MASTER OF SCIENCE

(COMPUTER SCIENCE)

SYLLABUS
FOR
CREDIT-BASED FLEXIBLE CURRICULUM

Board of Studies

DEPARTMENT OF COMPUTER APPLICATIONS
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620 015
TAMIL NADU INDIA

About us:

The Department of Computer Applications is one of the pioneering departments of the institution that offers Information Technology courses namely MCA, M.Sc in Computer Science and M.Tech in Data Analytics and one among the top five offering MCA course in the country. It is committed to impart quality education in the sub-fields of IT, a field growing in leaps and bounds.

Vision:

Towards a school of Information Science and Technology conforming to international standards

Mission:

- To offer state-of-art education in Information Science and Technology
- To provide strong theoretical foundation complemented with extensive practical training
- To inculcate value-based, socially committed professionalism to the cause of overall development of students and society

MASTER OF SCIENCE (COMPUTER SCIENCE)

Objectives of the Programme:

- To impart quality education in the field of Computer Science.
- To cater to the demands of the IT and IT enabled sectors through strong theoretical foundation with high quality teaching complemented with extensive practical training.
- To inculcate value-based, socially committed professionalism to the cause of overall development of research attitude and life-long learning.

The board of studies for Computer Applications Department includes the following members:

- **Chairman:**
  Dr. S.R.Balasundaram
  Head of the department

- **External Experts:**

  Dr.V.Ramachandran, Professor,
  Department of Information Science and Technology,
  Anna University, Chennai.

  Mr.Krishna Ramachnadran
  Principal Education & Research
  Infosys, Chennai.

- **Members:**
  1. Dr. N.P. Gopalan, Professor
  2. Dr. A.V. Reddy , Professor
  3. Dr. B. Ramadoss, Professor
  4. Dr.S.Nickolas, Professor
  5. Dr. Michael Arock, Professor
  6. Dr. P.J.A Alphonse, Professor
  7. Dr. S. Domnic , Associate Professor
  8. Dr. (Mrs) B.Janet , Assistant Professor
  9. Dr. (Mrs) S. Sangeetha, Assistant Professor
  10. Dr. (Mrs). R. Eswari, Assistant Professor
  11. Dr. U. Srinivasulu Reddy, Assistant Professor
  12. Dr. C.Sivaraj
  13. Dr. (Mrs). Adlin Suji
  14. Ms. Cynthia Devi
  15. Ms. Jenie Arock
  16. Mr.K.Vignesh

Semester	Subject Code	Subject Name	L	T	P	C
I	CAS 761	Mathematical Foundations of Computer Science	3	0	0	3
	CAS 763	Multimedia Communications	2	1	0	3
	CAS 765	Data Structures and Algorithms	2	1	0	3
	CAS 767	Database Technologies	2	1	0	3
	CAS 769	Advanced Operating Systems	3	0	0	3
	CAS 751	Data Structures Lab	0	0	4	2
	CAS 753	Operating Systems Lab – Unix & Shell Programming	0	0	4	2
II	CAS762	High Performance Computing	3	0	0	3
	CAS 764	Data Mining and Analytics	2	1	0	3
	CAS 766	Advanced Statistical Techniques for Data Science	3	0	0	3
	CAS 768	Problem Solving Using Python and R	3	0	0	3
	XXXXXX	Elective I	3	0	0	3
	CAS 752	High Performance Computing Lab	0	0	4	2
	CAS 754	DBMS and Data Mining Lab	0	0	4	2
III	CAS 771	Web Computing	2	1	0	3
	CAS 773	Artificial Intelligence	3	0	0	3
	CAS 775	Object Oriented Software Engineering	3	0	0	3
	XXXXXX	Elective-II	3	0	0	3
	XXXXXX	Elective-III	3	0	0	3
	CAS 755	Project Work- Phase I	0	0	4	2
	CAS 757	FOSS Lab	0	0	4	2
IV	CAS 799	Project Work –Phase II	0	0	0	10
		Grand Total	**40**	**5**	**24**	**67**

L: LECTURE | T: TUTORIAL | P: PRACTICAL | C: CREDITS

LIST OF ELECTIVES

Subject Code	Subject Name	L	T	P	C
CAS 7A1	Big Data Analytics	3	0	0	3
CAS 7A2	Computational Intelligence	3	0	0	3
CAS 7A3	Cyber Security	3	0	0	3
CAS 7B1	GPGPU Programming	3	0	0	3
CAS 7B2	Pattern Recognition	3	0	0	3
CAS 7B3	Cryptography	3	0	0	3
CAS 7C1	Design Patterns	3	0	0	3
CAS 7C2	Internet of Things	3	0	0	3
CAS 7C3	Cloud Computing and Virtualization Fundamentals	3	0	0	3

L: LECTURE | T: TUTORIAL | P: PRACTICAL | C: CREDITS

CAS761 MATHEMATICAL FOUNDATIONS OF COMPUTER SCIENCE

Objectives:

- *To acquire skills in solving mathematical and logical problems.*
- *To comprehend mathematical principles and logic.*
- *To understand fundamental concepts and tools in discrete mathematics with emphasis on their applications to computer science.*

Set Theory : Sets and operations, properties - power set - methods of proof - relations, graph and matrix of a relation - partial and total orders, well ordering - equivalence relations, classes and properties - functions, 1-1, onto and bijective - composition of relations and functions - inverse functions.

Mathematical Logic : Propositions and logical operators – Truth table – Equivalences and implications – Basic laws– Some more connectives – Functionally complete set of connectives – Review of Propositional Calculus - Validity - Satisfiability related concepts - CNF and DNF forms - Conversion of arbitrary propositional formula to CNF or DNF.

Graph Theory : Definitions and basic results - Representation of a graph by a matrix and adjacency list - Trees - Cycles - Properties - Paths and connectedness - Sub graphs - Graph Isomorphism - Operations on graphs - Vertex and edge cuts - Vertex and edge connectivity, Spanning Trees, Euler circuits, Hamiltonian graphs.

Probability Theory: Sample Spaces- Events - Axioms – Counting – Conditional Probability and Bayes' Theorem – The Binomial Theorem – Random variable and distributions : Mean and Variance of a Random variable-Binomial-Poisson-Exponential and Normal distributions, Correlation and Regression.

Sampling Distributions & Descriptive Statistics: The Central Limit Theorem, Distributions of the sample mean and the sample variance for a normal population, Sampling distributions (Chi-Square, t, F, z). Test of Hypothesis- Testing for Attributes – Mean of Normal Population – One-tailed and two-tailed tests, F-test and Chi-Square test - - Analysis of variance ANOVA – One way and two way classifications.

References:

1. Kenneth H. Rosen, "Discrete Mathematics and Its Applications", 7th Edition, McGraw-Hill, 2012.
2. Kolman, Busby and Ross, "Discrete Mathematical Structures", 6th Edition, PHI, 2013.
3. Sheldon M. Ross,"Introduction to Probability and Statistics for Engineers and Scientists", 5th edition, Academic Press; 2014.

Outcome:

Students will be able to:

- *Apply the concepts of discrete mathematics in the modeling and design of computational problems.*

CAS763 MULTIMEDIA COMMUNICATIONS

Objectives:

- *To understand multimedia content representation and transmission*
- *To be familiar with existing state-of-the-art in network protocols, architectures, and applications.*
- *To gain comprehensive knowledge about multimedia data transmission over the network.*

Introduction, multimedia information representation, multimedia networks, multimedia applications, media types, communication modes, network types media types, communication modes, network types, multipoint conferencing, network QoS application QoS. - Multimedia Information Representation: Introduction, digital principles, text, images, audio, video.

Compression - Text And Image Compression: Introduction, compression principles, text compression, image compression. - Audio And Video Compression: Introduction, audio compression, DPCM, ADPCM, APC, LPC, video compression, video compression principles, H.261, H.263, MPEG, MPEG-1, MPEG-2, and MPEG-4

Multimedia Information Networks: Introduction, LANs, Ethernet, Token ring, Bridges, FDDI High-speed LANs, LAN protocol

Internet: Introduction, IP Datagrams, Fragmentation, IP Address, ARP and RARP, QoS Support,IPv8. - Broadband ATM Networks: Introduction, Cell format, Switch and Protocol Architecture ATM LANs.

Transport Protocol: Introduction, TCP/IP, TCP, UDP, RTP and RTCP.

References:

1. Multimedia Communications: Applications, Networks, Protocols and Standards, Fred Halsall,Pearson Education, Asia, Second Indian reprint 2002.
2. Multimedia Information Networking, Nalin K. Sharda, PHI, 2003.
3. Multimedia Fundamentals: Vol 1 - Media Coding and Content Processing, Ralf Steinmetz, Klara Narstedt, PearsonEducation, 2004.
4. Multimedia Systems Design, Prabhat K. Andleigh, Kiran Thakrar, PHI, 2004

Outcomes:

Students will be able to:

- *Use and apply appropriate network protocols to transmit multimedia content*

CAS 765 DATA STRUCTURES AND ALGORITHMS

Objectives:

- *To learn the basics of programing*
- *To learn basic concepts of data structures*
- *To design and analyse algorithms*

Introduction – Arrays – Structures – Stack: Definition and examples, Representing Stacks - Queues and lists: Queue and its Representation, lists – Applications of Stack, Queue and Linked Lists-Basics of Programming and Data Structures.

Binary Trees – Binary Tree Representations – node representation, internal and external nodes, implicit array representation - Operations on binary trees – Binary tree Traversals - Representing Lists as Binary Trees–Search Trees.

Algorithms – Analyzing and Designing algorithms – Asymptotic notations – Recurrences – Methods to solve recurrences – Basic sorting techniques – selection sort, bubble sort, insertion sort and merge sort – Basic Search Techniques – linear search and binary search.

Revisiting various operations of different data structures with time complexity analysis – Design and Analysis of Heap Sort - Quick Sort – Sorting in linear time – Radix sort – Selection in linear time.

Design Strategies: Recursion - Divide and conquer methodology – Multiplication of large integers – Strassen's matrix multiplication – Greedy method – Prim's algorithm – Kruskal's algorithm – algorithm for Huffman codes – Dynamic Programming – Backtracking and Branch and bound method.

References

1. Stephen Prata,"C++ Primer Plus", 6th Edition ,Addison-Wesley Professional, 2011
2. Bjarne Stroustrup, "Programming: Principles and Practice Using C++,1st Edition, Addison-Wesley Professional, 2008
3. Bruce Eckel ,"Thinking in C++: Introduction to Standard C++: Volume One" 2nd Edition,PrenticeHall, 2000
4. T.H.Cormen, C.E.Leiserson, R.L.Rivest and C. Stein, "Introduction to algorithms", 3rd edition, 2009, MIT Press.
5. P. H. Dave and H. B.Dave, "Design and Analysis of Algorithms", 2009, Pearson Education India.
6. S. Lipschutz and G.A.V. Pai, "Data Structures", 2010, Tata McGraw-Hill.
7. Clifford A. Shaffer, "Practical Introduction to Data Structures and Algorithm Analysis", 2000, 2nd edition, Prentice Hall.
8. P. Brass, "Advanced Data Structures", 2008, Cambridge University Press.

Outcomes:

Students will be able to:

- *Design and implement abstract data types/Data structures.*
- *Design and analyse algorithms*

CAS 767 DATABASE TECHNOLOGIES

Objectives:

- *To learn different database models and design of databases*
- *To study query languages, transaction management, indexing and hashing*
- *To be aware of emerging database technologies*

Database system – Terminologies – Views – Data models – Database languages – Architecture – E-R Model – Conceptual design with E-R – Extended E-R - Relational Model - Codd's rule - Keys – Constraints – Relational database design – Anomalies - Functional dependencies – 1NF to 5NF – Decomposition - Denormalization

Relational Query Languages – Relational Algebra – Tuple and domain Relational Calculus – SQL – Query processing and optimization – Transformation of relational expressions – Evaluation plans

Transaction – Properties – Concurrent execution – Serializability – Concurrency control – Protocols – Recovery System – Database Security

File organization – Organization of records in files – Indexing – B tree and B+ tree index files – Static hashing – Dynamic hashing

Parallel and distributed databases – Object-based databases - Mobile databases - XML and Web databases – Intelligent databases – Mongo DB – NOSQL - PostgreSQL

References:

1. Silberschatz, Korth and Sudarshan, "Data Base System Concepts", McGraw-Hill, 6th Edition, 2011.
2. R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", 7thEdition, Pearson Education, 2017.
3. Raghu Ramakrishnan and Johannes Gehrke, "Data Base Management Systems", 3rd Edition, McGraw-Hill, 2014.
4. C. J. Date, "An Introduction to Database Systems", 8th Edition, Addison-Wesley, 2006.
5. Guy Harrison, "Next Generation Databases", Apress, 2015.
6. Eric Redmond, Jim R Wilson, "Seven Databases in Seven Weeks", LL. 2012.
7. Adam Fowler, "NoSQL for dummies", John Wiley & Sons, 2015.

Outcomes:

Students will be able to:

- *Illustrate the features of DBMS and models for designing databases*
- *Apply logical database design principles in solving real world problems*
- *Describe the nuances of data retrieval methods*
- *Acquire the knowledge about emerging database systems.*

CAS 769 ADVANCED OPERATING SYSTEMS

Objectives:

- *To understand design of an operating system and services provided by the OS.*
- *To understand what a process is and how processes are synchronized and scheduled.*
- *To acquire knowledge on different approaches to memory management*
- *To understand the structure and organization of the file system and disk.*
- *To know the concepts of distributed and Mobile operating systems*

Operating System concepts - OS Structure – OS Services - System calls – Process management: Process Concept-Operations on process-Cooperating processes- Inter-process communication. Process scheduling-Scheduling algorithms.

Threads- Multithreading models – Containers - Process synchronization- critical-section – Synchronization hardware – Semaphores – Classic problems of synchronization – critical regions. Deadlocks: Characterization, Prevention, Avoidance, Detection, and Recovery.

Memory Management: Paging, segmentation, Demand Paging, Page Replacement, Allocation of Frames. File Concepts, Access and Allocation Methods, Free Space Management.

Disk Structure, Disk Scheduling and Disk Management. Protection and security Case Studies: UNIX, Linux and Windows Operating Systems.

Distributed Operating Systems – Distributed system structure, Distributed file system; Mobile Operating systems

References:

1. Abraham Silberschatz, Peter B. Galvin and Greg Gagne, "Operating System Concepts ",8th edition, John Wiley & Sons Inc., 2013.
2. Andrew S. Tanenbaum, "Modern Operating Systems", 4th Edition, Prentice Hall, 2014.
3. William Stallings, "Operating Systems: Internals and Design Principles", 7th Edition, Prentice Hall, 2011.

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Outcomes:
Students will be able to:

- *Use system calls for managing processes, memory and the file system*
- *Be familiar with various types of operating systems including UNIX, Linux and windows.*
- *Explore the functionalities of distributed and Mobile operating systems.*

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CAS751 DATA STRUCURES LAB

Exercises for learning basic features of C and exercises to implement various data structures for real world applications

Course Outcomes:

Students will be able to:

1. Write C programs for solving any problems.
2. Implement linear and nonlinear data structures to solve real-time problems
3. Perform searching and sorting techniques to different application domains
4. Implement different design strategies to solve complex problems

CAS 753 OPERATING SYSTEMS LAB – UNIX & SHELL PROGRAMMING

Exercises for learning basic features of UNIX and to solve problems using shell programming

Course Outcomes:

Students will be able to:

1. Work on the concepts, design, and structure of the UNIX operating system.
2. Use basic UNIX Utilities
3. Work on UNIX shell programming.

CAS762 HIGH PERFORMANCE COMPUTING

Objectives:

- *To learn the fundamentals of High Performance Computing.*

Modern processors-Stored-program computer architecture - General-purpose cache-based microprocessor architecture - Memory hierarchies-Multicore processors - Multithreaded processors -Vector processors

Parallel computers-Taxonomy of parallel computing -Shared-memory computers- Distributed-memory computers-Hierarchical (hybrid) systems-Networks - Basics of parallelization - Why parallelize? Parallelism-Parallel scalability

Shared-memory parallel programming with OpenMP-OpenMP - Case study: OpenMP-parallel Jacobi algorithm -Advanced OpenMP: Wavefront parallelization- Efficient OpenMP programming-Profiling OpenMP programs -Performance pitfalls. Case study: Parallel sparse matrix-vector multiply

Locality optimizations on ccNUMA architectures-Locality of access on ccNUMA-Case study: ccNUMA optimization of sparse MVM-Placement - ccNUMA issues with C++

Distributed-memory parallel programming with MPI-Message passing –MPI - Example: MPI parallelization of a Jacobi solver - Efficient MPI programming- Hybrid parallelization with MPI and OpenMP-Basic MPI/OpenMP programming models - MPI taxonomy of thread interoperability-Hybrid decomposition and Potential benefits and drawbacks of hybrid programming

References:

1. G.Hager and G.Wellein, “Introduction to High Performance Computing for Scientists and Engineers”, Taylor & Francis, 2017.
2. R.A. Kudale and S.Y.Kulkarni, “High Performance Computing”, Vishwakarma Publications, 2016.
3. T.Sterling, M.Anderson and M.Brodowicz, “High Performance Computing: Modern Systems and Practices”, Morgan Kaufmann, 2018.

Outcomes:

Students will be able to:

- Deal with fundamental design issues in HPC
- Design parallel algorithms and handle advanced tools, techniques

CAS764 DATA MINING AND ANALYTICS

Objectives:

- *To introduce the basic concepts and techniques of data mining and analytics.*
- *To develop skills of using recent data mining and analytics software for solving problems.*
- *To be aware of advanced concepts of data mining and analytics techniques and its applications in the knowledge discovery process.*

Data Mining Techniques-Data Mining Process-Process with a typical set of data- Data Analytic Techniques-Big Data-Visualization of data through data mining and analytical software.

Data Mining Methods as Tools - Memory-Based reasoning methods of Data Mining - Algorithms with prototypical data based on real applications using data analytical methods.

Data Stream Mining, Mining Time Series, Text Mining, Data Stream Clustering, mining Big Data through data mining and analytical tools.

Market Basket Analysis - Fuzzy Data Mining approaches - Fuzzy Decision Tree approaches Fuzzy Association Rule applications. Rough Sets - Support Vector Machines - Genetic algorithms. Case studies.

Social Computing - Analysis -Graph Mining – Social Network Mining-Web Mining – Web Usage Mining-Privacy Preserving Data Mining-Recommender Systems. Case studies.

References:

1. David L. Olson and Dursun Delen, "Advanced Data Mining Techniques", Springer, 2008.
2. Charu C. Aggarwal and Haixun Wang, "Managing and Mining Graph Data", Springer, 2010.
3. Ian H. Witten, Eibe Frank and Mark A. Hall, "Data Mining: Practical Machine Learning Tools and Techniques", Morgan Kaufmann Publishers, 2011.
4. Jiawei Han and Micheline Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, 2006.
5. Margaret H. Dunham, "Data Mining Introductory and Advanced Topics", Prentice Hall, 2003.
6. Anand Rajaraman and Jeff Ullman, "Mining of Massive Datasets", Cambridge University Press, 2011.
7. Wolfganag, J., Business Analytics for managers, Spinger, 2011.

Outcomes:

Students will be able to:

- *Understand the concepts and algorithms of data mining and analytics.*
- *Apply data mining and analytic techniques for business intelligence.*
- *Be aware of the privacy and security issues in data mining and analytics.*

CAS766 Advanced Statistical Techniques for Data Science

Objectives:

- *To understand advanced statistical techniques*
- *To gain comprehensive knowledge on applications of statistical techniques for data analysis*

Principles of statistical inference- Formulation of problems with examples- Point estimation. Estimator and estimate-Criteria for good estimates. Method of moments estimation and maximum likelihood estimation - Fisher Information matrix- Properties of maximum likelihood estimator-Confidence intervals.

Basic multivariate statistics: multivariate descriptive statistics, multivariate distributions (normal, etc), multivariate inferential statistic.

Multivariate data- Analysis of variance (ANOVA), Multivariate analysis of variance (MANOVA)- Case study: MANOVA

Multiple linear regression- Multiple and partial correlation- Detection of Collinearity-Stepwise regression.

Validation of model assumptions- Detection of outliers- influential observation and autocorrelation

References:

1. Joseph F. Hair Jr,Rolph E. Anderson, Ronald L Tatham, and , Multivariate data analysis by Fifth Edition, Pearson Education, 1998.
2. R A Johnson and D W Wichern, Applied multivariate statistical analysis, Sixth Edition, PHI, 2012.
3. D. C. Montgomery and G. C. Runger, Applied Statistics and Probability for Engineers, 6th Edition, Wiley, 2014
4. G.K. Bhattacharya and R.A. Johnson, Statistical Concepts & Methods, 6th Edition, Wiley, 2010
5. D.C. Montgomery and E. Peck., Introduction to Linear Regression Analysis – 5th edition, wiley, 2012
6. W.J.Conover, Practical Nonparametric Statistics, Wiley, 3rd Edition, 1998

Outcomes:

Students will be able to:

- *Apply statistical techniques for real time data analysis applications*

CAS768 PROBLEM SOLVING USING Python and R

Objectives:

- *To write simple Python programs using Python data structures.*
- *To develop object oriented programs in Python*
- *To manipulate files using Python.*
- *To work on few python packages*
- *To write simple R programs for statistical computing.*

Problems solving fundamentals, Python: variables, expressions, statements, precedence of operators; Data structures: list, Dictionary, tuples; Lists: list slices, list methods, mutability, cloning lists, List comprehension; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; Conditional constructs; Iterative constructs. Strings: string slices, immutability, string functions and methods;

Functions: parameters, return values, local and global scope, function composition, recursion, and lambda functions;

Object orientation – Classes, Objects, methods, Operator overloading, and Inheritance. Files and exception: text files, reading and writing files, format operator; errors and exceptions, handling exceptions; creating modules and packages;

Python Modules and Packages: Python Standard Library, Numpy, Pandas, Matplotlib, GUI-Tkinter, wxWidgets ; Database- MySQLDB, Scikit-Learn, NLTK

R Programming - Control Structures - Functions - Data Manipulation - String Operations- Data Visualization – R for Statistical computing.

References:

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd edition, Updated for Python 3, O'Reilly Publishers, 2016
2. Zed Shaw's ,"Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code, Addison-Wesley Professional; 3 edition, 2013
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming in Python: An Inter - disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
4. Paul Teetor, R Cookbook- Proven Recipes for Data Analysis, Statistics, and Graphics, O'Reilly Media, 2011
5. Wesley J Chun, Core Python Programming , 2nd edition, Prentice Hall ,2009

Outcomes:

Students will be able to:

- Write programs using Python data structures.
- Develop solutions to real world problems using object oriented concepts
- Read and write data from/to files using Python.
- Make use of Python Modules and Packages to solve complex problems
- Write simple R programs for statistical computing.

CAS752 HIGH PERFORMANCE COMPUTING LAB

Exercises to implement parallel algorithms using openMP, MPI etc. with CUDA and other architectures.

Course Outcomes:
Students will be able to:

1. Investigate modern design structures of pipelined and multiprocessors systems.
2. Write algorithms using parallel programming principle.
3. Design the architecture of parallel systems.

CAS754 DBMS AND DATA MINING LAB

Exercises to construct and query databases.
Exercises to implement Data mining algorithms using ENCOG and WEKA

Course Outcome

Students will be able to:

1. Work with ETL tools
2. Demonstrate the classification, clustering and etc. in large data sets.
3. Ability to add mining algorithms as a component to the exiting tools.
4. Ability to apply mining techniques for realistic data.

CAS771 WEB COMPUTING

Objectives:

- *To comprehend basics of the internet and web terminologies.*
- *To introduce scripting language concepts for developing client side applications.*
- *To practice server side programming features – ASP .NET, PHP, JSP.*
- *To be familiar with database applications*
- *To know the usefulness of web services.*

Internet and World Wide Web : Introduction to Internet, www, Internet browsers Netscape & Explorer, Introduction to Client Server Architecture/Computing, History of the web, Growth of the web, Protocols governing the web, resources of Internet, H/W & S/W requirements of Internet, Internet service providers, Internet Services, Internet Clients and Internet Servers. Concept of E-Commerce and E-governance.

Markup Languages: Introduction to HTML, Formatting Tags, Links, Lists, Tables, Frames, Forms, Comments in HTML, DHTML and XML Documents, Data Interchange with an XML document, Document type definition, Features and Applications, Working with Style sheets.

Client Side Scripting: Scripting basics, Introducing JavaScript, Documents, Statements, Functions, Objects in javascript, Events and Event handling, Arrays, Forms, Buttons, Checkboxes, Text Fields and Text Area.

Server Side Scripting: Introduction to server side scripting language, RMI, The Problem with Servelet. JSP Application Design with MVC Setting Up and JSP Environment: Installing the Java Software Development Kit, Tomcat Server & Testing Tomcat- Generating Dynamic Content, Using Scripting Elements Implicit JSP Objects, Conditional Processing – Displaying Values Using an Expression to Set an Attribute, Declaring Variables and Methods Error Handling and Debugging - Sharing Data Between JSP pages, Requests and Users Passing Control and Date between Pages – Sharing Session and Application Data – Memory Usage Considerations

PHP Basic command with PHP examples, Connection to server, creating database, selecting a database, listing database, listing table names creating a table, inserting data, altering tables, queries, deleting database, deleting data and tables, PHP myadmin and database bugs.

References:

1. John Pollock, "Javascript : A biginers Guide", McGraw Hill
2. Mercer, "ASP 3.0: A Biginers Guide", McGraw Hill
3. Shelly Powers et al., "Dynamic web publishing ", Techmedia, 1998.
4. Scot Johnson et. al., "Using Active Server Pages", Que, 1997.
5. E-Commerce – Cutting Edge of Business – Kamlesh K. Bajaj, Debjani Nag – Tata McGraw Hill,1/e, 2003

Outcomes:

Students will be able to:

- *Design and develop web applications.*
- *Understand client and server side scripting and their applicability.*

CAS773 ARTIFICIAL INTELLIGENCE

***Objectives**:*

- *To explore various AI search algorithms*
- *To understand fundamentals of knowledge representation*
- *To acquire knowledge on the basic concepts and techniques of Machine Learning.*
- *To gain knowledge on the applications of AI..*

Philosophy of artificial intelligence, problem solving, search techniques, constraint satisfaction, and game playing - minimax, handling uncertainty: probability theory, Bayesian Networks.

Knowledge representation and reasoning: predicate logic, rule based systems, Decision tree, Semantic networks, Ontology, Basics of Semantic Web

Machine learning- Supervised learning- Regression, Classification; unsupervised learning- Clustering; Reinforcement learning.

Computational Intelligence- Fuzzy systems, Swarm intelligence, neural networks models- Learning through neural nets; Basics of Deep learning

Applications of Artificial Intelligence- Natural Language Processing, Speech recognition, Computer vision, Expert systems

References:

1. Richard E. Neapolitan, Xia Jiang, Artificial Intelligence -With an Introduction to Machine Learning, Second Edition, CRC press, 2018
2. Ertel, Wolfgang, "Introduction to Artificial Intelligence", 2nd edition, Springer, 2017
3. Ethem Alpaydin, Machine Learning – The New AI, MIT press, 2016
4. Wilber Fankhause, Artificial Intelligence Applications: Natural Language Processing, CreateSpace Independent Publishing Platform, 2015

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Outcomes:
Students will be able to:

- *Know how to build simple knowledge-based systems*
- *Apply knowledge representation and machine learning techniques to solve real world problems*
- *Apply Computational Intelligence techniques to solve real-world problems*

CAS 775 OBJECT ORIENTED SOFTWARE ENGINEERING

Objectives :

- *To comprehend basics of the software engineering process life cycle.*
- *To be introduced to the object-oriented (OO) approach to software development, through OO principles.*
- *To be conversant with UML (Unified Modelling Language) and the benefits of visual modeling / diagramming.*
- *To get introduced to software engineering principles for both procedural and object oriented approaches.*

Introduction -What is software engineering? – Software Development Life Cycles Models - Conventional Software Life Cycle Models- What is Object Orientation? – Objects and Classes – Features - Object Oriented Software Life Cycle Models -Object oriented Methodologies – Object – Oriented Modeling –Terminologies.

Software Requirements Elicitation and Analysis - Case Study: Library Management System- What is Software Requirement? – Requirements Elicitation Techniques – Characteristics of a good Requirement- Software Requirements Specification Document - Requirements Change Management - Object Oriented Analysis - Overview of Cost Estimation Techniques - Agile development – Classification of methods – The agile manifesto and principles – Agile project management Agile Methodology - Method overview – Lifecycle – Work products, Roles and Practices values – Process mixtures – Adoption strategies – Understanding SCRUM.

Software Design - Object Oriented Design - What is done in object oriented design? – UML - Refinement of Use Case Description – Refinement of classes and relationships - – Construction of Details class diagrams - Development of Details Design and Creation – Generating Test cases from User Cases – Object Oriented Design principles for Improving Software Quality.

Software Implementation - Quality and Metrics -Software Implementation – Tools and Techniques - What is software quality? – Software quality models - Measurement basic - analyzing the metric data - Metrics for measuring size and structure – Measuring software quality object oriented metrics – Overview of Scala for Implementation.

Software Testing and Maintenance -What is software testing? – Software verification techniques – Checklist: a popular verification tool - Functional Testing – Structural Testing – Object Oriented Testing - Class testing – State based testing - Mutation testing - Levels of testing - Software testing tools - What is a software maintenance? - Categories –Challenges of software maintenance – Maintenance of Object oriented Software - Software rejuvenation - Estimation of maintenance efforts - Configuration management – Regression testing.

References:

1. Yogesh Singh, Ruchika Malhotra, "Object-Oriented Software Engineering", PHI, 2012.
2. Timothy C. Lethbridge and Robert Laganiere, "Object-Oriented Software Engineering", McGraw-Hill, 2nd ed., 2004.

3. G. Booch, Benjamin/Cummings, "Object-Oriented Analysis and Design with Applications", 3rd Edition, Addison-Wesley, 2007.
4. Roger Pressman, "Software Engineering: A Practitioner's Approach", McGraw-Hill Higher Education, 2010.
5. S. Kenneth Rubin, "Essential Scrum: A Practical Guide to the Most Popular Agile Process", Pearson Publication, 2012
6. Jason Swartz, "Learning Scala Practical Functional Programming for the JVM", O'Reilly Media, December 2014

Outcomes:

Students will be able to:

- *Practice the application principles of object-oriented software development and various CASE tools.*
- *Convey design decisions using UML.*

CAS755 PROJECT WORK –Phase I

To explore various research papers pertaining to chosen domain and arrive at a survey.

Outcome: To publish papers in conference or a journal.

CAS757 FOSS LAB

To expose students to FOSS environment and introduce them to use and modify existing programs using open source packages/Technologies listed below:

1. Linux
2. Android/ Mozilla OS
3. GIMP: GNU Image Manipulation Program
4. Apache Struts
5. PHP
6. Python
7. Ruby
8. Apache Cassandra database
9. Mongo DB, NoSQL
10. Hadoop

CAS 799 PROJECT WORK –Phase II

Internal project work 6 Months duration with submission of thesis and viva-voce examination

Outcome: To publish papers in conference or a journal.

ELECTIVES

CAS7A1 BIG DATA ANALYTICS

Objectives:

- *To get introduced to big data analytics and to understand the importance of big data.*
- *To get introduced with different approaches of exploiting big data sources such as social media, mobile devices and sensors through understanding methodologies of analyzing big data.*
- *To acquire knowledge of handling unstructured and semi-structured data using NoSQL database.*

INTRODUCTION TO BIG DATA : Introduction to BigData Platform – Challenges of Conventional Systems - Intelligent data analysis – Nature of Data - Analytic Processes and Tools - Analysis vs Reporting - Modern Data Analytic Tools - Statistical Concepts: Sampling Distributions - Statistical Inference - Prediction Error.

Big Data Analytics: Classification, Clustering, and Mining, Information Extraction, Regression and Feature Selection, Reasoning: Logic and its Limits, Dealing with Uncertainty, Bayesian Inference, Forecasting, Neural Models, Introduction to Deep Learning.

HADOOP : History of Hadoop- The Hadoop Distributed File System – Components of Hadoop-Analyzing the Data with Hadoop- Scaling Out- Hadoop Streaming- Design of HDFS-Java interfaces to HDFS Basics- Developing a Map Reduce Application-How Map Reduce Works-Anatomy of a Map Reduce Job run-Failures-Job Scheduling-Shuffle and Sort – Task execution - Map Reduce Types and Formats- Map Reduce Features

NoSQL Databases : Evolution of Document DataBases – Design and use of NoSQL Databases – Storage and Retrieval of Unstructured Data – NoSQL Applications and query options. Types of NoSQL Databases, Graph Databases – Neo4j ; Case Studies - Real Time Sentiment Analysis, Stock Market Predictions.

FRAMEWORKS: Applications on Big Data Using Pig and Hive – Data processing operators in Pig – Hive services – HiveQL – Querying Data in Hive - fundamentals of HBase and ZooKeeper - Visualizations - Visual data analysis techniques, interaction techniques; Systems and applications ; Introduction to Tableau.

Introduction: IT revolution, digital media, relationship among people, media and information, The fundamental structure of web, Social media as a platform, the framework of media, the

References:

1. Michael Berthold, David J. Hand, “Intelligent Data Analysis”, Springer, 2007.
2. Tom White “ Hadoop: The Definitive Guide” Third Edition, O’reilly Media, 2012.
3. Chris Eaton, Dirk DeRoos, Tom Deutsch, George Lapis, Paul Zikopoulos, “Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data”, McGrawHill Publishing, 2012

4. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
5. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", JohnWiley & sons, 2012.
6. Glenn J. Myatt, "Making Sense of Data", John Wiley & Sons, 2007
7. PeteWarden, "Big Data Glossary", O'Reilly, 2011.
8. Jiawei Han, Micheline Kamber "Data Mining Concepts and Techniques", Second Edition, Elsevier, Reprinted 2008.
9. Da Ruan,Guoquing Chen, Etienne E.Kerre, GeertWets, Intelligent Data Mining, Springer,2007
10. Paul Zikopoulos ,Dirk deRoos , Krishnan Parasuraman , Thomas Deutsch , James Giles , David Corrigan , Harness the Power of Big Data The IBM Big Data Platform, Tata McGraw Hill Publications, 2012.

Outcomes

Students will be able to:

- *Comprehend the concepts of big data analytics.*
- *Build web-intelligence applications exploiting big data using new big data platforms based on the 'map-reduce' parallel programming framework.*
- *Effectively use NoSQL database for storage and retrieval of big data.*

CAS7A2 COMPUTATIONAL INTELLIGENCE

Objectives:

- *To introduce the fundamentals of key intelligent systems technologies including neural networks, fuzzy systems, evolutionary computation and swarm intelligence*
- *To explain the integration of intelligent systems technologies*

Introduction to Computational Intelligence - Intelligence machines - Computational Intelligence paradigms – Fuzzy logic - Fuzzy relationships - Fuzzy Sets - Operations on Fuzzy sets - Fuzzy rules - Fuzzy inference systems - Fuzzy expert systems - Applications of Fuzzy Set theory to different branches of science and engineering

Neural Network - Biological foundation of Neural Network - Neural Model - Network Architectures - Perceptron Learning - Supervised and unsupervised learning neural networks - Hebbian Learning - Back-propagation - Associative Learning - Competitive Networks - Hopfield Network - Deep neural networks and learning algorithms - Applications - Case studies

Neuro Fuzzy Systems - Adaptive Neuro - Fuzzy Inference Systems - Architecture - Hybrid Learning Algorithm - Learning Methods that Cross-fertilize ANFIS and RBFN - Coactive Neuro Fuzzy Modelling - Framework Neuron Functions for Adaptive Networks - Neuro Fuzzy Spectrum

Evolutionary computation – Chromosomes - Fitness functions - Selection mechanisms - Genetic algorithms - Crossover - mutation – Convergence – Applications - Genetic programming - Evolution strategies - Evolutionary neural network - Case studies

Swarm Intelligence - Foundations - Examples – Metaheuristics - ACO method - Ant System – Birds – PSO – Firefly Algorithm - Applications - Case Studies

References:

1. Eberhart and Shi, "Computational Intelligence - Concepts to Implementations" Morgan Kaufmann, 2007
2. S. Haykin, "Neural Networks – A Comprehensive Foundation", Prentice Hall, 1999
3. N. Sivanandam, S. N. Deepa," Principals of soft Computing", Wiley India, 2nd ed., 2011.
4. A.P. Engelbrecht, "Computational Intelligence: An Introduction", 2nd Edition, John Wiley & Sons, 2012.
5. H.K. Lam, S.S.H. Ling, and H.T. Nguyen, "Computational Intelligence and Its Applications: Evolutionary Computation, Fuzzy Logic, Neural Network and Support Vector Machine", Imperial College Press, 2011.
6. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, 2004
7. J. Freeman and D. Skapura, "Neural Networks: Algorithms, Applications, and Programming Techniques", Addison-Wesley, 1991
8. G. J. Klir, and B. Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Prentice-Hall, 1995
9. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2003

Outcomes:
Students will be able to:

- *Implement typical computational intelligence algorithms*
- *Apply intelligent systems technologies in a variety of engineering applications*
- *Model global optimization solutions for various real life problems*

CAS7A3 CYBER SECURITY

Objectives:

- *To study the concepts and principles of Cyber Security.*
- *To understand the various security threats and the ways to overcome them effectively.*
- *To know the effectiveness of various network and data security toolkits.*

Cyber Security - Security Model, Balancing Security and Access, Security SDLC

Cryptography: Classical Cryptography, Symmetric Cryptography, Public Key (Asymmetric cryptography), Modern Cryptography. Forensics: DRM technology (including watermarking andfinger printing), Steganography, Biometrics

Network Security:Wireless Security, IDS and IPS, Network Intrusion Management.

Application Security: Software Security, Mobile Security, and Database Security.

Data Security: Threats, Security Breach, Hacking Tools and Techniques.

References:

1. W. Stallings, Cryptography and Network Security: Principles and Practice, 6th Edition, Prentice Hall, 2013
2. Neil Daswani, Christoph Kern, Anita Kesavan, " Foundations of Security: What Every Programme", APRESS, 2007.
3. Michael E Whitman and Herbert J Mattord, "Principles of Information Security", Vikas Publishing House,2003

Outcomes:

Students will be able to:

- *Understand and anticipate cyber security issues and to suggest preventive measures.*
- *Design and execute penetration testing on a real computer network.*

CAS7B1 GPGPU PROGRAMMING

Objectives:

- *To introduce the features of massively parallel programming architecture.*
- *To utilize massively parallel computing capability of a GPU for high performance computing requirements.*
- *To provide an overview of parallel design patterns.*

Introduction: CPU Design – Latency Oriented, GPU Design – Throughput Oriented – Need to use both - Software Cost - Scalability, Portability, GPU Introduction and Architecture, History of GPU Computation, GPGPU Frameworks, Graphics Processor Architecture, Compute Capability, Drop-In Libraries, OpenACC Directives

Parallel Programming Patterns: Overview, Element Addressing - Multidimensional Kernel, Map, Gather, Scatter, Reduce, Scan, Thread Handling, Overview, Barrier Synchronization, Thread Synchronization Demo, Warp Divergence, Matrix Multiplication

CUDA Tools and APIs: Tools Overview, Using NSight Visual Studio and Eclipse, Running CUDA Apps, Debugging, Profiling, CUDA Architecture, CUDA APIs, CUDA 5.5 and 6 Features

CUDA programming: Overview, Compilation Process, Von Neumann Processor and CUDA Thread, Execution Model, First program in CUDA (Vector Addition), Location Qualifiers, Grid and Block Dimensions, Global Memory, Constant and Texture Memory, Shared Memory, Register and Local Memory, Data Movement, Error Handling, Device Introspection

Atomics: Overview, Need for Atomics, Atomic Functions, Atomic Sum, Monte Carlo Pi, Handling Events and Streams**,** Overview, Events, Event API, Event example, Pinned.

References:

1. D. Kirk and W. Hwu, "Programming Massively Parallel Processors – A hands-on approach", 2nd Edition, Morgan Kaufmann Publishers, 2010.
2. Thomas Rauber and Gudula Runger, "Parallel Programming for Multi-core and Cluster Systems", ACM Computing classification, 1998.
3. Shane Cook, "CUDA Programming - A Developer's Guide to Parallel Computing with GPUs", Morgan Kaufmann Publishers, 2012.
4. Jason Sanders and Edward Kandrot, "CUDA by Example", Addison Wesley, 2010.

Outcomes

Students will be able to:

- *Utilize massively parallel computing capability of a GPU.*
- *Solve High Performance Computing problems using GPUs.*

CAS7B2 PATTERN RECOGNITION

Objectives:

- *To understand the fundamental concepts related to image processing, feature extraction, pattern analysis etc.*
- *To apply the concepts to solve computer vision problems of different fields.*

Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement-Histogram Processing

Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.

Motion analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Pattern Analysis: Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

References:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003
3. Mark S. Nixon and Alberto S. Aguado, "Feature Extraction & Image Processing for Computer Vision", 3rd Edition, Academic Press, Elsevier, 2012.
4. R. Gonzalez and R. E. Wood, "Digital Image Processing", 3rd Edition, Prentice Hall of India, 2008.
5. K.Pratt, "Digital Image Processing", 4th Edition, McGraw Hill, 2007.

Outcomes:

Students will be able to:

- *Apply fundamental algorithms in Image Processing and analyse their applicability for real time problems.*
- *Design solutions for various computer vision problems.*

CAS7B3 CRYPTOGRAPHY

Objectives:

- *To understand the principles of encryption algorithms: conventional and public key cryptography.*
- *To have a detailed knowledge about authentication, hash functions and application level security mechanisms.*

Introduction: Cryptography and modern cryptography – The setting of private-key encryption – Historical ciphers and their cryptanalysis – Basic principles of modern cryptography – Services, Mechanisms and Attacks – OSI security architecture.

Symmetric techniques: Definition – Substitution ciphers – Transposition ciphers - Stream and block ciphers - Characteristics of good ciphers - Data Encryption Standard (DES) Advanced Encryption Standard – Block cipher modes of operation.

Asymmetric techniques: Principles of Public Key Cryptosystems – The RSA Algorithm – Key Management – Diffie Hellman Key Exchange – Elliptic Curve Cryptography – over reals, prime fields and binary fields.

Message authentication: Authentication requirements – Authentication functions – Message Authentication Codes (MAC) – Hash functions – Security of hash functions and MACs, MD5 Message Digest Algorithm.

Implementing cryptographic algorithms: Tamperproof Query strings, Hashed Passwords, Salted Passwords, Crypto Stream, Web Site Encryption, Digital Signatures - Authentication Protocols - Digital Signature Standard (DSS), Digital Certificates, Key Sizes and Storage, SSL/TSL.

References:

1. Bernard Menezes, "Network Security and Cryptography", Cengage Learning, 2010.
2. Ingemar J.Cox, Matthew L.Miller, Jeffrey A.Bloom, Jessica Fridrich and Ton Kalker, "Digital Watermarking and Steganography", Morgan Kaufmann Publishers, 2008.
3. William Stallings, "Cryptography and Network Security, Prentice Hall, 2006.
4. Wenbo Mao, "Modern Cryptography – Theory and Practice", Pearson Education, 2006.
5. Jonathan Katz and Yehuda Lindell, "Introduction to Modern Cryptography", Chapman & Hall/CRC, 2007.
6. Bruce Schneier, "Applied Cryptography", John Wiley & Sons, 2004.

Outcomes:

Students will be able to:

- *Understand fundamental techniques used in Cryptography.*
- *Decide upon the use of a particular cryptographic technique for a specific real time scenario.*

CAS7C1 DESIGN PATTERNS

Objectives

- *To comprehend the rationale and benefits of software design patterns.*
- *To impart knowledge on the development of good design patterns.*

Introduction: Introduction to Design Patterns, Object Oriented Analysis and Design, Types of Design Patterns, Applications of Design Patterns, Anti Patterns, Code Refactoring Techniques for design patterns

Creational Patterns: Factory Methods, Static Factory Pattern, Singleton Pattern, Abstract Factory Pattern, Object Pool Pattern, Prototype Pattern, Builder Pattern, Telescopic Constructor Pattern

Structural Patterns: Adapter Pattern, Bridge Pattern, Composite Pattern, Decorator Pattern, Façade Pattern, Flyweight Pattern, Private Class Data, Proxy Pattern

Behavioral Design Patterns - I: Chain of responsibility Pattern, Command Pattern, Interpreter Pattern, Iterator Pattern, Mediator Pattern

Behavioral Design Patterns – II: Memento Pattern, Null Object Pattern, Observer Pattern, State Pattern, Strategy Pattern, Template method, Visitor Pattern

References:

1. Gamma, "Design Patterns - Elements of Reusable Object-Oriented Software", Addison-Wesley, 1995.
2. Eric Freeman and Elisabeth Freeman, "Head First Design Patterns", O'Reilly, 2004.
3. Stephen Stelting and Olav Maassen, "Applied Java Patterns", Prentice Hall, 2002.
4. James W. Cooper, "Java Design Patterns - A Tutorial", Addison-Wesley, 2000.
5. Joshua Kerievsky, "Refactoring To Patterns", Addison-Wesley, 2005.

Outcomes

Students will be able to:

- *Solve common problems in software design with ease.*
- *Represent design decisions more effectively with examples and architectural use cases.*

CAS7C2 INTERNET OF THINGS

Objectives

- *To understand the fundamentals of internet of things.*
- *To acquire skills to program the embedded devices and connecting them to the web and cloud.*

Internet of things: Overview, technology of the internet of things, enchanted objects, Design principles for connected devices, Privacy, Web thinking for connected devices

Writing Code: building a program and deploying to a device, writing to Actuators, Blinking Led, Reading from Sensors, Light Switch, Voltage Reader, Device as HTTP Client, HTTP, Push Versus Pull

Pachube, Netduino, Sending HTTP Requests—The Simple Way, Sending HTTP Requests—The Efficient Way

HTTP: Device as HTTP Server, Relaying Messages to and from the Netduino, Request Handlers, Web Html, Handling Sensor Requests, Handling Actuator Requests

Going Parallel: Multithreading, Parallel Blinker, prototyping online components, using an API, from prototypes to reality, business models, ethics, privacy, disrupting control, crowdsourcing

References:

1. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley & Sons, 2013.
2. Cuno Pfister, "Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud", Maker Media, 2011.

Outcomes:

Students will be able to:

- *Program embedded devices.*
- *Program simple actuators and sensors.*
- *Build client programs that push sensor readings from a device to a web service.*

CAS7C3 CLOUD COMPUTING AND VIRTUALIZATION FUNDAMENTALS

Objectives:

- *To learn the various concepts of Distributed and Cloud computing.*
- *To study the Architecture and service models in Cloud computing.*

Distributed Systems Models and Enabling Technologies: Scalable Computing – Technologies for Network-Based Systems – System Models for Distributed and Cloud Computing – Software Environments for Distributed and Clouds – Performance, Security and Energy Efficiency

Virtualization concepts: Implementation Levels of Virtualization – Virtualization Structures - Tools and Mechanisms – Virtualization of CPU, Memory and I/O Devices – Virtual Clusters and Resource Management – Virtualization for Data-Center Automation, Introduction to Various Virtualization OS - VMware, KVM, Xen.

Service-Oriented Architecture for Distributed Computing: Services and SOA- Message oriented middleware– Portals and Science Gateways – Discovery-Registries-Metadata - Workflow in SOA

Cloud Computing and Service Models – Data-center Design and Interconnection Networks – Architectural Design of Compute and Storage Clouds – Public cloud Platforms – Inter-cloud Resource Management – Cloud Security and Trust Management

Cloud Programming and Software Environments – Features of Cloud and Grid Platforms – Parallel and Distributed Paradigms – Programming Support of Google App Engine – Amazon AWS and Microsoft Azure - Emerging Cloud Software Environments

References:

1. Kai Hwang, Geoffrey C.Fox, and Jack J. Dongarra,"Distributed and Cloud Computing", Elsevier India Private Limited, 2012.
2. Foster and Kesselman, "The Grid: Blueprint for a New Computing Infrastructure", Morgan Kauffman publishers Inc.,2004
3. Coulouris, Dollimore and Kindber, "Distributed System: Concept and Design", Fifth Edition, Addison Wesley, 2011.
4. Michael Miller, "Cloud Computing", Dorling Kindersley India, 2009.
5. Anthony T. Velte, Toby J. Velte and Robert Elsenpeter, "Cloud computing: A practical Approach", McGraw Hill, 2010.

Outcomes:

Students will be able to:

- *Be aware of the features of Cloud Computing.*
- *Understand several performance criteria to evaluate the quality of the cloud architecture.*