ALAGAPPA UNIVERSITY

(A State University Established in 1985)

Karaikudi - 630003. Tamil Nadu, India

2017 Accredited with A+ Grade by NAAC (CGPA : 3.64)

2018 MHRD UGC Graded as Category - I Unitech Autonomy

2018 MHRD Swachh Campus Rank : 4

2021 nirf NATIONAL INSTITUTIONAL RANKING FRAMEWORK Rank : 33

2021 QS UNIVERSITY RANKINGS Asia Rank : 199

FACULTY OF SCIENCE

DEPARTMENT OF COMPUTER APPLICATION

M.Phil., COMPUTER SCIENCE

REGULATIONS AND SYLLABUS

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

DEPARTMENT OF COMPUTER APPLICATIONS

M.PHIL. COMPUTER SCIENCE

REGULATIONS AND SYLLABUS

[For the candidates admitted from the Academic Year 2022 – 2023 onwards]

ALAGAPPA UNIVERSITY

(A State University Accredited with "A+" grade by NAAC (CGPA: 3.64) in the Third Cycle andGraded as Category-I University by MHRD-UGC)

Karaikudi - 630003, Tamil Nadu

DEPARTMENT OF COMPUTER APPLICATIONS
Choice Based Credit System (CBCS)

M.Phil. (Computer Science)
Regulations 2022 onwards

1. Candidates for admission to the Master of Philosophy in Computer Science M.Phil.(Computer Science) programme is required to pass in any one of the following Examinations of any recognized University with a minimum of 60% marks in (minimum 55% marks for SC/ST candidates):

   M.Sc. Degree in Computer Science/Information Technology or M.C.A. or any qualification equivalent thereto.

2. The M.Phil.(Computer Science) programme is a one year programme consisting of two semesters. Each semester consists of minimum 75 working days at the rate of 6 hours per day.

3. The course of study and the scheme of Examinations are shown in Appendix A.

4. The End-Semester Examinations are conducted in November and April of every academic year by the University in different courses according to the scheme given in Appendix A. A candidate will be permitted to appear for the Semester examination in a particular course at the end of each semester provided he/she secures not less than 75% of attendance in each course in that semester.

5. The revised curriculum is offered from the academic year 2022-2023.

6. Each student should take 40 credits to complete M.Phil. (Computer Science) programme.

7. Each theory course carries 5 credits with 75 marks in the End-Semester Examination and 25 marks in the Internal Assessment.

8. The End-Semester Examinations will be conducted for three hours duration.

9. Dissertation carries 20 credits. Dissertation carries 75 marks in the End-Semester Examination (50 marks for Dissertation Evaluation by External Examiner and 25 marks for viva-voce jointly awarded by both Internal and External Examiners) and 25 marks in the Internal Assessment (Dissertation monitoring and Evaluation by the Internal Examiner).

10. To pass in each course, a candidate is required to secure 40% marks in the Semester examinations and 40% marks in the Internal assessment and 50% marks in aggregate (marks in Semester Examination + marks in Internal Assessment).

11. A student is permitted to continue the programme from I to II semester irrespective of failure(s) in the courses of the earlier semester. The candidate will qualify for the M.Phil. (Computer Science) degree only if the student passes all the arrear courses within a period of THREE years.

12. Results will be declared after the completion of each End-Semester Examination and the marks/grades obtained by the candidates will be forwarded to them through the Head of the Department.

a) A Candidate who has passed all examinations in the first attempt within one year of admission is declared to pass in First Class with Distinction provided the candidate secures more than 75% marks in the aggregate.

b) A candidate who has passed all the examinations within one year of admission is declared to have passed in First Class provided the candidate secures not less than 60% in the aggregate.

c) All other candidates who have passed all the examinations in the prescribed courses shall be declared to have passed in Second Class.

13. All the candidates who have passed the examinations in all the prescribed courses shall be eligible for the award of the Degree of Master of Philosophy in Computer Science namely M.Phil. (Computer Science).

14. The common CBCS regulations prescribed for the Departments by the Alagappa University will be followed in all respect.

Programme Objectives

- To improve the standards of research.
- To introduce research skills and specialize in a relevant research interests
- Able to apply advanced theoretical and experimental methods, including the use of techniques,tools and simulations.
- Helps to inculcate research aptitude to pursue research leading to Ph.D.

Programme Specific Objectives

- This curriculum offers a number of practical exposures which equips the students to face theresearch challenges in computer science
- This programme introduce the new concepts and their applications which is useful in pursuing theresearch.
- It prepares a student to take minor research projects, to become project associate.
- Develops the ability to critically evaluate his current research topic, research techniques andmethodologies

Programme Outcomes

- After completion of M.Phil. Program, students are gaining through research knowledge incomputer science.
- Students will be able to publish research articles in reputed journals.
- This programme equips the students to become effective teachers and researchers in computerscience, to contribute to the needs of the society.

DEPARTMENT OF COMPUTER APPLICATIONS

M.Phil. (Computer Science)

Course Code	Course/Title	Credit	Hours /Week	Marks		Total
				Internal	External	
I SEMESTER						
561101	Research Methodology	4	4	25	75	100
561102	Advanced Computing Techniques	4	4	25	75	100
561103	General Skills in Science	4	4	25	75	100
	Total	**12**	**12**	**-**	**-**	**300**
II SEMESTER						
	Elective – I	4	4	25	75	100
561999	Dissertation	8	-	25	75	100
	Total	**12**	**4**	**-**	**-**	**200**
	Grand Total	**24**		**Total Marks**		**500**

ELECTIVE COURSES

Course Code	Title of the Course
561551	Information and Network Security
561552	Advanced Operating Systems
561553	Data Warehousing and Mining
561554	Artificial Intelligence and Machine Learning
561555	Mobile Computing
561556	Internet of Things
561557	Deep Learning
561558	Digital Image Processing
561559	Cloud Computing
561560	Big Data Analytics
561561	Blockchain Technology

Semester – I			
Course Code: 561101	**RESEARCH METHODOLOGY**	**Credits:4**	**Hours:4**

Objectives	➢ To impart the basic concepts on algorithms and research ➢ To give knowledge on thesis writing. ➢ To understand algorithms such as prim's algorithm, Dijikstra's algorithm. ➢ Understand Soft Computing techniques.
Unit- I	**Research Prelims:** Introduction – Mathematical tools for analysis – Research problems in management – Types of research – Research Process – Data Collection – Primary data – Secondary data – Data Presentation – Review of basic statistical measures – Measures of Central Tendency – Measures of Variation – Measures of Skewness.
Unit- II	**Algorithmic Research:** Introduction –Algorithmic Research Problems – Types of Algorithmic Research Problems – Types of Solution Procedure/Algorithm – Scope of Algorithms – Steps of Development of Algorithms – Data Structure – Introduction – Stack–Queue– Linked Lists – Binary Tree – Logarithmic analysis of algorithms – Design of Experiments and Comparison of Algorithms.
Unit- III	**Design of Algorithms:** Backtracking – N-Queens problem – Hamiltonian circuit problem – Subset sum problem – Branch and Bound - Assignment problem – Knapsack problem – Traveling salesman problem – Greedy method – Prim's algorithm – Kruksal's algorithm – Dijkstra's algorithm.
Unit- IV	**Soft Computing Techniques:** Basic concept of Soft Computing – Components – Characteristics – Applications – Fundamentals of Neural Networks: Properties – Architecture - learning methods: activation functions; Feed forward, Feedback & recurrent Neural Networks. Genetic Algorithm : Basic concept - Role of GA in optimization - Fitness function - Cross over – Mutation – Inversion – Deletion - Constraints Handling; Applications - Travelling Salesman Problem, Graph Coloring problem;.
Unit- V	**Thesis Writing:** Writing at the Tertiary Level – Planning the thesis – Computer tools forwriting and publishing – The General Format – Page and Chapter Format – Footnotes – Tables and Figures – References – Appendices. Thesis Writing tool – Latex.

Suggested Readings:-

R.Panneerselvam, 2013, "Research Methodology", 2nd edition, PHI.

R.Panneerselvam, 2016, "Design and Analysis of Algorithms", 2nd edition, PHI Learning.

Behrouz A. Forouzan, DebdeepMukhopadhyay, 2016, "Cryptography and Network Security", 3rd Edition, McGraw Hill.

Jonathan Anderson, Millicent Poole, 2001, "Assignment and Thesis writing", 4th edition, John Wiley& Sons.

T.S.Rajasekaran& G.A. VijaylakshmiPai, 2013, "Neural Networks, Fuzzy Logic & Genetic Algorithms– Synthesis & Applications", PHI.

ChetanShirore, 2015, "A Beginners Guide to LaTeX" , Lulu.com

Outcomes	After completing this course, students will be able to: ➢ To study and understand the research methodology ➢ Learn the basic methods for reading technical papers ➢ This purpose of this course is to impact knowledge on latex ➢ To develop with an ability to apply knowledge of Softcomputing technique

Semester – I			
Course Code: 561102	**ADVANCED COMPUTING TECHNIQUES**	**Credits:4**	**Hours:4**
Objectives	➢ Develop the skills to gain a basic understanding of neural network theory and fuzzy logictheory. ➢ Introduce students to artificial neural networks and learning methods ➢ To Learn the Concepts data mining ,Hadoop network framework		
Unit- I	**DBMS and Data mining:** DBMS - Introduction of transaction processing- Recovery techniques-Database System Architecture - Predictive analysis - Regression- Decision tree- Neural network- Ensemble method and the descriptive analytics (Association rule, Segmentation, Social network analysis) - Hadoop network framework. **Introduction to Data Science :** Introduction to Data Science – Evolution of Data Science – Data Science Roles – Stages in a Data Science Project – Applications of Data Science in various fields – Data Security Issues – Data Collection Strategies – Data Pre-Processing.		
Unit- II	**Digital image processing:** Image Enhancement- Spatial domain- Types of Point operation- Histogram Manipulation- Linear ,Non-Linear gray level transformation- Neighborhoodoperation-Classification of noises in image-different type of filters- Clustering techniques- different type of Thresholding - Classification of edges-shape representation-Morphologyoperation.		
Unit- III	**Network Security:** An Overview of Computer Security-Security Services-Security Mechanisms-Security Attacks-Access Control Matrix, Policy-Security policies, Confidentiality policies, Integrity policies and Hybrid policies- Secret Sharing Schemes- Kerberos- Pretty Good Privacy (PGP)-Secure Socket Layer (SSL)- Intruders – HIDS- NIDS - Firewalls – Viruses.		
Unit- IV	**Artificial Neural Network:** Introduction of neural networks - Fuzzy Logic-Fuzzy set operations-properties- defuzzyfication-fuzzy based and approximate reasoning- fuzzy decision making-ART1 &amp, ART2 - Genetic algorithm-Traditional optimization and search techniques-classification of Genetic algorithm - Neuro fuzzy hybrid - adaptive neuro fuzzy inference system- Genetic neuro and fuzzy hybrid- Genetic based back propagation.		
Unit- V	**Learning Methods:** Different learning methods and learning rules-Different network architecture with illustration-Different activation function and mathematical formula and graphical representation-Perceptron-multilayer perceptron-Back propagation network and its application-Radial basis function network and application-Self organized features map and its applications-Recurrent networks and its applications-Deep neural networks.		

Suggested Readings:- A Silberschatz, Henry F. Korth, 2010, "Database System Concepts", 6th Edition, McGraw Hill-Education. Cathy O'Neil and Rachel Schutt , 2015 "Doing Data Science", O'Reilly. Charu C. Aggarwal,2018, *Neural Networks and Deep Learning: A Textbook* 1st edition, SpringerJames A.Anderson, , 2001, "An Introduction to Neural Network", PHI. Jiawei Han, MichelineKamber, Jian Pei Professor, 2011, "Data Mining Concepts and Techniques",3rd Edition, Morgan Kaufmann. JojoMoolayil, 2016 "Smarter Decisions: The Intersection of IoT and Data Science" PACKT, RafelC.Gonzalez, Richard E.Woods, 2017, "Digital Image Processing, Pearson", 4th Edition, PearsonEdutation.	
Outcomes	After completing this course, students will be able to: ➢ To understand the fundamental theory and concepts of neural networks,Network Security, algorithms, applications and their limitations. ➢ Understand the concepts of digital image processing ➢ Learn about DBMS and Data mining

Semester – I			
Course Code: 561103	**GENERAL SKILLS IN SCIENCE**	**Credits:4**	**Hours:4**

Objectives	➢ Study the basic principles and applicationsof computers ➢ Understand the concepts of computer operating skills ➢ To learn Pedagogical skill for science teachers ➢ Acquire the knowledge of Communications skills
Unit- I	**Introduction to computers:** Computer Hardware : input devices and media – magnetic device and media – output devices and media – storage device and media – computer architecture – system software: types, operating system, and translators – Application software: types of language – application packages – integrated software – Introduction to operating system – Working with windows and office programs – Internet, Website and Email.
Unit- II	**Computer operating skills:** Starting a program and opening a document – saving and naming the document – create file and folders – deleting and un-deleting a document – closing a document – renaming and moving a document – finding a document – MS office: Word, Excel, Access, power point, outlook and integrated office applications – C programming – Principles, classes and structure of C++ Programming.
Unit- III	**Communication skills in English:** Understanding communication – greeting and introducing – making requests – asking for and giving permission – offering help – giving instruction and directions – art of small talk – participating in conversation – making a short formal speech – Describing the people, place, events and things. Telephone skill: understanding, handling calls, leaving message and making request. Written communication: report writing, note making – career skills: curriculum vitae and cover letters – Facing an interview and presentation skills – academic listening.
Unit- IV	**Artificial Neural Network:** Introduction of neural networks - Fuzzy Logic-Fuzzy set operations-properties- defuzzyfication-fuzzy based and approximate reasoning-fuzzy decision making-ART1 &amp, ART2 - Genetic algorithm-Traditional optimization and search techniques-classification of Genetic algorithm - Neuro fuzzy hybrid - adaptive neuro fuzzy inference system- Genetic neuro and fuzzy hybrid- Genetic based back propagation.
Unit- V	**Pedagogical skill for science teachers:** Science Teacher: Qualification, teacher competencies and professional growth. Theory and models of curriculum development: Concept and Technical scientific models of curriculum development – planning a science library – Handling of practical classes. Educational technology and classroom pedagogy: Educational Technology – Concept, Emerging technologies –New technologies on methodology of teaching, learning, skill of stimulus variation, questioning, explanation, reacting, linking and benefits.

Suggested Readings:-

For Unit I and II:

W.Joseph, Habraken, 2004,"Micorsoft office 2003", All in one, Que publishing.Curtis Frye, 2004, "Microsoft office Excel 2003 step by step", Microsoft press. Greg, Harvey, 2006, "Micrsoft office Excel 2007 for dummies", For dummies.

Guy Hart-DEavis, 2007,"How to everything with Microsoft office word 2007", Mac Graw-Hillprofessional.

Jim Boyce, 2003, "Absolute beginner's guide to Microsoft office 2003", Que publishing.

Benny Raphael, F.C. Smith, 2003,"Fundamentals of computer-aided engineering", John wiley&sons.

Dietel, "An introduction to operating system", Addison Wesley

Ravi Sethi, "Principles of Programming Languages", Addison Wesley

E.Balagurusamy, 1995, "C++ programming", Tata McGraw Hill, New Delhi.

B.S.Gottfried, 1990, "Theory and programming with C", McGraw Hill publishers, New Yark.L.Acklen et al, 1998, "Microsoft office 97 professional Essentials", Prentice-Hall India.

Shelley O'Hara, 1997," Discover Office 97", Comdex computer publishing.

For Unit-III:

Harry chambers, 2001, "Communication skills for scientific and technical professional", Perseus.

Alan Barker, 2000,"Improve your communication skills",Kogan page.

Libby kumin, 2003, "Early communication skills for children with Down syndrome", Wood fine House.

Dutt et al., 2007, "A course in communication skills", ebek public, Bangalore.

J.G.Ferguson, 2004, "Communication skills", Ferguson.

Elizabeth Arnold,Kathleen Underman Boggs, 2002, "Interpersonal Relationships Professional Communication Skills for Nurses Saunders".

For Unit-V:

Hope J.Hartman, 2001, "Metacognition in learning and instruction: theory, research and practice", Springer,

1996, "National Science Education Standards: observe, interact, change, learn, Manual prepared by National research council", published by National Academics Press.

Louis Rosenblatt, 2010, "Rethinking the Way We Teach Science: The Interplay of Content, Pedagogy, and the Nature of Science Published by Taylor & Francis".

VijayaKohli, 1992,"How to teach science: a treatise on methodology of teaching physics, chemistry and biology", Published by Vivek Publishers.

Raja Dan, Durga, 1982,"A Study of the International Influences in Functional Content of Curriculum Program", Kash. U.

Taba, Hilda, 1962, "Curriculum Development- Theory and Practice", Harcourt Brace and World Inc.

Outcomes	After completing this course, students will be able to: ➢ Work With C Programming And Structure of C++ Programming ➢ Design Curriculum Plan, Time Table scheduling, Evaluation – Strategies. ➢ Identify Pedagogical skill for science teachers ➢ Apply Communication skills, Career skills, telephone skills.

Semester – II (ELECTIVE COURSES)			
Course Code: 561551	**INFORMATION AND NETWORK SECURITY**	**Credits:4**	**Hours:4**
Objectives	➢ The use of the Internet for various purpose including social, business, communication and other day to day activities has been in common place. ➢ The information exchanged through Internet plays vital role for their owners and the security of such information/data is of prime importance. ➢ Knowing the concepts, principles and mechanisms for providing security to the information/data is very important for the students of Computer Engineering/Informationtechnology. ➢ The subject covers various important topics concern to information security like symmetric and asymmetric cryptography, hashing, message and user authentication, digital signatures, key distribution and overview of the malware technologies. ➢ The subject also covers the applications of all of these in real life applications.		
Unit- I	Information Security and Cryptography – Security Goals, Services and Mechanisms - Classical Encryption Methods – Transposition Ciphers – Substitution Ciphers – Caesar Ciphers – Mono alphabetic Substitution – Homophonic Substitution – Polygram Substitution – Playfair Ciphers - Hill Ciphers – Poly alphabetic Substitutions - Vigenere Ciphers – Compound Vigenere – Auto-key Cipher – Running-key Cipher – Vernam Cipher – One-time Pad – Cryptographic codes – Machine Ciphers – Jefferson Cylinder – Rotor- based Machines.		
Unit- II	Symmetric Key Cryptography – Symmetric Cipher Model – Types of Attacks – Block Ciphers Vs Stream Ciphers – Synchronous Stream Ciphers – Asynchronous Stream Ciphers – Evaluating Block Ciphers – Modes of Operations – Cascades of Ciphers and Multiple Encryption – DES – AES - Public Key Cryptography – Introduction – Basic Principles – The Chinese Remainder Theorem – RSA – Integer Factorization Problem – Knapsack Public Key Encryption – Probabilistic Public Key Encryption – Elliptic Curve Cryptography – Quantum.		
Unit- III	Information Hiding –Steganography – Evolution and System – Modern Techniques – Audio – Video – Textual Steganography – Real-time Steganography – Steganalysis – Applications – Digital Watermarking – Data Integrity – Introduction – Preventing Unauthorized Manipulation –Hash Functions – Essential Properties – Types - The Birthday Attack – Estimate of Probability of Finding a Collision – Hash Function Design Issues – Cryptanalysis and the Security of Hash Functions – Attacks on Hash Functions – Standard Hashing Algorithms.		
Unit- IV	Authentication – Objectives of Identification Protocols – Entity Authentication Techniques – Applications of Identification Protocols – Properties of Identification Protocols – Authentication Mechanisms – Challenge-Response Identification – Digital Signature –Digital Certificates – X.509 Protocol – RFC 2459 – RADIUS – CAPTCHA – Introduction to Biometrics – Definition – Features – Applications – Technological Issues in Biometric Systems – Face Recognition – Fingerprint Recognition – Iris Recognition – Voice – DNA as a Biometric Identifier – Multimodal Biometric Systems.		

Unit- V	Virus and Malware – Virus and Worms – Virus Structure and Operation – Defenses Against Viruses – Virus Writers and Antivirus Development – Generic Decryption Technology – Adware and Spyware – Mitigating Malware Risks – Web and Network Security - Introduction to SSL – SSL Operations and Layers – The SSL Record Protocol – The Alert Protocol – The Change Cipher Spec Protocol – SSL Handshake Protocol Specification - Errors – Introduction to Network Security – IPSec Security Architecture – Authentication Header – Encapsulating Security Payload – Security Associations – Key Management – Introduction to Firewalls – Design Goals – Types of Firewalls – Firewall Configurations.Dynamic Content: Visual Cryptography-Latest Techniques in Network Security.
Suggested Readings:- Dhiren R. Patel, "Information Security: Theory and Practice", AbeBooks, 2017. Behrouz A. Forouzan, "Cryptography and Network Security", Tata McGraw Hill, 2014 William Stalling, "Cryptography and Network Security", Prentice Hall, 2016.	
Outcomes	**After learning the course the students should be able to:** ➢ Define the concepts of Information security and their use. ➢ Describe the principles of symmetric and asymmetric cryptography. ➢ Understand and apply the various symmetric key algorithms. ➢ Understand and apply the various asymmetric key algorithms. ➢ Understand the concepts of hashing with algorithms and apply them. ➢ Understand and use the message authentication and its requirement. ➢ Understand the concepts of digital signature and digital certificates. ➢ List and explain various digital signature algorithms. ➢ Understand and use the various key management and remote authentication mechanisms. ➢ Understand the concept transport layer security.

Semester – II (ELECTIVE COURSES)			
Course Code: 561552	**ADVANCED OPERATING SYSTEMS**	**Credits:4**	**Hours:4**
Objectives	➢ To learn the fundamentals of Operating Systems. ➢ To gain knowledge on Distributed operating system concepts that includes architecture, Mutual exclusion algorithms, Deadlock detection algorithms and agreement protocols ➢ To gain insight on to the distributed resource management components viz. the algorithms for implementation of distributed shared memory, recovery and commit protocols. ➢ To know the components and management aspects of Real time, Mobile operating systems.		
Unit- I	Distributed Systems - Architecture types - issues - communication networks – communication primitives. Theoretical Foundations - inherent limitations – lamp ports logical clocks– vector clocks – casual ordering of messages – global state – cuts of a distributed computation – termination detection. Distributed Mutual Exclusion – introduction–the classification of mutual exclusion and associated algorithms – a comparative performance analysis.		
Unit- II	Distributed Deadlock Detection -Introduction - deadlock handling strategies issues in deadlock detection and resolution – control organizations for distributed deadlock detection – centralized and distributed deadlock detection algorithms – hierarchical deadlock detection algorithms. Agreement protocols – introduction-the system model, a classification of agreement problems, solutions to the Byzantine agreement problem, applications of agreement algorithms. Distributed resource management: introduction- architecture – mechanism for building distributed file systems – design issues – log structured file systems.		
Unit- III	Distributed shared memory-Architecture– algorithms for implementing DSM – memory coherence and protocols – design issues. Distributed Scheduling – introduction –issues in load distributing – load distributing algorithm – components – stability –performance comparison – selecting a suitable load sharing algorithm – requirements for load distributing -task migration and associated issues. Failure Recovery and Fault tolerance: introduction– basic concepts – classification of failures – backward and forward error recovery, backward error recovery- recovery in concurrent systems – consistent set of check points – synchronous and asynchronous check pointing and recovery – check pointing for distributed database systems- recovery in replicated distributed databases.		
Unit- IV	Multiprocessor operating systems - basic multiprocessor system architectures – interconnection networks for multiprocessor systems – caching – hypercube architecture. Multiprocessor Operating System - structures design issues- threads- process synchronization and scheduling. Database Operating systems - requirements Concurrency control : theoretical aspects – introduction, database systems – a concurrency control model of database systems- the problem of concurrency control – serializability theory- distributed database systems, concurrency control algorithms –basic synchronization primitives - lock based algorithms-timestamp based algorithms, optimistic algorithms – concurrency		

	control algorithms, data replication.
Unit- V	Multiprocessor operating systems - basic multiprocessor system architectures – inter connection networks for multiprocessor systems – caching – hypercube architecture. Multiprocessor Operating System - structures design issues- threads- process synchronization and scheduling. Database Operating systems - requirements Concurrency control : theoretical aspects – introduction, database systems – a concurrency control model of database systems- the problem of concurrency control – serializability theory- distributed database systems, concurrency control algorithms –basic synchronization primitives - lock based algorithms-timestamp based algorithms, optimistic algorithms – concurrency control algorithms, data replication. **Dynamic content: PROCESS COMMUNICATION AND PROGRAM EXECUTION**: Process Communication - Pipes -Usage - Data Structures - Creating and Destroying a Pipe - Reading From and Writing into a Pipe. Program Execution - Executable Files - Process Credentials - Command-Line Arguments and Shell Environment - Libraries - Program Segments and Process Memory Regions - Execution tracing - Executable Formats - Execution Domains - The exec Functions.
Suggested Readings:- MukeshSinghal, NiranjanG.Shivaratri, 2001, "Advanced concepts in operating systems:Distributed, Database and multiprocessor operating systems", TMH. Andrew S.Tanenbaum, 2009, "Modern operating system", PHI. PradeepK.Sinha, , 2012, Distributed operating system-Concepts and design", PHI.Andrew S.Tanenbaum, 2003, "Distributed operating system", Pearson education. Michael Beck, Harald Bohme, MirkoDziadzka, Ulrich Kunitz, Robert Magnus, Dirk Verworner, 2002,"Linux Kernel Internals, 2nd Edition, Addison-Wesley. Robert Love, 2010 "Linux Kernel Development, 3rd Edition, Addison-Wesley.	
Outcomes	**After learning the course the students should be able to:** ➢ Discuss the various synchronization, scheduling and memory management issues ➢ Demonstrate the Mutual exclusion, Deadlock detection and agreement protocolsof Distributed operating system ➢ Discuss the various resource management techniques for distributed system ➢ Identify the different features of real time and mobile operating systems ➢ Install and use available open source kernel ➢ Modify existing open source kernels in terms of functionality or features used.

Semester – II (ELECTIVE COURSES)			
Course Code: 561553	**DATA WAREHOUSING AND MINING**	**Credits:4**	**Hours:4**

Objectives	➢ To understand data warehouse concepts, architecture, business analysis and tools ➢ To understand data pre-processing and data visualization techniques ➢ To study algorithms for finding hidden and interesting patterns in data ➢ To understand and apply various classification and clustering techniques using tools.
Unit- I	Data warehousing Components –Building a Data warehouse –- Mapping the Data Warehouse to a Multiprocessor Architecture – DBMS Schemas for Decision Support – Data Extraction, Cleanup, and Transformation Tools –Metadata.
Unit- II	Reporting and Query tools and Applications – Tool Categories – The Need for Applications – Cognos Impromptu – Online Analytical Processing (OLAP) – Need – Multidimensional Data Model – OLAP Guidelines – Multidimensional versus Multi- relational OLAP – Categories of Tools – OLAP Tools and the Internet.
Unit- III	Data mining - Introduction – Data – Types of Data – Data Mining Functionalities – Interestingness of Patterns – Classification of Data Mining Systems – Data Mining Task Primitives – Integration of a Data Mining System with a Data Warehouse – Issues –Data Preprocessing.
Unit- IV	Mining Frequent Patterns, Associations and Correlations – Mining Methods – Mining Various Kinds of Association Rules – Correlation Analysis – Constraint Based Association Mining – Classification and Prediction - Basic Concepts - Decision Tree Induction - Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction.
Unit- V	Cluster Analysis - Types of Data – Categorization of Major Clustering Methods – K-means Partitioning Methods – Hierarchical Methods - Density-Based Methods – Grid Based Methods – Model-Based Clustering Methods – Clustering High Dimensional Data - Constraint – Based Cluster Analysis – Outlier Analysis – Data Mining Applications.Various mining tools and techniques for implementation: Weka, Rapidminer and Matlab.

Suggested Readings:-

C S R Prabhu, 2013, "Data Warehousing – concepts, techniques and applications ", 3rd editionPrentice, Hall of India.

Jiawei Han and MichelineKamber, 2016, "Data Mining Concepts and Techniques", 3rd Edition,Elsevier.

Arun K Pujari, 2015, "Data Mining Techniques", Universitypress (India) Pvt Limited.

Alex Berson and Stephen J. Smith, 2007, "Data Warehousing, Data Mining & OLAP", Tata McGraw – Hill Edition, Tenth Reprint.

Pang-Ning Tan, Michael Steinbach and Vipin Kumar, 2017, " Introduction To Data Mining",Pearson Education, 2e.

Margaret H Dunham, 2008, "Data mining - Introductory and advanced topics", Pearson Education.

G. K. Gupta, 2014 ," Introduction to Data Mining with Case Studies", Easter Economy Edition,Prentice Hall of India.

Outcomes	**After learning the course the students should be able to:** ➢ Design a Data warehouse system and perform business analysis with OLAP tools. ➢ Apply suitable pre-processing and visualization techniques for data analysis ➢ Apply frequent pattern and association rule mining techniques for data analysis ➢ Apply appropriate classification and clustering techniques for data analysis

Semester – II (ELECTIVE COURSES)			
Course Code: 561554	**ARTIFICIAL INTELLIGENCEAND MACHINE LEARNING**	**Credits:4**	**Hours:4**

Objectives	• To Understand the basic concepts in Artificial Intelligence and Knowledge • Become familiar with basic principles of AI toward problem solving, inference, perception,knowledge representation, and learning. • To know about the basic concepts of Machine Learning • To acquire knowledge about various tools of Machine Learning • To understand about Probability and statistical tools
Unit-I	Artificial Intelligence - The AI Problems – The Underlying Assumptions – AI Techniques Problems: Problems Spaces and Search – Defining the Problems as a State Space Search – Production Systems –Problem Characteristics – Production System Characteristics – Issues in the Design of Search Programmes - Generate – and-Test – Hill Climbing – Best-First Search – Problem Reduction – Constraint Satisfaction – Means – Ends – Analysis.
Unit-II	Knowledge Representation Issues: Representation and Mappings – Approaches to Knowledge Representation – Issues in Knowledge Representation – The Frame Problem - Using predicate logic – Representing Simple facts in Logic – Representing Instance and Is a relationships – Computable functions and Predicates – Resolutions – Natural Deductions – Representing Knowledge Using Rules: Procedural versus Declarative Knowledge – Forward versus Backward Reasoning – Matching – Control Knowledge.
Unit-III	Introduction to Machine Learning : Human Learning - Types of Human Learning - Machine Learning - Types of Machine Learning - Problems Not to be Solved using Machine Learning - Applications of Machine Learning - State of the Art Languages / Tools in Machine Learning - Issues in Machine Learning
Unit-IV	Preparing to Model: Introduction - Machine Learning Activities - Basic Types of Machine Learning - Exploring Structure of Data - Data Quality and Remuneration - Data Pre-processing. Modelling and Evaluation : Introduction - Selecting a Model - Training a Model - Model Representation and Interpretability – Evaluating Performance of a Model - Improving Performance of a Model.
Unit-V	Overview of Probability : Introduction - Importance of Statistical Tools in Machine Learning - Concept of Probability - Random Variables - Common Discrete Distributions - Multiple Random Variables - Central Limit Theorem - Sampling Distributions - Hypothesis Testing - Monte Carlo Approximation - Bayesian Concept Learning : Introduction - Importance of Bayseian Methods - Bayes Theorem - Bayes Theorem and Concept Learning - Bayesian Belief Network.

Suggested Readings:-

Anuradha Srinivasaraghavan, Vincy Elizabeth, 2019, *Machine Learning*, Wiley Publications. Kevin Night and Elaine Rich, Nair B , 2017 ,"*Artificial Intelligence*", Mc Graw Hill - (Unit I,II)Russel, Artificial Intelligence, 2015, *A Modern Approach, Pearson Education India*; 3rd Edition.SaikatDutt, Subramanian Chandramouli, Amit Kumar Das, 2018 "*Machine Learning*" - Pearson

	Education; First Edition, (Unit III,IV and V)
Outcomes	• Understand about Artificial Intelligence and about Knowledge Representation • Knowledge about AI development tools • Understand machine learning model for simulation and analysis. • Explore the current scope, potential, limitations, and implications of intelligent systems. • Understand about the Basic Types of Machine Learning, Modelling, Evaluation andProbability.

Semester – II (ELECTIVE COURSES)			
Course Code: 561555	**MOBILE COMPUTING**	**Credits:4**	**Hours:4**

Objectives	➢ To understand the basic concepts of mobile computing. ➢ To learn the basics of mobile telecommunication system . ➢ To be familiar with the network layer protocols and Ad-Hoc networks. ➢ To know the basis of transport and application layer protocols. ➢ To gain knowledge about different mobile platforms and application development
Unit- I	Medium Access Control – Motivation for Specialized MAC – SDMA – FDMA – TDMA – CDMA – Comparison of Access Mechanisms – Tele communications GSM – DECT – TETRA – UMTS – IMT – 200 – Satellite Systems Basics – Routing – Localization – Handover – Broadcast Systems Overview – Cyclic Repetition of Data – Digital Audio Broadcasting – Digital Video Broadcasting.
Unit- II	**Search and Game Playing**: Breadth first search, depth first search, iterative deepening, uniform cost search, hill climbing, simulated annealing, genetic algorithm search, heuristic search, Best first search, A* algorithm, AO* algorithm, Minmax& game trees, refining minmax, Alpha – Beta pruning, constraint satisfaction
Unit- III	Wireless LAN Infrared Vs Radio Transmission – Infrastructure Networks– Ad hoc Networks – IEEE 802.11 – HIPERLAN – Bluetooth – Wireless ATM Working Group– Services – Reference Model – Functions – Radio Access Layer – Handover – Location Management – Addressing Mobile Quality of Service – Access Point Control Protocol.
Unit- IV	Traditional TCP – Indirect TCP – Snooping TCP – Mobile TCP – Fast Retransmit/ Fast Recovery – Transmission/ Timeout Freezing – Selective Retransmission – Transaction Oriented TCP.
Unit- V	Architecture – Datagram Protocol – Transport Layer Security – Transaction Protocol – Session Protocol – Application Environment – Wireless Telephony Application. **Dynamic content:** **MOBILE TRANSPORT AND APPLICATION LAYER:** Mobile TCP– WAP – Architecture – WDP – WTLS – WTP –WSP – WAE – WTA Architecture – WML **MOBILE PLATFORMS AND APPLICATIONS** Mobile Device Operating Systems – Special Constraints & Requirements – Commercial Mobile Operating Systems – Software Development Kit: iOS, Android, BlackBerry, Windows Phone – MCommerce – Structure – Pros & Cons – Mobile Payment System – Security Issues

Suggested Readings:- J.Schiller, 2003," Mobile Communication", Addison Wesley. William Stallings, 2005, "Wireless Communication and Networks", Pearson Education 2e.Singhal, 2003,"WAP: Wireless Application Protocol", Pearson Education. LotherMerk, Martin S. Nicklaus and Thomas Stober, 2011,"Principles of Mobile Computing", 2ndEdition, Springer,. William C. Y. Lee, 2010, "Mobile Communication Design Fundamentals", John Wiley, 2e. Prasant Kumar Pattnaik, Rajib Mall, 2012, "Fundamentals of Mobile Computing", PHI Learning Pvt.Ltd,New Delhi.	
Outcomes	**After learning the course the students should be able to:** ➢ Explain the basics of mobile telecommunication systems ➢ Illustrate the generations of telecommunication systems in wireless networks ➢ Determine the functionality of MAC, network layer and Identify a routingprotocol for a given Ad hoc network ➢ Explain the functionality of Transport and Application layers ➢ Develop a mobile application using android/blackberry/ios/Windows SDK.

Semester – II (ELECTIVE COURSES)			
Course Code: 561556	**INTERNET OF THINGS**	**Credits:4**	**Hours:4**

Objectives	➢ To understand the fundamentals of Internet of Things. ➢ To learn about the basics of IOT protocols. ➢ To build a small low cost embedded system using Raspberry Pi. ➢ To apply the concept of Internet of Things in the real world scenario
Unit- I	**INTRODUCTION TO IoT:** Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology.
Unit- II	**IoT ARCHITECTURE**: M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model – functional model - communication model - IoT reference architecture
Unit- III	**IoT PROTOCOLS**: Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer –6LowPAN - CoAP – Security.
Unit- IV	**BUILDING IoT WITH RASPBERRY PI & ARDUINO**: Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi - Board - Linux on Raspberry Pi - Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other IoT Platforms -Arduino.
Unit- V	**CASE STUDIES AND REAL-WORLD APPLICATIONS:** Real world design constraints - Applications - Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT.

Suggested Readings:-

ArshdeepBahga, Vijay Madisetti, 2015, “Internet of Things: A hands-on approach”, Universities Press. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), 2011, “Architecting the Internet ofThings”, Springer.

Honbo Zhou, 2012, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press.

Jan Ho¨ ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, 2014, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier.

Olivier Hersent, David Boswarthick, Omar Elloumi, 2012, “The Internet of Things – Key applications and Protocols”, Wiley.

Outcomes	**After learning the course the students should be able to:** ➢ Analyze various protocols for IoT. ➢ Develop web services to access/control IoT devices. ➢ Design a portable IoT using Rasperry Pi. ➢ Deploy an IoT application and connect to the cloud. ➢ Analyze applications of IoT in real time scenario

Semester – II (ELECTIVE COURSES)			
Course Code: 561557	**DEEP LEARNING**	**Credits:4**	**Hours:4**

Objectives	➢ Introduce major deep learning algorithms, the problem settings, and their applicationsto solve real world problems. ➢ To learn about the basics of the Deep Feedforward network. ➢ To understand the traning deep models and sequence modelling.
Unit- I	Introduction : Historical Trends in Deep Learning – Linear Algebra : Scalars, Vectors, Matrices and Tensors – Machine Learning Basics : Learning Algorithms - Capacity, Overfitting and Underfitting - Hyperparameters and Validation Sets - Estimators, Bias and Variance - Maximum Likelihood Estimation - Bayesian Statistics – Supervised Learning Algorithms – Unsupervised Learning Algorithms - Stochastic Gradient Descent – Building Machine learning algorithm – Challenges motivating Deep Learning.
Unit- II	Deep FeedForward Networks : Gradient-based Learning – Hidden Units – Architecture Design - Back-Propagation and Other Differentiation Algorithms – Regularization for Deep Learning : Parameter Norm Penalties - Norm Penalties as Constrained Optimization - Regularization and Under-Constrained Problems - Dataset Augmentation – Noise Robustness – Semi-supervised Learning – Multitask Learning – Early stopping - Parameter Tying and Parameter Sharing – Sparse Representations - Bagging and Other Ensemble Methods - Adversarial Training - Tangent Distance, Tangent Prop and Manifold Tangent Classifier
Unit- III	Optimization for Training Deep Models : How Learning differs from Pure Optimization - Challenges in Neural Network Optimization – Basic Algorithms : Stochastic Gradient Descent, Momentum, Nesterov Momentum - Parameter Initialization Strategies - Algorithms with Adaptive Learning Rates : AdaGrad, RMSProp, Adam, Choosing the Right Optimization Algorithm - Approximate Second-Order Methods : Newton's Method, Conjugate Gradients, BFGS Algorithm - Optimization Strategies and Meta-Algorithms : Batch Normalization, Coordinate Descent, Polyak Averaging, Supervised Pretraining, Designing Models to Aid Optimization, Continuation Methods and Curriculum Learning.
Unit- IV	Convolutional Networks : The Convolution Operation – Motivation – Pooling - Convolution and Pooling as an Infinitely Strong Prior - Variants of the Basic Convolution Function – Structured Outputs – Data Types – Efficient Convolution Algorithms - Random or Unsupervised Features - The Neuroscientific Basis for Convolutional Networks - Convolutional Networks and the History of Deep Learning
Unit- V	Sequence Modeling: Recurrent and Recursive Nets - Unfolding Computational Graphs - Recurrent Neural Networks - Bidirectional RNNs - Encoder-Decoder Sequence-to- Sequence Architectures - Deep Recurrent Networks - Recursive Neural Networks - The Challenge of Long-Term Dependencies - Echo State Networks - Leaky Units and Other Strategies for Multiple Time Scales - The Long Short-Term Memory and Other Gated RNNs - Optimization for Long-Term Dependencies – Explicit Memory

Suggested Readings:- Ian Goodfellow and YoshuaBengio and Aaron Courville, 2016, "Deep Learning", MIT PressMichael Nielsen, , 2016, "Neural Networks and Deep Learning", Online Book YoshuaBengio, 2009, " Learning Deep Architectures for AI", NOW Publishers	
Outcomes	**After learning the course the students should be able to:** ➢ Identify problems where artificial intelligence techniques are applicable ➢ Apply selected basic AI techniques; judge applicability of more advancedtechniques. ➢ Participate in the design of systems that act intelligently and learn from experience.

Semester – II (ELECTIVE COURSES)			
Course Code: 561558	**DIGITAL IMAGE PROCESSING**	**Credits:4**	**Hours:4**
Objectives	➢ To learn about the basic concepts of digital image processing and various images transforms. ➢ To familiarize the student with the image enhancement techniques. ➢ To expose the student to a broad range of image processing techniques and their applications. To appreciate the use of current technologies those are specific to image processing systems. ➢ To expose the students to real-world applications of image processing.		
Unit- I	Digital Image Processing: Origins of Digital Image Processing, Steps in Digital Image Processing, Digital Image Fundamentals: Elements of Visual Perception, Light and the Electromagnetic Spectrum, Image Sensing and Acquisition, Image Sampling and Quantization, Basic Relationships between Pixels, Mathematical Tools used in DigitalImage Processing.		
Unit- II	Image Transformation & Filters: Basic Intensity Transformation Functions, Histogram Processing, Fundamentals of Spatial Filtering, Smoothing Spatial Filter, Sharpening Spatial Filters, Combining Spatial Enhancement methods, Fuzzy techniques for Intensity Transformation and Spatial Filtering. Filtering in the Frequency Domain: Preliminary Concepts, Sampling and the Fourier Transforms of Sampled Functions, The Discrete Fourier Transform (DFT), Properties of the 2-D DFT, Filtering in the Frequency Domain, Image Smoothing and Sharpening using Frequency Domain Filters, Selective Filtering.		
Unit- III	Image Restoration, Reconstruction and Image Segmentation: Image Degradation/Restoration process, Noise Models, Restoration in the presence of Noise only- Spatial Filtering, Periodic Noise Reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Estimating the Degradation Functions, Inverse Filtering, Wiener Square Error Filtering, Constrained Least Square Filtering, Geometric Mean Filter, Image Reconstruction from Projections. Image Segmentation: Point, Line and Edge Detection, Thresholding, Region-Based Segmentation, Segmentation Using Morphological Watersheds, Use of Motion in Segmentation.		
Unit- IV	Color Image Processing: Color Fundamentals, Color Models, Pseudocolor Image Processing, Full Color Image Processing, Color Transformation, Smoothing and Sharpening, Image Segmentation Based on Color, Noise in Color Images. Wavelets and Multiresolution Processing: Multiresolution Expansion, Wavelet Transforms in One Dimension, The Fast Wavelet Transforms, Wavelet Transforms in Two Dimensions, Wavelet Packets. Image Compression: Fundamentals, Basic Compression Methods, Digital Image Watermarking.		
Unit- V	Morphological Image Processing: Erosion and Dilation, Opening and Closing, The Hit-Or- Miss Transformation, Basic Morphological Algorithms, Gray-Scale Morphology. Object Recognition: Patterns and Pattern Classes, Recognition Based on Decision-Theoretic Methods, Structural Methods		

Suggested Readings:- Rafael C. Gonzalez, Richard E. Woods, 2018, "Digital Image Processing", 4th Edition, Pearson Education. A. Jain, 2001,"Fundamentals of Digital Image Processing", Prentice Hall of India. B. Chandra and D.Dutta Majumder, 2006, "Digital Image Processing and Analysis", Prentice-Hall of Indiaprivate limited, New delhi,.	
Outcomes	**After learning the course the students should be able to:** ➢ Implement basic image processing algorithms. ➢ Design an application that uses different concepts of Image Processing. ➢ Apply and develop new techniques in the areas of image enhancement-restoration segmentation- compression-wavelet processing and image morphology. ➢ Critically analyze different approaches to different modules of Image Processing.

Semester – II (ELECTIVE COURSES)			
Course Code: 561559	**CLOUD COMPUTING**	**Credits:4**	**Hours:4**
Objectives	➢ To understand the concept of cloud and utility computing. ➢ To understand the various issues in cloud computing. ➢ To familiarize themselves with the lead players in cloud. ➢ To appreciate the emergence of cloud as the next generation computing paradigm. ➢ To be able to set up a private cloud.		
Unit- I	Introduction to Cloud Computing, Definition, Characteristics, Components, Cloud provider, SAAS, PAAS, IAAS and Others, Organizational scenarios of clouds, Administering & Monitoring cloud services, benefits and limitations, Deploy application over cloud, Comparison among SAAS, PAAS, IAAS Cloud computing platforms: Infrastructure as a Service: Virtual Machines – Layered Architecture-Life Cycle – VM Provisioning Process – Provisioning and Migration Services. Management of Virtual Machines Infrastructure – Scheduling Techniques. Cluster as a service – RVWS Design – Logical Design. Cloud Storage - Amazon EC2, Platform as Service: Google App Engine, Microsoft Azure, Utility Computing, Elastic Computing.		
Unit- II	Introduction to Cloud Technologies, Study of Hypervisors Compare SOAP and REST Webservices, AJAX and mashups-Web services: SOAP and REST, SOAP versus REST, AJAX: asynchronous 'rich' interfaces, Mashups: user interface services Virtualization Technology: Virtual machine technology, virtualization applications in enterprises, Pitfalls of virtualization Multitenant software: Multi-entity support, Multi-schema approach, Multitenance using cloud data stores, Data access control for enterprise applications.		
Unit- III	Data in the cloud: Relational databases, Cloud file systems: GFS and HDFS, BigTable, HBase and Dynamo. Map-Reduce and extensions: Parallel computing, The map-Reduce model, Parallel efficiency of Map-Reduce, Relational operations using Map-Reduce, Enterprise batch processing using Map-Reduce, Introduction to cloud development, Example/Application of Mapreduce, Features and comparisons among GFS,HDFS etc, Map-Reduce model		
Unit- IV	Cloud security fundamentals, Vulnerability assessment tool for cloud, Privacy and Security in cloud Cloud computing security architecture: Architectural Considerations- General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Micro-architectures; Identity Management and Access controlIdentity management, Access control, Autonomic Security Cloud computing security challenges: Virtualization security managementvirtual threats, VM Security Recommendations, VM-Specific Security techniques, Secure Execution Environments and Communications in cloud.		

Unit- V	Issues in cloud computing, Implementing real time application over cloud platform, Issues in Intercloud environments, QOS Issues in Cloud, Dependability, data migration, streaming in Cloud. Quality of Service (QoS) monitoring in a Cloud computing environment. Cloud Middleware. Mobile Cloud Computing. Inter Cloud issues. A grid of clouds, Sky computing, load balancing, resource optimization, resource dynamic reconfiguration, Monitoring in Cloud'. Cloud computing platforms, Installing cloud platforms and performance evaluation Features and functions of cloud platforms: Xen Cloud Platform, Eucalyptus, OpenNebula, Nimbus, TPlatform, Apache Virtual Computing Lab (VCL), Enomaly Elastic Computing PlatformApplications: Best Practices in Architecting cloud applications in the AWS cloud – Massively multiplayer online Game hosting on cloud Resources – Building content delivery Networks using clouds – Resource cloud Mashups.

Suggested Readings:-

Naresh Kumar Sehgal Pramod Chandra P. Bhatt, 2018, "Cloud Computing: Concepts andPractices, Springer", 1st ed.

Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper, 2012, "Cloud Computing for Dummies", (Wiley IndiaEdition).

Bible Barrie Sosinsky, 2013, "Cloud Computing", Wiley India.

GautamShroff,Cambridge , , 2013, "Enterprise Cloud Computing " .

Ronald Krutz and Russell Dean Vines, 2014, "Cloud Security ", Wiley-India,.

RajkumarBuyya, James Broberg, and AndrzejGoscinski, 2011, " Cloud Computing Principles andParadigms", John Wiley and Sons, Inc,

George Reese, 2009, "Cloud Application Architectures, First Edition, O'Reilly Media, Inc.

Outcomes	**After learning the course the students should be able to:** ➢ Articulate the main concepts, key technologies, strengths and limitations of cloudcomputing. ➢ Identify the architecture, infrastructure and delivery models of cloud computing. ➢ Explain the core issues of cloud computing such as security, privacy and interoperability. ➢ Choose the appropriate technologies, algorithms and approaches for the relatedissues.

Semester – II (ELECTIVE COURSES)			
Course Code: 561560	**BIG DATA ANALYTICS**	**Credits:4**	**Hours:4**

Objectives	➢ To know the fundamental concepts of big data and analytics. ➢ To explore tools and practices for working with big data. ➢ To learn about stream computing. ➢ To know about the research that requires the integration of large amounts of data
Unit- I	**INTRODUCTION TO BIG DATA :** Big Data – Definition, Characteristic Features – Big Data Applications - Big Data vs Traditional Data - Risks of Big Data - Structure of Big Data - Challenges of Conventional Systems - Web Data – Evolution of Analytic Scalability - Evolution of Analytic Processes, Tools and methods - Analysis vs Reporting - Modern Data Analytic Tools.
Unit- II	**HADOOP FRAMEWORK :** Distributed File Systems - Large-Scale File System Organization – HDFS concepts - MapReduce Execution, Algorithms using MapReduce,Matrix-Vector Multiplication – Hadoop YARN
Unit- III	**DATA ANALYSIS :**Statistical Methods: Regression modelling, Multivariate Analysis - Classification: SVM & Kernel Methods - Rule Mining - Cluster Analysis, Types of Data in Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density Based Methods, Grid Based Methods, Model Based Clustering Methods, Clustering High Dimensional Data - Predictive Analytics – Data analysis using R.
Unit- IV	**MINING DATA STREAMS :**Streams: Concepts – Stream Data Model and Architecture - Sampling data in a stream - Mining Data Streams and Mining Time-series data – Real Time Analytics Platform (RTAP) Applications - Case Studies - Real Time SentimentAnalysis, Stock Market Predictions.
Unit- V	**BIG DATA FRAMEWORKS :** Introduction to NoSQL – Aggregate Data Models – Hbase: Data Model and Implementations – Hbase Clients – Examples – Cassandra: Data Model – Examples – Cassandra Clients – Hadoop Integration. Pig – Grunt – Pig Data Model – Pig Latin – developing and testing Pig Latin scripts. Hive – Data Types and File Formats – HiveQL Data Definition – HiveQL Data Manipulation – HiveQL Queries.

Suggested Readings:-

Bill Franks, 2012,"Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams withAdvanced Analytics", Wiley and SAS Business Series.

David Loshin, 2013, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools,Techniques, NoSQL, and Graph".

Michael Berthold, David J. Hand, 2007, "Intelligent Data Analysis", Second Edition, Springer.

Michael Minelli, Michelle Chambers, and AmbigaDhiraj, 2013, "Big Data, Big Analytics: EmergingBusiness Intelligence and Analytic Trends for Today's Businesses", Wiley.

P. J. Sadalage and M. Fowler, 2012, "NoSQL Distilled: A Brief Guide to the Emerging World of PolyglotPersistence", Addison-Wesley Professional,.

Richard Cotton, 2013, "Learning R – A Step-by-step Function Guide to Data Analysis", O'Reilly Media.

Outcomes	**After learning the course the students should be able to:** ➢ Work with big data tools and its analysis techniques. ➢ Design efficient algorithms for mining the data from large volumes. ➢ Design an efficient recommendation system. ➢ Design the tools for visualization. ➢ Learn No SQL databases and management.

Semester – II (ELECTIVE COURSES)			
Course Code: 561561	**BLOCKCHAIN TECHNOLOGY**	**Credits:4**	**Hours:4**

Objectives	• To Introduce the Basic Concepts and Types • To understand the concept of Private and Public Blockchain. • Develop smart contracts in Ethereum framework • To know about Security and Applications of Blockchain Technology. • To know about how to perform a transaction in bitcoin
Unit-I	Fundamentals of Blockchain : Introduction - Origin of Blockchain - Blockchain Solution - Components of Blockchain - Components of Blockchain - Block in Blockchain - The Technology and the Future.
Unit-II	Blockchain types and Consensus Mechanism : Introduction - Decentralization and Distribution - Types of Blockchain - Consensus Protocol - CRYPTOCURRENCY - BITCOIN, ALTCOIN and TOKEN: Introduction - Bitcoin and Crypto currency Basics - Types of Crypto currency – Crypto currency Usage.
Unit-III	Public Blockchain System: Introduction - Public Blockchain - Popular Public Blockchains - TheBitcoin Clockchain - EtherumBlockchain.
Unit-IV	Private Blockchain System : Introduction - Key Characteristics of Private Blockchain - Why We Need Private Blockchain - Private Blockchain Examples - Private Blockchain and Open Source - E-Commerce Site Examples - Varous Commands in E-Commerce Blockchain - Smart Contract in Private Environment - State Machine - Different Algorithms of Permissioned Blockchain - Byzantine Fault – Multichain.
Unit-V	Security in Blockchain : Introduction - Security Aspects in Bitcoin - Security and Privacy Challenges of Blockchain in General - Performance and Scalability - Identity Management and Authentication - Regularity Compliance and Assurance - Safeguarding Blockchain Smart Contract - Security Aspects in Hyper ledger Fabric - Applications Of Blockchain : Blockchain in Banking and Finance - Blockchain in Healthcare.

Suggested Readings:-

Chandramouli Subramaniam, AshaA George, Abhilash K A, Meera Karthikeyan, *Blockchain Technology,*2020, University Press

Daniel Drescher Blockchain Basics, 2017,: *A Non-Technical Introduction*, A press

DebajaniMohanty ,2018, *Block Chain From Concept to Execution,* BPB

Outcomes	• Understand the Basic Idea of Blockchain Technology • Know about the fundamental characteristics of Blockchain using bitcoin. • Identify the Differences Between Public and Private Blockchain Technologies. • Know about Algorithms in Blockchain technology. • Understanding the Security Challenges

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