SRINIVASA INSTITUTE OF TECHNOLOGY AND SCIENCE

(AUTONOMOUS)

ApprovedbyAICTE,NewDelhi–AffiliatedtoJNTUA,Ananthapuramu

Accredited by NAAC with 'A' Grade

Chennai-HyderabadBypassRoad,Ukkayapalli,Kadapa-516002

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M. Tech (Regular-Full Time)

(Effective for the students admitted into I year I Sem from the Academic Year **2025-26** onwards)

M.TECH.-COMPUTER SCIENCE & ENGINEERING

I, II, III & IV SEMESTER COURSE STRUCTURE & SYLLABUS

SEMESTER – I

S.No.	Code	Course Name	Category	Hours per week			Credits
				L	T	P	
1.		Advanced Data Structures & Algorithms	PC	3	0	0	3
2.		Distributed Operating Systems	PC	3	0	0	3
3.		**Program Elective-I** 1. Advanced Computer Architecture 2. Cloud Computing 3. Applied Machine Learning	PE	3	0	0	3
4.		**Program Elective-II** 1. Natural Language Processing 2. Smart Sensor Networks &IoT 3. Computing for Data Analytics	PE	3	0	0	3
5.		Advanced Data Structures &Algorithms Lab	PC	0	0	4	2
6.		Distributed Operating Systems Lab	PC	0	0	4	2
7.		Research Methodology and IPR	MC	2	0	0	2
8.		Full stack Development Using MERN	SE	0	1	2	2
9.		Audit Course – I English for Research Paper Writing Disaster Management Essence of Indian Traditional Knowledge	AC	2	0	0	0
Total:							**20**

SEMESTER – II

S.No.	Code	Course Name	Category	Hours per week			Credits
				L	T	P	
1.		Advances in Software Engineering	PC	3	0	0	3
2.		Advanced Database Management Systems	PC	3	0	0	3
3.		**Program Elective – III** 1. Block Chain Technology 2. Advanced Computer Networks 3. Deep Learning	PE	3	0	0	3
4.		**Program Elective – IV** 1. Generative AI 2. Digital Forensics 3. Robotic Process Automation	PE	3	0	0	3
5.		Advance in Software Engineering Lab	PC	0	0	4	2
6.		Advanced Database Management SystemsLab	PC	0	0	4	2
7.		Quantum Technologies And Applications	MC	2	0	0	2
8.		Comprehensive Viva Voce	PC	0	0	0	2
9.		Audit Course – II	AC	2	0	0	0
Total							**20**

****Students have to undergo an Industry Internship after I Year II Semester for a duration of 6 to 8 weeks**

SEMSTER - III

S.No.	Code	Course Name	Category	Hours per week			Credits
				L	T	P	
1.		**Program Elective – V** 1. Software Defined Networks 2. Reinforcement Learning 3. Data Science	PE	3	0	0	3
2.		Open Elective-I	OE	3	0	0	3
3.		Dissertation Phase – I	PR	0	0	20	10
4.		Industry Internship		0	0	0	2
5.		Co- Curricular Activities		0	0	0	1
Total							19

SEMESTER - IV

S.No.	Corse Codes	Course Name	Category	Hours per			Credits
				L	T	P	
1.		**Dissertation Phase – II**	PR	0	0	32	16
Total							**16**

OPEN ELECTIVE OFFERED TO OTHER DEPARTMENS

- **Advanced Data Structures & Algorithms**
- **Cloud Computing**

	ADVANCED DATA STRUCTURES AND ALGORITHMS	L	T	P	C
		3	0	0	3

Course Objectives:

The course aims to:

1. Introduce fundamental data structures including linked lists, stacks, queues, trees, graphs, dictionaries, and hashing techniques.
2. Develop algorithmic skills for designing and analyzing searching, sorting, and traversal methods.
3. Teach implementation of priority queues, binary search trees, and balanced trees (AVL, Red-Black, Splay, B-Trees).
4. Enable students to select and apply appropriate data structures for solving computational problems efficiently.
5. Foster understanding of the performance analysis and comparative evaluation of data structures and algorithms.

Course Outcomes:

After completing this course, students will be able to:

CO1: Implement and manipulate linear data structures like singly/doubly linked lists, circular lists, stacks, and queues using dynamic memory allocation.
CO2: Apply and analyze searching and sorting algorithms including linear, binary search, bubble, selection, insertion, quick, and merge sort.
CO3: Design and implement dictionaries and hashing techniques to efficiently store and retrieve data.
CO4: Construct and operate on trees and priority queues, performing insertion, deletion, and traversal operations.
CO5: Compare and implement balanced search trees (AVL, Red-Black, Splay, B-Trees) for optimized data access and storage.

UNIT I: Introduction
Introduction to Data Structures, Singly Linked Lists, Doubly Linked Lists, Circular Lists-Algorithms. Stacks and Queues: Algorithm Implementation using Linked Lists.

UNIT II: Searching and Sorting:
Linear and Binary, Search Methods, Sorting: -Basic sorting techniques, Radix Sort, Bucket Sort, Shell Sort Trees- Binary trees, Properties, Representation and Traversals, Expression Trees (Infix, prefix, postfix). Graphs-Basic Concepts, Storage structures and Traversals.

UNIT III: Dictionaries and Hashing
Dictionaries: Definition, Dictionary Abstract Data Type, Implementation of Dictionaries.
Hashing: Review of Hashing, Hash Function, Collision Resolution Techniques in Hashing, Separate Chaining, Open Addressing, Linear Probing, Quadratic Probing, Double Hashing, Rehashing, Extendible Hashing

UNIT IV: Priority queues

Definition, ADT, Realizing a Priority Queue Using Heaps, Definition, Insertion, Deletion .Search Trees- Binary Search Trees, Definition, ADT, Implementation, Operations-Searching, Insertion, Deletion.

UNIT V: Search Trees-

AVL Trees, Definition, Height of AVL Tree, Operations-, Insertion, Deletion and Searching, Introduction to Red-Black and Splay Trees, B-Trees, Height of B-Tree, Insertion, Deletion and Searching, Comparison of Search Trees.

Text Books:

1. Data Structures: A Pseudo Code Approach, 2/e, Richard F.Gilberg, Behrouz A. Forouzon and Cengage
2. Data Structures, Algorithms and Applications in java, 2/e, SartajSahni, University Press

Reference Books:

1. Data Structures and Algorithm Analysis, 2/e, Mark Allen Weiss, Pearson.
2. Data Structures and Algorithms, 3/e, Adam Drozdek, Cengage
3. C and Data Structures: A Snap Shot Oriented Treatise Using Live Engineering Examples, N.B.Venkateswarulu, E.V.Prasad and S Chand & Co.

	DISTRIBUTED OPERATING SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives: Thiscourseis aimedatenabling thestudents to

- Introduce the architectures, principles, and design issues of distributed, database, and multiprocessor operating systems.
- Develop an understanding of communication, synchronization, deadlock handling, and agreement protocols in distributed environments.
- Explain distributed resource management, shared memory, scheduling, and fault tolerance techniques.
- Provide knowledge of security and protection models, and cryptographic methods for secure distributed computing.
- Explore the structure and design issues of multiprocessor and database operating systems with concurrency control mechanisms.

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

CO1: Explain the architectures, limitations, and synchronization mechanisms (logical clocks, mutual exclusion) in distributed systems.

CO2: Analyze distributed deadlock detection methods, agreement protocols, and distributed resource management techniques.

CO3: Apply concepts of distributed shared memory, scheduling, and fault-tolerance techniques for reliable system design.

CO4: Evaluate models of protection, access control, and cryptographic algorithms for ensuring data security in distributed systems.

CO5: Compare multiprocessor and database operating systems, and analyze concurrency control algorithms for distributed databases.

UNIT – I Architectures of Distributed Systems, System Architecture types, issues in distributed operatingsystems,communicationnetworks,communicationprimitives.TheoreticalFoundations,inherentlimitations of a distributed system, lamp ports logical clocks, vector clocks, casual ordering of messages,global state, cutsof adistributed computation, termination detection. Distributed Mutual Exclusion,introduction, the classification of mutual exclusion and associated algorithms, a comparative performance analysis

UNIT – II DistributedDeadlockDetection,Introduction,deadlockhandlingstrategiesindistributedsystems,issuesindeadlockdetectionandresolution,control organizationsfordistributeddeadlock detection,centralizedanddistributeddeadlockdetectionalgorithms,hierarchicaldeadlockdetectionalgorithms.Agreement protocols, introduction-the system model, a classification of agreement problems,solutions to the Byzantine agreement problem, and applications of agreement algorithms. Distributed resource management: introduction-architecture, mechanism for building distributed file systems designissues,log structured filesystems

UNIT – III Distributedshared memory,Architecture,algorithmsforimplementingDSM,memory coherence and protocols, design issues. Distributed Scheduling, introduction, issues in load distributing,componentsofaloaddistributingalgorithm,stability,loaddistributingalgorithm,performance comparison, selecting a suitable load sharing algorithm, requirements for load distributing, task migrationand associated issues. Failure Recovery and Fault tolerance: introduction, basic concepts, classification offailures, backward and forward error recovery, backward error recovery, recovery in concurrent systems,consistentsetofcheckpoints,synchronousandasynchronouscheckpointingandrecovery,checkpointingfordistributed database systems,recovery in replicated distributed databases

UNIT – IV Protection and security, preliminaries, the access matrix model and its implementations.-safetyin matrix model, advanced models of protection. Data security, cryptography: Model of cryptography,conventional cryptography modern cryptography, private key cryptography, data encryption standard publickey cryptography,multiple encryptions,authentication in distributed systems

UNIT – V

Multiprocessor operating systems, basic multiprocessor system architectures, inter connection networks for multiprocessor systems, caching hypercube architecture. Multiprocessor Operating System,structuresofmultiprocessoroperatingsystem,operatingsystemdesign issues,threads,process synchronization and scheduling.

Concurrency control model of database systems, the problem of concurrency control, serializability theory, distributed database systems, concurrency control algorithms, introduction, basic synchronization primitives, lockbased algorithms,timestampbasedalgorithms,optimistic algorithms,concurrencycontrolalgorithms,data replication.

TEXT BOOKS

1.Advancedconceptsinoperatingsystems:Distributed,Databaseandmultiprocessoroperating systems",MukeshSinghal, Niranjan andG.Shivaratri,TMH, 2001

2. **Andrew S. Tanenbaum, Maarten Van Steen**, *Distributed Systems: Principles and Paradigms*, Pearson Education, 2nd Edition, 2006.

REFERENCES

1. **Andrew S. Tanenbaum, Maarten Van Steen**, *Distributed Systems: Principles and Paradigms*, Pearson Education, 2nd Edition, 2006.
2. **Silberschatz, Galvin, Gagne**, *Operating System Concepts*, Wiley, 9th Edition, 2018.
3. **M. Mitzenmacher, E. Upfal**, *Probability and Computing: Randomized Algorithms and Probabilistic Analysis*, Cambridge University Press, 2005.
4. **Alan Tucker**, *Applied Combinatorics*, John Wiley & Sons, 5th Edition, 2007.
5. **Nancy A. Lynch**, *Distributed Algorithms*, Morgan Kaufmann, 1996.
6. **George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair**, *Distributed Systems: Concepts and Design*, Pearson, 5th Edition, 2011.

	ADVANCED COMPUTER ARCHITECTURE (Program Elective I)	L	T	P	C
		3	0	0	3

Pre-requisites: Computer Organization

Course Objectives:

- To impart the concepts and principles of parallel and advanced computer architectures.
- To develop the design techniques of Scalable and multithreaded Architectures.
- To apply the concepts and techniques of parallel and advanced computer architectures to design modern computer systems

Course Outcomes: After the completion of the course, student will be able to

- Analyze various parallel computer models, program partitioning techniques, and system interconnect architectures to evaluate conditions for parallelism.
- Apply performance metrics and scalability analysis to assess parallel processing applications using advanced processor and memory technologies.
- Design and differentiate linear, non-linear, instruction, and arithmetic pipelines to enhance execution performance in modern processors.
- Examine multiprocessor and multicomputer architectures, cache coherence protocols, and synchronization mechanisms for scalable system design.
- Evaluate vector and SIMD processing principles through case studies like CM-5 to identify their effectiveness in solving computationally intensive applications.

UNIT I: Micro Processors

Theory of Parallelism, Parallel computer models, The State of Computing, Multiprocessors and Multi computers, Multi vector and SIMD Computers, PRAM and VLSI models, Architectural development tracks, Program and network properties, Conditions of parallelism, Program partitioning and Scheduling, Program flow Mechanisms, System interconnect Architectures.

UNIT II: Parallel Processing

Principles of Scalable performance, Performance metrics and measures, Parallel Processing applications, Speed up performance laws, Scalability Analysis and Approaches, Hardware Technologies, Processes and Memory Hierarchy, Advanced Processor Technology, Superscalar and Vector Processors

UNIT III: Pipeline Processors

Shared-Memory Organizations, Sequential and weak consistency models, Pipelining and superscalar techniques, Linear Pipeline Processors, Non-Linear Pipeline Processors, Instruction Pipeline design, Arithmetic pipeline design, superscalar pipeline design.

UNIT IV: Architecture of Microprocessors

Parallel and Scalable Architectures, Multiprocessors and Multi computers, Multiprocessor system interconnects, cache coherence and synchronization mechanism, Three Generations of Multi computers, Message-passing Mechanisms, Multi vector and SIMD computers.

UNIT V: Applications

Vector Processing Principles, Multi vector Multiprocessors, Compound Vector processing, SIMD computer Organizations, The connection machine CM-5.

Text Books:

1. Advanced Computer Architecture, Kai Hwang, 2nd Edition, Tata McGraw Hill Publishers.

Reference Books:

1. Computer Architecture, J.L. Hennessy and D.A. Patterson, 4th Edition, ELSEVIER.
2. Advanced Computer Architectures, S.G.Shiva, Special Indian edition, CRC, Taylor &Francis.
3. Introduction to High Performance Computing for Scientists and Engineers, G. Hager and G.Wellein, CRC Press, Taylor & Francis Group.
4. Advanced Computer Architecture, D. Sima, T. Fountain, P. Kacsuk, Pearson education.
5. Computer Architecture, B. Parhami, Oxford Univ. Press.

	CLOUD COMPUTING (Program Elective I)	L	T	P	C
		3	0	0	3

Course Objectives:

- Analyze the trade-offs between deploying applications in the cloud and over the local infrastructure. Compare the advantages and disadvantages of various cloud computing platforms.
- Investigate how a global storage solution can be optimized so that it can be delivered successfully from the cloud
- Evaluate information storage management design in a cloud environment and how it relates to the business objectives of an organization
- Analyze how best to provide reliable access to information both locally and remotely using storage technologies
- Critically appraise the opportunities and challenges of information management in complex business environments.

Course Outcomes:

After the completion of the course, student will be able to

- Deploy applications over commercial cloud computing infrastructures such as Amazon Web Services, Windows Azure, and Google App Engine.
- Program data intensive parallel applications in the cloud.
- Analyze the performance, scalability, and availability of the underlying cloud technologies and software.
- Identify security and privacy issues in cloud computing.
- Solve a real-world problem using cloud computing through group collaboration.

UNIT–I:

Definition, characteristics, components, Cloud service provider, the role of networks in Cloud computing, Cloud deployment models- private, public & hybrid, Cloud service models, multitenancy, Cloud economics and benefits, Cloud computing platforms - IaaS: Amazon EC2, PaaS: Google App Engine, Microsoft Azure, SaaS.

UNIT–II:

Virtualization concepts, Server virtualization, Storage virtualization, Storage services, Network virtualization, Service virtualization, Virtualization management, Virtualization technologies and architectures, virtual machine, Measurement and profiling of virtualized applications. Hypervisors: KVM, Xen, VMware hypervisors and their features

UNIT–III: Relational databases, Cloud file systems: GFS and HDFS, Bigtable, HBase and Dynamo. MapReduce and extensions: Parallel computing, the map -Reduce model, Parallel efficiency of Map Reduce.

UNIT–IV: Cloud security fundamentals, Vulnerability assessment tool for cloud, Privacy and Security in cloud. Cloud computing security architecture: General Issues, Trusted Cloud computing, Secure Execution Environments and Communications, Micro - architectures; Identity Management and Access control, Autonomic security.

UNIT–V: Issues in cloud computing Implementing real time application over cloud platform, Issues in Inter - cloud environments, QOS Issues in Cloud, Dependability, data migration, streaming in Cloud. Quality of Service (QoS) monitoring in a Cloud computing environment. Cloud Middleware.

TEXT BOOKS:

1. Enterprise Cloud Computing by Gautam Shroff, Cambridge publication
2. Gautam Shroff, "Enterprise Cloud Computing Technology Architecture Applications", Cambridge University Press; 1 edition, [ISBN: 978-0521137355], 2010.

REFERENCE BOOKS:

1. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley -India
2. Dr. Kumar Saurabh, "Cloud Computing", Wiley Publication
3. Dimitris N. Chorafas, "Cloud Computing Strategies" CRC Press; 1 edition [ISBN: 1439834539],2010 4. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach" McGraw Hill Osborne Media; 1 edition [ISBN: 0071626948], 200
5. RajkumarBuyya, James Broberg, Andrzej M. Goscinski, "Cloud Computing: Principles and Paradigms", Wiley Publication, 2011
6. Tim Mather, SubraKumaraswamy, Shahed Latif, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance", O'ReillyMediaInc, 2009

	APPLIED MACHINE LEARNING (Program Elective I)	L	T	P	C
		3	0	0	3

Course Objectives:

- To know the fundamental concepts of Machine Learning.
- To understand linear, distance based, and decision tree based models
- To explore tools and practices for Machine learning in Real world situation.
- To know the Artificial Neural Network and Reinforcement Learning.

Course Outcomes: After the completion of the course, student will be able to

- Understand the fundamental concepts of machine learning
- Apply linear, distance based, and decision tree based models
- Analyze probabilistic, neural network models
- Design a suitable machine learning model for a given scenario

UNIT I:

Introduction to Machine Learning: Introduction. Different types of learning, Examples of Machine Learning Applications Supervised Learning: Learning a Class from Examples, Probably Approximately Correct Learning, Learning multiple classes, Model selection and generalization Regression: Linear regression, Multiple Linear regression, Logistic Regression.

UNIT-II:

The ingredients of machine learning: Tasks, Models, Features Binary classification and related tasks: Classification, Assessing classification performance, Visualizing classification performance Beyond binary classification: Multi-class classification, Regression, Unsupervised and descriptive learning

UNIT-III:

Decision Tree learning – Introduction, Decision tree representation, Appropriate problems for decision tree learning, The basic decision tree learning algorithm, Inductive bias in decision tree, Issues in decision tree learning. Linear models: The least-squares method, Multivariate linear regression, The perceptron, Support vector machines, Soft margin SVM, Going beyond linearity with kernel methods.

UNIT –IV:

Distance Based Models: Introduction, Neighbours and exemplars, Nearest Neighbours classification, K-Means algorithms, Clustering around medoids Probabilistic Models: Using Naïve Bayes Model for classification, Expectation Maximization, Gaussian Mixture models

UNIT –V:

Artificial Neural Networks: Introduction, Neural network representation, appropriate problems for neural network learning, Multilayer networks and the back propagation, Advanced topics in Artificial Neural Networks Reinforcement Learning: Introduction, Learning tasks, Q-learning

TEXT BOOKS:

1. Machine Learning: The art and Science of algorithms that make sense of data, Peter Flach, Cambridge University Press, 2012
2. Tom M. Mitchell, Machine Learning, India Edition 2013, McGraw Hill Education

REFERENCE BOOKS:

1. AurélienGéron, Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition
2. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014
3. EthemAlpaydın, Introduction to machine learning, second edition, MIT press.
4. T. Hastie, R. Tibshirani and J. Friedman, "Elements of Statistical Learning", Springer Series, 2nd edition

	NATURAL LANGUAGE PROCESSING (Program Elective-II)	L	T	P	C
		3	0	0	3

Course Objectives :

1. Introduce the fundamental concepts of human language, linguistic structures, and their computational representation for Natural Language Processing.
2. Develop knowledge of grammars, parsing strategies, semantic interpretation, and language modelling techniques for designing NLP systems.
3. Explore advanced NLP applications such as machine translation, multilingual information retrieval, and cross-lingual language processing.

After completing this course, students will be able to:

1. **Understand linguistic foundations** of English syntax and various levels of language analysis for Natural Language Processing.
2. **Apply parsing techniques** such as top-down, bottom-up, ATNs, and feature-based systems for grammatical analysis of natural language.
3. **Analyse different grammar formalisms and parsing approaches** to handle language phenomena like movement, ambiguity, and human preferences in parsing.
4. **Construct semantic representations** using logical forms, thematic roles, and speech acts, and apply n-gram and statistical models for language modeling.
5. **Evaluate and compare machine translation approaches** and demonstrate understanding of systems like Anusaraka for multilingual language processing.
6. **Implement and analyze multilingual information retrieval systems**, applying appropriate pre-processing, evaluation metrics, and tools for cross-lingual retrieval.

UNIT-I:
The Study of Language, Applications of NLP, Evaluating Language Understanding Systems, Different Levels of Language Analysis, Representations and Understanding, Organization of Natural language Understanding Systems, Linguistic Background: An outline of English Syntax.

UNIT-II:
Grammars and Parsing- Top-Down and Bottom-Up Parsers, Transition Network Grammars, Feature Systems and Augmented Grammars, Morphological Analysis and the Lexicon, Parsing with Features, Augmented Transition Networks, Bayes Rule, Shannon game, Entropy and Cross Entropy.

UNIT-III:
Grammars for Natural Language, Movement Phenomenon in Language, Handling questions in Context Free Grammars, Hold Mechanisms in ATNs, Gap Threading, Human Preferences in Parsing, Shift Reduce Parsers, Deterministic Parsers.

UNIT-IV:
Semantic Interpretation: Semantic & Logical form, Word senses & ambiguity, The basic logical form language, Encoding ambiguity in the logical Form, Verbs & States in logical form, Thematic roles, Speech acts &embedded sentences, Defining semantics structure model theory.
Language Modelling: Introduction, n-Gram Models, Language model Evaluation, Parameter Estimation, Language Model Adaption, Types of Language Models, Language-Specific Modelling Problems, Multilingual and Cross lingual Language Modelling.

UNIT-V:

Machine Translation Survey: Introduction, Problems of Machine Translation, Is Machine Translation Possible, Brief History, Possible Approaches, Current Status. Anusaraka or Language Accessor: Background, Cutting the Gordian Knot, The Problem, Structure of Anusaraka System, User Interface, Linguistic Area, Giving up Agreement in Anusarsaka Output, Language Bridges.

Multilingual Information Retrieval: Introduction, Document Pre-processing, Monolingual Information Retrieval, CLIR, MLIR, Evaluation in Information Retrieval, Tools, Software and Resources.

Textbooks:

1. James Allen, Natural Language Understanding, 2nd Edition, 2003, Pearson Education.
2. Multilingual Natural Language Processing Applications: From Theory To Practice-Daniel M.Bikel and ImedZitouni, Pearson Publications.
3. Natural Language Processing, Apaninian perspective, AksharBharathi, Vineetchaitanya, Prentice–Hall of India.

Reference Books:

1. Charniack, Eugene, Statistical Language Learning, MIT Press, 1993.
2. Jurafsky,Dan and Martin, James, Speech and Language Processing, 2nd Edition, Prentice Hall, 2008.
3. Manning, Christopher and Henrich, Schutze, Foundations of Statistical Natural Language Processing, MIT Press, 1999.

	SMART SENSOR NETWORKS & IOT (Program Elective-II)	L	T	P	C
		3	0	0	3

Course Objectives:

- To provide an in-depth understanding of IoT concepts, applications, and research areas in domains such as smart cities, smart health, smart energy, and smart transportation.
- To analyzeIoT system architectures, design constraints, physical devices, communication protocols, and middleware for advanced implementation.
- To explore industrial and commercial IoT applications, including automation, sensor networks, and emerging trends like edge computing, cloud of things, and digital twins.

Course Outcomes: After the completion of the course, student will be able to

- Explain the fundamental concepts, applications, and research areas of IoT across various domains.
- AnalyzeIoT reference architectures, functional and deployment views, and real-world design constraints including hardware, technical, and operational limitations.
- Demonstrate practical knowledge of IoT devices, programming, operating systems, communication protocols, network security, and database management.
- Apply IoT principles to industrial automation and enterprise integration using frameworks such as SOCRADES and IMC-AESOP.
- Evaluate case studies in commercial building automation and emerging IoT trends, including edge/fog computing, predictive maintenance, and digital twin technologies.

UNIT I:

Introduction and Applications: smart transportation, smart cities, smart living, smart energy, smart health, and smart learning. Examples of research areas include for instance: Self-Adaptive Systems, Cyber Physical Systems, Systems of Systems, Software Architectures and Connectors, Software Interoperability, Big Data and Big Data Mining, Privacy and Security IoT Reference Architecture Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

UNIT II:

Real-World Design Constraints- Introduction, Technical Design constraints, hardware, Data representation and visualization, Interaction and remote control.

UNIT III:

IOT Physical Devices & Endpoints: What is an IOT Device, Exemplary Device Board, Linux on Raspberry, Interface and Programming & IOT Device. Hardware Platforms and Energy Consumption, Operating Systems, Time Synchronization, Positioning and Localization, Medium Access Control, Topology and Coverage Control, **Routing:** Transport Protocols, Network Security, Middleware, Databases

UNIT IV:

Industrial Automation-Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial Building Automation-Introduction,

UNIT V:

Case study: phase one-commercial building automation today.

Case study: phase two commercial building automation in the future. Recent trends in sensor network and IOT architecture, Automation in Industrial aspect of IOT.

Textbooks:

1. Mandler, B., Barja, J., MitreCampista, M.E., Cagáová, D., Chaouchi, H., Zeadally, S., Badra, M., Giordano, S., Fazio, M., Somov, A., Vieriu, R.-L., Internet of Things. IoT Infrastructures, Springer International Publication
2. Internet of Things: A Hands-On Approach Paperback – 2015, by ArsheepBahga (Author), Vijay Madisetti (Author)
3. IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Things by Pearson Paperback – 16 Aug 2017 ,by Hanes David (Author), Salgueiro Gonzalo (Author), Grossetete Patrick (Author), Barton Rob (Author).

	COMPUTING FOR DATA ANALYTICS (Program Elective-II)	L	T	P	C
		3	0	0	3

Course Objectives

The course aims to:

1. Provide knowledge of the **data analytics lifecycle**, including business understanding, data science roles, and project deliverables.
2. Develop a strong foundation in **statistical methods, probability, and hypothesis testing** for data-driven decision-making.
3. Equip students with skills to apply **predictive analytics, regression, time series forecasting, and experimental design techniques** to real-world datasets.

Course Outcomes

After completing this course, students will be able to:

1. **Understand the data analytics lifecycle** and identify the roles and responsibilities of data scientists in business analytics projects.
2. **Apply statistical techniques** such as measures of central tendency, variation, skewness, and kurtosis for data summarization and interpretation.
3. **Analyze probability distributions** (binomial, Poisson, normal, exponential, gamma, etc.) and apply them in modeling uncertain events.
4. **Perform hypothesis testing and predictive analytics** using t-tests, chi-square tests, regression, correlation, and multiple correlation methods.
5. **Design forecasting models** (moving average, exponential smoothing, seasonal trends) and conduct **design of experiments** (ANOVA, Latin square, factorial design) for analytical problem solving.

UNIT – I DATA ANALYTICS LIFE CYCLE
Introduction to Big data Business Analytics - State of the practice in analytics role of data scientists - Key roles for successful analytic project - Main phases of life cycle - Developing core deliverables for stakeholders.

UNIT – II STATISTICS
Sampling Techniques - Data classification, Tabulation, Frequency and Graphic representation - Measures of central value - Arithmetic mean, Geometric mean, Harmonic mean, Mode, Median, Quartiles, Deciles, Percentile - Measures of variation – Range, IQR, Quartile deviation, Mean deviation, standard deviation, coefficient variance, skewness, Moments & Kurtosis.

UNIT – III PROBABILITY AND HYPOTHESIS TESTING
Random variable, distributions, joint probability function, marginal density function. Random vectors - Some special probability distribution - Binomial, Poison, Geometric, uniform, exponential, normal, gamma and Erlang - Normal distribution.

UNIT – IV PREDICTIVE ANALYTICS
Sampling distribution – Estimation - point, confidence - Test of significance, 1& 2 tailed test, uses of t-distribution, F-distribution, $\chi 2$ distribution - Predictive modeling and Analysis - Regression Analysis, Correlation analysis, Rank correlation coefficient, Multiple correlation.

UNIT – V TIME SERIES FORECASTING AND DESIGN OF EXPERIMENTS

Forecasting Models for Time series : MA, SES, TS with trend, season - Design of Experiments, one way classification, two way classification, ANOVA, Latin square, Factorial Design.

Text Books:

1. Chris Eaton, Dirk Deroos, Tom Deutsch et al., ―Understanding Big Data, Mc Graw Hill, 2012.
2. Alberto Cordoba, ―Understanding the Predictive Analytics Lifecycle, Wiley, 2014.
3. Eric Siegel, Thomas H. Davenport, ―Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die, Wiley, 2013.

Reference Books:

1. James R Evans,―Business Analytics – Methods, Models and Decisions, Pearson 2013.
2. R. N. Prasad, Seema Acharya, ―Fundamentals of Business Analytics, Wiley, 2015.
3. S M Ross, ―Introduction to Probability and Statistics for Engineers and Scientists‖, Academic Foundation, 2011.
4. David Hand, HeikiMannila, Padhria Smyth, ―Principles of Data Mining, PHI 2013.
5. Spyros Makridakis, Steven C Wheelwright, Rob J Hyndman, ―Forecasting methods and applications Wiley 2013(Reprint).
6. David Hand, HeikkiMannila, Padhraic Smyth, ―Principles of Data mining, PHI 2013.

	ADVANCED DATA STRUCTURES AND ALGORITHMS LAB	L	T	P	C
		0	0	4	2

Course Objectives :

1. To introduce students to the implementation of linear and non-linear data structures using linked representation.
2. To provide practical knowledge on stack and queue operations and their applications in problem solving.
3. To enable students to implement tree structures and perform operations like traversal, insertion, deletion, and balancing.
4. To develop skills in implementing searching and sorting techniques to improve problem-solving efficiency.
5. To expose students to advanced data structures such as AVL Trees, B-Trees, and Hashing for efficient storage and retrieval.
6. To enhance the ability to design, test, and analyze algorithms for graph traversal and dictionary

Course Outcomes:

After completing these experiments, students will be able to:

1. **Implement linear data structures** such as single, double, and circular linked lists to perform insertion, deletion, searching, and traversal operations.
2. **Apply stack and queue concepts** using linked lists to solve real-world computational problems such as expression evaluation and infix-to-postfix conversion.
3. **Develop and test tree-based and Graph-based data structures** including Binary Search Trees, AVL Trees, and B-Trees using recursive and iterative approaches, Graph traversals.
4. **Implement and compare searching and sorting techniques** to analyze their performance and efficiency.
5. **Apply hashing techniques** for efficient dictionary implementation and collision resolution.
6. **Analyze and evaluate the performance of different data structures** to select appropriate techniques for given computational problems.

Experiment 1:
Write a program to perform various operations on single linked list

Experiment 2:
Write a program for the following
a) Reverse a linked list
b) Sort the data in a linked list
c) Remove duplicates
d) Merge two linked lists

Experiment 3: Write a program to perform various operations on doubly linked list.

Experiment 4: Write a program to perform various operations on circular linked list.

Experiment 5: Write a program for performing various operations on stack using linked list.

Experiment 6: Write a program for performing various operations on queue using linked list.

Experiment 7: Write a program for the following using stack
a) Infix to postfix conversion.
b) Expression evaluation.

Experiment 8: Write a program to implement various operations on Binary Search Tree Using Recursive and Non-Recursive methods.

Experiment 9: Write a program to implement the following for a graph. a) BFS b) DFS

Experiment 10: Write a program to implement various Sorting Techniques

Experiment 11: Write a program to implement various Searching Techniques

Experiment 12: Write a program to implement various operations on AVL trees.

Experiment 13: Write a program to perform the following operations:
a) Insertion into a B-tree
b) Searching in a B-tree

Experiment 15: Write a program to implement all the functions of Dictionary (ADT) using Hashing.

References:

1. **Ellis Horowitz, SartajSahni, and SanguthevarRajasekaran** – *Fundamentals of Computer Algorithms*, Universities Press, 2008.
2. **Mark Allen Weiss** – *Data Structures and Algorithm Analysis in C++ / Java*, Pearson Education, 4th Edition, 2013.
3. **Seymour Lipschutz** – *Data Structures with C*, Schaum's Outline Series, McGraw Hill, 2011.
4. **Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein** – *Introduction to Algorithms*, MIT Press, 3rd Edition, 2009.

	DISTRIBUTED OPERATING SYSTEMS LAB	L	T	P	C
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Course Objectives

1. To provide hands-on experience in implementing synchronization, deadlock detection, and resource management algorithms in distributed and multiprocessor systems.
2. To develop the ability to design and simulate mechanisms for fault tolerance, load balancing, task migration, and secure communication using cryptographic techniques.
3. To enable students to apply concurrency control methods in distributed databases and critically analyze the performance of various distributed algorithms.

Course Outcomes:

After completing this lab, students will be able to:

1. Implement and analyze synchronization mechanisms in distributed environments.
2. Develop and evaluate distributed deadlock detection techniques.
3. Design and implement distributed shared memory models and scheduling algorithms.
4. Apply security and cryptographic techniques to distributed systems.
5. Implement concurrency control algorithms in database operating systems.
6. Gain hands-on experience in developing efficient multiprocessor operating system components.

List of Experiments

Unit I: Architectures & Synchronization

1. **Implementation of Lamport's Logical Clocks** – Simulate logical clock updates in a distributed system.
2. **Vector Clocks and Causal Ordering** – Implement vector clocks and analyze message ordering.
3. **Distributed Mutual Exclusion Algorithms** – Implement Ricart-Agrawala and Maekawa's mutual exclusion algorithms.

Unit II: Deadlock Detection & Resource Management

4. **Simulation of Distributed Deadlock Detection Algorithms** – Implement centralized and distributed deadlock detection techniques.
5. **Hierarchical Deadlock Detection** – Implement a hierarchical approach to detecting deadlocks in a distributed system.

Unit III: Shared Memory, Scheduling & Fault Tolerance

6. **Implementation of Load Balancing Algorithms** – Compare load balancing techniques (static and dynamic).
7. **Task Migration Mechanism** – Implement and analyze task migration in a distributed system.

Unit IV: Security & Cryptography

8. **Access Matrix Model Implementation** – Simulate access control using an access matrix.
9. **Implementation of Data Encryption Standard (DES) Algorithm** – Encrypt and decrypt messages using DES.
10. **Public Key Cryptography using RSA** – Implement RSA encryption and authentication mechanisms.

Unit V: Multiprocessor & Database OS

11. **Process Synchronization in Multiprocessor Systems** – Implement and analyze thread synchronization.
12. **Concurrency Control using Lock-Based Algorithms** – Implement two-phase locking protocol.
13. **Timestamp-Based Concurrency Control** – Develop a timestamp-based concurrency control mechanism.
14. **Optimistic Concurrency Control Algorithm** – Implement an optimistic concurrency control protocol.

References

1. **MukeshSinghal and Niranjan G. Shivaratri** – *Advanced Concepts in Operating Systems: Distributed, Database, and Multiprocessor Operating Systems*, McGraw Hill, 2001.
2. **Andrew S. Tanenbaum and Maarten Van Steen** – *Distributed Systems: Principles and Paradigms*, Pearson Education, 2nd Edition, 2007.
3. **George Coulouris, Jean Dollimore, Tim Kindberg, and Gordon Blair** – *Distributed Systems: Concepts and Design*, Pearson Education, 5th Edition, 2012.
4. **Pradeep K. Sinha** – *Distributed Operating Systems: Concepts and Design*, PHI Learning, 2008.

	FULL STACK DEVELOPMENT USING MERN (Skill Enhancement Course)	L	T	P	C
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Course Objectives:
The course aims to:

- Provide strong foundations in web development technologies (HTML, CSS, JavaScript, ES6).
- Introduce server-side programming with Node.js and Express.js for building scalable applications.
- Enable students to work with relational (MySQL) and non-relational (MongoDB) databases.
- Impart skills to design and develop interactive user interfaces using ReactJS.
- Enhance problem-solving abilities through full-stack web application development experiments.

Course Outcomes (COs) :
After completing the course, the students will be able to:
CO1: Apply fundamental web technologies (HTML, CSS, JavaScript, ES6) to design responsive web pages.
CO2: Develop server-side applications using Node.js and Express.js with REST API integration.
CO3: Perform database operations using MySQL and MongoDB and integrate them with backend services.
CO4: Design and implement dynamic, component-based user interfaces using ReactJS.
CO5: Develop and deploy full-stack applications by combining frontend, backend, and database skills.
CO6: Demonstrate problem-solving, debugging, and version control skills in web development projects.

Module 1: Web Development Fundamentals
Fundamentals of Web Design, Webpage and Website, Web application HTML Typography, Images, Tables, Lists, Hyperlinks etc. CSS Syntax and usage, CSS Selectors, CSS on body, CSS on Text, CSS on Links, CSS on Tables, CSS on Lists, CSS on Forms, CSS on Images, CSS on DIV, W3.CSS Framework

List of Experiments :

- **HTML & CSS Basics** – Create a personal portfolio webpage using HTML (headings, lists, tables, hyperlinks, forms) and style it with CSS selectors.
- **Responsive Layout** – Develop a responsive webpage using DIV, CSS box model, and W3.CSS framework.
- **Styled Components** – Design a webpage for a college event with images, tables, and styled navigation menu using CSS.

Module 2: JavaScript and ECMA Script 6
JavaScript Fundamentals - Grammar and types, Control flow and error handling - Loops, Function - Objects, Arrays, Promises - ES6 Let and const, Template literals - Arrow Function, Default parameter, Async Await

List of Experiments :

- **JavaScript Fundamentals** – Build a simple calculator app using functions, loops, and control flow.
- **Array & Object Manipulation** – Write a program using ES6 features (let/const, arrow functions, template literals) to manage student records.
- **Async Programming** – Create a webpage that fetches and displays random user data from a public API using Promises and Async/Await.

Module 3: Node.js

overview, Node.js - basics and setup - Node.js console, Node.js command utilities - Node.js modules, concepts - Node.js events, database access - Node.js with Express.js, Express.js Request/Response - Express.js Get, Express.js Post - Express.js Routing, Express.js Cookies - Express.js File Upload, Middleware - Express.js Scaffolding, Template

List of Experiments:

- **Node.js Basics** – Write a Node.js script to create a local server and display "Hello World" in the browser.
- **Express.js Routing** – Build a REST API with Express.js that handles GET and POST requests for a student information system.
- **File Handling** – Develop a Node.js application to upload, read, and display a text/JSON file using Express middleware.

Module 4: MySQL and MongoDB

MySQL Concepts - Create, Read, Update, Delete Operation - SQL and NoSQL concepts - Create and manage MongoDB - Migration of data into MongoDB - MongoDB with NodeJS - Services offered by MongoDB

List of Experiments :

- **MySQL CRUD** – Create a MySQL database for employee records and perform Create, Read, Update, Delete (CRUD) operations.
- **MongoDB CRUD with Node.js** – Build a Node.js application that connects to MongoDB and manages student data.
- **Migration Project** – Write a script to migrate data from MySQL to MongoDB and display it through a Node.js API.

Module 5: React JS

ReactJS introduction and overview - ReactJS installation and environment setup - Introducing JSX, Rendering Elements - Components and Props - State and Lifecycle - Handling Events - Conditional Rendering - Lists and Keys, Forms - Lifting State Up

List of Experiments :

- **React Components** – Build a React app to display a list of courses using functional components and props.
- **State & Events** – Create a counter and a form component in React using useState and event handling.
- **Conditional Rendering & Lists** – Develop a React to-do list application with add/delete functionality and conditional rendering of completed tasks.

Textbooks

1. **Alex Banks, Eve Porcello** – *Learning React: Modern Patterns for Developing React Apps*, O'Reilly.
2. **StoyanStefanov** – *React Up & Running: Building Web Applications*, O'Reilly.
3. **Mario Casciaro, Luciano Mammino** – *Node.js Design Patterns*, Packt.
4. **Seyed M.M. Iravani** – *Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics*, O'Reilly.

Reference Books

1. **Robin Wieruch** – *The Road to React*, Leanpub.
2. **Carl Rippon** – *React 18 Design Patterns and Best Practices*, Packt.
3. **KirupaChinnathambi** – *Learning React: A Hands-On Guide to Building Web Applications*, Addison-Wesley.

4. **Ethan Brown** – *Web Development with Node and Express: Leveraging the JavaScript Stack*, O'Reilly.
5. **Kristina Chodorow** – *MongoDB: The Definitive Guide*, O'Reilly.
6. **Ben Forta** – *SQL in 10 Minutes, Sams Teach Yourself*, Sams Publishing.