Structure and Curriculum

Of

M. Tech. (Computer Science & Engineering)

Full Time Programme

CBCS and as per AICTE guidelines

(Academic Year: 2018-19 Onwards)

GOVERNMENT COLLEGE OF ENGINEERING AURANGABAD

GOVERNMENT COLLEGE OF ENGINEERING, AURANGABAD
(An Autonomous Institute of Government of Maharashtra)
Department of Computer Science & Engineering
Proposed Teaching and Evaluation Scheme
M. Tech. (Computer Science and Engineering) Full-Time (2018-19 onwards)
SEMESTER-I

S. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)						
			L	T	P		Theory			Term Work	Practical/Viva-voce	Total	
							Test	TA	ESE				
1	GE 51001	Research Methodology	2	-	-	2	20	20	60	-	-	100	CF
2	CS 51001	Mathematical Foundations for Computer Science	3	-	-	3	20	20	60	-	-	100	PC
3	CS 51002	Advanced Data Structures & Algorithm	3	-	-	3	20	20	60	-	-	100	PC
4	CS 51003-5	Elective-I	3	-	-	3	20	20	60	-	-	100	PE
5	CS 51006-8	Elective-II	3	-	-	3	20	20	60	-	-	100	PE
6		Audit Course I	2	-	-	--	-	-	-	-	-	-	AC
LABORATORY COURSES													
1	CS 51009	Lab Adv. Data Structure & Algorithm	-	-	4	2	-	-	-	25	25	50	PC
2	CS 51010-12	Lab Elective I	-	-	4	2	-	-	-	25	25	50	PE
		TOTAL	**16**		**8**	**18**	**100**	**100**	**300**	**50**	**50**	**600**	

SEMESTER-II

S. No	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)						
			L		P		Theory			Term Work	Practical/ Viva-voce	Total	
							Test	TA	ESE				
1	CS 51013	Advanced Data Science	3	-	-	3	20	20	60	-	-	100	PC
2	CS 51014	Block chain Technology	3	-	-	3	20	20	60	-	-	100	PC
3	CS 51015-17	Elective-III	3	-	-	3	20	20	60	-	-	100	PE
4	CS 51018-20	Elective-IV	3	-	-	3	20	20	60	-	-	100	PE
5	CS 51021-23	Elective –V	3	-	-	3	20	20	60			100	PE
LABORATORY COURSES													
1	CS 51024	Lab Advanced Data Science	-	-	4	2	-	-	-	25	25	50	PC
2	CS 51025-27	Lab Elective III	-	-	4	2	-	-	-	25	25	50	PE
3	CS 51028	Mini Project	-	-	4	2	-	-	-	50	50	100	PC
		TOTAL	**15**	**-**	**12**	**21**	**100**	**100**	**300**	**100**	**100**	**700**	

L-Lectures, T-Tutorials, P-Practicals, TA-Teacher Assessment, ESE-End-Semester Examination

Elective –I	Elective-II	Elective-III	Elective-IV	Elective- V
CS51003: Adv. Machine Learning	CS51006:Speech & Natural Language Processing	CS51015:Recommender Systems	CS51018:Big Data Analytics : Theory & Applications	CS51021:Computer Vision
CS51004:Advancement in Computer Network	CS51007:Distributed Computing Systems	CS51016:Cryptography &Information Security	CS51019:High Performance Computing	CS51022:Advanced Cloud Computing
CS51005:Soft Computing	CS51008:Internet of Things with Raspberry Pi	CS51017:Biometrics	CS51020:Wireless & Sensor Network	CS51023:Robotic Processor & Architecture & Chatbot

SEMESTER III

S. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)						
			L	T	P		Theory			Term Work	Practical/Viva-voce	Total	
							Test	TA	ESE				
1		Open Elective*	3	-	-	3	20	20	60	-	-	100	OE
LABORATORY COURSES													
1	CS 51029	Dissertation-I	-	-	20	10	-	-	-	50	50	100	PC
		TOTAL	**03**	**-**	**20**	**13**	**20**	**20**	**60**	**50**	**50**	**200**	

SEMESTER-IV

S. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)						
			L	T	P		Theory			Term Work	Practical/ Viva-voce	Total	
							Test	TA	ESE				
1	CS 51030	Dissertation-II	-	-	32	16	-	-	-	100	150	250	PC
		TOTAL	**-**	**-**	**32**	**16**	**-**	**-**	**-**	**100**	**150**	**250**	
		GRAND TOTAL	**34**	**-**	**72**	**68**	**220**	**220**	**660**	**300**	**350**	**1750**	

L-Lectures, T-Tutorials, P-Practicals, TA-Teacher Assessment, ESE-End-Semester Examination

*Students going for Industrial Project/Dissertation will complete these courses through MOOCs, NPTEL, SWAYAM etc.

Note: Minimum 2 months and Maximum 3 months of internship/Industrial Training should be completed by the students either in vacations or in second year

Open Elective: CS51031: Professional Ethics and Cyber Laws
CS51032: Essentials of Cloud Computing
CS51033: Introduction to Internet of Things

Approved in XIXth Academic Council, dated 27/07/2018

GOVERNMENT COLLEGE OF ENGINEERING, AURANGABAD
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M. Tech. (Computer Science and Engineering) Part-Time (2018-19 onwards)
SEMESTER-I

S. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)						
			L	T	P		Theory			Term Work	Practical/Viva-voce	Total	
							Test	TA	ESE				
1	GE 51001	Research Methodology	2	-	-	2	20	20	60	-	-	100	CF
2	CS 51001	Mathematical Foundations for Computer Science	3	-	-	3	20	20	60	-	-	100	PC
3	CS 51002	Advanced Data Structures & Algorithm	3	-	-	3	20	20	60	-	-	100	PC
LABORATORY COURSES													
1	CS 51009	Lab Adv. Data Structure & Algorithm	-	-	4	2	-	-	-	25	25	50	PC
		TOTAL	**8**		**4**	**10**	**60**	**60**	**180**	**25**	**25**	**350**	

SEMESTER-II

S. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)						
							Theory			Term Work	Practical/ Viva-voce	Total	
			L		P		Test	TA	ESE				
1	CS 51013	Advanced Data Science	3	-	-	3	20	20	60	-	-	100	PC
2	CS 51014	Block chain Technology	3	-	-	3	20	20	60	-	-	100	PC
3	CS 51015-17	Elective-III	3	-	-	3	20	20	60	-	-	100	PE
LABORATORY COURSES													
1	CS 51024	Lab Advanced Data Science	-	-	4	2	-	-	-	25	25	50	PC
2	CS 51025-27	Lab Elective III	-	-	4	2	-	-	-	25	25	50	PE
		TOTAL	**9**	**-**	**8**	**13**	**60**	**60**	**180**	**50**	**50**	**400**	

SEMESTER-III

S. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)						
			L	T	P		Theory			Term Work	Practical/Viva-voce	Total	
							Test	TA	ESE				
1		Open Elective*	3	-	-	3	20	20	60	-	-	100	OE
2	CS 51003-5	Elective-I	3	-	-	3	20	20	60	-	-	100	PE
3	CS 51006-8	Elective-II	3	-	-	3	20	20	60	-	-	100	PE
4		Audit Course I	2	-	-	--	-	-	-	-	-	-	AC
LABORATORY COURSES													
1	CS 51010-12	Lab Elective I	-	-	4	2	-	-	-	25	25	50	PE
		TOTAL	**11**		**4**	**11**	**60**	**60**	**180**	**25**	**25**	**350**	

SEMESTER-IV

S. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)						
			L		P		Theory			Term Work	Practical/ Viva-voce	Total	
							Test	TA	ESE				
1	CS 51018-20	Elective-IV	3	-	-	3	20	20	60	-	-	100	PE
2	CS 51021-23	Elective –V	3	-	-	3	20	20	60			100	PE
LABORATORY COURSES													
1	CS 51028	Mini Project	-	-	4	2	-	-	-	50	50	100	PC
		TOTAL	**6**	**-**	**4**	**8**	**40**	**40**	**120**	**50**	**50**	**300**	

L-Lectures, T-Tutorials, P-Practicals, TA-Teacher Assessment, ESE-End-Semester Examination

SEMESTER V

S. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)						
			L	T	P		Theory			Term Work	Practical/Viva-voce	Total	
							Test	TA	ESE				
1	CS 51029	Dissertation-I	-	-	20	10	-	-	-	50	50	100	PC
		TOTAL	**-**	**-**	**20**	**10**	**-**	**-**	**-**	**50**	**50**	**100**	

SEMESTER-VI

S. No.	Course Code	Subject	Scheme of Teaching (Hrs/Week)			Total Credits	Scheme of Evaluation (Marks)						
			L	T	P		Theory			Term Work	Practical/ Viva-voce	Total	
							Test	TA	ESE				
1	CS 51030	Dissertation-II	-	-	32	16	-	-	-	100	150	250	PC
		TOTAL	**-**	**-**	**32**	**16**	**-**	**-**	**-**	**100**	**150**	**250**	
		GRAND TOTAL	**34**	**-**	**72**	**68**	**220**	**220**	**660**	**300**	**350**	**1750**	

L-Lectures, T-Tutorials, P-Practicals, TA-Teacher Assessment, ESE-End-Semester Examination

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Elective –I	Elective-II	Elective-III	Elective-IV	Elective- V
CS51003: Adv. Machine Learning	CS51006:Speech & Natural Language Processing	CS51015:Recommender Systems	CS51018:Big Data Analytics : Theory & Applications	CS51021:Computer Vision
CS51004:Advancement in Computer Network	CS51007:Distributed Computing Systems	CS51016:Cryptography &Information Security	CS51019:High Performance Computing	CS51022:Advanced Cloud Computing
CS51005:Soft Computing	CS51008:Internet of Things with Raspberry Pi	CS51017:Biometrics	CS51020:Wireless & Sensor Network	CS51023:Robotic Processor & Architecture &Chatbot

Open Elective: CS51031: Professional Ethics and Cyber Laws
CS51032: Essentials of Cloud Computing
CS51033: Introduction to Internet of Things

CS51001: Mathematical Foundations in Computer Science

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Total Credits	3	End-Semester Examination	60 Marks

Prerequisite: Discreet Mathematical Structures

Course Outcomes:

After Completing the course student will be able to

CO1:Use the mathematical fundamentals that is prerequisites for a variety of courseslike Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning.

CO2:Develop& understand the mathematical and logical basis to many modern techniques in information technology like machine learning, programming language design, and concurrency.

CO3:Solve sampling and classification problems.

UNIT 1	Probability mass, density, and cumulative distribution functions, Parametric families of distributions, Expected value, variance, conditional expectation, Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Markov chains	
UNIT 2	Random samples, sampling distributions of estimators, Methods of Moments and Maximum Likelihood,	
UNIT 3	Statistical inference, Introduction to multivariate statistical models: regression and classification problems, principal components analysis, The problem of overfitting model assessment.	
UNIT 4	Graph Theory: Isomorphism, Planar graphs, graph coloring, hamilton circuits and euler cycles. Permutations and Combinations with and without repetition. Specialized techniques to solve combinatorial enumeration problems	
UNIT 5	**Computer Science and Engineering applications** Data mining, Network protocols, analysis of Web traffic, Computer security, Software engineering, Computer architecture, operating systems, distributed systems, Bioinformatics, Machine learning. Recent Trends in various distribution functions in mathematical field of computer science for varying fields like bioinformatics, soft computing, and computer vision.	

References:

1. John Vince, Foundation Mathematics for Computer Science, Springer.
2. K. Trivedi. Probability and Statistics with Reliability, Queuing, and Computer Science Applications. Wiley.
3. M. Mitzenmacher and E. Upfal.Probability and Computing: Randomized Algorithms and Probabilistic Analysis.
4. Alan Tucker, Applied Combinatorics, Wiley

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CS51002: Advanced Data Structures & Algorithms			
Teaching Scheme		**Evaluation Scheme**	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Total Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

1. Study of a set of tools for design and analysis of new algorithms for new problems
2. Identify major directions of research for a wide variety of data structures
3. Understanding Hashing, the most used data structure in computer science.
4. Learn geometric data structures like maps and database tables.

Course Outcomes

After Completing the course student will be able to

CO1:Searching for phrases in giant text

CO2:Devise an improved solution to the problem under consideration

CO3: Design queries super-fast, close to constant time, and independent of the problem size as possible.

CO4: Formulate and seek known solutions to an algorithmic problem.

CO5:Implement the algorithm in order to study its performance in practice

UNIT 1	**Advanced Concepts** Hashing, Dynamic graphs(link-cut trees, euler tour trees, dynamic connectivity	
UNIT 2	**Advanced data structures with applications** Geometric data structures, like a map, Temporal data structures, Dynamic trees, Finger search trees, Fibonacci heaps	
UNIT 3	**String Algorithms and maximum flows** Rabin-Karp Fingerprinting Algorithm. Suffix Trees. Augmenting Paths and Push-Relabel Methods, searching for phrases in giant text(eg. google, DNA)	
UNIT 4	**Computational Geometry** Convex Hull, Range Trees, kd trees.	
UNIT 5	**Streaming Algorithms** Sampling, Sketching, Counting Distinct and Frequent Elements.	

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References:

1. Computational Geometry: Algorithms and Applications, Mark de Berg, Otfried Cheong, Marc van Kreveld, Mark Overmars,3Rd Edition , Springer-Verlag ,ISBN:3540779736 9783540779735
2. Data Streams: Algorithms and Applications (Foundations and Trends in Theoretical Computer Science,) S. Muthukrishnan
3. Advanced Data Structures, Peter Brass
4. Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology, **Dan Gusfield**

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CS51003: Advanced Machine Learning			
Teaching Scheme		**Evaluation Scheme**	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Total Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

To introduce various feature selection and machine learning techniques for future detection.

Course Outcomes Expected:

After Completing the course student will be able to

CO1: Analyze useful feature set using machine learning techniques for real time dataset.

CO2: Select & Use appropriate machine learning technique for classification.

CO3: Construct & evaluate machine learning model for future prediction.

UNIT 1	**Unsupervised learning** K-means,EM,Mixture of Gaussians,Factoranalysis,PCA (Principal components analysis),ICA (Independent components analysis).	
UNIT 2	**Reinforcement learning** MDPs,Bellmanequations,Value iteration and policy iteration,Linear quadratic regulation (LQR). LQG, Q-learning. Value function approximation.	
UNIT 3	**Supervised learning** Supervised Learning, Discriminative Algorithms , Linear and Logistic regression. Perceptron. Exponential family. Generative learning algorithms. Gaussian discriminant analysis. Naive Bayes. Support vector machines.	
UNIT 4	**Evaluating and debugging learning algorithms** Bias/variance tradeoff, Model selection and feature selection,ConvexOptimization,Hoeffding'sinequality,Boosting algorithms and weak learning	
UNIT 5	**Generative Adversarial Networks (GANs)** Adversarial machine learning, Applications of GAN(**Predicting the next frame in a video,Increasing Resolution of an image ,Interactive Image Generation,Image to Image Translation**)	

References:

1. Understanding Machine Learning: From Theory to Algorithms,ShaiShalev-Shwartz

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and Shai Ben-David

2. The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani and Jerome Friedman
3. Deep Learning, Ian Goodfellow, YoshuaBengio and Aaron Courville
4. Mining of Massive Datasets,JureLeskovec, AnandRajaraman and Jeff Ullman

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CS51004: Advancement in Computer Network			
Teaching Scheme		**Evaluation Scheme**	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Total Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

- To discuss the terminology and concepts of the Advance computer network
- To discuss the concepts of protocols, network interfaces, and design/performance issues in local area networks and wide area networks
- To be familiar with Network Management and Services.
- To distinguish between secret and public cryptography.
- To identify issues in networking technologies.

Course Outcomes Expected:

After Completing the course student will be able to

CO1: Analyze and implement routing algorithms.

CO2: Evaluate the performances of computer networks

CO3:Design and use the network simulators.

UNIT 1	Introduction: Brief history of Computer Networks, Network Layer, Transport Layer, and Applications Layer: HTTP and other protocols, Layering abstraction. Network architecture and protocols, Packet switching, Internetworking protocols	
UNIT 2	Addressing, IP versions, routing, Routing in the Internet: Intra and inter domain routing; Unicast Routing Protocols : RIP, OSPF, BGP, Socket programming.	
UNIT 3	Network Management and Services : SNMP : Concept, Management components, Multi-media over Internet : RTP, RSVP, IP Multicasting, VOIP	
UNIT 4	Cryptography, Enterprise Network Security : DMZ, NAT, Proxy	
UNIT 5	Storage and Networking, Software Defined Networks, Open Stack Networking, Neutron.	

References:

1. B. A. Forouzan , "TCP/IP Protocol Suite", Tata McGraw Hill edition, Third Edition.
2. N. Olifer V. Olifer, "Computer Networks:Principles, Technologies and Protocols for Network design", Wiley India Edition (1st Edition).
3. Marc Farley, Building Storage Networks , Tata McGraw Hill
4. Thomas D NAdeau and Ken Grey, Software Defined Networking, O'Reilly, 2013
5. SDN and NFV Simplified SDN and NFV Simplified Jim Doherty Copyright © 2016 Pearson Education, Inc. ISBN-13: 978-0-13-430640-7
6. S. Tanenbaum , "Computer Networks", Pearson Education, Fourth Edition.

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CS51005: Soft Computing

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

- To introduce soft computing concepts and techniques and foster their abilities in designing appropriate technique for a given scenario.
- To implement soft computing based solutions for real-world problems.
- To give students knowledge of non-traditional technologies and fundamentals of artificial neural networks, fuzzy sets, fuzzy logic, genetic algorithms.
- To provide student an hand-on experience on MATLAB/Python to implement various strategies.

Course Outcomes Expected:

After Completing the course student will be able to

CO1: Identify and describe soft computing techniques and their roles in building intelligent machines

CO2: Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering

CO3: Apply genetic algorithms to combinatorial optimization problems.

CO4: Evaluate and compare solutions by various soft computing approaches for a given problem.

UNIT 1	**INTRODUCTION TO SOFT COMPUTING AND NEURAL NETWORKS:** Evolution of Computing: Soft Computing Constituents, From Conventional AI to Computational Intelligence: Machine Learning Basics	
UNIT 2	**FUZZY LOGIC:** Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert Systems, Fuzzy Decision Making.	
UNIT 3	**NEURAL NETWORKS:** Machine Learning Using Neural Network, Adaptive Networks, Feed forward Networks, Supervised Learning Neural Networks, RadialBasis Function Networks : Reinforcement Learning, Unsupervised Learning NeuralNetworks, Adaptive Resonance architectures, Advances in Neural networks	
UNIT 4	**Matlab/Python Lib:** Introduction to Matlab/Python, Arrays and array operations, Functions and Files, Study of neural network toolbox and fuzzy logic toolbox, Simple implementation of Artificial Neural Network and Fuzzy Logic	
UNIT 5	Recent Trends in deep learning, various classifiers,. Implementation of recently proposed soft computing techniques.	

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References:

1. Robert J. Schalkoff, "Artificial Neural Networks" -MGH
2. S.R.Jang,C.T.sun , "Neuro Fuzzy and Soft Computing ",E.Mizutani-Person
3. S.N.Sivanandam,S.N.Deepa,"Principles of Soft Computing",Second Edition, Wiley India Edition
4. Jyh:Shing Roger Jang, Chuen:Tsai Sun, EijiMizutani, Neuro: "Fuzzy and Soft Computing ", Prentice:Hall of India, 2003.
5. George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic:Theory and Applications", Prentice Hall, 1995.

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CS51006: Speech and Natural Language Processing

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

To introduce concepts in speech & natural language processing and explore research opportunities in this area.

Course Outcomes Expected:

After Completing the course student will be able to

CO1: Apply the concepts of preprocessing on natural language text.

CO2: Apply the concepts of morphology, POS for feature extraction.

CO3: classify text based on language features.

UNIT 1	Introduction Overview of NLP. Statistical machine translation. Language models and their role in speech processing.Basic Text Processing: Tokenization, Stemming Language Modeling: N-gram Language Models and Information Theory smoothing	
UNIT 2	Corpora and other resources ,Morphology, Parts of Speech Tagging Syntax: PCFGs, Dependency Parsing, Parser Comparison	
UNIT 3	Distributional Semantics Lexical Semantics, Word Sense DisambiguationWordNets and WordNet-API	
UNIT 4	Information Extraction (IE) and Named Entity Recognition (NE Information sources, rule-based methods, evaluation (recall, precision). Introduction to supervised machine learning methods. Naïve Bayes (NB) classifiers for entity classification.Relation extraction, Event extraction Text Summarization	
UNIT 5	Text Classification Machine Translation	

Reference:

1. Daniel Jurafsky and James H. Martin. 2009. *Speech and Language Processing: An Introduction to Natural Language Processing, Speech Recognition, and Computational Linguistics.* 2nd edition. Prentice-Hall.

2. Christopher D. Manning and HinrichSchütze. 1999. *Foundations of Statistical Natural Language Processing*. MIT Press.
3. James Allen. 1995. Natural Language Understanding. Benjamin/Cummings, 2ed.
4. Gerald Gazdar and Chris Mellish. 1989. Natural Language Processing in X. Addison-Wesley. [Where X = Prolog, Lisp, or, I think, Snobol.

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CS51007: Distributed Computing Systems

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

Course Outcomes Expected:

After Completing the course student will be able to

- Create models for distributed systems.
- Apply different techniques learned in the distributed system.

UNIT 1	Introduction to Distributed Computing Systems, System Models, and Issues in Designing a Distributed Operating System, Examples of distributed systems.	
UNIT 2	Features of Message Passing System, Synchronization and Buffering, Introduction to RPC and its models, Transparency of RPC, Implementation Mechanism, Stub Generation and RPC Messages, Server Management, Call Semantics, Communication Protocols and Client Server Binding.	
UNIT 3	Introduction, Design and implementation of DSM system, Granularity and Consistency Model, Advantages of DSM, Clock Synchronization, Event Ordering, Mutual exclusion, Deadlock, Election Algorithms.	
UNIT 4	Task Assignment Approach, Load Balancing Approach, Load Sharing Approach, Process Migration and Threads.	
UNIT 5	File Models, File Accessing Models, File Sharing Semantics, File Caching Schemes, File Replication, Atomic Transactions, Cryptography, Authentication, Access control and Digital Signatures.	

References:

1. Pradeep. K. Sinha: "Distributed Operating Systems: Concepts and Design", PHI, 2007.
2. George Coulouris, Jean Dollimore, Tim Kindberg: "Distributed Systems", Concept and Design, 3rd Edition, Pearson Education, 2005.
3. A.D. Kshemkalyani, M. Singhal, "Distributed Computing: Principles, Algorithms, and Systems", ISBN: 9780521189842, paperback edition, Cambridge University Press, MarchHagitAttiya, Jennifer Welch , "Distributed Computing: Fundamentals, Simulations, and Advanced Topics",Wiley

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CS51008: Internet of Things & Raspberry Pi

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

1. Describe IoT and its applications
2. Understanding various IoT Platforms
3. Learn Python language
4. Understand Technology and Protocols and build apps using Raspberry Pi
5. Understand Threats and Apply security to IOT Apps

Course Outcomes Expected:

CO1: Identify applicability of IoT in given scenario

CO2: Install and Work on IoT platform

CO3: Write Programs using Python Language

CO4: Write programs for Raspberry Pi

CO5: Secure their IoT App

UNIT I	**What Is the Internet of Things (IoT)** Introduction to IOT,Introduction to the Internet of Things, Background, What is Internet of Things (IoT)?, Introduction to Embedded System, Embedded Boards, General Introduction to Arduino Boards, Are Mobile Phones IoT devices? IoT Platforms, Wearable Platform, Embedded Platforms, Cloud Platform for IoT, What IoT means for the developers	
UNIT II	**IOT Platforms** Getting Started With Arduino Development Environment, Basics of Arduino C Program, Writing our First Arduino Program, Simple Blinking Program, Taking Input from Serial Port, Working With Digital Switches, Working with Sensors (Touch Switch Example), User Defined Functions, ArdOS – Installation, Working With ArdOS	
UNIT III	**Introduction to Raspberry Pi with Raspbian OS** Raspberry Pi system specifications Ports, Pins and their uses , Raspberry Pi with Raspian OS, Setting Up Raspian OS, Configuring your Raspian, GUI - Lightweight X11 Desktop Environment" or in short LXDE, File system layout (Logical layout,	

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GE51001: Research Methodology

Teaching Scheme		Evaluation Scheme	
Theory	2 Hrs/Week	Class Test	20 Marks
		Teacher's Assessment	20 Marks
Total Credits	**2**	End Semester Examination	60 Marks

Prerequisite: Not applicable

Course Description: The objective of this course is to expose the prospective researchers to basic methodologies and techniques of carrying out research work. The course provides detailed knowledge of developing a research plan and research design. Various statistical methods are included in this course which will be needed for a research work. Along with this, optimization techniques, modeling and simulation and soft computing techniques required for solution of a research problem are included in the course. At the end, Interpretation of result and technique of report writing will be taught to the students.

Course Outcomes:

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

1. Develop a research plan and define the research problem
2. Analyze the data required for research
3. Solve the mathematical model developed with the help of optimization techniques
4. Write a research paper and dissertation scientifically

Detailed Syllabus:

Unit -1:	**Introduction and Research Process:** Objectives of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Defining the Research Problem, Selecting the Problem, Technique Involved in Defining a Problem, Research Design, Important Concepts Relating to Research Design, Developing a Research Plan, Literature review.	
Unit -2:	**Statistics:** Basic Concepts of Probability, Probability Axioms, Measures of Central Tendency, Measures of Dispersions, Measures of Symmetry, Measures of Peakedness. Regression Analysis – Simple Linear Regression, Multiple linear Regression, Correlation. Tests of Hypothesis and Goodness of Fit: Definition of null and alternative hypothesis, students't' distribution: properties, application with example. Chi-square distribution: definition, constants of Chi-square distribution. Application with example. F-test: example of application.	
Unit -3:	**Optimization Techniques:** Linear Programming, Simplex Method, Dual Simplex, Sensitivity Analysis. Artificial Variable Technique, Dynamic Programming, Introductory	

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	Physical Layout) Installing and uninstalling software - Finding Software, Installing Software, Uninstalling Software, Upgrading Software, "Hello World" Programming on Raspberry Pi	
UNIT IV	**Web Service & Sensors** Creating a Web Service to be consumed by connected Devices via Internet, Working with Sensors like, proximity sensors, temperature sensor, image sensor, rfid sensor etc	
UNIT V	**Securing IoT Apps**- Introduction to Wireless Hacking, Security Model and Threat Taxonomy for Internet of Things (IoT), Privacy Issues in Smart Devices, Introduction to Lightweight Symmetric Cryptosystem, Public Key Cryptography for IoT	

References:

1. Pfister, "Getting started with the internet of things" ,
2. Rowland, "Designing connected products: ux for the consumer internet of things"
3. Dhanjani, "Abusing the internet of things"

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	concepts of non-linear programming. **Or** **Modeling and simulation:** Introduction to modeling: Concept of system, continuous and discrete systems. Experimental Methods: Importance of experimental analysis, guidelines for designing experiments, uncertainty and error analysis, concept of uncertainty, propagation of uncertainty, planning experiments from uncertainty analysis.	
Unit -4:	**Soft Computing:** Fuzzy logic: Introduction, Concepts, Basic Fuzzy Mathematical Operations, Fuzzy databases, Membership Functions, Fuzzy Linear Programming, Neural Networks: Artificial Neural Networks, architectures and algorithms, Basic neuron models, Neural network models, Learning algorithms, Genetic Algorithms: Introduction to genetic algorithm, Operators, Applications.	
Unit -5:	**Interpretation and Report Writing:** Meaning of Interpretation, Techniques of Interpretation, Significance of Report Writing, Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Writing a technical paper, plagiarism and its implications.	

References:

1. Gupta . S.P., " Statistical Methods", S. Chand & Sons, New Delhi
2. Kothari C.R., " Research Methodology-Methods and Techniques", New Age International Publishers, New Delhi.
3. Gupta S.L. and Gupta Hitesh , "Research Methodology-Text and cases with SPSS applications" International Book House Pvt. Ltd., New Delhi.
5. Rao V and Rao H., "C++, Neural Networks and Fuzzy Logic", BPB Publications, New Delhi.
6. Goldberg, D.E., "Genetic Algorithms in Search, Optimization & Machine Learning", Addison Wesley Longman (Singapore) Pte. Ltd., Indian Branch, Delhi.
7. Klir George J. and Yuan Bo, "Fuzzy Sets and Fuzzy Logic", PHI Learning Pvt. Ltd, New Delhi

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CS51009: Lab Advanced Data Structure & Algorithm

Teaching Scheme		**Evaluation Scheme**	
Practicals	4Hrs/Week	Term Work	25 Marks
Total Credits	2	Practical	25 Marks

Course Outcomes Expected:

After Completion of this course student will be able to

- Use advanced data structures like B Trees, Bionomial Heap with randomized algorithms for real time problem solving.
- Apply Dynamic programming approach.

List of Practical's :

Implementation of the following algorithms:

1.Hashing and building dynamic trees
2.Link-cut and Euler tree
3.Range Trees and kd-trees
4.String and Phrase searching algorithms
5.Sampling algorithms
6.Sketching algorithms
7.Data stream algorithms for counting distinct and frequent itemsets

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CS51010: Lab Advanced Machine Learning

Teaching Scheme		Evaluation Scheme	
Practicals	4Hrs/Week	Term Work	25 Marks
Total Credits	2	Practical	25 Marks

Course Outcomes Expected:

After Completion of this course student will be able to

- Select appropriate machine learning algorithm for real time problem statement.
- Analyze efficiency of software system.
- Give justification for an optimum solution.

List of Practical's :

Implementation of machine learning algorithms using Python standard Libraries:

1.Unsupervised Learning:K-means,PCA and ICA

2.Supervised Learning:Regression:Linear and Logistic Regression

3.Supervised Learning:Classification:DecisionTrees,NaiveBayes,Bagging and Boosting

4.Reinforcement Learning:Q-Learning

5.Linear Discrimination:Multilayer Perceptron

6.Design and analysis of machine learning experiments.

Applying the learning machine learning concepts for project assignment in any of the following domains:

Healthcare,Financial,Agriculture,Telecomm,Retail,Bioinformatics,anomaly detection or any other subject domain of student's choice

The submission of the project assignment will be in the form of research paper.

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CS51011: Lab Advancement in Computer Network

Teaching Scheme		Evaluation Scheme	
Practicals	4Hrs/Week	Term Work	25 Marks
Total Credits	2	Practical	25 Marks

Course Outcomes Expected:

After Completion of this course student will be able to

- Design and use network simulators.
- Analyze and implement routing algorithms.
- Implementations of various network protocol.
- Implementations of encryption and decryption.

List of Practical's :

1. Installation & demonstration of Network simulation .
2. Ethernet LAN protocol. To create Scenario and study the performance of CSMA/CD protocol through simulation
3. To create scenario and study the performance of token bus and token ring protocols through simulation
4. To create scenario and study the performance of network with CSMA/CA protocol and compare with CSMA/CD protocols
5. Implementation and study of Stop and Wait protocol
6. Implementation and study of Go back N and Selective Repeat protocols
7. Implementation of Distance Vector Routing algorithm
8. Implementation of Link state routing algorithm
9. Implementation of data encryption and decryption
10. File transfer using socket programming.

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CS51012: Lab Soft Computing

Teaching Scheme		Evaluation Scheme	
Practicals	4Hrs/Week	Term Work	25 Marks
Total Credits	2	Practical	25 Marks

Course Outcomes Expected:
After Completion of this course student will be able to
CO1: Demonstrate algorithms based on Fuzzy logic.

CO2: Learn how to create Neural Network architecture to solve real world problem.

List of Practical's :

1. Introduction to Matlab
2. Implementation of single layer perceptron
3. Implementation of multilayer perceptron
4. Classification with Backprapogation algorithm
5. Unsupervised clustering of data
6. Implementation of pattern classification with deep learning
7. Character recognition with neural network by supervised technique
8. Character recognition with unsupervised method

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Semester II

CS51013: Advanced Data Science			
Teaching Scheme		**Evaluation Scheme**	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Total Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

Course Outcomes Expected:

After Completing the course student will be able to

CO1: Use Python and other tools to scrape, clean, and process data
CO2:Use data management techniques to store data locally and in cloud infrastructures
CO3:Use statistical methods and visualization to quickly explore data
CO4: Apply statistics and computational analysis to make predictions based on data
CO5:Apply basic computer science concepts such as modularity, abstraction, and encapsulation to data analysis problems

UNIT 1	Data munging/scraping/sampling/cleaning in order to get an informative, manageable data set	
UNIT 2	Data storage and management in order to be able to access data - especially big data - quickly and reliably during - subsequent analysis	
UNIT 3	Exploratory data analysis to generate hypotheses and intuition about the data	
UNIT 4	Prediction based on statistical tools such as regression, classification, and clustering	
UNIT 5	Communication of results through visualization, stories, and interpretable summaries	

REFERENCE BOOKS:

1. Python for Data Analysis: Data Wrangling With Pandas, NumPy and IPython, by Wes McKinney
2. Storytelling With Data: A Data Visualization Guide for Business Professionals, by Cole NussbaumerKnaflic
3. Machine Learning Yearning, by Andrew Ng

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CS51014: Block Chain Technology			
Teaching Scheme		**Evaluation Scheme**	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

To introduce withthe technological revolution that's taking the financial world by storm.

Course Outcomes Expected:

After Completing the course student will be able to

CO1: Describe the basic technology behind block chain technology.

CO2: Familiarize with Bitcoin and understand limitations.

CO3: Get introduced with Ethereum.

UNIT I	Introduction Blockchain? Definition, Pillars of Block chain, Distinction between Block chain vs Crypto currency vs Token, Industry Applications of Block chain in Government, Healthcare , Shift from gold standard to flat currency to Hash cash/digital currency (look at BEM) / Bitcoin	
UNIT II	Crypto currency and Markets Crypto currencies - Bitcoin / Ethereum ,How to Set up a Wallet, Wallet Options/ why is a wallet important, Tokens and ICO	
UNIT III	Working Block chain and Bit coin Peer to Peer network - Silicon Valley, What is a block? Distributed consensus, Cryptography - . Hashing, Data Integrity, MerkleTrees,Bitcoin and block sizes ,Implications of the Cryptography and Decentralization , Framework of IBM Hyper Ledger	
UNIT IV	Mining and Crypto currencies Mining Proof of Work v Stake ,What this does, how miners make money, What this meant as an impact to the world, Motivations, incentives, strategy, What miners do - business model, overview, the purpose,. Revenue at a Protocol Level - Block Rewards/Fees/ETC	
UNIT V	Types of Block chain and Enterprise Public and Private Block chains, JP Morgan Quorum, IBM's stuff, How people are using block chain - Numerai, DAO, etc., Use Cases - Digital Rights - ownership and accessibility, education, Industry - healthcare, finance	

References:

1. Alan T Norman, " Block chain Technology Explained"
2. **Andreas M. Antonopoulos , "Mastering Bitcoin: Programming the Open Blockchain" 2nd Edition, Kindle Edition**

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CS51015: Recommender System

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

Learn about the design of recommender systems: the underlying concepts, design space, and tradeoffs

Course Outcomes Expected:

After Completing the course student will be able to

CO1: To understand the design space of recommender systems

CO2:To provide design recommendations for a particular application domain

CO3:To critique a design to point out its strengths and weaknesses

UNIT 1	**History, Motivation, and Overview** Onset of Information Overload, Filtering, Customization Dichotomies, CS Content Areas, Basic Principles, Integrated Frameworks, Application Areas (Books, Music, Movies, Web Sites)	
UNIT 2	**Models of Recommender Systems** Information Filtering, Collaborative Filtering, Ratings, User Evaluations, Diffusion, Effusivity& Sparsity in Recommender Systems, Social Networks, Random Graphs, "Expert Sites" (Askme.com, Epinions.com etc.),	
UNIT 3	**Search Engines** Indexing (Traditional Search Engines, Link-Based Approaches (Google, Clever), Semantic Corpora Analysis, Graph Structure in the Web (Bow-Tie Analysis), Diameter of the Web, Scaling Properties of the Web.	
UNIT 4	**Integrated Aproaches** Non-Destructive Personalization (e.g. footprints), Destructive Personalization (e.g. PIPE), Classification Hierarchies, Navigation vs. Personalization, Taxonomies and Meta-Data, Adaptive Web Sites, knowledge-based recommender system, Social tagging recommender systems, Trust-centric recommendations, Group recommender systems.,	
UNIT 5	**Applications of recommender systems** Applications in Non-Conventional Areas (e.g. Scientific Computing, Wireless System Design) , Non-Traditional Environments (News on Demand, Handheld Devices)	

References:

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1. Recommender Systems, Resnick and Varian,
2. Electronic Commerce Recommendation Applications,Schafer, Konstan, and Riedl, in Journal of Data Mining and Knowledge Discovery.
3. GroupLens: An Open Architecture for Collaborative Filtering of Netnews(link is external), Resnick, Iacovou, Suchak, Bergstrom, Riedl, in proceedings of CSCW'94

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CS 51016: Cryptography and Information Security

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

- To be familiar with concepts of Computer Security
- To discuss the concepts of AES (Advance Encryption Standards)
- To learn the principle of Public-Key Cryptography and RSA algorithm.
- To discuss the Information Security Overview.
- To identify issues in networking technologies.

Course Outcomes Expected:
After Completion of this course student will be able to

CO1: Analyze security issues in computer system.
CO2: Design and evaluate the Cryptosystems.
CO3:Identify and resolve issues in computer network.

UNIT 1	Overview: Computer Security Concepts, The OSI Security Architecture, A Model for Network Security, Block Ciphers and the Data Encryption Standard	
UNIT 2	Advanced Encryption Standard: The Origins AES, AES Structure, AES Round Functions, AES Key Expansion, An AES Example, AES Implementation	
UNIT 3	Public-Key Cryptography and RSA: Principles of Public-Key Cryptosystems, The RSA Algorithm, Other Public-Key Cryptosystems: Diffie-Hellman Key Exchange, Elliptic Curve Cryptography	
UNIT 4	Information Security Overview, Risk Analysis, Compliance with Standards, Regulations, and Laws, Secure Design Principles, Security Policies, Standards, Procedures, and Guidelines, Data Security: Securing Unstructured Data, Information Rights Management, Storage Security, Database Security	
UNIT 5	Network Security: Secure Network Design, Network Device Security, Firewalls, Virtual Private Networks, Wireless Network Security, Intrusion Detection and Prevention Systems	

References:

1. William Stallings "CRYPTOGRAPHY AND NETWORK SECURITY PRINCIPLES AND PRACTICE FIFTH EDITION" (Fifth Edition) Pearson Education.
2. Mark Rhodes-Ousley "The Complete Reference Information Security Second Edition" Second Edition, Tata McGraw Hill.
3. N. Olifer V. Olifer, "Computer Networks:Principles, Technologies and Protocols for Network
design", Wiley India Edition (1st Edition).

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4. Marc Farley, Building Storage Networks , Tata McGraw Hill.
5. S. Tanenbaum , "Computer Networks", Pearson Education, Fourth Edition.

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CS 51017: Biometrics

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

The objective of this course is to introduce Bio-metric and traditional authentication methods. Application of bio-metric systems in government sector and various face recognition and finger print recognition methods are included.

Course Outcomes Expected:

After Completion of this course student will be able to

CO1: Perform R&D on bio-metrics methods and systems.

CO2: A good understanding of the various modules constituting a bio-metric system.

CO3: Familiarity with different bio-metric traits and to appreciate their relative significance.

CO4:A good knowledge of the feature sets used to represent some of the popular bio-metric traits.

CO5: Evaluate and design security systems incorporating bio-metrics.

CO6: Recognize the challenges and limitations associated with bio-metrics.

UNIT 1	Introduction and Definitions of bio-metrics, Traditional authenticated methods and technologies.	
UNIT 2	Bio-metric technologies: Fingerprint, Face, Iris, Hand Geometry, Gait Recognition, Ear, Voice, Palm print, On-Line Signature Verification, 3D Face Recognition, Dental Identification and DNA.	
UNIT 3	The Law and the use of multi bio-metrics systems.	
UNIT 4	Statistical measurement of Bio-metric.	
UNIT 5	Case Studies of bio-metric system, Bio-metric Transaction. Bio-metric System Vulnerabilities. Recent trends in Bio-metric technologies and applications in various domains. Template security of Biometric & multibiometric.	

References:

1. Biometrics for network security, Paul Reid, Hand book of Pearson
2. D. Maltoni, D. Maio, A. K. Jain, and S. Prabhakar, Handbook of Fingerprint Recognition, Springer Verlag, 2003.
3. A. K. Jain, R. Bolle, S. Pankanti (Eds.), BIOMETRICS: Personal Identification in NetworkedSociety, Kluwer Academic Publishers, 1999.
4. J. Wayman, A.K. Jain, D. Maltoni, and D. Maio (Eds.), Biometric Systems: Technology, Design and Performance Evaluation, Springer, 2004.
5. Anil Jain, Arun A. Ross, Karthik Nanda kumar, Introduction to biometric, Springer, 2011.
6. Biometric Systems: Technology, Design and Performance Evaluation, J. Wayman, A.K. Jain, D. Maltoni, and D. Maio

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CS51018: Big Data Analytics : Theory & Applications

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

1. Familiarize the students with most important information technologies used in manipulating, storing, and analyzing big data.
2. Harness the power of high performance computing architectures and data mining, text analytics, and machine learning algorithms.
3. Understanding basic network and distributed programming.
4. Mastering Spark 2.0 big data processing framework
5. Learn to build and maintain reliable, scalable, distributed systems

Course Outcomes Expected:

After Completing the course student will be able to

CO1: Applying MapReduce paradigm to solve problems

CO2: Able to apply Hadoop ecosystem components for big Data use cases

CO3:Constructing a real world application to solve specific business problems using powerful analytic techniques.

CO4:Ability to initiate and design highly scalable systems that can accept, store, and analyze large volumes of unstructured data in batch mode and/or real time.

CO5: Analysis of data near real time.

UNIT 1	**Spark and Map-Reduce** Evolution of Hadoop and Map/Reduce, semi-structured data: web logs, videos, speech recordings, photographs, e-mails, Tweets, and similar dat	
UNIT 2	**TensorFlow** Regression, Clustering, and Classification.	

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UNIT 3	**NoSQL storage solutions** Cassandra for their critical features: speed of reads and writes, ability to scale to extreme volumes.	
UNIT 4	**Memory-resident and graph databases** Spark GraphX , VoltDB, SciDB and Ne4J	
UNIT 5	**Messaging systems** Kafka and Amazon Kinesis.	

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. Learning Real-time Processing with Spark Streaming , Sumit Gupta
4. Cassandra: The Definitive Guide: , EbenHewitt,O,Reilly publications
5. TensorFlow for Deep LearningFrom Linear Regression to Reinforcement Learning, Reza Zadeh, BharathRamsundar, O'Reilly Media
6. Kafka: The Definitive Guide: Real-Time Data And Stream Processing At Scale, Neha Narkhede
7. Graph Databases: New Opportunities for Connected Data, Ian Robinson (Author), Jim Webber (Author), Emil Eifrem (Author)

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CS5019: High Performance Computing

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

- To discuss need for the design of HPC System.
- To provide vision for how computing can seamlessly scale from single processor to limitless computing power.
- To expose analysis of current issues including parallel, cloud computing.

Course Outcomes Expected: After Completing the course student will be able to

- Design HPC System.
- Apply different computing techniques.

UNIT 1	Overview of Grid Computing Technology, History of Grid Computing, High Performance Computing, Cluster Computing. Peer-to-Peer Computing, Internet Computing, Grid Computing Model and Protocols, Types of Grids: Desktop Grids, Cluster Grids, Data Grids, High-Performance Grids, Applications and Architectures of High Performance Grids, High Performance Application Development Environment.	
UNIT 2	Open Grid Services Architecture, Introduction, Requirements, Capabilities, Security Considerations, GLOBUS Toolkit.	
UNIT 3	Overview of Cluster Computing, Cluster Computer and its Architecture, Clusters Classifications, Components for Clusters, Cluster Middleware and SSI, Resource Management and Scheduling, Programming, Environments and Tools, Cluster Applications, Cluster Systems,	
UNIT 4	Beowulf Cluster: The Beowulf Model, Application Domains, Beowulf System Architecture, Software Practices, Parallel Programming with MPL, Parallel Virtual Machine (PVM).	
UNIT 5	Overview of Cloud Computing, Types of Cloud, Cyber infrastructure, Service Oriented Architecture Cloud Computing Components: Infrastructure, Storage, Platform, Application, Services, Clients, Cloud Computing Architecture.	

References:

1. Ahmar Abbas, "Grid Computing: Practical Guide to Technology & Applications", Firewall Media, 2004.
2. Joshy Joseph and Craig Fellenstein , "Grid Computing" Pearson Education, 2004.
3. Ian Foster, et al.,"The Open Grid Services Architecture", Version 1.5 (GFD.80). Open Grid Forum, 2006. (available at http://www.ogf.org)
4. Ian Foster. *Globus Tool kit Version 4: Software for Service-Oriented Systems*. IFIP International Conference on Network and Parallel Computing, Springer-Verlag LNCS 3779, pp 2-13,2006. (available athttp://www.globus.org/)
5. RajkumarBuyya. High Performance Cluster Computing: Architectures and Systems. Prentice-Hall India, 1999.

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CS51020: Wireless Sensor Network

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

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Course Outcomes Expected: After Completing the course student will be able to

CO1:To provide awareness about challenges wireless sensor networks
CO2:To acquire knowledge of various networking sensors
CO3: To comprehend the infrastructure establishment
CO4:To discuss sensor network platforms and tools

UNIT 1	OVERVIEW OF WIRELESS SENSOR NETWORKS Challenges for Wireless Sensor Networks, Enabling Technologies for Wireless SensorNetworks.	
UNIT 2	ARCHITECTURES Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes , Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios.	
UNIT 3	NETWORKING SENSORS Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC.	
UNIT 4	INFRASTRUCTURE ESTABLISHMENT Topology Control , Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.	
UNIT 5	SENSOR NETWORK PLATFORMS AND TOOLS Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms	

References:

1. Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless Sensor Networks" , John Wiley, 2005. REFERENCE BOOK:
2. Feng Zhao & Leonidas J. Guibas, “Wireless Sensor Networks- An Information Processing Approach", Elsevier, 2007.

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CS51021: Computer Vision			
Teaching Scheme		**Evaluation Scheme**	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Total Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

1. To introduce students the fundamentals of image formation;
2. To introduce students the major ideas, methods, and techniques of computer vision and pattern recognition;
3. To develop an appreciation for various issues in the design of computer vision and object recognition systems;
4. To provide the student with programming experience from implementing computer vision and object recognition applications.

Course Outcomes Expected:

After Completing the course student will be able to

CO1 :Identify basic concepts, terminology, theories, models and methods in the field of computer vision,

CO2 : Describe known principles of human visual system,

CO3 :Illustrate basic methods of computer vision related to multi-scale representation, edge detection and detection of other primitives, stereo, motion and object recognition,

CO4 : Suggest a design of a computer vision system for a specific problem

UNIT 1	**The image, its representations and properties** – image representations a few concepts, Image digitization, Digital image properties, Color images, Image Formation Models :Monocular imaging system, Orthographic& Perspective Projection, Camera model and Camera calibration, Binocular imaging systems	
UNIT 2	**The image, its mathematical and physical background** – Linear integral transforms, Images as stochastic processes, Image formation physics.	
UNIT 3	**Segmentation II** – Mean Shift Segmentation , Active contour models – snakes, Geometric deformable model – level sets and geodesic active contours, Fuzzy connectivity, Towards 3D graph – based image segmentation, Graph cut segmentation, Optimal single and multiple surface segmentation.	
UNIT 4	**Use of 3D vision** – Shape from X, Full 3D objects, 3D model-based vision, 2D view-based representations of a 3D scene, 3Dreconstruction from an unorganized set of 2D views – a case study. Human Vision: Stereopsis	
UNIT 5	**Texture** – Statistical texture description, Syntactic texture description	

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	methods, Hybrid texture description methods, Texture recognition method applications.	

References:

1. Digital Image processing and Computer Vision", Sonka-Hlavac-Boyle, CENGEAGE LEARNING
2. Image Processing for Computer Graphics and Vision, Jonas Gomes, Luiz Velho, Alejandro C. Frery, Springer publication , 2nd edi.
3.Computer Vision, A Modern Approach, David Forsyth, Jean Ponce,ISBN-13: 978-0136085928
4. Computer Vision: Algorithms and Applications (Texts in Computer Science), Richard Szeliski ,Springer,ISBN-13: 978-1848829343

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CS51022: Advanced Cloud Computing			
Teaching Scheme		**Evaluation Scheme**	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Total Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

- To study cloud computing concepts.
- Enhancing cloud computing environment.
- To study various platforms.
- To study the applications that uses cloud computing.

Course Outcomes Expected:

After Completing the course student will be able to

CO1: To install cloud computing environments.

CO2: To present a survey on cloud building blocks and technologies.

CO3: To perform cloud computing admin and programming using open source tools.

UNIT 1	Introduction, Roots of Cloud Computing: From mainframe to Cloud, Benefits ofCloud Computing SOA, Web services,Web 2.0, Mashups, Grid computing, Utility computing, Hardware virtualization,Essentials of Cloud characteristics, Challenges, Cloud economics,Role of Networks in Cloud Computing: Cloud types and service models,Cloud computing platforms : Openstack, Opennimbus, EucalyptusPrimary Cloud Service models, Cloud Services brokerage, Primary clouddeployment models, cloud computing reference model, The greenfield andbrownfield deployment options	
UNIT 2	Introduction, Characteristics of Virutalized environments, Taxonomy of Virtualization techniques, Pros and Cons of Virtualization, Technology examples:Xen, KVM, Vmware, Microsoft Hyper-VInfrastructure as Service, best-of breed cloud infrastructure components,cloud ready converged infrastructure, Virtual machine provisioning and migrationservices, Anatomy of Cloud infrastructure, Distributed management of virtualinfrastructure, scheduling techniques, SLA Commitment	
UNIT 3	Storage system architecture, Big data, Virtualize data centre(VDC) architecture, VDC Environment, server, storage, networking, desktop and application	

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	virtualization techniques and benefits, Virtual Machine Components and Process of converting physical to VMs, Block and file level storage virtualization, Virtual Provisioning, and automated storage tiering, VLAN, VSAN and benifits, Network traffic management techniques in VDC, Cloud file systems: GFS and HDFS, BigTable, HBase and Dynamo. Features and comparisons among GFS,HDFS.	
UNIT 4	Introduction and architecture for federated cloud computing, Performance prediction for HPC on Cloud. SLA management: Types of SLA, Life cycle of SLA, Traditional approaches of SLA.service catalog, service ordering process, management and functional interfacesof services , cloud portal and its functions, cloud interface standards along withSOAP and REST, system integration and work-flow modeling, cloud service life-cyclephases: service planning, service creation, service operation, and service terminationControl layer, its functions and benefits,element and unified manager, softwaredefined approach and techniques for managing IT resources	
UNIT 5	Introduction, Global Risk and Compliance aspects in cloud environments and key security terminologies, Technologies for Data security, Data security risk, Cloud computing and identity, Digital identity and access management, Content level security, Security-As-A-Cloud Service	

References:

1. RajkumarBuyya, "Cloud computing principles and paradigms", Wiley
2. Gautam Shroff, Enterprise Cloud Computing, Cambridge
3. Handbook of Cloud Computing, Springer Publication
4. RajkumarBuyya, "Mastering Cloud computing", McGraw Hill
5.Tim Mather, Subra K, ShahidL.,Cloud Security and Privacy, Oreilly, ISBN-13 978-81-8404-815-5
6.. Dr. Kumar Saurabh,"Cloud Computing", Wiley Publication
7.. Greg Schulr,"Cloud and virtual data storage networking",CRC Press
8. Barrie Sosinsky,"Cloud Computing", Wiley India
9. Kailash Jayaswal, " Cloud computing", Black Book, Dreamtech Press
10. Anthony T. Velte, Cloud Computing: A Practical Approach, Tata McGraw Hill, 2009, ISBN: 070683514
11. Richard Hill, Guide to Cloud Computing: Principals and Practices, Springer ISBN-10: 1447146026

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CS 51023: Robotic Processor Architecture & Chatbot

Teaching Scheme		Evaluation Scheme	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

To introduce the most impactful technologies in process automation in all kind of organizations with support of Chatbot.

Course Outcomes Expected:

After Completion of this course student will be able to

CO1: Know about the history of automation & advent of RPA.

CO2: Debate surrounding RPA and its consequences on the meaning of work

CO3: Extract the primary features of RPA.

CO4: Learn chat bot for RPA.

UNIT 1	What is Robotic Process Automation, Scope & techniques of RPA, What can RPA do, Benefits of RPA, Components of RPA, RPA Platforms	
UNIT 2	Beyond pressing a button: The automation of automation, From Transactional to analytical: The upsides of Robotic process automation	
UNIT 3	What are bots, Bot Types, Bots Platform, Difference between RPA &Chatbot, Integrating chatbot with RPA.	
UNIT 4	The evolution of RPA and the New Bot Economy ,The business value of a ready-to-deploy digital workforce,	
UNIT 5	Recent use cases for accelerated automation with Bot Store, The future of Bot Store and its impact on digital transformation	

References:

1. Frank Casale, Rebecca Dilla, "Introduction to Robotic Process Automation: a Primer Kindle Edition)"

2. Alok Mani Tripathi, "Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool – UiPath" Kindle Edition

3. "Amir Shevat", Designing Bots: Creating Conversational Experiences 1st Edition, ISBN-13: 978-1491974827 ,ISBN-10: 1491974826 4. www.automationanywhere.com

CS51024: Lab Advanced Data Science

Teaching Scheme		Evaluation Scheme	
Practicals	4Hrs/Week	Term Work	25 Marks
Total Credits	2	Practical	25 Marks

Course Outcomes Expected:

After Completion of this course student will be able to

CO1: Use Python and other tools to scrape, clean, and process data

CO2: Use data management techniques to store data locally and in cloud infrastructures

CO3: Use statistical methods and visualization to quickly explore data

List of Practical's :

Minimum of 8 Programs should be completed which will be based on the subject and record for the same shall be submitted

Case Study of real time problems such as

From any of the following Domains

Health Care, Finance, It for Analytics, Marketing Analytics & Decision & Operations Analytics.

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CS51025: Lab Recommender Systems

Teaching Scheme		Evaluation Scheme	
Practicals	4Hrs/Week	Term Work	25 Marks
Total Credits	2	Practical	25 Marks

Course Outcomes Expected:

After Completion of this course student will be able to

CO1:To implement all types of recommendation system

CO2:To Generate random graphs

CO3:To implement collaborative filtering.

List of Practical's :

To apply different feature reduction algorithms eg. PCA

To implement content based collaborative filtering.

To implement item based collaborative filtering.

To implement random graphs for recommendations.

To implement model based collaborative filtering

To implement memory based collaborative filtering.

To implement personalized recommendation system.

To implement hybrid recommendation system.

To implement recommendation system for movies.

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CS51026: Lab Cryptography & Information Security			
Teaching Scheme		**Evaluation Scheme**	
Practicals	4Hrs/Week	Term Work	25 Marks
Total Credits	2	Practical	25 Marks

Course Outcomes Expected:

After Completion of this course student will be able to

- Design and use Information Security tools.
- Analyze the threats in information security and implement solution for it.
- Implementations of various Anti-Intrusion Techniques.
- Implementations of encryption and decryption.

List of Practical's :

1 Implementation of Network Security fundamentals - Ethical Hacking, Social Engineering practices.
2. Implementation of System threat attacks - Denial of Services.
3. Implementation of Sniffing and Spoofing attacks.
4. Implementation of Techniques uses for Web Based Password Capturing.
5. Implementation of Different attacks causes by Virus and Trojans.
6. Implementation of Anti-Intrusion Technique – Honey pot.
7. Implementation of Symmetric Encryption Scheme – RC4.
8. Implementation of S-DES algorithm for data encryption
9. Implementation of Asymmetric Encryption Scheme – RSA.
10. Implementation of IP based Authentication.

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CS51027: Lab Biometrics

Teaching Scheme		Evaluation Scheme	
Practicals	4Hrs/Week	Term Work	25 Marks
Total Credits	2	Practical	25 Marks

Course Outcomes Expected:

After Completion of this course student will be able to

- Learn and explore Matlab for selective tools
- Design and evaluate figure print recognition systems using real time database.
- Apply and execute algorithms for face recognition.
- Demonstrate and justify optimum security system.

List of Practical's :

1. Introduction to Matlab
2. Preprocessing and enhancing fingerprint images
3. Minutiae point feature extraction and matching
4. Fingerprint recognition for any database
5. Template security in Biometrics
6. Face image preprocessing
7. Feature extraction for face image
8. Classification with nearest neighbor method
9. Classification with neural network
10. Design a Face recognition system
11. Analysis of Biometrics system with different measures

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CS51028: Mini Project			
Teaching Scheme		**Evaluation Scheme**	
Practical	4Hrs/Week	Term Work	25 Marks
Credits	2	Practical Viva	25 Marks

Course Outcomes Expected:

After Completing the course student will be able to

CO1: Identify and Finalize problem statement by surveying variety of domains.

CO2: Perform requirement analysis and identify design methodologies

CO3: Apply advanced programming techniques

CO4: Present technical report by applying different visualization tools and Evaluation metrics in a comprehensive manner.

Term Work:

The Mini Project with Seminar shall consist of collection of literature from a chosen field of Computer Science & Engineering from various sources such as refereed journals, proceedings of national international conferences, PG/PhD theses etc. Based on the literature survey, case studies, data collection, surveys, pilot studies, mathematical/analytical modeling, etc., as necessary the candidate shall define the problem for the dissertation.

The candidate shall prepare a technical report in a prescribed format and present before a panel of examiners consisting of guide and at least one faculty member of the department.

Viva Voce Examination: It consists of two parts.

Part-I: Mid-Term Evaluation for 10 Marks: A mid-term evaluations for 10 marks out of 25 marks shall be done as per the schedule given in the institute academic calendar. Student should prepare a power point presentation and present before the panel of examiners and class students and should be able to answer questions asked by the panel of examiners and class students. Panel of examiner consists of guide as internal examiner and one faculty members appointed by the DCoE as external examiners. The panel of examiner will assess the contents and presentation and give the suggestions, if any and assigns the marks out of 10. In this phase student is expected to collect and present substantial literature.

Part-II: End Semester Evaluation for 15 Marks: Student should prepare technical report in prescribed format duly incorporating suggestions of Part-I and present power point presentation before the panel of examiners and class students. The student should be able to answer the questions asked. The panel of examiner will assess the seminar contents and seminar presentation and assigns the marks out of 15. In this phase the students is expected to define the problem for dissertation through further literature survey, case studies, data collection, surveys, pilot studies, mathematical/analytical modeling, etc., as necessary.

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CS 51029: Dissertation I

Teaching Scheme			**Evaluation Scheme**	
Practical	20Hrs/Week		Term Work	50 Marks
Total Credits	10		Practical/Viva Voce	50 Marks

The dissertation will consist of the work on the topic selected for the project .The dissertation must be done individually.

CS 51030: Dissertation II

Teaching Scheme			**Evaluation Scheme**	
Practical	32Hrs/Week		Term Work	100 Marks
Total Credits	16		Practical/Viva Voce	150 Marks

The candidate is expected to select the project, do the requirements analysis, carry out the necessary design procedure and complete the implementation.

The candidate will submit dissertation in triplicate to head of the institution.

Term Work:

The assessment of the term work should be done by two internal examiners, one of which will be the guide and the other will be HOD or senior staff member of the concerned branch of the institute.

Practical Examination:

Practical Examination will consist of a presentation along with the demonstration of the project.

The said examination will be conducted by a panel of two examiners(one internal guide and one external examiner).

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CS51031: Professional Ethics and Cyber Laws (OPEN ELECTIVE)				
Teaching Scheme			**Evaluation Scheme**	
Lectures	3 Hrs/Week		Test	20 Marks
			Teacher Assessment	20 Marks
Total Credits	3		ESE	60 Marks

Prerequisites: Basics of Computer and Internet

Course description: This course will introduce concepts of Professional and Philosophical Ethics amongst the students; it will summarize Cyber Crimes and its associated investigation and forensics with relation to Cyber law. Students will have a new dimension to look towards their day to day computer activities.

Course Objectives:

- Describe Professional & Philosophical Ethics
- Describe the process of Securing Intellectual Property
- Enable Students on how to Recover the Evidence and Investigation
- Demonstrate on how to secure own presence online
- Describe Cyber Law provision related to all type cyber crimes

Course Outcomes

After completion of this course student will be able to

CO1	Apply Philosophical and Professional Ethics to solve Ethical Dilemma & identify their Professional Responsibilities
CO2	Examine Intellectual Property Rights in Cyber space
CO3	Summarize Cyber Forensics and its role in Cyber Laws
CO4	Evaluate Cyber Crimes and its severity, and measures for Incident detection and response
CO5	Describe Scope, jurisdiction, offense and contraventions, powers of police, adjudication

Detailed Syllabus:

Unit 1	**Computer and Philosophical ethics:** Moral v/s Ethics, Why Computer Ethics, Philosophical Ethics: Distinguishing Descriptive and Normative Claims, Ethical Relativism, Utilitarianism, Deontological Theories, Rights, Virtue Ethics, Professional Ethics: Why Professional Ethics, Characteristics of Professionals, The System of Professionals, is Computing a Profession.., Professional Relationships, Code of Ethics and Professional Conduct, Steps in Ethical Decision Making
Unit 2	**Ethics & Internet:** Three Moraly Significant Characteristics, Hacking & Hacker Ethics, Netiquette **Intellectual property issues in cyberspace** :Introduction to intellectual property Protections via Trade Secrets, Trademarks, Patents, Etc.Contracting to protect intellectual property, Protection options - Encryption / PGP, copyright on web-content, Copyright on software,

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	digital contracts, digital signatures
Unit 3	**Data and Evidence Recovery-** Introduction to Deleted File Recovery, Formatted Partition Recovery, Data Recovery Tools, Data Recovery Procedures and Ethics, Preserve and safely handle original media, Document a "Chain of Custody", Complete time line analysis of computer files based on file creation, file modification and file access, Recover Internet Usage Data, Recover Swap Files/Temporary Files/Cache Files, Introduction to Encase Forensic Edition, Forensic Tool Kit (FTK) etc, Use computer forensics software tools to cross validate findings in computer evidence-related cases. **Cyber Forensics Investigation-** Introduction to Cyber Forensic Investigation, Investigation Tools, eDiscovery, Digital Evidence Collection, Evidence Preservation, E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Encryption and Decryption methods, Search and Seizure of Computers, Recovering deleted evidences, Password Cracking
Unit 4	**Cyber Security-** Introduction to Cyber Security, Implementing Hardware Based Security, Software Based Firewalls, Security Standards, Assessing Threat Levels, Types ofincidents, Stages of incident response Threats in cyberspace, Blendedattacks, , incident prevention and detection, Forming an Incident Response Team, Reporting Cyber crime, Operating System Attacks, Application Attacks, Reverse Engineering &Cracking Techniques and Financial Frauds
Unit 5	**Information technology Act 2000 :**Scope, jurisdiction, offense and contraventions, powers of police, adjudication

References

1. *Computers, Ethics, And Social Values*, Johnson and Nissenbaum, 1994 Prentice Hall
2. *Cyber security operations Handbook, John Rittinghouse,William Hancock*
3. *Computer ethics, Deborah G.Johnson, third edition, Pearson education*

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CS51032: Introduction to Internet of Things(OPEN ELECTIVE)			
Teaching Scheme		**Evaluation Scheme**	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Total Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

1. Describe IoT and its applications
2. Understanding various IoT Platforms
3. Learn Cloud Computing
4. Understand Technology and Protocols and build apps using Raspberry Pi
5. Understand Threats and Apply security to IOT Apps

Course Outcomes Expected:

After Completing the course student will be able to

CO1:Identify applicability of IOT in given scenario

CO2:Install and Work on IOT platform

CO3:Understand Concepts of Cloud Computing

CO4:Write programs for Raspberry Pi

CO5;Secure their IOT App

UNIT 1	**What Is the Internet of Things (IoT)** Introduction to IOT,Current technological trends and near future prospects, M2M communication and automation history, General introduction to Arduino, Raspberry Pi and smartWIFI boards and its Sensors, **Understanding IOT Ecosystem** What is IOT application? What are basic elements / building blocks of IOT app? How are these blocks connected together? The systematic method to design IOT application, Architecture of IOT Ecosystem	
UNIT 2	**IOT Platforms** Software's, programs and stacks required, preliminary installations, Installation of various packages necessary for project and list of tools. **Understanding MQTT Protocol Basics** How it works, Broker and client terminologies, Publisher and subscriber model	
UNIT 3	**Introduction to Cloud:** Introduction, Benefits of Cloud Computing SOA, Deployment Model, Service Model, Cloud Architecture	
UNIT 4	**Technology and Protocols** Introduction to Raspberry Pi with Raspbian OS, Introduction Background, What is Raspberry Pi? Getting	

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CS51033: Essentials of Cloud Computing(OPEN ELECTIVE)			
Teaching Scheme		**Evaluation Scheme**	
Lectures	3 Hrs/Week	Test	20 Marks
		Teacher Assessment	20 Marks
Total Credits	3	End-Semester Examination	60 Marks

Course Educational Objectives:

- To study cloud computing concepts.
- Enhancing cloud computing environment.
- To study IoT& Cloud.
- To study the applications that uses cloud computing.

Course Outcomes Expected:

After Completing the course student will be able to

CO1: Install cloud computing environments.

CO2: Present a survey on cloud building blocks and technologies.

CO3: Perform cloud computing admin and programming using open source tools.

UNIT 1	Introduction to Cloud Computing Defining Cloud computing, Characteristics, Components, deployment model, service model, Applications, Benefits of cloud computing, Limitations of cloud computing. Grid Computing, Grid vs Cloud Computing.	
UNIT 2	Deployment Models Cloud architecture, Services and Applications Exploring cloud computing stack –Composability, Infrastructure, Platforms, Virtual Appliances, Communication Protocols, Applications, Defining Infrastructure as a Service (IaaS), Defining Software as a Service (SaaS), Defining Platform as a Service (PaaS), Defining Identity as a Service (IDaaS), Defining Compliance as a Service (CaaS)	
UNIT 3	**What Is the Internet of Things (IoT)** Introduction to IOT,Introduction to the Internet of Things, Background, What is Internet of Things (IoT)?, Introduction to Embedded System, Embedded Boards, General Introduction to Arduino Boards, Are Mobile Phones IoT devices?IoT Platforms, Wearable Platform, Embedded Platforms, Cloud Platform for IoT, What IoT means for the developers Using IoT and Cloud together.	
UNIT 4	Introduction and architecture for federated cloud computing, Performanceprediction for HPC on Cloud. SLA management: Types	

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	of SLA, Life cycle of SLA,Traditional approaches of SLA.service catalog, service ordering process, management and functional interfacesof services , cloud portal and its functions, cloud interface standards along withSOAP and REST, system integration and work-flow modeling,	
UNIT 5	Cloud Administration and Security Management, Management responsibilities, lifecycle management, cloud management, products, Cloud management standards. Cloud security, data security, Identity and presence protocol standards, Availability management in SaaS, IaaS, PaaS, Access Control, Security Vulnerability, Patch and Configuration Management, Security as a Service of cloud, Future of Security in Cloudcomputing.	

References:

1. RajkumarBuyya, "Cloud computing principles and paradigms", Wiley

2. Gautam Shroff, Enterprise Cloud Computing, Cambridge

3. Handbook of Cloud Computing, Springer Publication

4. RajkumarBuyya, "Mastering Cloud computing", McGraw Hill

5.Tim Mather, Subra K, ShahidL.,Cloud Security and Privacy, Oreilly,

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6. Pfister, "Getting started with the internet of things" ,
7. Rowland, "Designing connected products: ux for the consumer internet of things"
8. Dhanjani, "Abusing the internet of things"