Course Code	Course Name	Load Distribution (L T P C)
TCS 801	Distributed System	3 0 0 3

Learning Outcome:

After Completing this course students will be able to learn:

1. Extend the hardware and software concepts. Designing issues like transparency, synchronization using clocks.
2. Interpretation of several resources and scheduling in distributed operating system. Concept of deadlock and several techniques to overcome from deadlocks.
3. Identify several techniques of cryptographic algorithm for providing authentication, authorization and validation among end users.
4. Distinguish several types of transaction and various types of lock. Time stamp ordering and various types of concurrency protocols.
5. Determine the concept for communication protocol and routing algorithm to determine the route followed by the nodes in the network. Choose several algorithms to provide priority to processes accessing the resources.

Detailed Syllabus:

UNIT-I **8 Hours**

Characterization of Distributed Systems: Introduction, Examples of distributed systems, Resource sharing and the web challenges, System Models: Architectural models, Fundamental Models,
Theoretical Foundation for Distributed System: Limitation of distributed system, Absence of global clock, Shared memory, Logical clocks, Lamport's & vectors logical clocks, Causal ordering of messages, Global state, Termination detection.
Distributed Mutual Exclusion: Classification of distributed mutual exclusion, Requirement of mutual exclusion theorem, Token based and non token based algorithms, Performance metric for distributed mutual exclusion algorithms.

UNIT-II **10 Hours**

Distributed DeadlockDetection: System model, Resource Vs communication deadlocks, Deadlock prevention, Avoidance, Detection & resolution, Centralized dead lock detection, Distributed dead lock detection, Path pushing algorithms, Edge chasing algorithms,
Agreement Protocols: Introduction, System models, Classification of Agreement problem, Byzantine agreement problem, Consensus problem, Interactive consistency problem, Solution to Byzantine Agreement problem, Application of Agreement problem.

UNIT-III **8 Hours**

Distributed Objects and Remote Invocation: Communication between distributed objects, Remote procedure call, Events and notifications, Java RMI case study,
Security: Overview of security techniques, Cryptographic algorithms, Digital signatures Cryptography pragmatics, Case studies: Needham Schroeder, Kerberos, SSL& Millicent,
Distributed File Systems: File service architecture, Sun Network File System, The Andrew File System, Recent advances.

UNIT-IV **8 Hours**

Transactions and Concurrency Control: Transactions, Nested transactions, Locks, Optimistic concurrency control, Timestamp ordering, Comparison of methods for concurrency control.

UNIT-V **8 Hours**

Distributed Algorithms: Introduction to communication protocols, Balanced sliding window protocol, Routing algorithms, Destination based routing, APP problem, Deadlock free Packet switching, Introduction to Wave & traversal algorithms, Election algorithm. CORBA Case study, CORBA RMI, CORBA services.

Text Books:

1. Singhal&Shivaratri, "Advanced Concept in Operating Systems", McGraw Hill, 2001.
2. Coulouris, Dollimore, Kindberg, "Distributed System: Concepts and Design", Pearson, 2009.

Course Code	Course Name	Load Distribution (L T P C)
TCS 821	**Knowledge Management**	**3 0 0 3**

Learning Outcome:

After Completing this course students will be able to learn:

1. Understand the fundamentals of knowledge representation (logic-based, frame-based, semantic nets), able to Translate English into first order logic and vice versa and will be able to do knowledge acquisition.

2. Able to do reasoning and frame rules in production system.

3. Understand the taxonomies and classification in the knowledge representation.

4. Able to understand uncertainty and degrees of belief for solving the problem.

5. Able to solve the complex problem and apply the different planning methods.

Detailed Syllabus:

UNIT-I **8 Hours**

Introduction: Key concepts, Knowledge representation and reasoning, Language of first order logic, Syntax, semantic pragmatics, Expressing knowledge, Levels of representation, Knowledge acquisition and sharing, Sharing ontology, Language Ontology, Language Patterns, Tools for knowledge acquisition.

UNIT-II **8 Hours**

Resolution and Reasoning: Proportional case, Handling variables and qualifies, Dealing with intractability, Reasoning with horn clauses, Procedural control of reasoning, Rules in production, Description logic, Vivid knowledge, Beyond vivid.

UNIT-III **8 Hours**

Representation: Object oriented representations, Frame formalism, Structured descriptions, Meaning and entailment, Taxonomies and Classification, Inheritance, Networks strategies for defensible inheritance, Formal account of inheritance networks.

UNIT-IV **9 Hours**

Defaults, Uncertainty and Expressiveness: Defaults, Introduction to closed world reasoning, Circumscription, Default logic limitations of logic, Fuzzy logic, Non-monatomic logic, Theories and world semiotics Auto epistemic logic, Vagueness, Uncertainty and Degrees of belief, Non-categorical reasoning, Objective and subjective probability.

UNIT-V **9 Hours**

Actions and Planning: Explanation and diagnosis, Purpose, Syntax, Semantics of context, First order reasoning, Modal reasoning in context, Encapsulating objects in context, Agents, Actions, Situational calculus, Frame problem, Complex actions, Planning, Strips, Planning as reasoning, Hierarchical and conditional planning.

Text Books:

1. Ronald Brachman, Hector Levesque “Knowledge Representation and Reasoning”, The Morgan Kaufmann Series in Artificial Intelligence 2004.

2. John F. Sowa, " Knowledge Representation: Logical, Philosophical, and Computational Foundations", 2000.

Reference Books:

1. Arthur B. Markman, "Knowledge Representation", Lawrence Erlbaum Associates, 1998.

Course Code	Course Name	Load Distribution (L T P C)
TCS 822	**Data Storage Networks**	**3 0 0 3**

Learning Outcome:

After Completing this course students will be able to :

1. Understand different types of storage technology .
2. Apply various types of storage technology .
3. Define the input-output techniques in storage network.
4. Define the storage virtualization.
5. Manage the different types of storage networks.

Detailed Syllabus

UNIT-I **8 Hours**

Introduction to Storage Technology: Introduction to storage network, Five pillars of IT, parameters related with storage, data proliferation, problem caused by data proliferation, Hierarchical storage management, Information life cycle management (ILM), Role of ILM, Information value vs. time mapping, Evolution of storage, Storage infrastructure component, basic storage management skills and activities, Introduction to Datacenters, Technical & Physical components for building datacenters

UNIT-II **8 Hours**

Technologies for Storage network: Server centric IT architecture & its limitations, Storage centric IT architecture & advantages, replacing a server with storage networks, Disk subsystems, Architecture of disk subsystem, Hard disks and Internal I/O channel, JBOD, RAID& RAID levels, RAID parity, comparison of RAID levels, Hot sparing, Hot swapping, Caching : acceleration of hard disk access, Intelligent Disk subsystem architecture

Tape drives: Introduction to tape drives, Tape media, caring for Tape& Tape heads, Tape drive performance, Linear tape technology, Helical scan tape technology

UNIT-III **8 Hours**

I/O techniques: I/O path from CPU to storage systems, SCSI technology – basics & protocol, SCSI and storage networks, Limitations of SCSI

Fiber channel: Fiber channel, characteristic of fiber channel, serial data transfer vs. parallel data transfer, Fiber channel protocol stack, Links, ports & topologies, Data transport in fiber channel, Addressing in fiber channel, Designing of FC-SAN, components, Interoperability of FCSAN, FC products

IP Storage: IP storage standards (iSCSI, iFCP, FCIP, iSNS), IPSAN products, Security in IP SAN, introduction to infini band, Architecture of Infini band

NAS – Evolution, elements & connectivity, NAS architecture,

UNIT-IV **8 Hours**

Storage Virtualization: Introduction to storage virtualization, products, definition, core concepts, virtualization on various levels of storage network, advantages and disadvantages, Symmetric and asymmetric virtualization, performance of San virtualization, Scaling storage with virtualization

UNIT-V **8 Hours**

Management of storage Networks: Management of storage network, SNMP protocol, requirements of management systems, Management interfaces, Standardized and proprietary mechanism, In-band& Out-band management, Backup and Recovery

Text Book:

1. "Storage Networks: The Complete Reference", R. Spalding, McGraw-Hill
2. "Storage Networking Fundamentals: An Introduction to Storage Devices, Subsystems, Applications, Management, and Filing Systems", Marc Farley, Cisco Press
3. "Designing Storage Area Networks: A Practical Reference for Implementing Fibre Channel and IP SANs, Second Edition", Tom Clark Addison Wesley

Course Code	Course Name	Load Distribution (L T P C)
TCS 823	**Natural Language Processing**	**3 0 0 3**

Learning Outcome:

After Completing this course students will be able to learn:

1. The basics of human speech and natural languages and algorithms to transduce the speech and language inputs into parsable tokens.
2. To create models for tagging human speech and natural language units and parsing tokens using Finite state machines and Context Free Grammers.
3. To create unification algorithms based on feature structures and implement lexicalized and probabilistic parsing.
4. The meaning structures of language and to apply semantic analysis techniques to lexemes and their relationship and to create a database of lexical relations.
5. The techniques of word sense disambiguation and methods of information retrieval and to create systems which can generate natural language.

Detailed Syllabus

UNIT-I **8 Hours**

Introduction: Knowledge in speech and language processing, Ambiguity-models and algorithms, Language thought and understanding regular expressions and automata, Regular expressions, Finite state automata, Morphology and finite-state transducers, Survey of english morphology, Finite-state Morphological parsing, Combining FST lexicon and rules, Lexicon, Free FSTs, The porter stammer, Human morphological processing.

UNIT-II **9 Hours**

Syntax : Word classes and part-of-speech tagging, English word classes, Tagsets for English, Part-of-speech tagging, Rule-based part-of-speech tagging, Stochastic part-of-speech tagging, Transformation-based tagging, Other issues, Context-Free grammars for English, Constituency, Context-Free rules and trees, Sentence-level constructions, The noun phrase, Coordination, Agreement, Verb phase and sub categorization, Auxiliaries, Spoken language syntax, Grammars equivalence and normal form, Finite-State and Context-Free grammars, Grammars and human processing, Parsing with context-Free grammars, Parsing as search, Basic top-down parser, Problems with the basic top-down parser, Early algorithm, Finite-State parsing methods.

UNIT-III **8 Hours**

Advanced Features and Syntax: Features and unification, Feature structures, Unification of feature structures, Features structures in the grammar, Implementing unification, Parsing with unification constraints, Types and Inheritance, Lexicalized and probabilistic parsing, Probabilistic context-free grammar, Problems with PCFGs , Probabilistic lexicalized CFGs, Dependency Grammars, Human parsing.

UNIT-IV **8 Hours**

Semantics: Representing Meaning: Computational desiderata for representations, Meaning structure of language, First order predicate calculus, Some linguistically relevant concepts,

Related representational approaches, Alternative approaches to meaning, **Semantic Analysis:** Syntax-Driven semantic analysis, Attachments for a fragment of English, Integrating semantic analysis into the early parser, Idioms and compositionality, Robust semantic analysis, **Lexical semantics:** Relational among lexemes and their senses, **WordNet:** A database of lexical relations, Internal structure of words, Creativity and the lexicon.

UNIT-V **9 Hours**

Application: Word Sense Disambiguation and Information Retrieval: Selectional restriction-based disambiguation, Robust word sense disambiguation, Information retrieval, other information retrieval tasks, **Natural Language Generation:** Introduction to language generation, Architecture for generation, Surface realization ,Discourse planning, Other issues, **Machine Translation:** Language similarities and differences, Transfer metaphor, **Interlingua idea:** Using meaning, Direct translation Using statistical techniques, Usability and system development.

Text Books:

1. Daniel Jurafsky& James H.Martin, " Speech and Language Processing", Pearson Education (Singapore) Pte.Ltd., 2002.

Reference Books:

1. James Allen, "Natural Language Understanding", Pearson Education, 2003.

Course Code	Course Name	Load Distribution (L T P C)
TCS 824	**Building Enterprise Applications**	**3 0 0 3**

Learning Outcome:

After Completing this course students will be able to learn:

1. Understand enterprise application and their types and software engineering methodologies.
2. Designing prototypes for business models, functional and non functional requirements.
3. Apply techniques for the development of various networking and communication protocols.
4. Evaluation of test cases that can be used for testing.
5. Implementation of methods and strategies for development of enterprise application for business.

Detailed Syllabus

UNIT-I **8 Hours**

Introduction to enterprise applications and their types, software engineering methodologies, life cycle of raising an enterprise application, introduction to skills required to build an enterprise application, key determinants of successful enterprise applications, and measuring the success of enterprise applications

UNIT-II **8 Hours**

Inception of enterprise applications, enterprise analysis, business modeling, requirements elicitation, use case modeling, prototyping, non functional requirements, requirements validation, planning and estimation

UNIT-III **8 Hours**

Concept of architecture, views and viewpoints, enterprise architecture, logical architecture, technical architecture - design, different technical layers, best practices, data architecture and design – relational, XML, and other structured data representations, Infrastructure architecture and design elements - Networking, Internetworking, and Communication Protocols, IT Hardware and Software, Middleware, Policies for Infrastructure Management, Deployment Strategy, Documentation of application architecture and design

UNIT-IV **8 Hours**

Construction readiness of enterprise applications - defining a construction plan, defining a package structure, setting up a configuration management plan, setting up a development environment, introduction to the concept of Software Construction Maps, construction of technical solutions layers, methodologies of code review, static code analysis, build and testing, dynamic code analysis – code profiling and code coverage

UNIT-V **8 Hours**

Types and methods of testing an enterprise application, testing levels and approaches, testing environments, integration testing, performance testing, penetration testing, usability testing, globalization testing and interface testing, user acceptance testing, rolling out an enterprise application.

Text Book:

1. Raising Enterprise Applications – Published by John Wiley, authored by Anubhav Pradhan, Satheesha B. Nanjappa, Senthil K. Nallasamy, Veera kumar Esakimuthu
2. Building Java Enterprise Applications – Published by O'Reilly Media, authored by Brett McLaughlin

Course Code	Course Name	Load Distribution (L T P C)
TCS– 831	Advanced Computer Architecture	3 0 0 3

Learning Outcome:

After completing this course students will be able to:

1. Understand the principles of Computer Design and measure performance enhanced.
2. Examine different types of hazards in instruction pipelining and conclude some optimized techniques.
3. Perceive modern architectures such as RISC, Super Scalar, VLIW.
4. Design the overall organization of cache, virtual memories and pipelined processors.
5. Evaluate various multiprocessing configurations.

Detailed Syllabus:

UNIT-I **8 Hours**

Introduction: Review of basic computer architecture, quantitative techniques in computer design, measuring and reporting performance. CISC and RISC processors.

UNIT-II **8 Hours**

Pipelining: Basic concepts, instruction and arithmetic pipeline, data hazards, control hazards, and structural hazards, techniques for handling hazards.Exception handling.Pipeline optimization techniques.Compiler techniques for improving performance.

UNIT-III **8 Hours**

Instruction-level parallelism: basic concepts, techniques for increasing ILP, superscalar, super pipelined and VLIW processor architectures. Array and vector processors.

UNIT-IV **8 Hours**

Hierarchical memory technology: Inclusion, Coherence and locality properties; Cache memory organizations, Techniques for reducing cache misses; Virtual memory organization, mapping and management techniques, memory replacement policies.

UNIT-V **8 Hours**

Multiprocessor architecture: Taxonomy of parallel architectures. Centralized shared-memory architecture: synchronization, memory consistency, interconnection networks. Distributed shared-memory architecture. Cluster computers. Non von Neumann architectures: data flow computers, reduction computer architectures.

Text Books:

1. Computer Architecture: A Quantitative Approach by John L. Hennessy, David A. Patterson, 5th edition, Morgan Kaufmann
2. Advanced Computer Architecture by Kai Hwang, McGrawHill Publishing

Course Code	Course Name	Load Distribution (L T P C)
TCS – 832	Embedded Systems	3 0 0 3

Learning Outcome:

After Completing this course students will be able to:

1. Define the embedded system and its classification. .
2. Understand the services and buses for device network.
3. Design the embedded system programming in c and c++.
4. Understand real time operating system and their handling.
5. Understand software development methodology

Detailed Syllabus

UNIT-I **8 Hours**

Introduction to Embedded Systems: **Definition and Classification:** Overview of processors and hardware units in an embedded system, Software embedded into the system, Exemplary embedded systems, Embedded systems on a Chip (SoC) and the use of VLSI designed circuits, Embedded micro controller cores, Embedded memories, Examples of embedded systems.

UNIT-II **9 Hours**

Devices and Buses for Devices Network:I/O Devices, Device I/O types and examples, Synchronous, ISO, Synchronous and asynchronous communications from Serial devices , Examples of internal serial, Communication devices, UART and HDLC, Parallel port Devices, Sophisticated interfacing features in devices/ports, Timer and counting devices ,'12C', 'USB', 'CAN' and advanced I/O serial high speed buses, ISA, PCI, PCI-X, CPCI and advanced buses.

UNIT-III **8 Hours**

Programming Concepts and Embedded Programming In C, C++: Programming in assembly language (ALP) vs. High level language, C Program elements, Macros and functions, Use of pointers, NULL Pointers, Use of function calls, Multiple function calls in a Cyclic order in the main function pointers, Function queues and interrupt service routines queues pointers, Concepts of Embedded programming in C++, Objected Oriented Programming, Embedded Programming in C++, 'C' Program compilers, Cross compiler, Optimization of memory codes.

UNIT-IV **10 Hours**

Real Time Operating Systems: Definitions of process, tasks and threads, ISRs and tasks by their characteristics, Operating system services, Structures, Kernel, Process management, Memory management, Device management, File system organisation and implementation, I/O Subsystems, **Interrupt routines Handling in RTOS:**RTOS task scheduling models, Handling of task scheduling and latency and deadlines as performance metrics, Co-operative Round Robin scheduling, Cyclic scheduling with time slicing (Rate Monotonics Co-operative Scheduling), Preemptive scheduling model strategy by a Scheduler, Critical section service by a preemptive scheduler, Fixed (Static) real time scheduling of tasks, Inter process communication and synchronisation, Shared data problem, Use of semaphore(s), Priority Inversion problem and deadlock situations, Inter process communications using signals, Semaphore flag or mutex as resource key, Message queues, Mailboxes, Pipes, Virtual (Logical)

sockets, Remote Procedure Calls (RPCs)-Case study of Micro C/OS-II or VX works or any other popular RTOS.

UNIT-V **7 Hours**

Software Development Methodology: Real-time UML (RoseRT), DOORS, Case studies, Controlling an Injection moulding process, Flight simulator, digital call center handler, Codec.

Text Books:

1. Rajkamal, Embedded Systems Architecture, Programming and Design, TATA McGraw- Hill, 2008.
2. Jack Ganssle, The Art of Designing Embedded Systems, Newnes, 2008.

Reference Book:

1. C.M. Krishna and Kang G. Shin, RTS: Real-Time Systems, McGraw-Hill, 2010.

Course Code	Course Name	Load Distribution (L T P C)
TCS – 833	Data Mining and Warehousing	3 0 0 3

Learning Outcome:

After Completing this course students will be able to learn:

1. Understand Data Warehouse concepts including its components.
2. Designing pre processing methods for data transformation
3. Applying techniques for content based mining and association mining.
4. Development of tools for the predictions and classification.
5. Implementation of techniques used for web based and text mining.

Detailed Syllabus

UNIT-I **10 Hours**

Data Warehousing: Introduction, data warehouse, Multidimensional data model, Data warehouse architecture, Implementation, Data warehousing to data mining, Data warehousing components, Building a data warehouse, Mapping the Data warehouse to an architecture, Data extraction, Cleanup, Transformation tools, Metadata, OLAP, Patterns and models, Data visualization principles.

UNIT-II **8 Hours**

Data preprocessing language, Architectures, Concept description, Preprocessing, Cleaning, Integration, Transformation, Reduction, Discretization, Concept hierarchy Generation, Data mining primitives, Query language, Graphical user interfaces, Concept description, Data generalization, Characterizations, Class comparisons, Descriptive statistical measures.

UNIT-III **8 Hours**

Association Rule: Association rule mining, Single-dimensional Boolean association Rules from transactional databases, Multi-level association rules from transaction databases, Mining multidimensional association rules, Association mining to correlation analysis, Constraint based association mining.

UNIT-IV **8 Hours**

Classification and Prediction: Classification and prediction, Issues, Decision tree Induction, Bayesian classification, Association rule based, Other classification methods, Prediction, Classifier accuracy.

UNIT-V **8 Hours**

Cluster Analysis: Cluster analysis, Types of data, Categorization of methods, Partitioning methods, Hierarchical methods, Density based methods, Grid based methods, Outlier analysis, Recent trends, Multidimensional analysis and descriptive mining of complex data objects, Spatial databases, Multimedia databases, Time series and sequence data, Text databases, World Wide Web, applications and trends in data mining

Text Books:

1. J. Han and M. Kamber, “Data Mining: Concepts and Techniques”, Harcourt India MorganKauffman, 2001.

2. Alex Berson and Stephen J. Smith, “Data Warehousing, Data mining and OLAP”, Tata McGraw-Hill, 2004.

Reference Books:

1. Margaret H. Dunham, “Data Mining: Introductory and Advanced Topics”, Pearson Education, 2004.

Course Code	Course Name	Load Distribution (L T P C)
TCS – 834	Machine Learning	3 0 0 3

Learning Outcome:

After Completing this course students will be able to learn:

1. Have a good understanding of the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.
2. Have an understanding of the strengths and weaknesses of many popular machine learning approaches.
3. Appreciate the underlying relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.
4. Utilize the structure and design concepts of neural networks applications to solve real life problems
5. Plan and execute successful machine learning and big data projects, including selecting an adequate process for the specific task and avoiding the machine learning pitfalls.

Detailed Syllabus:

UNIT I

Review of Statistical Concepts used in Machine Learning: Mode of Dataset, Finding Mean, Mean with Outlier, Requirement for Median, Finding Median, Median with outlier, Range, Average Deviation, Absolute Deviations, Squared Deviations, Sum of Squares, Standard Deviation

Machine Learning Foundations: What is Machine Learning, Definition of learning systems. Goals and applications of machine learning, Dataset, training, tuning, Basic understanding of different approaches in machine learning, Use of machine learning in real world

UNIT II

Supervised Learning: Introduction, Regression and Classification

Decision Trees: Introduction, Decision tree representation, Decision trees Learning, Appropriate problems for decision tree learning, basic decision tree algorithm, Decision tree accuracy, Data Impurity and Entropy, Entropy calculation, Decision Tree Strength and Weaknesses

UNIT III

Bayesian Learning: Naïve Bayes, Probability theory and Bayes rule. Bayesian Learning

Instance Based Learning: Introduction, K-Nearest Neighbor

Neural Networks: Introduction, Perceptron Training, Multilayer Network and Back Propagation Algorithm

UNIT IV

Unsupervised Learning and Clustering: Introduction, Clustering, K-means clustering, Soft Clustering, Clustering properties, Impossibility Theorem
Feature Scaling, Feature Selection

UNIT V

Reinforcement Learning: Introduction, Markov Decision Processes
Deep Learning: Introduction, Deep Neural Networks, Convolution Neural Networks

Text Books

1. Machine Learning by Tom M. Mitchell, McGraw Hill International Edition

Reference Books

1. Practical Statistics for Data Scientists by Peter Bruce and Andrew Bruce, Shroff/O'Reilly; First edition (15 June 2017)
2. Foundations of Machine Learning (Adaptive Computation and Machine Learning series) by Mehryar Mohri, Afshin Rostamizadeh and Ameet Talwalkar, The MIT Press
3. Python Machine Learning by Example by Yuxi Liu, Packt Publishing Limited, 2017 edition