MASTER OF COMPUTER SCIENCE

SYLLABUS
FOR
CREDIT-BASED CURRICULUM
(Applicable for 2014-2015 onwards)

DEPARTMENT OF COMPUTER APPLICATIONS
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI-620 015
TAMIL NADU - INDIA
HEAD OF THE DEPARTMENT:

1. Dr. A. Vadivel

MEMBERS OF THE DEPARTMENT:

1. Dr. N.P. Gopalan
2. Dr. A.V. Reddy
3. Dr. B. Ramadoss
4. Dr. Michael Arock
5. Dr. S. Nickolas
6. Dr. S.R. Balasundaram
7. Dr. P.J.A. Alphonse
8. Dr. S. Domnic
9. Dr. (Mrs). B. Janet
10. Dr. S. Sangeetha
11. Dr. R. Eswari
12. Dr. U. Srinivasulu Reddy
13. Dr. M.P. Anuradha (On Contract)
14. Dr. V. Gayathri (On Contract)
15. Dr. S. Suresh (On Contract)
16. Dr. R. Siva Shankar (On Contract)
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<th>Semester</th>
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**Grand Total** | 40 | 5 | 24 | 67

L: LECTURE | T: TUTORIAL | P: PRACTICAL | C: CREDITS
LIST OF ELECTIVES

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<tr>
<th>Subject Code</th>
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L: LECTURE  | T: TUTORIAL  | P: PRACTICAL  | C: CREDITS
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.


Groups, Rings and Fields: Introduction-Algebraic Structures, Groups, Abelian Group, Order, Cyclic Group, Homomorphism (Definition), Isomorphism (Definition), Kernel of f (Definition), Rings, Field and its Axioms, Sub-fields, Finite Fields, Powers and primitive roots in finite fields.

Basic Number Theory: Basic Notions-Prime Number Theorem, GCD, Euclidean algorithm, Solving $ax + by = d$, Congruence, The Chinese Remainder Theorem, Modular Exponentiation, Fermat and Euler, Primitive Roots, Inverting Matrices Mod $n$, Square Roots Mod $n$, Legendre and Jacobi Symbols, Perfect Numbers and Mersenne Numbers.

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.

References:


Outcome:

Students will be able to:

- Apply the concepts of discrete mathematics in the modeling and design of computational problems.
CAS763 COMPUTER ORGANIZATION AND ARCHITECTURE

Objectives:
- To understand the basic structure of a digital computer.
- To be conversant with the operations of internal components.
- To analyze architectures and computational designs.

Introduction – Computer Evolution and performance – Function and Interconnection - Number Systems – Digital Logic

Cache memory – Internal memory –External Memory - Input/output

Computer Arithmetic – ALU - Instruction Sets - Addressing modes and formats - Instruction pipeline – RISC - CISC

Register organization - Processor organization – Instruction Cycle - Super scalar processor.

Control Unit Operations - Micro programmed Control – Parallel Processing – Multicore Architecture - APU Architecture

References:

Outcomes:
Students will be able to:
- Identify the internal components in computing systems.
- Design and analyze the main functional units of a computer.
- Synthesize new and better architectures.
Objectives:

- To design and implement different data structures.
- To study various searching, sorting techniques and their Applications.
- To compute complexity of algorithms.
- To be taught algorithm design methodologies.


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.


References


Outcomes:

Students will be able to:

- Understand common data structures and algorithms, implement them.
- Choose among variety of data structures to design algorithms and solve problems in scientific computing.
- Comprehend algorithmic complexity and choose the best among various data structures and algorithms for problem solving, based on complexity.
Objectives:

- To understand the needs of a database management system.
- To provide a solid technical overview of database management systems, both in terms of usage and implementation.
- To be aware of emerging database technologies.


References:


Outcomes:

Students will be able to:

- Understand the role of a database management system in an organization.
- Assimilate basic database concepts and construct database queries using SQL.
- Apply logical database design principles in solving real world problems.
CAS 769 OPERATING SYSTEMS

**Objectives:**
- To provide a clear understanding of operating system concepts.
- To be aware of the services provided by operating systems and their underlying principles.
- To be introduced to various types of operating systems and their design perspectives.


Memory Management: Paging, segmentation, Demand Paging, Page Replacement, Allocation of Frames.


**References:**


**Outcomes:**
Students will be able to:
- Know the concepts of operating system functions and structures.
- Understand the design issues associated with operating systems.
- Be familiar with various types of operating systems including UNIX, Linux and windows.
CAS 751 PROGRAMMING LAB FOR DSA

Exercises to implement various algorithms using C/C++/Java

1. Programs using one dimensional, two dimensional arrays.
2. Implementation of Stack, Queue operations.
3. Implementation of operations on singly, doubly, circular linked lists.
4. Implementation of operations on binary tree.
5. Implementation of binary tree traversal.
6. Implementation of basic sorting techniques (selection sort, bubble sort, insertion sort and merge sort).
7. Implementation of sorting techniques like heap, quick and radix sort.
8. Implementation of searching algorithms.
10. Implementation of Greedy method.

CAS 753 OPERATING SYSTEMS LAB – UNIX & SHELL PROGRAMMING

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

1. Write shell script to perform basic arithmetic, logic and string operations.
2. To write a menu Driven shell program using shell commands with menu options to perform file/directory manipulations.
3. Write a program to implement Round Robin Scheduling.
4. Write a program to implement The Bounded-Buffer problem.
5. Write a program to implement The Reader-Writer Problem.
6. Write a program to implement The Dining Philosopher Problem.
7. Write a program to implement Bankers Algorithm.
8. Write a program to implement the First fit, Best fit, Worst Fit Memory management Techniques.
9. Write a program to implement the FIFO, LRU, OPTIMAL page replacement Techniques.
10. Write a program to implement the FCFS, SCAN, C-SCAN, LOOK, C-LOOK Disk scheduling algorithm.
SEMESTER – II
CAS762 FUNDAMENTALS OF PARALLEL PROGRAMMING

**Objectives:**
- To explore the concept of parallel programming and its importance.
- To analyze and optimize the complexity of each parallel algorithm.
- To familiarize parallel programming paradigms and techniques with introduction to CUDA tool.

Introduction-Parallel Programming Paradigms-Parallel Architecture- Case studies -Open MP-features and functions - PRAM Model of Computation

PRAM - Models of Parallel Computation, Complexity - Memory Consistency - Performance Issues - Parallel Program Design - Shared Memory and Message Passing – MPI -features and functions


Lower Bounds Lock Free Synchronization, Load Stealing - Lock Free Synchronization, Graph theoretic parallel algorithms


**References:**

**Outcomes:**
Students will be able to:
- Design and develop parallel algorithms.
- Analyze the real world problems and implement in parallel environment.
CAS764 DATA MINING

**Objectives:**

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

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

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

Data Stream Mining, Mining Time Series, Text Mining, Data Stream Clustering, mining Big Data

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


**References:**


**Outcomes:**

*Students will be able to:*

- Understand the concepts and algorithms of data mining.
- Apply data mining techniques for business intelligence.
- Be aware of the privacy and security issues in data mining.
CAS766 COMPUTER NETWORKS

Objectives:
- To be familiar with existing state-of-the-art in network protocols, architectures, and applications.
- To gain comprehensive knowledge about the layered communication architectures and its functionalities.
- To understand the principles, key protocols, design issues and significance of various layers.


Error Detection and Correction – LRC - CRC- Checksum – Hamming Distance for Error Correction – simulator development to capture various packets flowing in the Data Link Layer Flow control and error control – Stop and wait – Go back-N ARQ – Selective repeat ARQ – Sliding window protocol


Reliable Byte Stream (TCP) – Simple Demultiplexer (UDP) – TCP Congestion Control – Congestion Avoidance Mechanisms – Streaming Protocol

Domain Name Service (DNS) – Email - SMTP – MIME – HTTP – SNMP-TELNET-FTP

References:

Outcomes:
Students will be able to:
- Understand basic network theory and layered communication architectures.
- Use and apply current technical concepts and practices in computer network installation.

Industrial Component: Software Defined Networks.
Objectives:

- To understand the basic concepts of graphics and multimedia systems.
- To acquire skills, to be conversant with technology and to assimilate formal concepts to solve a wide range of graphic design problems.
- To become familiar with creation and implementation of multimedia standards and techniques.


Output Primitives and Attributes of Output Primitives Points and Lines – Line Drawing Algorithms – Circle generating algorithms – Ellipse generating algorithms – Filled area primitives – Antialiasing


References:


Outcomes:

Students will be able to:

- Obtain insight into the basics of computer graphics and multimedia.
- Analyze and design solutions to problems pertaining to graphics and multimedia.
CAS752 PARALLEL PROGRAMMING LAB

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

1. Implement a parallel program for selection problem.
2. Implement a parallel program for merging problem.
3. Implement a parallel modified quick sort program.
4. Implement a parallel program for searching problem.
5. Implement a parallel program for matrix transpose problem.
6. Implement a parallel program for matrix multiplication problem.
7. Implement a parallel program for convolution problem in image processing.
8. Implement a parallel program for finding connected components problem.
9. Implement a parallel program for all-pairs shortest path problem.
10. Implement a parallel program for minimum spanning tree problem.

CAS754 DBMS AND DATA MINING LAB

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

1. Execution of Data Definition Language
2. Execution of Data Manipulation Language
3. Querying the database tables using simple queries, nested queries, aggregate functions and joins
4. Creation of Views
5. Execution of PL/SQL programs – procedures, functions, and cursors
6. Execution of triggers
7. Applications involving finance management systems, vendor management systems etc.
8. Implementation of Apriori algorithm to generate frequent Item Sets
9. Implementation of the following clustering algorithms
   a. K-means
   b. K-medoids
10. Implementation of Decision Tree Induction classification algorithm
11. Performing data Preprocessing using WEKA
12. Performing Discretization of data using WEKA
13. Execution of Apriori algorithm using WEKA
14. Execution of Classification algorithms using WEKA
SEMESTER – III

CAS71 WEB TECHNOLOGY

Objectives:

- To comprehend basics of the internet and web terminologies.
- To introduce the features of HTML5 to develop rich applications.
- 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.


PHP - Adding PHP to HTML, Syntax and Variables, Passing information between pages, Strings - Arrays and Array Functions – Numbers - Basic PHP errors / problems - Sessions and Cookies and Database Connectivity.


References:


Outcomes:

Students will be able to:

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

- To introduce the concepts of mobile communication system and pervasive computing.
- To understand the concepts of emerging mobile technology.
- To be aware of pervasive computing practices.


Pervasive Computing: Past, Present and Future Pervasive Computing - Pervasive Computing Market – m-Business – Application Examples: Retail, Airline check-in and booking – Sales force automation – Health care – Tracking – Car information system – E-mail access via WAP


References:


Outcomes:

Students will be able to:

- Be conversant with various mobile computing ideas and best practices to solve practical problems.
- Apply pervasive computing techniques in various domains of importance.
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.


References:


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.

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 for 6 months duration with submission of thesis and viva-voce examination

Outcome: To publish a paper 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: 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 paths of messages: transition and diffusion, Hadoop Framework.


Communities: Observation and discrimination of the special crowds, (communities) living in the words of social media, methods and tools for identifying online communities (big data analytics), Clarifying the principles of embedding, concatenation and emergence operations in online society, Analysis of the different stages in the development of community.

NoSQL Databases: Evolution of Document Databases, Design and use of NoSQL databases, Storage and retrieval of unstructured data, NoSQL applications and query options, NewSQL.

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, Deep Learning, and Research Topics.

**References:**


**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.
Objectives:

- To introduce the techniques of soft computing.
- To explain the hybridization of soft computing systems.
- To distinguish between conventional AI and Soft Computing systems in terms of its tolerance to imprecision and uncertainty.


Neural Network (NN), Biological foundation of Neural Network, Neural Model and Network Architectures, Perceptron Learning, Supervised Hebbian Learning, Back-propagation, Associative Learning, Competitive Networks, Hopfield Network, Computing with Neural Nets and applications of Neural Network.


Introduction to Swarm Intelligence and key principles (e.g., self-organization, stigmergy), natural and artificial examples, computational and embedded SI. From real to virtual ants: Ant System (AS), the first combinatorial optimization algorithm based on ant trail. Application to a classical operational research problem: the Travel Salesman Problem (TSP). Introduction to unsupervised multi-agent machine-learning techniques for automatic design and optimization: terminology and classification, Genetic Algorithms (GA) and Particle Swarm optimization (PSO). Comparison between both techniques in theory and practice.

References:

Outcomes:
Students will be able to:
- Implement soft computing algorithms.
- Model global optimization solutions for various real life problems.

Industrial Component: A series of tutorials on MATLAB.

CAS7A3 COMPUTER SECURITY

Objectives:
- To study the concepts and principles of Information Security.
- To understand the network principles, various security threats and the ways to overcome them effectively.
- To know the effectiveness of various network security toolkits.


Network and Server Attacks and Penetration - Principles of Intrusion Detection Systems - Security Scanning - System Security Scanning and Discovery

References:


Outcomes:
Students will be able to:
- Understand and anticipate information 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.


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:

Outcomes:
Students will be able to:
- Utilize massively parallel computing capability of a GPU.
- Solve High Performance Computing problems using GPUs.
CAS7B2 IMAGE PROCESSING

Objectives:
- To study and understand the image fundamentals and the mathematical models used to perform various operations on an image.
- To apply image processing techniques in real time applications.

Introduction: The human vision system - Computer vision system - Mathematical system - image formation, sampling, quantization - Basic image processing operations: point operators, group operations, statistical operators.


Fundamentals of Spatial filtering - Smoothing spatial filters - sharpening Spatial filters - Basics of filtering in Frequency Domain - Image smoothing using frequency domain filters - Image sharpening by frequency domain filters.


Representation and Description: Boundary descriptor, Regional descriptor, Relational descriptor - Object Recognition.

References:

Outcomes:
Students will be able to:
- Apply fundamental algorithms in Image Processing and analyse their applicability for real time problems.
- Design solutions for various content based information retrieval problems.
- Understand the perception of human vision.
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.


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:

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.
CAS 7C1 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:

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.
**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:**


**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

**Objectives:**

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


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:**


**Outcomes:**

Students will be able to:

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