard and compound gates.

3. Understand the modeling and simulation of digital combinational circuits and sequential circuits using Verilog Hardware Description Language (HDL).

Course Code: 18CP305T					**Course Name: Information Security**			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/ Wk**	**Theory**			**Total**
					Continuous Evaluation	**Mid Semester**	**End Semester**	**Marks**
3	0	0	3	3	25	25	50	100

Learning objectives:

- To introduce the concepts, technologies, practices, and challenges associated with Information Security.
- Introduce the principles and practice of cryptography.
- To understand the different classical cipher techniques for encoding.
- Introduce the concept of Symmetric and Public Key Cryptography.
- Understand the techniques for message authentication.

Unit wise allocation of course content

UNIT 1 (10 L)

Information Security Requirements, Security Attacks, Security Services, Security Mechanism, Substitution Ciphers, Permutation Ciphers, Playfair Cipher, Hill Cipher, Polyalphabetic Ciphers, One Time Pad, Machine Ciphers, Introduction to Steganography. Introduction to Number Theory, Divisibility, Division Algorithm, Binary Operations, Euclidean Algorithm, Modular Arithmetic, Matrices, Linear Congruence, Groups, Rings, and Fields, Finite Fields of the form GF(p), Polynomial Arithmetic

UNIT 2 (10 L)

Introduction to Symmetric Key Cryptography, S-boxes, Advanced Encryption Standard (AES), Analysis of AES, Data Encryption Standard (DES), Multiple DES, DES Analysis, Security of DES, Modern Block Ciphers, Modes of Operation, Synchronous and Asynchronous Stream Ciphers, Use of Modern Block Ciphers and Stream Ciphers.

UNIT 3(10L)

Introduction to Public Key Cryptography, Public Key Requirements, Diffie-Hellman Key Exchange, RSA Cryptosystem, Attacks on RSA. Authentication Protocols : Biometric, Kerberos, X.509, public key infrastructure, Kerberos encryption techniques.

UNIT 4 (9 L)

Application of Cryptographic Hash Functions, Message Authentication, Requirements of Hash Functions, MD5, SHA, Message Authentication Code (MAC), MAC based on Hash Function (HMAC), Key Management and Distribution

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs
Tutorial: 0 Hrs
Approximate Total: 39 Hrs

Texts and References:

1. William Stallings, "Cryptography and Network Security Principles and Practice", Pearson Education
2. Atul Kahate, "Cryptography and Network Security", Tata McGraw-Hill Education
3. Charlie Kaufman, Radia Perlman, Mike Speciner, "Network Security: Private Communication in a Public World", Prentice Hall
4. Behrouz A. Forouzan, "Cryptography and Network Security", McGraw-Hill Education
5. Menezes, Oorschot, Vanstone : "Handbook of Applied Cryptography", CRC Press
6. Douglas Stinson, "Cryptography: Theory and Practice", Chapman& Hall
7. Menezes Bernard, "Network Security and Cryptography", Cengage Learning India

Course Outcomes (COs):

At the end of this course students will be able to

1. Understand the importance and necessity of security and privacy policies.
2. Understand the concepts related to the basics of information security and cryptography.
3. Deduce the mechanisms to be employed while trying to satisfy any of the security services.
4. Ability to design and decode the encrypted message using classical ciphers, symmetric key cryptography algorithms.
5. Understand public key cryptography algorithms and ability to apply the different encryption algorithms according to the system requirements.
6. Understand the techniques for message authentication

18CP305T– Information Security

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
18CP305T.1	3	3	2	3	3	3	2	3	2	3	2	3	3	2
18CP305T.2	3	3	2	3	3	3	2	3	2	3	2	3	3	2
18CP305T.3	3	3	2	3	3	3	2	3	2	3	2	3	3	2
18CP305T.4	3	3	3	3	3	3	2	3	2	3	2	3	3	2
18CP305T.5	3	3	3	3	3	3	2	3	2	3	2	3	3	2
18CP305T.6	3	3	3	3	3	3	2	3	2	3	2	3	3	2
18CP305T	3	3	2.5	3	3	3	2	3	2	3	2	3	3	2

Constituent COs in Assessment: 18CP305T – Information Security

Assessment	18CP305T.1	18CP305T.2	18CP305T.3	18CP305T.4	18CP305T.5	18CP305T.6
MS	Y	Y	Y	Y	N	N
ES	Y	Y	Y	Y	Y	Y
CE	Y	Y	Y	Y	Y	Y

Course Code: 19CP402T					**Course Name: Machine Learning**			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/ Wk**	**Theory**			**Total**
					Continuous Evaluation	**Mid Semester**	**End Semester**	**Marks**
4	0	0	4	4	25	25	50	100

Prerequisites: Linear Algebra, Probability, Calculus

Learning objectives:

1. Understand the basic principles of machine learning.
2. Work with widely popular machine learning algorithms.
3. Learn methodology and tools for applying machine learning to real data and its performance evaluation.

Unit wise allocation of course content

UNIT 1 (9 L) Fundamentals and Regression
Introduction, examples of machine learning applications, General Design perspectives and issues in Machine Learning, Supervised, Semi Supervised and unsupervised learning models, Linear Regression, Univariate and Multivariate cases, Logistic Regression, hypothesis formulation, decision boundary, cost function, gradient descent, regularization, bias variance dilemma, accuracy measures

UNIT 2 (8 L) Dimensionality reduction
Subset selection, Principal Component Analysis, Probabilistic PCA, case study using PCA, Factor analysis, Linear Discriminant Analysis, Comparison of PCA and LDA, Case study using LDA

UNIT 3 (10 L) Kernel machines
Optimal Hyperplane for linearly and non-separable patterns, soft margin hyperplane, cost function formulation, Kernel trick, vectorial kernels, multiple kernel learning, multiclass kernel machine

Unit 4 (10 L) Reinforcement Learning
Introduction, K-Armed Bandit, Elements of reinforcement learning, Model based learning, temporal difference learning, Generalisation

UNIT 5 (15 L) Deep Networks
Introduction, CNN Architecture, RNN architecture, Training, Loss functions, Problems of vanishing gradients, LSTM Activation functions, Batch Normalisation, Weight Initialisation, Learning rate decay, Long short term memory networks

Student centered learning: The element of project in the course will enable this pedagogy. Instructor will decide project in consultation with students at the beginning of the semester.

Lecture: 52Hrs
Tutorial: 00Hrs
Approximate Total: 52Hrs

Texts and References:

1.Ethem Alpaydin, Introduction to Machine Learning, Third edition, PHI, 2015
2.Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016
3.Shai Shalev-Shwartz, Shai Ben-David, Understanding Machine Learning from Theory to Algorithms, Cambridge University Press, 2014.
4.Tom Mitchell, Machine Learning, McGraw-Hill, 1997
5.Simon Haykin, Neural Networks and Learning Machines, Third Edition, Paper Back, Pearson India, Low Price Edition
6.Duda, R.O., Hart, P.E., and Stork, D.G. Pattern Classification. Wiley-Interscience. 2nd Edition. 2001.
7.Bishop, C. M. Pattern Recognition and Machine Learning. Springer. 2007.
8.Marsland, S. Machine Learning: An Algorithmic Perspective. CRC Press. 2009.
9.Hastie, T., Tibshirani, R. and Friedman, J. The Elements of Statistical Learning. Springer. 2001.

Journals

IEEE Transactions on Neural Networks, IEEE Transactions on Pattern Analysis and Machine Intelligence, Machine Learning, Journal of Machine Learning Research, IEEE Transactions on Knowledge and Data Engineering, ACM Special Interest Group on Knowledge Discovery and Data Mining Explorations Journal

Conference Proceedings

Neural Information Processing Systems (NIPS), Uncertainty in Artificial Intelligence (UAI), International Conference on Machine Learning (ICML), Computational Learning Theory (COLT), International Joint Conference on Artificial Intelligence (IJCAI)

Data set repositories UCI Repository for machine learning is the most popular repository:
http://www.ics.uci.edu/~mlearn/MLRepository.html

Open source Software Weka 3: Data Mining Software in Java
http://www.cs.waikato.ac.nz/ml/weka/

Course Outcomes (COs):

At the end of this course students will be able to

1.Select appropriate machine learning algorithm for real-world applications.
2.Apply the appropriate machine learning technique to classification, pattern recognition, optimization and decision problems.
3.Perform evaluation of learning algorithms and model selection.
4.Use open source deep learning libraries for implementation of the algorithms.

19CP402T – Machine Learning

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
19CP402T.1	3	3	3	3	2	3	1	1	2	3	2	1	2	1
19CP402T.2	3	3	3	3	3	1	1	1	3	2	2	1	3	1
19CP402T.3	3	3	3	3	3	3	1	1	3	1	2	1	3	3
19CP402T.4	3	3	3	2	3	1	1	1	3	2	2	1	3	3
19CP402T	3.00	3.00	3.00	2.75	2.75	2.00	1.00	1.00	2.75	2.25	2.00	1.00	2.75	2.00

Constituent COs in Assessment: 19CP402T – Machine Learning

Assessment	19CP402T.1	19CP402T.2	19CP402T.3	19CP402T.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19IC402P					**Course Name: Mini Project**			
Teaching Scheme					**Examination Scheme**			
					Review			**Total**
L	**T**	**P**	**C**	**Hrs/ Wk**	**Continuous Evaluation Review**	**Mid Semester Review**	**End Semester Review**	**Marks**
0	0	14	7	14	30	30	40	100

Prerequisites: All core courses

Learning objectives:

To provide an opportunity to the final year student to understand / design / develop / implement systems involving relevant aspects of engineering and its applications, involving individual effort by the student.

Scope:

The students of B.Tech. (ICT) programs are expected to work on mini project in any of the ICT/CSE related areas. The different kinds of academic/Industrial projects that could be accepted as the student's mini project are conceived broadly as follows:

- Software Development
- System Design and Simulation
- Hardware Development / Implementation
- Embedded System (Software & Hardware combined) Development / Implementation
- Theoretical Modeling, Design and Analysis
- Technical Study including feasibility and comprehensive evaluation of technologies
- Technical Survey and Modeling
- Modules of a research and development project jointly guided by teams of faculty with a focus on synthesis of their class-room learning to solve real world problems

At the end of this course students will be able to do some of the following:

- Comprehensively investigate/study and development of software and/or algorithms in the related area.
- Development of Hardware / Embedded System/ ASIC (Circuits, HDL, FPGA, etc)
- Attempt to use the class-room learning to solve real world problems in the form of a team
- Design and apply different tools.

Lecture:0 Hrs
Tutorial: 0 Hrs
Approximate Total: 182 Hrs

Course Code: 19CP405					Course Name: Cloud Computing			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Learning objectives:

1. To provide an in-depth and comprehensive knowledge of the Cloud Computing fundamental issues, technologies, applications and implementations.
2. To expose the students to the frontier areas of Cloud Computing
3. To motivate students to do programming and experiment with the various cloud computing environments
4. To shed light on the issues and challenges in Cloud Computing

Unit wise allocation of course content

UNIT I (8 L): Cloud Foundation and Overview: History of Centralized and Distributed Computing - Overview of Distributed Computing, Cluster computing, Grid computing. Introduction to Cloud Computing- Cloud issues and challenges, Service models - Infrastructure as a Service (IaaS) - Resource Virtualization: Server, Storage, and Network - Case studies. Platform as a Service (PaaS) - Cloud platform & Management: Computation, Storage - Case studies. Software as a Service (SaaS) - Web services - Web 2.0 - Web OS - Case studies

UNIT II (13 L): Virtualization: Virtual and Physical computational resources - Data-storage. Virtualization concepts - Types of Virtualization- Introduction to Various Hypervisors - High Availability (HA)/Disaster Recovery (DR) using Virtualization, Moving VMs, Pros and cons of virtualization, Virtualization Technology examples.
Resource Management and Load Balancing: Distributed Management of Virtual Infrastructures, Server consolidation, Dynamic provisioning, Resource dynamic reconfiguration, Scheduling Techniques for Advance Reservation, Capacity Management to meet SLA Requirements, and Load Balancing, Various load balancing techniques.

UNIT III (12 L): Industrial Platforms and New Developments: Study of Cloud computing Systems like Amazon EC2 and S3, Google App Engine, and Microsoft Azure, Build Private/Hybrid Cloud using open source tools. MapReduce and its extensions to Cloud Computing, HDFS, and GFS, Cloud Applications, Cloud Application Programming and the Aneka Platform.

UNIT IV (6 L): Advanced Topics in Cloud Computing: Energy efficiency in clouds, Market-based management of clouds, Federated clouds/InterCloud, Cloud Security - Cloud Access: authentication, authorization and accounting, Cloud Reliability and fault-tolerance - privacy, policy and compliance- Cloud federation, interoperability and standards.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture:39 Hrs
Tutorial: 0 Hrs
Approximate Total: 39 Hrs

Texts and References:

1. Mastering Cloud computing, by Rajkumar Buyya, Christian Vacchiola, S Thamarai Selvi, McGraw Hill
2. Kai Hwang, Geoffrey C. Fox and Jack J. Dongarra, "Distributed and cloud computing from Parallel Processing to the Internet of Things", Morgan Kaufmann, Elsevier – 2012
3. Cloud Computing: Principles and Paradigms, by Rajkumar Buyya, James Broberg,Andrzej M Goscinski, Wiley publication
4. Cloud Computing: A Practical Approach, by Toby Velte, Anthony Velte, McGraw-Hill Osborne Media
5. Essentials of Cloud Computing by K. Chandrasekaran
6. Recent publications for case studies

Course Outcomes (COs):

At the end of this course students will be able to

1. Articulate the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing
2. Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.
3. Explain the core issues of cloud computing such as security, Resource management and interoperability.
4. Provide the appropriate cloud computing solutions and recommendations according to the applications used.

19CP405 – Cloud Computing

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
19CP405.1	1	3	3	1	2	2	1	0	2	2	2	2	3	3
19CP405.2	1	3	3	3	3	2	1	0	2	2	2	2	3	3
19CP405.3	2	2	3	3	3	2	1	0	2	2	3	2	3	3
19CP405.4	1	3	3	3	3	2	1	0	2	2	3	2	3	3
19CP405	1.25	2.75	3.00	2.50	2.75	2.00	1.00	0	2.00	2.00	2.50	2.00	3.00	3.00

Constituent COs in Assessment: 19CP405 – Cloud Computing

Assessment	19CP405.1	19CP405.2	19CP405.3	19CP405.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19CP406					Course Name: Advanced Operating System			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: Operating System, Computer Organization and Programming, Distributed systems.

Learning objectives:

- Operating system structuring
- Synchronization, communication and scheduling in parallel systems
- Distributed systems, their communication mechanisms, distributed objects and middleware
- Failures and recovery management
- System support for Internet-scale computing

Unit wise allocation of course content

UNIT I (06 L)

Introduction to Operating systems, Hardware resources, OS functionalities, Managing CPU and memory, Monolithic, Microkernel, spin structures,

UNIT II (10 L)

Virtualization: Introduction, Memory Virtualization, CPU and Device Virtualization. Shared Memory for Parallel systems: Synchronization, Communication, Lightweight RPC, Scheduling, Shared memory in Multiprocessor OS. Distributed OS: Lamport clock, Latency limits, Active network, Object based system, Java RMI.

UNIT III (11 L)

Global memory systems, Distributed shared memory systems, Distributed File System, System recovery and fault tolerance.

UNIT IV (12 L)

Map-Reduce and Content Delivery Network, Throughput and Latency, Security.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Students projects may include: • Distributed file systems • Data aware scheduling algorithms • Distributed operating systems • Distributed job management systems • Parallel programming languages • Distributed workflow systems • Distributed monitoring systems • Scientific computing with GPUs • Scientific computing with MapReduce • Distributed caching strategies • Distributed cache eviction policies • Distributed hash tables • Virtualization impact for data-intensive computing

Useful software for project may include: Operating systems: Linux, Windows • Scripting: BASH • Source control: SVN • Programming languages: Java, C/C++ • Job submission systems: GRAM, PBS, Condor, Cobalt, SGE, Falkon • Programming models: MapReduce (Hadoop), MPI (MPICH), Multi-Threading (PThreads), Workflows (Swift, Pegasus/DAGMan, Nimrod, Taverna, BPEL) • File systems: FUSE Parallel file systems: GPFS, PVFS, Lustre • Distributed file systems: GPS, HDFS • Data

services: GridFTP • Grid middleware: Globus • Cloud middleware: Nimbus, Eucalyptus, OpenNebula • Distributed hash tables: Chord, Tapestry • Simulation environments: GridSim, SimGrid, OptorSim, GangSim, Bricks • Virtualization: Sun Virtual Box, XEN, VMWare

Lecture: 39 Hrs
Tutorial: 0 Hrs
Approximate Total: 39 Hrs

Texts and References

1. William Stallings, Operating Systems, Prentice Hall, 1995
2. Andrew S. Tanenbaum and Maarten van Steen. "Distributed Systems: Principles and Paradigms", Prentice Hall, 2nd Edition, 2007
3. Randy Chow and Theodore Johnson. "Distributed Operating Systems & Algorithms", Addison-Wesley, 1997.
4. Jean Bacon, Concurrent Systems, Addison – Wesley, 1998

Course Outcomes:

At the end of the course, the student will be able to:

1. Address general issues of design and implementation of distributed systems.
2. Focus on inter-process communication, distributed processing.
3. Understand sharing and replication of data and files.
4. Understand different file systems.

19CP406 – **Advanced Operating System**

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
19CP406.1	2	3	2	3	3	1	0	0	3	2	2	3	3	3
19CP406.2	2	3	3	2	2	1	0	0	3	2	2	3	3	3
19CP406.3	2	3	3	2	2	1	0	0	3	2	2	3	3	3
19CP406.4	2	3	3	2	3	1	0	0	3	2	2	3	3	3
19CP406	2.00	3.00	2.75	2.25	2.50	1.00	0	0	3.00	2.00	2.00	3.00	3.00	3.00

Constituent COs in Assessment: 19CP406 – **Advanced Operating System**

Assessment	19CP406.1	19CP406.2	19CP406.3	19CP406.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19IC403					Course Name: Image Processing			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: Mathematics, Digital Signal Processing

Learning objectives:

- To understand tools and techniques for digital image processing.
- To develop hand-on experience in applying the tools.
- To develop understanding for multi-dimensional signal processing

Unit wise allocation of course content

UNIT I (10 L) Fundamentals and spatial domain processing

Introduction, Image sampling and quantization, basic relationships in pixels, basic intensity transformations, histogram processing, spatial filtering: smoothing and sharpening, basic mathematical tools in image processing, color models

UNIT II (09 L) Frequency domain processing

Sampling 2D functions, Aliasing, 2D Fourier Transform and properties, Filtering in frequency domain: smoothing, sharpening, selective filtering.

UNIT III (10 L) Image restoration and morphological operations

Model of image degradation process, restoration in presence of noise, estimating degradation function, Inverse filtering, MMSE filtering, Morphological operations: Erosion and dilation, opening and closing, basic morphological algorithms

UNIT IV (10 L) Image Segmentation and description

Point, line and edge detection, thresholding, basic segmentation algorithms: region based, watershed, image representation: chain codes, polygonal approximation, boundary and regional descriptors: textures, moments

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs
Tutorial: 0 Hrs
Approximate Total: 39 Hrs

Texts and References:

1. Gonzalez, R. C., & Woods, R. E., "Digital image processing", Pearson.
2. Sonka, Milan, "Image processing, analysis and machine vision". Cengage Learning Pvt. Ltd.
3. Jayaraman, "Digital Image Processing". McGrawhill.

4. Gose, Earl, "Pattern recognition and Image Analysis" PHI Learning Pvt. Ltd.
5. Alasdair, McAndrew, "A Computational Introduction to Digital Image Processing". CRC Press.
6. Artyom M ,Grigoryan, "Image Processing". Taylor & Francis Ltd.
7. Castleman, Kenneth "Digital Image Processing". Pearson Education.

Course Outcomes:

At the end of the course, the student will be able to:

1. Apply various mathematical transforms for image processing.
2. Understand linkages between signals, linear algebra, and applications.
3. Understand and apply various image processing algorithms.
4. Apply various open source tools for real world problems.

19IC403: Image Processing

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
19IC403.1	3	3	3	3	3	2	1	1	3	3	2	3	2	2	3
19IC403.2	3	3	3	3	3	1	1	1	3	3	2	3	2	2	3
19IC403.3	3	3	3	3	3	2	1	1	2	2	2	2	2	2	2
19IC403.4	3	2	3	2	3	1	2	2	3	3	2	3	2	2	3
19IC403	3.00	2.75	3	2.75	3	1.5	1.25	1.25	2.75	2.75	2	2.75	2	2	2.75

Constituent COs in Assessment: 19IC403: Image Processing

Assessment	19IC403.1	19IC403.2	19IC403.3	19IC403.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19CP407					Course Name: Data Compression			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: None

Learning objectives:

- To identify a problem statement
- To collect data
- To convert data to information
- Presentation of information.

Unit wise allocation of course content

UNIT I (10 L)

Compression Techniques :Lossless Compression , Lossy Compression ,Measures of Performance
Mathematical Preliminaries for Lossless Compression Models: Physical Models, Probability Models, Markov Models, Composite Source Model, Coding: Uniquely Decodable Codes, Prefix Codes, Algorithmic Information Theory, Minimum Description Length Principle.
Huffman Coding: The Huffman coding Algorithm, Minimum Variance Huffman Codes, Adaptive Huffman Coding, Update Procedure, Encoding Procedure, Decoding Procedure, Golomb Codes, Rice Codes, Tunstall Codes, Applications of Huffman Coding, Lossless Image Compression, Text Compression, Audio Compression

UNIT II (09 L)

Arithmetic Coding, Introduction, Coding a Sequence, Generating a Tag, Deciphering the Tag, Generating a Binary Code, Uniqueness and Efficiency of the Arithmetic Code, Algorithm Implementation, Integer Implementation, Comparison of Huffman and Arithmetic Coding, Adaptive Arithmetic Coding
Dictionary Techniques : Static Dictionary, Digram Coding, Adaptive Dictionary, The LZ77 Approach, The LZ78 Approach, Applications : File Compression—UNIX compress, Image Compression—The Graphics Interchange Format (GIF), Image Compression—Portable Network Graphics (PNG), Compression over Modems—V.42 bis

UNIT III (10 L)

Predictive Coding: Prediction with Partial match (ppm), The basic algorithm, The ESCAPE SYMBOL, Length of context, The Exclusion Principle, The Burrows-Wheeler Transform: Move-to-front coding, Lossless Image Compression CALIC, JPEG-LS, Multi-resolution Approaches, Facsimile Encoding, Dynamic Markov Compression.
Mathematical Preliminaries for Lossy Coding: Distortion criteria, Models, The Quantization Problem, Uniform Quantizer, Adaptive Quantization, Forward Adaptive Quantization, Backward Adaptive Quantization, Nonuniform Quantization, pdf-Optimized Quantization, Companded Quantization

UNIT IV (10 L)

Vector Quantization: Advantages of Vector Quantization over Scalar Quantization, The Linde-Buzo-Gray Algorithm, Initializing the LBG Algorithm, The Empty Cell Problem, Use of LBG for Image Compression, Tree-Structured Vector Quantizers, Design of Tree-Structured Vector Quantizers, Pruned Tree-Structured Vector Quantizers, Structured Vector Quantizers, Pyramid Vector Quantization, Polar and Spherical Vector Quantizers, Lattice Vector Quantizers
Transform Coding: KLT, DCT, DFT, DWHT, Quantization and coding of Transformation coefficient,

Application to Image compression: JPEG, Applications to audio compression.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs
Tutorial: 0 Hrs
Approximate Total: 39 Hrs

Open Ended problems:

1. Design an architecture and algorithm for data compression in cache and main memory.
2. Design an algorithm for compressing photo or video that is shared across social media.
3. Design an algorithm for compressing data at sensor which is reporting temperature data.

Texts and References

1. Introduction to Data Compression, Khalid Sayood, Morgan Kaufmann Publishers
2. The Data Compression book, Mark Nelson, Jean Loup Gaily
3. Data Compression : The Complete Reference", David Saloman, Springer
4. An Introduction to Information Retrieval, Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, Cambridge University Press, Cambridge, England
5. Information storage and retrieval , Robert Korfhage, WILEY

Online reference: http://ocw.usu.edu/Electrical_and_Computer_Engineering/Information_Theory/

Course Outcomes:

At the end of the course, the student will be able to:

1. Understand and select appropriate coding techniques for compression.
2. Differentiate between Lossy and Lossless compression.
3. Understand Dictionary based compression concepts.
4. Understand data transformation techniques.

19CP407 – Data Compression

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO1 1	PO12	PO1 3	PO1 4
19CP407. 1	3	3	3	3	3	0	0	0	3	2	2	3	3	2
19CP407. 2	3	2	2	2	3	0	0	0	3	2	1	3	3	2
19CP407. 3	3	3	3	3	3	0	0	0	3	2	1	3	3	2
19CP407. 4	3	3	3	3	3	0	0	0	3	2	2	3	3	2
19CP407	3.0 0	2.7 5	2.7 5	2.7 5	3.0 0	0	0	0	3.0 0	2.00	1.5	3.00	3.00	2.00

Constituent COs in Assessment: 19CP407– Data Compression

Assessment	19CP407.1	19CP407.2	19CP407.3	19CP407.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19CP408					**Course Name: Biometrics**			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/Wk**	**Theory**			**Total**
					Continuous Evaluation	**Mid Semester**	**End Semester**	**Marks**
3	0	0	3	3	25	25	50	100

Learning objectives:

- To provide an in-depth and comprehensive knowledge of the Bio-metrics.
- To expose the students to the frontier areas of Bio-metrics
- To motivate students to do programming and experiment with the various Bio-metrics environments
- To shed light on the issues and challenges in Bio-metrics

Unit wise allocation of course content

Unit I (09 L)
Introduction of Biometric traits and its aim, image processing basics, basic image operations, filtering, enhancement, sharpening, edge detection, smoothening, enhancement, thresholding, localization. Fourier Series, DFT, inverse of DFT.

Unit II (10 L)
Biometric system, identification and verification. FAR/FRR, system design issues. Positive/negative identification. Biometric system security, authentication protocols, matching score distribution, ROC curve, DET curve, FAR/FRR curve. Expected overall error, EER, biometric myths and misrepresentations.

Unit III (10 L)
Selection of suitable biometric. Biometric attributes, Zephyr charts, types of multi biometrics. Verification on multimodal system, normalization strategy, Fusion methods, Multimodal identification.

Unit IV (10 L)
Biometric system security, Biometric system vulnerabilities, circumvention, covert acquisition, quality control, template generation, interoperability, data storage. Recognition systems: Face, Signature, Fingerprint, Ear, Iris etc

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture:39Hrs
Tutorial: 0 Hrs

Approximate Total: 39Hrs

Texts and References:

1. Introduction to Biometrics, Anil Jain, Arun Ross, Nandkumar, Karthik, Springer
2. Guide to Biometrics, By: Ruud M.Bolle, Sharath Pankanti, Nalini K. Ratha, Andrew W. Senior, Jonathan H. Connell, Springer
3. Pattern Classification, By: Richard O. Duda, David G.Stork,Peter E. Hart, Wiley
4. Recent publications for case studies

Course Outcomes (COs):

At the end of this course students will be able to

1. Articulate the main concepts, key technologies, strengths, and limitations of bio-metrics and the possible applications for state-of-the-art bio-metrics
2. Explain the core issues of bio-metrics such as security methods.
3. Provide the appropriate bio-metrics solutions and recommendations as per requirement.
4. Design and develop applications.

19CP408 – Biometrics

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PO1 3	PO1 4
19CP408. 1	3	3	3	3	3	0	0	0	3	2	2	2	3	3
19CP408. 2	3	3	3	3	3	0	0	2	3	2	1	2	3	3
19CP408. 3	3	3	3	3	3	2	0	0	3	2	3	2	3	3
19CP408. 4	3	3	3	3	3	2	0	0	3	2	3	2	3	3
19CP408	3.0 0	3.0 0	3.0 0	3.0 0	3.0 0	1.0	0	0.5	3.0 0	2.00	2.25	2.00	3.00	3.00

Constituent COs in Assessment: 19CP408 – Biometrics

Assessm ent	19CP408.1	19CP408. 2	19CP408 .3	19CP408. 4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19IC404					Course Name: Fundamentals of Remote Sensing			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: Computer Programming, Mathematics and Statistics.

Learning objectives:

- To identify a problem statement
- To collect data
- To convert data to information
- Presentation of information.

Unit wise allocation of course content

UNIT I (06 L)

Introduction – Sun and atmosphere, Concept of Signatures, Remote Sensing System, Indian Remote Sensing Programme; **Electromagnetic Radiation** – Velocity of EM Radiation, Polarization, Coherent Radiation, Propagation of EM waves from one medium to another, Attenuation, Sources of EM radiation for remote sensing; Reflection and Scattering mechanisms.

UNIT II (10 L)

Physical Basis of Signatures – Signature in the reflective OIR region, Microwave region;

UNIT III (12 L)

Remote Sensors – Classification of remote sensors, Selection of sensors, Spatial resolution, spectral resolution, temporal resolution; Introduction to Optical (Imaging mode, pushbroom cameras) and Microwave sensors (active and passive microwave sensors, side looking radar) , **Data Reception and Data Products** – Data formats, Ground segment organization, Data product generation, IRS data products;

UNIT IV (11 L)

Interpretation of remotely sensed data - Data Analysis, Visual Image analysis, Digital classification, Classification Accuracy

Applications of Remote Sensing for Earth Resources Management – agriculture, land cover/land use mapping. Application of deep learning techniques using open source tools in Remote sensing.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs
Tutorial: 0 Hrs
Approximate Total: 39 Hrs

Texts and References

1. George Joseph – Fundamentals of Remote Sensing, Universities Press, 2005.
2. Reddy, M ANJI, Remote sensing and Geographical information systems, BS publications
3. John R. Jensen – Remote Sensing of the Environment, Pearson IN, 2016. ISBN 978-93-325-

1894-0

Course Outcomes:

At the end of the course, the student will be able to:

1. Select appropriate model
2. Observe and experiment data
3. Interpret data
4. Drawing conclusions

19IC404– Fundamentals of Remote Sensing

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PO1 3	PO1 4	PO1 5
19IC40 4.1	3	3	2	3	2	2	3	1	3	2	3	3	3	3	3
19IC40 4.2	3	3	3	3	2	2	1	1	3	2	2	3	3	3	3
19IC40 4.3	3	3	3	2	2	2	2	1	3	2	2	3	3	3	3
19IC40 4.4	3	3	3	3	2	2	2	1	3	2	2	3	3	3	3
19IC40 4	3.0 0	3.0 0	2.8 3	2.6 7	2.0 0	2.0 0	1.6 7	1.0 0	3.0 0	2.00	2.17	3.00	3.00	3.00	3.00

Constituent COs in Assessment: **19IC404– Fundamentals of Remote Sensing**

Assess ment	19IC404.1	19IC404. 2	19IC404 .3	19IC404. 4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19IC405					Course Name: Computer Vision			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: Linear Algebra, Probability

Learning objectives:

- Insight into image and video formation design, modelling and analysis.
- Ability to work with features above the pixel level.
- Develop ability to understand the difference in theory and practice of Computer Vision.

Unit wise allocation of course content

UNIT I (9 L)

Low level vision

Introduction, Pin hole camera, Intrinsic and extrinsic parameters of a camera, Geometric camera calibration, Color perception and representation, Color model and inference from color, Convolutions, Correlation filter as templates, Scale and image pyramid, Working with Image gradients and corners, SIFT and HOG features, Texture and Filters, Textons, Texture Synthesis and shape from texture

UNIT II (10 L)

Midlevel Vision

Segmentation by Clustering pixels, Segmentation by graphs Comparison of segmentation techniques, Hough Transform, Fitting lines and planes, Fitting using probabilistic models: EM algorithm, Motion Segmentation: Optical flow, Simple tracking strategies: Detection, matching, Particle filtering

UNIT 3 (10 L)

High Level Vision

Revision Learning to classify: Error, loss, classification strategies, classifying images: Features, Single subjects, Object detection: Face, detecting humans, State of the art in Object detection: Mask RCNN, Object Recognition, Hidden Markov Model, Fitting an HMM with EM, parsing people in image, structure model, Tracking people: Kinematic tracking

UNIT 4 (10 L)

Computer Vision using Deep Learning

Convolutional Neural Networks architectures, Convolution and Pooling, training CNN, Data Augmentation and Transfer Learning, Recurrent Neural Networks, LSTM, GRU, Applications like Image Captioning, Visual Question answering, soft attention

Student centered learning: The element of project in the course will enable this pedagogy. Instructor will decide project in consultation with students at the beginning of the semester.

Lecture: 39Hrs
Tutorial: 00Hrs

Approximate Total: 39Hrs

Texts and References:

1. Forsyth and Ponce, Computer Vision: A Modern Approach, 2/e, Pearson Education
2. Simon Prince, Computer Vision: Models, Learning, and Interface, Cambridge University Press, 1/e
3. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010
4. Suetens, P. Fundamentals of Medical Imaging, Cambridge University Press
5. Prince, J. & Links, J. Medical Imaging Signals and Systems, Prentice Hall.
6. Deep Learning for Medical Image Analysis 1st Edition by S. Kevin Zhou (Editor), Hayit Greenspan (Editor), Dinggang Shen (Editor), Academic Press
7. Handbook of Medical Imaging: Processing and Analysis Management (Biomedical Engineering) 1st Edition, by Isaac Bankman, Academic Press
8. Koller and Friedman, Probabilistic Graphical Models: Principles and Techniques, MIT Press, 2009.
9. Yoo, Terry S. Insight into Images: Principles and Practice for Segmentation, Registration and Image Analysis, CRC Press,
10. Vision Science Photons to Phenomenology By Stephen E. Palmer, MIT Press
11. Vision A Computational Investigation into the Human Representation and Processing of Visual Information By David Marr, MIT Press

MOOC

https://www.udacity.com/course/introduction-to-computer-vision--ud810

http://crcv.ucf.edu/videos/lectures/2014.php

Other important CV pages

http://www-inst.eecs.berkeley.edu/~cs280/sp15/index.html

http://vision.stanford.edu/teaching/cs223b/syllabus.html

http://www.cs.ucf.edu/~bagci/teaching/computervision16.html

http://homepages.inf.ed.ac.uk/rbf/CVonline

Course Outcomes (COs):

At the end of this course students will be able to:

1. Work with low level to high level vision.
2. Combine computer vision fundamentals with other domains like natural language processing.
3. Develop applications like classification, semantic segmentation, tracking, person identification.
4. Design and apply models based on deep neural networks.

19IC405 Computer Vision

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
19IC405.1	3	3	3	3	3	3	0	0	3	2	2	2	3	2	2
19IC405.2	3	3	3	3	3	3	3	2	3	2	2	2	3	2	2
19IC405.3	3	3	3	3	3	3	3	2	3	2	2	2	3	3	3
19IC405.4	3	3	3	3	3	3	0	2	3	2	2	2	3	3	3
19IC405	3.00	3.00	3.00	3.00	3.00	3.00	1.50	1.50	3.00	2.00	2.00	2.00	3.00	2.50	2.50

Constituent COs in Assessment: 19IC405 Computer Vision

Assessment	19IC405.1	19IC405.2	19IC405.3	19IC405.4
MS	Y	N	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19CP409					Course Name: Big Data Analytics			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: None

Learning objectives:

- Learn the issues of Big data.
- Learn Injecting data into Hadoop.
- Learn to build and maintain reliable, scalable, distributed systems with Hadoop.
- Able to apply Hadoop ecosystem components.

Unit wise allocation of course content

UNIT I (10 L)

Introduction to big data:

Introduction, distributed file system, Big Data and its importance, Drivers, Big data analytics, Big data applications. Algorithms, Matrix-Vector, Multiplication by Map Reduce.

UNIT II (10 L)

Introduction to HADOOP:

Big Data, Apache Hadoop & Hadoop Ecosystem, MapReduce, Data Serialization.

UNIT III (9 L)

HADOOP Architecture:

Architecture, Storage, Task trackers, Hadoop Configuration

UNIT IV (10 L)

HADOOP ecosystem and yarn:

Hadoop ecosystem components, Hadoop 2.0 New Features NameNode High Availability, HDFS Federation, MRv2, YARN, Running MRv1 in YARN.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs
Tutorial: 0 Hrs
Approximate Total: 39 Hrs

Texts and References

1. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, “Professional Hadoop Solutions”, Wiley, ISBN: 9788126551071, 2015.

2. Chris Eaton, Dirk deroos et al. "Understanding Big data", McGraw Hill, 2012.
3. Tom White, "HADOOP: The definitive Guide", O Reilly 2012.
4. MapReduce Design Patterns (Building Effective Algorithms & Analytics for Hadoop) by Donald Miner & Adam Shook

Course Outcomes:

At the end of the course, the student will be able to:

1. Learn injecting data into Hadoop.
2. Learn distributed systems with Apache Hadoop.
3. Deploy Hadoop ecosystem components.
4. Design and develop distributed applications.

19CP409 – Big Data Analytics

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
19CP409.1	2	3	3	3	3	1	0	0	3	2	2	2	3	3
19CP409.2	2	3	3	3	3	1	0	0	3	2	2	2	3	3
19CP409.3	2	3	3	3	3	1	0	0	3	2	3	2	3	3
19CP409.4	2	3	3	3	3	1	0	2	3	2	3	3	3	3
19CP409	2.00	3.00	3.00	3.00	3.00	1.0	0	0.5	3.00	2.00	2.50	2.25	3.00	3.00

Constituent COs in Assessment: 19CP409 – Big Data Analytics

Assessment	19CP409.1	19CP409.2	19CP409.3	19CP409.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19CP4010					Course Name: Software Testing Methodologies			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: None

Learning objectives:

- To understand the software testing methodologies such as flow graphs and path testing, transaction flows testing, data flow testing, domain testing and logic base testing.

Unit wise allocation of course content

UNIT I (10 L)

Introduction

Purpose of testing, Dichotomies, model for testing, consequences of bugs, taxonomy of bugs. Flow graphs and Path testing:- Basics concepts of path testing, predicates, path predicates and achievable paths, path sensitizing, path instrumentation, application of path testing.

UNIT II (10 L)

Transaction Flow Testing:

Transaction flows, transaction flow testing techniques. Dataflow testing:- Basics of dataflow testing, strategies in dataflow testing, application of dataflow testing.

UNIT III (9 L)

Domain Testing:

Domains and paths, Nice & ugly domains, domain testing, domains and interfaces testing, domain and interface testing, domains and testability.

UNIT IV (10 L)

Paths, Path products and Regular expressions:

Path products & path expression, reduction procedure, applications, regular expressions & flow anomaly detection. Logic Based Testing:- overview, decision tables, path expressions, kv charts, specifications.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs
Tutorial: 0 Hrs
Approximate Total: 39 Hrs

Texts and References

1. Software Testing techniques – Boris Beizer, Dreamtech, second edition.
2. Software Testing Tools – Dr. K.V.K.K. Prasad, Dreamtech.

3. The craft of software testing – Brian Marick, Pearson Education.
4. Software Testing, 3rd edition, P.C. Jorgensen, Aurbach Publications (Dist.by SPD).
5. Software Testing, N.Chauhan, Oxford University Press.
6. Introduction to Software Testing, P. Ammann & J. Offutt, Cambridge Univ. Press.
7. Effective methods of Software Testing, Perry, John Wiley, 2nd Edition, 1999.
8. Software Testing Concepts and Tools, P.Nageswara Rao, dreamtech Press.
9. Software Testing, M.G.Limaye, TMH.
10. Software Testing, S.Desikan, G.Ramesh, Pearson.
11. Foundations of Software Testing, D.Graham & Others, Cengage Learning.
12. Foundations of Software Testing, A.P.Mathur, Pearson.

Course Outcomes:

At the end of the course, the student will be able to:

1. Understand the concepts of software testing methods.
2. Apply the process of testing and various methodologies in testing for developed software.
3. Write test cases for given software to test it before delivery to the customer.
4. Fine tune the end product.

19CP4010 – Software Testing Methodologies

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
19CP4010.1	1	3	2	3	3	1	0	0	3	2	2	2	1	3
19CP4010.2	1	3	2	3	3	1	0	0	3	2	2	2	2	3
19CP4010.3	1	3	3	3	3	1	0	2	3	2	3	2	3	3
19CP4010.4	1	3	3	3	3	3	0	2	3	2	3	2	3	3
19CP4010	1.0	3.00	2.50	3.00	3.00	1.50	0	1.00	3.00	2.00	2.50	2.00	2.25	3.00

Constituent COs in Assessment: 19CP4010 - Software Testing Methodologies

Assessment	19CP4010.1	19CP4010.2	19CP4010.3	19CP4010.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19IC406					**Course Name: Vehicular Networks**			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/ Wk**	**Theory**			**Total**
					Continuous Evaluation	**Mid Semester**	**End Semester**	**Marks**
3	0	0	3	3	25	25	50	100

Prerequisites: basic knowledge of network protocols and wireless communication

Learning objectives:

- To understand the concepts of communication in vehicular environment
- To appreciate the design principles of protocols addressing high mobility of agents
- To design and implement the applications for vehicular environment

Unit wise allocation of course content

UNIT 1 (8 L):

Introduction, principles of vehicular communication, enabling technologies, cooperative system architecture, applications,

UNIT II (11 L):

vehicular communication standards: 802.11P MAC, DSRC and WAVE; channel capacity modeling and analysis; Vehicle mobility models: random, flow, trajectory analysis

UNIT III (10 L):

Routing protocols in VANET: location based routing, dealing with topology dynamics, information communication in VANET: local measurement, aggregation, dissemination

UNIT IV (10 L):

VANET Applications design: design of safety applications, real time communcation; infotainment applications; introduction to simulation framework: VsimRTI, integrating application, traffic and network simulators

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture:39 Hrs
Tutorial: 0 Hrs
Approximate Total: 39 Hrs

Texts and References:

1. VANET: Vehicular Applications and Inter-Networking Technologies, Hannes Hartenstein (Editor), Kenneth Laberteaux (Editor), Wiley publisher
2. Vehicular ad hoc Networks: Standards, Solutions, and Research; Editors: Campolo, Claudia, Molinaro**,** Antonella, Scopigno**,** Riccardo (Eds.) ; Springer publisher
3. Recent Research papers as communicated in class

Course Outcomes (COs):

At the end of this course students will be able to:

1. Understand the concept of wireless communication in vehicular environment
2. Understand the design priciples of protocols and standards used in VANET
3. Design and implement the protocols for use in VANET
4. Design and implement the safety and infotainment applications using VANET

19IC406 Vehicular Networks

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
19IC406.1	2	3	3	3	2	2	2	1	2	2	2	2	3	2	3
19IC406.2	2	3	3	3	2	2	2	1	2	2	2	2	3	2	3
19IC406.3	3	3	3	3	3	2	2	1	3	2	2	2	3	2	3
19IC406.4	3	3	3	3	3	2	2	1	3	2	2	2	3	2	3
19IC406	2.50	3.00	3.00	3.00	2.50	2.00	2.00	1.00	2.50	2.00	2.00	1.00	3.00	2.00	3.00

Constituent COs in Assessment: 19IC406 Vehicular Networks

Assessment	19IC406.1	19IC406.2	19IC406.3	19IC406.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19IC407 (Department Elective)					**Course Name: Statistical Signal Processing**			
Teaching Scheme					**Examination Scheme**			
					Theory			**Total**
L	**T**	**P**	**C**	**Hrs/Wk**	**Continuous Evaluation**	**Mid Semester**	**End Semester**	**Marks**
3	0	0	3	3	25	25	50	100

Prerequisites: Linear Algebra, Probability, Communication, Calculus, Digital Signal Processing

Learning objectives:

- Introduce mathematical ideas for analysis of signals and systems.
- Show applicability of statistical analysis in wide range of engineering applications.
- Explore programming tools for statistical analysis and characterization.

Unit wise allocation of course content

UNIT I (10 L) Fundamentals

Discrete time random processes, stationarity and ergodicity, Covariance and Power Spectral density, Filtering of random processes, Poles, zeroes, and spectral factorization, Wold Decomposition.

UNIT II (10 L) Estimation

Maximum Likelihood, Fisher Information, Cramer Rao bound, MAP estimation, MMSE estimation, Non parametric spectral estimation, Periodogram, windowing, Parametric spectral estimation, AR and ARMA modelling, the Yule Walker equations

UNIT III (10 L) Adaptive Filtering

The Wiener filter, the LMS algorithm, recursive least squares, Kalman filters and its variants, the constant modulus algorithm, adaptive beam forming and generalized side lobe canceller

UNIT IV (9 L) Non Gaussian Signal Processing

The cock tail party problem, Independent component analysis and Blind Source Separation, partial correlations and concentration matrix, Granger and other Causality measures.

Student centered learning: (The element of project in the course will enable this pedagogy and instructor will decide project in consultation with students at the beginning of the semester.)

Lecture: 39Hrs
Tutorial: 00Hrs
Approximate Total: 39Hrs

Text

1. Statistical Digital Signal Processing and Modelling, Monson H Hayes, Wiley India (Low Price Edition), 2008. ISBN: 978-81-265-1610-0
2. Fundamentals of Statistical Signal Processing: Estimation Theory: Vol. 1, Steven M Kay, Paper Back, Pearson Indian Edition, 2011.
3. Modern Spectral Estimation, Theory and Application, Steven Kay, Paper Back, Pearson Indian Edition, ISBN: 9788131733561
4. Linear Estimation, Thomas Kailath, Pearson Education, Paper Back, 2016, ISBN:9789332575370.

5. Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering, and Array Processing", McGraw-Hill, 2005.
6. Harry L. Van Trees,Kristine L. Bell,Zhi Tian, "Detection Estimation and Modulation Theory, Part I: Detection, Estimation, and Filtering Theory", 2nd Edition, Wiley-Blackwell, 2013

Course Outcomes (COs):

At the end of this course students will be able to

1. Analyse signals and develop their statistical models.
2. Design apply and analyze algorithms for estimation of various signal parameters.
3. Design and apply adaptive filtering techniques to wide range of engineering applications.
4. Use modern software tools for programming, analysis and visualization.

19IC407 Statistical Signal Processing

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
19IC407.1	3	3	3	3	2	3	3	2	3	3	2	3	2	2	3
19IC407.2	3	2	3	2	3	1	1	1	3	2	2	0	2	3	3
19IC407.3	2	2	3	1	3	1	1	1	3	2	2	0	3	3	3
19IC407.4	3	3	3	3	2	3	3	2	2	1	2	3	3	2	3
19IC407	2.75	2.50	3.00	2.25	2.50	2.00	2.00	1.50	2.75	2.00	2.00	1.50	2.50	2.50	3.00

Constituent COs in Assessment: 19IC407 Statistical Signal Processing

Assessment	19IC407.1	19IC407.2	19IC407.3	19IC407.4
MS	Y	N	N	N
ES	Y	Y	N	Y
CE	Y	Y	Y	Y

Course Code: 19IC408 (Department Elective)					Course Name: Cognitive and Software Defined Radio			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: Communication Systems, Digital Signal Processing

Learning objectives:

- To understand the interplay of signal processing for power as well as spectrum efficient communication.
- To motivate for selecting appropriate commercial solutions for a practical transceiver design.
- To facilitate the understanding of resource management in communication systems.

Unit wise allocation of course content

UNIT 1 (10 L)

Introduction

The Need, Characteristics and benefits of Software Defined Radio (SDR), Anatomy of SDR, Design considerations

Communication Engineering Framework

RF Implementation issues, The Purpose of RF Front End, Dynamic Range, The Principal Challenge of Receiver Design, RF Receiver Front End Topologies, Enhanced Flexibility of the RF Chain with Software Radios, Importance of the Components to Overall Performance, Transmitter Architectures and Their Issues, Noise and Distortion in the RF Chain, Separation of Digital and RF, A brief about Radiation Pattern Control, Directional Antennas, Smart Antennas, MIMO, Adaptive Modulation and Coding, Multicarrier Modulation.

UNIT 2 (10 L)

Signal Processing Framework

Multi-Rate Signal Processing: Introduction, Sample Rate Conversion Principles, Poly-phase Filters, Digital Filter Banks, Timing Recovery in Digital Receivers Using Multi-rate Digital Filters, Pulse Shaping using Digital Filters.

Digital Generation of Signals: Introduction, Comparison of Direct Digital Synthesis with Analog Signal Synthesis, Approaches to Direct Digital Synthesis- Analysis of Spurious Signals, Spurious Components due to Periodic jitter, Band Pass Signal Generation, Performance of Direct Digital Synthesis Systems, Hybrid DDS, PLL Systems, Applications of Direct Digital Synthesis, Generation of Random Sequences, ROM Compression Techniques.

UNIT 3 (09 L)

Implementation Framework

Digital Hardware Choices: Trade-Offs in Using DSPs, FPGAs, and ASICs, Power Management Issues, Using a Combination of DSPs, FPGAs, and ASICs, Architecture of FPGA based SDR, Advance Buses, Hardware acceleration, Software considerations, Resource sharing.

Analog to Digital and Digital to Analog Conversion: Parameters of ideal data converters, Parameters of Practical data converters- Analog to Digital and Digital to Analog Conversion Techniques to improve data converter performance, Common ADC and DAC architectures, ADC and DAC Distortion.

UNIT 4 (10 L)
Cognitive Radio
Cognitive radio cycle, SDR architecture for Cognitive radio, Spectrum node sensing, Cognitive radio performance analysis, Cooperative sensing, Blind receiver design, UWB and cognitive radio, Applications of Cognitive radio in harsh and irregular environments, Case studies.
Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39Hrs
Tutorial: 00Hrs
Approximate Total: 39Hrs

Texts and References:

1. Jeffrey H. Reed, "Software Radio: A Modern Approach to Radio Engineering," Prentice Hall PTR.
2. Di Pu, Alexander M. Wyglinski, "Digital Communication Systems Engineering with Software Defined Radio", Artech House.
3. Hüseyin Arslan (Ed.), "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems," Ser. Signals and Communication Technology, Springer.
4. Peter B. Kenington, "RF and Baseband Techniques for Software Defined Radio", Artech House.
5. Walter H.W. Tuttle bee, "Software Defined Radio: Enabling Technologies," John Wiley and Sons Ltd.
6. Johnson, C.R. and W.A. Sethares, "Telecommunication Breakdown: Concepts of Communication Transmitted via Software-Defined Radio", Pearson Prentice Hall.
7. Tony J. Rouphael, "RF and Digital Signal Processing for Software-Defined Radio: A Multi Standard Multi-Mode Approach", Elsevier Inc.
8. B. G. Golderg, "Digital Techniques in Frequency Synthesis", McGraw Hill.

Course Outcomes (COs):
At the end of this course students will be able to
1. Understand the design principles of software defined radio.
2. Understand the analog RF components as front end block in implementation of SDR.
3. Understand digital hardware architectures and development methods.
4. Understand the radio resource management in heterogeneous networks.
5. Understand design flexibility in software defined radio.
6. Take up some case studies for implementation using SDR concepts.

19IC408 Cognitive and Software Defined Radio

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
19IC408.1	3	3	3	3	3	2	1	1	2	2	3	2	3	3	2
19IC408.2	3	3	3	3	3	2	1	1	2	2	3	2	3	3	2
19IC408.3	3	3	3	3	3	2	1	1	2	2	3	2	3	3	2
19IC408.4	3	3	3	3	3	2	1	1	2	2	3	2	3	3	2
19IC408.5	3	3	3	3	3	2	1	1	2	2	3	2	3	3	2
19IC408.6	3	3	3	3	3	2	2	1	2	3	3	2	3	3	2
19IC408	3.00	3.00	3.00	3.00	3.00	2.00	1.17	1.00	2.00	2.17	3.00	2.00	3.00	3.00	2.00

Constituent COs in Assessment: 19IC408 Cognitive and Software Defined Radio

Assessment	19IC408.1	19IC408.2	19IC408.3	19IC408.4	19IC408.5	19IC408.6
MS	Y	Y	Y	N	N	N
ES	Y	Y	Y	Y	Y	N
CE	Y	Y	Y	Y	Y	Y

Course Code: 19IC409					**Course Name: Theory of Automata and Computation**			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/ Wk**	**Theory**			**Total**
					Continuous Evaluation	**Mid Semester**	**End Semester**	**Marks**
3	0	0	3	3	25	25	50	100

Prerequisites: Nil

Learning objectives:

- To provide introduction to some of the central ideas of theoretical computer science from the perspective of formal languages.
- To introduce the fundamental concepts of formal languages, grammars and automata theory.
- Classify machines by their power to recognize languages.
- Employ finite state machines to solve problems in computing.
- To understand deterministic and non-deterministic machines.
- To understand the differences between decidability and undecidability.

Unit wise allocation of course content

UNIT 1 (10 L)

Introduction to Finite Automata, Structural Representations, Automata and Complexity, the Central Concepts of Automata Theory – Alphabets, Strings, Languages, Problems. Deterministic Finite Automata, Nondeterministic Finite Automata, Finite Automata with Epsilon-Transitions.

Regular Expressions, Finite Automata and Regular Expressions, Applications of Regular Expressions, Algebraic Laws for Regular Expressions, Properties of Regular Languages-Pumping Lemma for Regular Languages, Applications of the Pumping Lemma, Closure Properties of Regular Languages, Decision Properties of Regular Languages, Equivalence and Minimization of Automata.

UNIT 2 (9 L)

Context-Free Grammars**:** Definition of Context-Free Grammars, Derivations Using a Grammar, Leftmost and Rightmost Derivations, the Language of a Grammar, Sentential Forms, Parse Tress, Applications of Context-Free Grammars, Ambiguity in Grammars and Languages. Push Down Automata,: Definition of the Pushdown Automaton, the Languages of a PDA, Equivalence of PDA's and CFG's, Deterministic Pushdown Automata.

UNIT 3 (10 L)

Normal Forms for Context- Free Grammars, the Pumping Lemma for Context-Free Languages, Closure Properties of Context-Free Languages. Decision Properties of CFL's - Complexity of Converting among CFG's and PDA's, Chomsky Normal Form. Introduction to Turing Machines-Problems That Computers Cannot Solve, Programming Techniques for Turing Machines, Extensions to the basic Turing machine, Restricted Turing Machines

UNIT 4 (10 L)

Undecidability**:** A Language that is Not Recursively Enumerable, An Undecidable Problem That is RE, Undecidable Problems about Turing Machines, Post Correspondence Problem, Other Undecidable Problems, Intractable Problems**:** The Classes P and NP, An NP-Complete Problem.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs
Tutorial: 00 Hrs
Approximate Total: 39 Hrs

Texts and References:

1. Introduction to Automata Theory, Languages, and Computation, John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, Pearson Education.
2. Theory of Computer Science – Automata languages and computation, Mishra and Chandrashekaran, PHI.
3. Introduction to the Theory of Computation, Michael Sipser, Cengage Learning.
4. Introduction to Languages and The Theory of Computation, John C Martin, TMH.
5. Introduction to Computer Theory, Daniel I.A. Cohen, John Wiley.
6. A Text book on Automata Theory, P. K. Srimani, Nasir S. F. B, Cambridge University Press.

Course Outcomes (COs):

At the end of this course students will be able to

1. Able to understand the concept of abstract machines and their power to recognize the languages.
2. Able to employ finite state machines for modeling and solving computing problems.
3. Able to design context free grammars for formal languages.
4. Able to understand the concepts of Turing machine.
5. Able to distinguish between decidability and undecidability.
6. Able to gain proficiency with mathematical tools and formal methods.

19IC409– Theory of Automata and Computation

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
19IC409.1	3	3	2	3	2	2	2	1	3	2	2	3	3	3	3
19IC409.2	3	3	3	3	2	2	2	1	3	2	2	3	3	3	3
19IC409.3	3	3	3	3	2	2	2	1	3	2	2	3	3	3	3
19IC409.4	3	3	3	3	2	2	2	1	3	2	2	3	3	3	3
19IC409.5	3	3	3	3	2	2	2	1	3	2	2	3	3	3	3
19IC409.6	3	3	3	3	2	2	2	1	3	2	2	3	3	3	3
19IC409	3.00	3.00	2.83	3.00	2.00	2.00	2.00	1.00	3.00	2.00	2.00	3.00	3.00	3.00	3.00

Constituent COs in Assessment: 19IC409– Theory of Automata and Computation

Assessment	19IC409.1	19IC409.2	19IC409.3	19IC409.4	19IC409.5	19IC409.6
MS	Y	Y	Y	N	N	N
ES	Y	Y	Y	Y	Y	Y
CE	Y	Y	Y	Y	Y	Y

Course Code: 19CP403					Course Name: Internet of Things			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites:

- Fundamentals of Computing, Basics of Electronics, Basic knowledge of Digital Electronics and Microprocessors

Learning objectives:

- Explain the components of IoT Architecture and platforms of IoT ecosystem
- Identify difference between M2M and IoT with SDN and NFV
- Developing IoT Systems using Raspberry Pi and Python
- Apply analytics and transform data to draw meaningful conclusions from IoT Data

Unit wise allocation of course content

UNIT 1 (10 L): Introduction to IoT: IoT Basics, Physical and Logical Designs, Elements of IoT - Basic Architecture of an IoT Application Sensors & Actuators, Edge Networking (WSN), Gateway. Domain Specific IoTs - Home Automation, Smart Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health and Life Style.

UNIT 2 (13 L): M2M and IoT: Introduction, M2M, Difference between M2M and IoT, Software Defined Networking and Network Function Virtualization for IoT, **IoT Architecture -State of the Art** – Introduction, State of the art, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

UNIT 3 (8 L): Developing Internet of Things: IoT Systems – Logical Design using IoT, IoT Physical Devices and Endpoints, Programming Raspberry Pi with Python, Other IoT Devices, IoT Physical Servers and Cloud Offerings. Case Studies Illustrating IoT Design, Data Analytics for IoT, Internet of Things Privacy, Security and Governance. Data Aggregation for the IoT, Business Scope

UNIT 4 (8 L):

Introduction to Arduino platform and its programming using readymade libraries; Actuators: Study of selected actuators, their operating principles, applications, etc; Sensors: study of fundamental principles of sensors for various parameters, such as: temperature, humidity, pressure, gas, light, water-level (resistance), rotational/linear acceleration, solar radiation, color, GPS, etc. Their comparisons and use in IoT. Interfacing of camera, ethernet shield, xbee , wifi, bluetooth modules with the Arduino/Raspberry Pi platforms.

Project 1: Home Automation using IoT: To develop electronic system that controls electric appliances like fan, AC, window curtails, and Light using embedded system and IoT.

Project 2: Irrigation System Automation using IoT: To develop electronic system that controls applications like water level control, sprinkling of water, fertilizers, and pesticides using embedded

system and IoT.
Similar projects/topics could be: Smart dustbin, Intelligent Building, Smart harvesting, Smart Hospital, Smart classroom, Smart transportation/traffic, Smart museum, etc.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture:39 Hrs
Tutorial: 0 Hrs
Approximate Total: 39 Hrs

Texts and References:

1. "Internet of Things: A Hands - on approach" by Arsheep Bahga and Vijay Madisetti., Orient Blackswan Private Limited - New Delhi
2. Pethuru Raj and Anupama C. Raman. The Internet of Things: Enabling technologies, platforms, and use cases. Auerbach Publications,.
3. Internet of Things with Python, Gaston C. Hillar, Packt Open Source
4. Rajkumar Buyya and Amir Vahid Dastjerdi, eds. Internet of Things: Principles and paradigms. Elsevier.
5. Gastón C. Hillar. MQTT Essentials-A Lightweight IoT Protocol. Packt Publishing Ltd.
6. "The Internet of Things: Do-It-Yourself at Home Projects for Arduino, Raspberry Pi and BeagleBone Black" by Donald Norris, McGraw-Hill Education TAB
7. "Motors for Makers", by Matthew Scarpino, QUE
8. Make: Sensors" by Tero Karvinen, Shroff Publishers & Distributors Pvt Ltd
9. The internet of Things: Key Applications and Protocols" By Harsent, Boswarthick and Elloumi, Wiley
10. "Raspberry Pi User Guide" by Upton and Halfacree, John Wiley & Sons;
11. Recent publications for case studies.

Course Outcomes (COs):

At the end of this course students will be able to

1. Understand the vision of IoT from a global context and understand the applications of IoT.
2. Determine the Market perspective of IoT.
3. Use of Devices, Gateways and Data Management in IoT.
4. Building state of the art architecture in IoT and application of IoT in Industrial and Commercial Building Automation along with Real World Design Constraints.

19CP403 – Internet of Things

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
19CP403.1	3	3	3	3	2	2	3	1	3	2	3	1	3	2
19CP403.2	2	3	3	3	2	2	1	0	2	2	3	1	3	2
19CP403.3	3	3	3	2	3	2	1	0	2	2	2	2	3	2
19CP403.4	3	3	3	3	3	2	3	1	3	2	3	2	3	2
19CP403	2.75	3.00	3.00	2.75	2.50	2.00	2.00	0.50	2.50	2.00	2.75	1.50	3.00	2.00

Constituent COs in Assessment: 19CP403 – Internet of Things

Assessment	19CP403.1	19CP403.2	19CP403.3	19CP403.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19IC4010					Course Name: ICT for Energy Sector			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: None

Learning objectives:

- To understand the concepts of smart grid and smart metering
- To understand the role of ICT in improving operations in energy sector
- To be able to design the energy efficient solutions for the real world problem

Unit wise allocation of course content

UNIT 1 (10 L)

Smart Energy Infrastructure, Smart Grids, Energy Consumption Profiling, Energy Data Management and Intelligent Load Control, Intelligent Scalable Monitoring and Control Technologies for Smart Micro-Grids and Grids. Software for energy applications; Data mining and decision support techniques for energy data; Models and techniques for energy consumption forecasting; Descriptions and characterizations of energy consumption patterns; Integration of energy data; Energy data visualization; Sensor networks, metering and energy data acquisition; Interoperability solutions including middleware and protocols for energy applications; Demand-side management; Home and building automation applications to energy; Energy-efficient control techniques; and Intelligent load control.

UNIT 2 (10 L)

Energy Management Systems in Industry: Demand control, Equipment scheduling, Temperature and humidity monitoring and control, Weather monitoring, Fan selection and speed control, Pump and valve monitoring and control, Refrigeration optimization, Boiler and turbine control, Safety and security, Smoke alarm monitoring, Sprinkler monitoring, Exhaust fan emergency control, Flood alarm, Perimeter door control, Elevator control, Building operations, Equipment maintenance scheduling, Maintenance cost accounting

UNIT 3 (10 L)

Green infrastructure-energy-efficient buildings, intelligent cooling systems, renewable power sources; green hardware - multicore computing systems, energy efficient server design and solid-state storage; and green software and applications - parallelizing computational science algorithms to run on modern energy efficient multi-core clusters, intelligent load distribution and CPU switch-off

UNIT 4 (9 L)

Smart Transportation Using ICT: Engine Management- The Need for More Precise Engine Management, Reliability, Electronic Ignition Systems, Fuel Injection and Carburetor Systems; Transmission Control, Transport Planning: Depot Siting, Route Planning, Vehicle Scheduling, Scheduling of Road Transport Fleets, Scheduling of Other Transport Fleets; Urban Traffic Control; Route Guidance

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs
Tutorial: 0Hrs
Approximate Total: 39 Hrs

Texts and References:

1. Smart Grid: Fundamentals of Design and Analysis, James A. Momoh, Wiley Publisher
2. Smart Grid: Technology and Applications, Akihiko Yokoyama, Janaka Ekanayake, Jianzhong Wu, Kithsiri Liyanage, and Nick Jenkins, Wiley Publisher
3. Intelligent Transportation Systems: Smart and Green Infrastructure Design; Sumit Ghosh and Tony S. Lee, CRC Press
4. Research papers discussed in class

Course Outcomes (COs):

At the end of this course students will be able to:

1. Understand the concept of smart grid and smart metering
2. Understand the role of ICT in energy sector and transportation
3. Design and implement the energy efficient solutions for industry operations using ICT technologies
4. Design and implement smart transportation solutions using ICT technologies

19IC4010 ICT for Energy Sector

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
19IC4010.1	1	2	2	3	3	3	3	0	2	1	1	2	3	2	3
19IC4010.2	1	2	2	3	3	3	3	0	2	1	1	2	3	2	3
19IC4010.3	2	3	3	3	3	3	3	0	3	2	2	2	3	2	3
19IC4010.4	2	3	3	3	3	3	3	0	3	2	2	2	3	2	3
19IC4010	1.50	2.50	2.50	3.00	3.00	3.00	3.00	0.00	2.50	1.50	1.50	2.00	3.00	2.00	3.00

Constituent COs in Assessment: 19IC4010 ICT for Energy Sector

Assessment	19IC4010.1	19IC4010.2	19IC4010.3	19IC4010.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19CP4012	Course Name: Human Computer Interaction

Teaching Scheme					Examination Scheme			
					Theory			Total
L	T	P	C	Hrs/Wk	Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: -

Learning Objectives:

- Learn the foundations of Human Computer Interaction
- Learn the guidelines for user interface
- Study the technologies for designing effective Human Computer Interfaces for individuals and persons with disabilities

Unit wise allocation of course content

UNIT I (10 L)

Introduction, Foundations of HCI: Human Vs. Computer, Goals and evolutions of HCI, I/O channels, Interaction: Models, frameworks, Ergonomics, styles, elements. Interactivity- Paradigms

UNIT II (9 L)

Models and Theories, Cognitive models, Socio-Organizational issues and stake holder requirements, Communication and collaboration models, Hypertext, Multimedia and WWW.

UNIT III (10 L)

Design Issues, Interactive Design basics: process, scenarios, navigation, screen design, Iteration and prototyping. HCI in software process: usability engineering, Prototyping in practice, design rationale. Interaction Styles: Direct Manipulation and Virtual Environments, Menu Selection, Form Filling and Dialog Boxes, Command and Natural Languages.
Design standards, guidelines, rules. Evaluation Techniques: Universal Design

UNIT IV (10 L)

Mobile and Web Interface Design, Designing Web Interfaces – Drag & Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Case Studies.
Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design and Tools.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs
Tutorial: 0Hrs
Approximate Total: 39 Hrs

Text Book / Reference Books:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", 3rd Edition, Pearson Education, 2004
2. Bill Scott and Theresa Neil, "Designing Web Interfaces", First Edition, O"Reilly, 2009
3. Ben Shneiderman, "Designing the User Interface-Strategies for Effective Human Computer Interaction", ISBN:9788131732557, Pearson Education , 2010
4. Brian Fling, "Mobile Design and Development", First Edition , O"Reilly Media Inc., 2009
5. Usability Engineering: Scenario-Based Development of Human-Computer Interaction, by Rosson, M. and Carroll, J. (2002)

Course Outcomes (COs):

At the end of this course students will be able to:

1. Understand what interaction design is and how it relates to human computer interaction and other fields; understand what cognition is and why it is important for interaction design
2. Develop software prototype for interfaces with necessary interactive design standards and guidelines
3. Demonstrate usability testing of interactive design prototypes through examples
4. Design web and mobile interfaces with design concepts such as inlays, overlays and virtual concepts and various design tools

19CP4012 – Human Computer Interaction

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
19CP4012.1	0	3	2	3	3	1	0	0	3	2	2	2	1	1
19CP4012.2	1	3	3	3	3	1	0	0	3	2	2	2	3	1
19CP4012.3	1	3	3	3	3	1	0	0	3	2	3	2	3	1
19CP4012.4	1	3	3	3	3	1	0	0	3	2	3	2	3	1
19CP4012	0.75	3.00	2.75	3.00	3.00	1.00	0	0	3.00	2.00	2.50	2.00	2.50	1.00

Constituent COs in Assessment: 19CP4012 – Human Computer Interaction

Assessment	19CP4012.1	19CP4012.2	19CP4012.3	19CP4012.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19IC4011					Course Name: Statistical Pattern Recognition			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: Linear Algebra, Probability, Calculus

Learning objectives:

- Design and construction of pattern recognition system.
- Exposure to theoretical issues in design of pattern recognition systems.
- Understanding of major approaches in statistical pattern recognition.

Unit wise allocation of course content

UNIT 1 (10 L) Fundamentals and Feature Extraction

Introduction, Over view of Probability theory and Linear Algebra, Gaussian Distribution, Bayesian Decision Theory, Normalisation, Dimensionality Reduction, Feature Selection

UNIT 2 (10 L) Clustering and Non parametric density estimation

K-means, Hierarchical clustering, Fuzzy Clustering, Graph based clustering, Gaussian Mixture models, parametric estimation, Maximum Likelihood estimation, Maximum A Posteriori, Expectation Maximization, Sampling methods, Non parametric methods, Histograms, Parzen Window, Nearest neighbor

UNIT 3 (10 L) Classifiers and Ensemble

Linear Discriminants, Logistic Regression, Kernel Methods, Naïve Bayes, Nearest Neighbors, Boosting, Bagging, other combination techniques

UNIT 4 (15 L)Models

Model selection, over fitting, Bias-vs.-variance dilemma, Regularization, cross validation, Graphical models, Bayesian Networks, MRF, Inference in graphical models, Markov chains, HMM, PAC learning, VC dimensions

Student centered learning: The element of project in the course will enable this pedagogy. Instructor will decide project in consultation with students at the beginning of the semester.

Lecture: 39Hrs
Tutorial: 00Hrs
Approximate Total: 39Hrs

Text Book

1. Duda, R.O., Hart, P.E., and Stork, D.G. Pattern Classification. Wiley-Interscience. 2nd Edition.

2001.
2. Bishop, C. M. Pattern Recognition and Machine Learning. Springer. 2007.
3. Marsland, S. Machine Learning: An Algorithmic Perspective. CRC Press. 2009.
4. Theodoridis, S. and Koutroumbas, K. Pattern Recognition. Edition 4. Academic Press, 2008.
5. Russell, S. and Norvig, N. Artificial Intelligence: A Modern Approach. Prentice Hall Series in Artificial Intelligence. 2003.
6. Bishop, C. M. Neural Networks for Pattern Recognition. Oxford University Press. 1995.
7. Hastie, T., Tibshirani, R. and Friedman, J. The Elements of Statistical Learning. Springer. 2001.
8. Koller, D. and Friedman, N. Probabilistic Graphical Models. MIT Press. 2009.

Papers

1. Anil K. Jain, etc., "Statistical Pattern Recognition: A Review," IEEE Tran. on Pattern Analysis and Machine Intelligence, vol 22, No 1, Jan. 2000.
2. A K Jain, etc., "Data clustering: A Review," ACM Computing Surveys, vol. 31, no. 3, Sept. 1999.

Important Links

http://kdd.ics.uci.edu/

Course Outcomes (COs):

At the end of this course students will be able to:

1. Identify where, when and how pattern recognition can be applied.
2. Implement a pattern classifier and ensemble recognition systems.
3. Use modern software libraries while solving the problems.
4. Analyse related research in the pattern recognition.

19IC4011 Statistical Pattern Recognition

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
19IC4011.1	3	3	3	3	2	3	3	2	3	3	2	3	2	2	3
19IC4011.2	3	2	3	2	3	1	1	1	3	2	2	0	2	3	3
19IC4011.3	2	2	3	1	3	1	1	1	3	2	2	0	3	3	3
19IC4011.4	3	3	3	3	2	3	3	2	2	1	2	3	3	2	3
19IC4011	2.75	2.50	3.00	2.25	2.50	2.00	2.00	1.50	2.75	2.00	2.00	1.50	2.50	2.50	3.00

Constituent COs in Assessment: 19IC4011Statistical Pattern Recognition

Assessment	19IC4011.1	19IC4011.2	19IC4011.3	19IC4011.4
MS	Y	N	N	N
ES	Y	Y	N	Y
CE	Y	Y	Y	Y

Course Code: 19CP4013					Course Name: Information Retrieval System			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: None

Learning objectives:

- To provide an overview of Information Retrieval.
- To introduce students about insights of the several topics of Information retrieval such as – Boolean retrieval model, Vector space model.
- To provide comprehensive details about various Evaluation methods.
- To provide implementation insight about the topics covered in the course.

Unit wise allocation of course content

UNIT I (10 L)

Introduction to Information retrieval

History of IR - Components of IR - Issues – Open source Search engine Frameworks - The impact of the web on IR - The role of artificial intelligence (AI) in IR – IR Versus Web Search - Components of a Search engine - Characterizing the web, Information retrieval process, Indexing, Information retrieval model, Boolean retrieval model

UNIT II (09 L)

Dictionary and Postings

Tokenization, Stop words, Stemming, Inverted index, Skip pointers, Phrase queries Tolerant Retrieval Wild card queries, Permuterm index, Bigram index, Spelling correction, Edit distance, Jaccard coefficient, Soundex

UNIT III (10 L)

Evaluation Measure

Precision, Recall, F-measure, E-measure, Normalized recall, Evaluation problems

Latent Semantic Indexing

Eigen vectors, Singular value decomposition, Lowrank approximation, Problems with Lexical Semantics

UNIT IV (10 L)

Query Expansion

Relevance feedback, Rocchio algorithm, Probabilistic relevance feedback, Query Expansion and its types, Query drift.

Probabilistic Information Retrieval, Probabilistic relevance feedback, Probability ranking principle, Binary Independence Model, Bayesian network for text retrieval

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs
Tutorial: 0 Hrs
Approximate Total: 39 Hrs

Texts and References

1. C. Manning, P. Raghavan, and H. Schutze, Introduction to Information Retrieval, Cambridge University Press, 2008.
2. Ricardo Baeza -Yates and Breathier Ribeiro - Neto, Modern Information Retrieval: The Concepts and Technology behind Search 2nd Edition, ACM Press Books 2011.
3. Bruce Croft, Donald Metzler and Trevor Strohman, Search Engines: Information Retrieval in Practice, 1st Edition Addison Wesley, 2009.
4. Mark Levene, An Introduction to Search Engines and Web Navigation, 2nd Edition Wiley, 2010.
5. Stefan Buettcher, Charles L. A. Clarke, Gordon V. Cormack, Information Retrieval: Implementing and Evaluating Search Engines, The MIT Press, 2010.
6. Ophir Frieder "Information Retrieval: Algorithms and Heuristics: The Information Retrieval Series", 2nd Edition, Springer, 2004.
7. Manu Konchady, "Building Search Applications: Lucene, Ling Pipe", and First Edition, Gate Mustru Publishing, 2008.

Course Outcomes:

At the end of the course, the student will be able to:

1. Understand different Information retrieval model.
2. Understand evaluation methods of the information retrieval model.
3. Appreciate the challenges associated with each topic
4. Design and implement the various Information retrieval models.

19CP4013 – Information Retrieval System

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
19CP4013.1	2	3	2	3	3	1	0	0	3	2	2	1	2	2
19CP4013.2	2	3	3	3	3	1	0	0	3	2	2	1	2	2
19CP4013.3	2	3	3	3	3	1	0	0	3	2	3	1	3	2
19CP4013.4	2	3	3	3	3	1	0	0	3	2	3	1	3	2
19CP4013	2.00	3.00	2.75	3.00	3.00	1.00	0	0	3.00	2.00	2.50	1.00	2.50	2.00

Constituent COs in Assessment: 19CP4013 – Information Retrieval System

Assessment	19CP4013.1	19CP4013.2	19CP4013.3	19CP4013.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19CP4014					**Course Name: Blockchain Technology**			
Teaching Scheme					**Examination Scheme**			
L	**T**	**P**	**C**	**Hrs/ Wk**	**Theory**			**Total**
					Continuous Evaluation	**Mid Semester**	**End Semester**	**Marks**
3	0	0	3	3	25	25	50	100

Prerequisites:- Information Security

Learning objectives:

- To understand the concepts of distributed consensus and trust management
- To understand the design principles of the block chains
- To design and implement the distributed ledger and the smart contracts

Unit wise allocation of course content

UNIT I (10 L)

Introduction to Blockchain, Building blocks: SHA 256, Peer to Peer Network, Distributed Ledger, Block mining, Proof of work, Miners and incentive mechanisms, Merkle tree, case-study applications of block chain framework: Bitcoin and transactions

UNIT II (08 L)

Consensus Algorithms: byzantine agreements, public and private block chain, hard and soft fork, side chains, 51% attack

UNIT III (11 L)

Ethereum Framework: Introduction, smart contract, Messages and transaction, state transition function, gas, applications, Solidity programming language: smart contract design, Rinke by testnet

UNIT IV (10 L)

Other frameworks: comparison with the liner block chains, Neo framework, proof of stake, IOTA Tangle, adding and verifying transactions, stability analysis, real-time operations on blockchain,

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture:39Hrs
Tutorial: 0 Hrs
Approximate Total: 39Hrs

Texts and References:

1. White papers of Bitcoin, Ethereum, IOTA and Neo frameworks and research papers as communicated in the class

Course Outcomes (COs):

At the end of this course students will be able to

1. Understand the concept of distributed trust management.
2. Understand the design principles of various blockchain frameworks
3. Design and implement trusted distributed applications
4. Design and implement smart contracts

19CP4014 – Blockchain Technology

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
19CP4014.1	2	3	2	3	3	2	1	2	3	2	2	1	2	3
19CP4014.2	2	3	2	3	3	2	1	2	3	2	2	1	2	3
19CP4014.3	2	3	3	3	3	2	1	2	3	2	3	1	3	3
19CP4014.4	2	3	3	3	3	2	1	2	3	2	3	1	3	3
19CP4014	2.00	3.00	2.50	3.00	3.00	2.00	1.00	2.00	3.00	2.00	2.50	1.00	2.50	3.00

Constituent COs in Assessment: 19CP4014 – Blockchain Technology

Assessment	19CP4014.1	19CP4014.2	19CP4014.3	19CP4014.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19CP4015					Course Name: Green Computing			
Teaching Scheme					Examination Scheme			
L	T	P	C	Hrs/ Wk	Theory			Total
					Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: None

Learning objectives:

- To learn the fundamentals of Green Computing.
- To analyze the Green computing Grid Framework.
- To understand the issues related with Green compliance.
- To study and develop various case studies.

Unit wise allocation of course content

UNIT I (10 L)

Fundamentals

Green IT Fundamentals: Business, IT, and the Environment – Green computing: carbon foot print, scoop on power – Green IT Strategies: Drivers, Dimensions, and Goals – Environmentally Responsible Business: Policies, Practices, and Metrics.

UNIT II (10 L)

Green Assets and Modeling:

Green Assets: Buildings, Data Centers, Networks, and Devices – Green Business Process Management: Modeling, Optimization, and Collaboration – Green Enterprise Architecture – Environmental Intelligence – Green Supply Chains – Green Information Systems: Design and Development Models.

UNIT III (9 L)

Grid Framework:

Virtualization of IT systems – Role of electric utilities, Telecommuting, teleconferencing and teleporting – Materials recycling – Best ways for Green PC – Green Data center – Green Grid framework.

UNIT IV (10 L)

Green Compliance:

Socio-cultural aspects of Green IT – Green Enterprise Transformation Roadmap – Green Compliance: Protocols, Standards, and Audits – Emergent Carbon Issues: Technologies and Future.

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39 Hrs

Tutorial: 0 Hrs

Approximate Total: 39 Hrs

Texts and References

1. Bhuvan Unhelkar, ―Green IT Strategies and Applications-Using Environmental Intelligence, CRC Press, June 2014.
2. Woody Leonhard, Katherine Murray, ―Green Home computing for dummies, August 2012.
3. Alin Gales, Michael Schaefer, Mike Ebbers, ―Green Data Center: steps for the Journey, Shroff/IBM rebook, 2011.
4. John Lamb, ―The Greening of IT, Pearson Education, 2009.
5. Jason Harris, ―Green Computing and Green IT- Best Practices on regulations & industry, Lulu.com, 2008
6. Carl speshocky, ―Empowering Green Initiatives with IT, John Wiley & Sons, 2010.
7. Wu Chun Feng (editor), ―Green computing: Large Scale energy efficiency, CRC Press

Course Outcomes:

At the end of the course, the student will be able to:

1. Acquire knowledge to adopt green computing practices to minimize negative impacts on the environment.
2. Enhance the skill in energy saving practices in their use of hardware.
3. Evaluate technology tools that can reduce paper waste and carbon footprint by the stakeholders.
4. Understand the ways to minimize equipment disposal requirements.

19CP4015 – Green Computing

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14
19CP4015.1	0	2	2	3	3	3	3	0	1	2	1	1	0	0
19CP4015.2	0	2	2	3	3	2	3	0	1	2	1	1	2	0
19CP4015.3	0	2	3	3	3	2	3	2	1	2	1	1	3	0
19CP4015.4	0	2	2	3	3	2	3	0	1	2	1	1	0	0
19CP4015	0	2.00	2.25	3.00	3.00	2.00	3.00	0.50	1.00	2.00	1.00	1.00	1.25	0

Constituent COs in Assessment: 19CP4015 – Green Computing

Assessment	19CP4015.1	19CP4015.2	19CP4015.3	19CP4015.4
MS	Y	Y	N	N
ES	Y	Y	Y	Y
CE	Y	Y	Y	Y

Course Code: 19IC4012					Course Name: Advanced Communication Systems			
Teaching Scheme					Examination Scheme			
					Theory			Total
L	T	P	C	Hrs/Wk	Continuous Evaluation	Mid Semester	End Semester	Marks
3	0	0	3	3	25	25	50	100

Prerequisites: Digital Signal Processing, Communication Systems

Learning objectives:

- To understand advanced topics in digital communications.
- To motivate for understanding of the design concepts and analysis for communication systems.
- To facilitate the understanding of current and future communication system design.

Unit wise allocation of course content

UNIT 1 (6 L)

Signal Processing for Communication Systems

Introduction: Digital signal and system concepts, mathematical background of signals, FFT, DFT,time-frequency analysis, wavelet analysis, Introduction to SCILAB based digital signal processing, digital modulation, demodulation techniques.

UNIT 2 (6 L)

Equalization

Optimal zero forcing equalization, generalized equalization method, fractionally spaced equalizer, transversal filter equalizer, ISI , channel capacity, DFE, Adaptive equalization, fractionally spaced, passband equalization, SG algorithm.

UNIT 3 (6 L)

MIMO Communication

Gausssian MIMO channel, memoryless MIMO channel, MIMO detection, Fading and diversity, Rayleigh fading, Diversity-interference tradeoff, transmit diversity, Space time modems, Error probability, advanced coding.

UNIT 4 (13 L)

Digital Optical Communication

Introduction, Modulation Formats and Optical Signal Generation, Advanced Modulation Formats, Incoherent Optical Receivers, DSP-Coherent Optical Receivers, Transmission of Ultra-Short Pulse Sequence, Electronic equalization, ultra short pulse transmission, Optical Fiber: General Properties, Geometrical Structures and Index Profile, Fundamental Mode of Weakly Guiding Fibers, Equivalent Step-Index, nonlinear effects, phase modulation, scattering effect, attenuation distortion , optical transmitter-receiver, performance evaluation.

UNIT 5 (8 L)

Advanced wireless technology

Introduction to 4G, 5G technology, Spectrum sensing techniques, Cognitive radio network, energy

efficient routing algorithms, wireless ad-hoc networks, Li-Fi, millimeter wave communication,

Student centering learning: (The student centering learning contents should be declared at the commencement of semester. It should be maximum 10% ; however exact contents is left to faculty)

Lecture: 39Hrs
Tutorial: 00Hrs
Approximate Total: 39Hrs

Texts and References:

1. Simon S. Haykin, Michael Moher ,"Modern Wireless Communications". Pearson.
2. Evgenii Krouk, Sergei Semenov "Modulation and Coding Techniques in Wireless Communications", Wiley.
3. Ivan B. Djordjevic , "Advanced Optical and Wireless Communications Systems". Springer.
4. Le Nguyen Binh ."Advanced Digital Optical Communications". CRC Press.
5. Theodore Rappaport , "Wireless Communications: Principles and Practice". Pearson.
6. John R. Barry, Edward A. Lee, David G. Messerschmitt , "Digital Communication". Springer.

Course Outcomes (COs):

At the end of this course students will be able to:

1. Understand various mathematical transforms for communication systems.
2. Understand equalization concept and its importance in communication system.
3. Understand MIMO systems.
4. Understand Digital optical communication system.
5. Understand the design of advanced communication system.

19IC4012 Advanced Communication Systems

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PO14	PO15
19IC4012.1	3	3	3	3	3	2	1	1	2	2	3	2	3	3	3
19IC4012.2	3	3	3	3	3	2	1	1	2	2	3	2	3	3	3
19IC4012.3	3	3	3	3	3	2	1	1	2	2	3	2	3	3	3
19IC4012.4	3	3	3	3	3	2	1	1	2	2	3	2	3	3	3
19IC4012.5	3	3	3	3	3	2	2	1	2	2	3	2	3	3	3
19IC4012	3.00	3.00	3.00	3.00	3.00	2.00	1.2	1.00	2.00	2	3.00	2.00	3.00	3.00	3.00

Constituent COs in Assessment: 19IC4012 Advanced Communication Systems

Assessment	19IC4012.1	19IC4012.2	19IC4012.3	19IC4012.4	19IC4012.5
MS	Y	Y	Y	N	N
ES	Y	Y	Y	Y	Y
CE	Y	Y	Y	Y	Y