Syllabus for 4 Year B. Tech Course in Computer Science and Engineering (Artificial Intelligence)

Fifth Semester

Career Advancement & Skill Development-V SAP (TIU-UTR-S313)
Contact Hours/Week: 2–0–0 (L–T–P)
Credit: Sessional–2

Course Content

Module-1: SAP System Architecture
SAP System Architecture and flow of a program
Module-2: Object Navigator, Repository and ABAP Programs
SAP Object Navigator and Repository, Developing Programs and Organizing Developments, Creating Packages, Developing a Program in ABAP, Creating Transaction in SAP, How to add Transactions to your Personal Favorites, How to create an ABAP program
Module-3: Basic ABAP statements, ABAP Structures and ABAP Logical Expressions
Working with Elementary Data Objects, Basic ABAP statements, Performing ABAP calculations, ABAP Calculator, ABAP Conditional Statements, ABAP Logical Expressions, ABAP Loops, ABAP Search Helps F4, ABAP Elementary Search Help, String Manipulation
Module-4: Selection Screen In ABAP
Radio Button, Check Box
Module-5: ABAP Object Oriented Programming
Concept of OOP, Creating Class, Creating Object, Methods, Creating Interface
Module-6: Creating Structure In ABAP
Module-7: Transparent Tables in the ABAP Dictionary
Data Modeling and ABAP Dictionary, How to create transparent tables,Table Maintenance Generator, Viewing data in transparent tables
Module-8: ABAP Database Handling
Concept of Data Base, Open SQL,Modification of Transparent Table using Open SQL, SAP Data Retrieval Using A Select Loop, Open SQL ABAP JOIN Statement
Module-9: ABAP Subroutines
ABAP Subroutines and procedures, ABAP Modularization, ABAP Include Programs
Module-10: ABAP ALV Grid Control
Overview of ALV Programming, ALV Report Generation

Design and Analysis of Algorithms (TIU-UCS-T321)
Contact Hours/Week: 3–0–0 (L–T–P)
Credit: Theory–3

Course Outcome

CO1	Be familiar with the basic concepts of designing, analyzing and implementing of an algorithm
CO2	Capable of classifying the problem feature to devise an efficient algorithm
CO3	Able to identify the tractable and in-tractable problems
CO4	Get acquainted with real-life problem solving in terms of algorithm design, implement and complexity analysis

Course Content

Module-1: Foundation of Algorithm & Analysis

Introduction to algorithm design and importance of its analysis, Asymptotic notations and their significance, Complexity analysis of algorithms – best case, worst case and average case with example of Insertion sort, Quick sort and Heap sort, Time & space trade-offs, Analysis of recursive algorithms – Substitution method, Recursion tree method and Masters' theorem, Lower bound for comparison-based sort.

Module-2: Algorithmic Paradigms

Classification of algorithm design techniques for problem solving: Brute-force, Divide-and-Conquer, Greedy, Dynamic Programming, Backtracking and Branch-and-Bound, Methodology and application domains, Illustration of the techniques with suitable examples: Activity selection, Huffman code, Knapsack problem, Matrix Chain Multiplication, 8-Queen problem, 15-puzzle problem. [extra problem in tutorial]

Module-3: Graph Algorithms

Traversal algorithms: DFS, BFS - concept, complexity analysis and applications, Minimum Spanning Tree finding algorithm: Prim's, Kruskal - concept, complexity analysis, Disjoint set operations, shortest path finding algorithm: single source and all pairs –Bellman-Ford, Dijkstra and Floyd-Warshall, Topological sort, Network flow algorithm: Ford-Fulkerson, Max-flow Min-cut theorem.

Module-4: Problem Reducibility and NP-completeness

Problem classification on Computability: P, NP, NP-complete and NP-hard, Reducibility of NP-complete problems with example – Satisfiability, Vertex cover, Traveling Salesman problem, Cook's theorem.

Module-5: Advanced Topics

Approximation algorithm, Randomized algorithm technique Amortized analysis.

Recommended Books:

Main Reading

1. T. H. Cormen, C. L. Leiserson, R. L. Rivest, and C. Stein, Introduction to Algorithms, MITPress.

2. J. Kleinberg and E. Tardos,AlgorithmDesign,Addison-Wesley.
3. Harry R. Lewis and Larry Denenberg, Data Structures and their Algorithms, Harper Collins.
4. A. Gibbons, Algorithmic Graph Theory, Cambridge University Press.
5. E. Horowitz and S. Sahani, Fundamentals of Computer Algorithms, Computer Science Press.

Supplementary Reading

1. MichaelT. Goodrich and Roberto Tamassia, Algorithm Design:Foundations,Analysis, and Internet Examples, John Wiley.
2. R. Sedgewick, Algorithms in C (Parts 1-5), AddisonWesley.
3. M. H. Alsuwaiyel,Algorithm Design Techniques and Analysis, World Scientific.
4. Gilles Brassard and Paul Bratley,Algorithmics : theory and practice, Prentice-Hall.
5. UdiManber,Introduction to Algorithms:A Creative Approach, Addison-Wesley.
6. Sara Baase and Allen Van Gelder,ComputerAlgorithms:Introduction to Design and Analysis, Addison-Wesley.
7. D. E. Knuth, The Art Of Computer Programming-Vol-III, Narosa Publication.

Database Management System (TIU-UCS-T301)

Contact Hours/Week: 3–0–0 (L–T–P)
Credit: Theory–3

Course Outcome

CO1	Understand the core concepts and features of Database Management System
CO2	Design and development of DBMS solutions based on relevant project work
CO3	Analyze and troubleshoot database related problems and finding the solution using the DBMS knowledge as acquired
CO4	Study the latest trends in DBMS and get the connectivity with the cutting-edge technologies

Course Content

Module 1: Introduction

General introduction to database systems, Concept of file System and Disadvantages, Database-DBMS distinction, Role of DBA, approaches to building a database, Data models, Database management system, Three-schema architecture of a database, Data Independency, Integrity constraints.

Module 2: Relational Data Model

Concept of relations, Schema-instance distinction, Keys, Referential integrity and foreign keys. Relational Algebra Operators: Selection, Projection, Union, Intersection, set difference,

Cross product, Rename, Assignment, Various types of joins, Division, Example queries. Tuple Relational Calculus, Domain Relational Calculus.

Module 3: SQL

Introduction, Data definition in SQL, Table, key and foreign key definitions, Update behaviors, querying in SQL, Basic select- from- where block and its semantics, Nested queries-correlated and uncorrelated, Notion of aggregation, Aggregation functions group by and having clauses,Embedded SQL.

Module 4: Database Design Concepts (part-1) - Dependencies and Normal forms

Importance of a good schema design, Problems encountered with bad schema designs, Motivation for normal forms, dependency theory – functional dependencies, Armstrong's axioms for FD's, Closure of a set of FDs, Minimal covers, Definitions of 1NF, 2NF, 3NF and BCNF, Decompositions and desirable properties of them, Algorithms for 3NF and BCNF normalization, multi-valued dependencies and 4NF, Join dependencies and definition of 5NF, DKNF.

Module 5: Database Design Concepts (part-2) -ER Model

Conceptual data modeling-motivation, Entities, Entity types, Various types of attributes, Relationships, Relationship types, E/R diagram notation, High-level conceptual modeling, ER Modeling concepts, ER Diagrams, Cardinality constraints Enhanced ER Model: Higher-order relationships, Enhanced ER Model (EER), Weak-entity types, Subclasses and inheritance, Specialization and Generalization, Modeling of UNION types using categories.

Module 6: Data Storage and Indexes

File organizations, Primary, Secondary index structures, Various index structures - hash-based, Dynamic hashing techniques, multi-level indexes, B+ trees.

Module 7: Transaction Processing and Concurrency Control

Transaction Fundamentals: OLTP environments, Concurrency issues, need for transactions, Necessary properties of transactions (ACID properties), Transaction states, serializability, Serial schedules, Conflict serializability, View serializability, Recoverable and non-recoverable schedules, Cascading rollbacks, Cascadeless schedules.

Concurrency control: Serialized and non-serialized schedules, testing for serializability, Locking, Lock compatibility matrix, Locking and serializability, Deadlocks and starvation, Two-phase locking (2PL) protocol, Conservative, strict and rigorous 2PL, 2PL with lock conversions, Timestamp-ordering based protocol, Multi-versioning protocol, Multi-granularity locking, Deadlock prevention protocols, Wait-die and wound-wait schemes, Time-out based schemes, Deadlock recovery, Nested transactions.

Module 8: Database Recovery Techniques:

Recovery concepts, Deferred updates technique, Immediate update technique, Shadow paging.

Module 9: Query Processing and Optimization
Translating SQL into relational algebra, Basic query operations, Heuristics in query optimization, Selectivity and cost estimates in query optimization, Semantic query optimization.

Module 9: Trending Technologies
Microsoft SQL Server 2019, Azure SQL, Azure Cosmos DB

Recommended Books:

Main Reading

1. Ramez Elmasri and Shamkant Navathe, Fundamentals of Database Systems, Publisher -Pearson Education, 5th Edition.
2. Avi Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts,Tata McGraw - Hill Education.

Supplementary Reading

1. Microsoft SQL Server 2019 documentation: Databases - SQL Server | Microsoft Docs
2. Microsoft Azure SQL documentation: Azure SQL documentation - Azure SQL | Microsoft Docs
3. Microsoft Azure CosmosDB documentation: Introduction to Azure Cosmos DB |Microsoft Docs
4. Articles on Microsoft Azure and SQL Server: Sucharita Das, Author at SQLServerCentral
5. Transaction Processing in SQL Server: https://youtu.be/vO4OgihpAGw

Operating Systems (TIU-UCS-T317)

Contact Hours/Week: 3–0–0 (L–T–P)
Credit: Theory–3
Course Outcome

CO1	Understand fundamental operating system abstractions such as processes, threads, files, semaphores, IPC abstractions, shared memory regions, etc.
CO2	Analyze important algorithms e.g. Process scheduling and memory management algorithms, Disk scheduling algorithms
CO3	Categorize the operating system's resource management techniques, dead lock management techniques, memory management techniques
CO4	Demonstrate the ability to perform OS tasks in Red Hat Linux Enterprise

Course Content

Module-1:
Operating Systems Overview: Operating system functions, Operating system structure, Operating systems operations, Computing environments, Open-Source Operating Systems.
System Structures: Operating System Services, User and Operating-System Interface, systems call, Types of System Calls, system programs, operating system structure, operating system debugging, System Boot.

Module-2:
Process Concept: Process scheduling, Operations on processes, Inter-process communication, Communication in client server systems.
Multithreaded Programming: Multithreading models, Thread libraries, Threading issues.
Process Scheduling: Basic concepts, Scheduling criteria, Scheduling algorithms, Multiple processor scheduling, Thread scheduling.
Inter-process Communication: Race conditions, Critical Regions, Mutual exclusion with busy waiting, Sleep and wakeup, Semaphores, Mutexes, Monitors, Message passing, Barriers, Classical IPC Problems – Dining philosophers problem, Readers and writers problem.

Module-3:
Memory-Management Strategies: Introduction, Swapping, Contiguous memory allocation, Paging, Segmentation.
Virtual Memory Management: Introduction, Demand paging, Copy on-write, Page replacement, Frame allocation, Thrashing, Memory-mapped files, Kernel memory allocation.

Module-4:
Deadlocks: Resources, Conditions for resource deadlocks, Ostrich algorithm, Deadlock detection and recovery, Deadlock avoidance, Deadlock prevention.
File Systems: Files, Directories, File system implementation, management and optimization.
Secondary-Storage Structure: Overview of disk structure, and attachment, Disk scheduling, RAID structure, Stable storage implementation.

Module-5:
System Protection: Goals of protection, Principles and domain of protection, Access matrix, Access control, Revocation of access rights.
System Security: Introduction, Program threats, System and network threats, Cryptography for security, User authentication, implementing security defenses, Firewalling to protect systems and networks, Computer security classification.
Case Studies: Linux, Microsoft Windows.

Recommended Books:

Main Reading

1. Silberschatz A, Galvin P B, and Gagne G, Operating System Concepts, 9th edition, Wiley, 2013.

2. Tanenbaum A S, Modern Operating Systems, 3rd edition, Pearson Education, 2008. (ForInterprocess Communication and File systems.)

Supplementary Reading

1. Dhamdhere D M, Operating Systems A Concept Based Approach, 3rd edition, Tata McGraw-Hill, 2012.
2. Stallings W, Operating Systems -Internals and Design Principles, 6th edition, Pearson Education, 2009
3. Nutt G, Operating Systems, 3rd edition, Pearson Education, 2004.

Automata Theory (TIU-UCS-T323)

Contact Hours/Week: 3–0–0 (L–T–P)
Credit: Theory–3

Course Outcome

CO1	Describe the concepts of formal theory of language, the meaning of computing and algorithms
CO2	Describe and analyze different models of computing such as FA, CFG/PDA, TM
CO3	Design above models for problem solving
CO4	Analyze and identify the strengths and shortcomings of the above computing models
CO5	Describe basic concepts of complexity theory: solvable and unsolvable problems, complexity classes, etc.

Course Content

Module-1: Regular Languages and Finite Automata

Introduction, Alphabet, Language, and Grammar. Regular Expressions and Languages, Deterministic Finite Automata (DFA) and Equivalence with Regular Expressions, Nondeterministic Finite Automata (NFA) and Equivalence with DFA, Regular Grammars and Equivalence with Finite Automata, Properties of Regular Languages, Pumping Lemma For Regular Languages, Minimization of Finite Automata.

Module-2: Context-Free Grammar/Languages

Context-Free Grammars (CFG) and Context-Free Languages (CFL), Production, Parse Tree, and Derivation; Chomsky and Greibach Normal Forms, Non-deterministic Pushdown Automata (PDA) and Equivalence with CFG, Parse Trees, Ambiguity in CFG, Pumping Lemma for Context-Free Languages, Deterministic Pushdown Automata, Closure Properties of CFLs. Chomsky Hierarchy of Languages.

Context-Sensitive Grammars: Context-Sensitive Grammars (CSG) and Context sensitive Languages (CSL), Linear Bounded Automata (LBA) and its Equivalence with CSG.

Module-3: Turing Machines
The Basic Model of Turing Machines (TM), Turing-Recognizable (Recursively Enumerable) and Turing-Decidable (Recursive) Languages and Their Closure Properties, Variants of Turing Machines, Non-deterministic TMs and its Equivalence with Deterministic TMs, Unrestricted Grammars and Equivalence with Turing Machines, TMs as Enumerators.

Module-4: Undecidability
Church-Turing Thesis, Universal Turing Machine, The Universal and Diagonalization Languages, Reduction between Languages and Rice's Theorem, Undecidable Problems about Languages.

Recommended Books:

Main Reading

1. John E. Hopcroft, Jeffery D. Ullman, Introduction to Automata Theory, Language, and Computation, Pearson, 3rd Edition, 2007.
2. Michael Sipser, Introduction to the Theory of Computation. Cengage Learning, 2nd Edition, 2006.

Supplementary Reading

1. K.L.P. Mishra and N. Chandrasekharan. Theory of Computer Science, PHI, 3rd Edition, 2008.
2. Harry R. Lewis and Christos H. Papadimitriou. Elements of the Theory of Computation., Prentice Hall, 2nd Edition, 1998.
3. John Martin. Introduction to Languages and the Theory of Computation., McGraw Hill, 4th Edition, 2011.

Image Processing and Pattern Recognition (TIU-UCS-T327)

Contact Hours/Week: 3–0–0 (L–T–P)
Credit: Theory–3

Course Outcome

CO1	Understand the fundamental concepts of digital image processing, including sampling and quantization, image transforms, and image enhancement.
CO2	Apply spatial and frequency domain methods to enhance images.
CO3	Segment images using edge detection, thresholding, and region-based methods.
CO4	Represent and describe images using different schemes.
CO5	Understand the fundamental problems in pattern recognition, including classification, clustering, and feature selection.

Course Content:

Module-1: Digital Image Fundamentals & Image Transforms
Sampling and Quantization, Binary image Analysis, 2-D FFT, Properties, Walsh Transform, Hadamard Transform, Discrete cosine Transform, Discrete Wavelet Transform.

Module-2: Image Enhancement:
Spatial domain methods: Introduction, Image Enhancement in Spatial Domain, Enhancement Through Point Operation, Types of Point Operation, Histogram Manipulation, gray level Transformation, local or neighbourhood operation, median filter, spatial domain high- pass filtering.
Frequency domain methods:Filtering in Frequency Domain, Obtaining Frequency Domain Filters from Spatial Filters, Generating Filters Directly in the Frequency Domain, Low Pass(smoothing) and High Pass (sharpening) filters in Frequency Domain

Module-3: Image Segmentation and Morphological Image Processing
Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region oriented segmentation
Dilation and Erosion, structuring element, Opening and closing, The Hit and Miss Transform

Module-4: Representation and description
Representation schemes, Boundary descriptors, Regional descriptors (Texture, moments)
Module-5: Fundamental problem in pattern recognition
Basic problem of pattern recognition with example, Pattern, Pattern class, Classification, Classifier, Pattern Recognition Model, Feature selection, False alarms.

Module-6: Clustering
Fundamental of lustering, Metric and non-metric proximity, Density estimation (Parzen window approach, nearest neighbor approach), Seed point selection (Single seed, Multi seed techniques), Hierarchical clustering (Agglomerative, Divisive: K-means, ISODATA), Fuzzy C-means

Module-8: Classification
Pattern classification by likelihood function, Bayes classifier, Artificial Neural Net (Neuron, types of neurons, Neural network model, Hopfield net algorithm, Single layer perceptron algorithm and multi-layer perceptron algorithm)

Module-9: Remote sensing and application
Characteristics of remote sensing (resolution, bands, spectral range, spectral reflection, LANDSAT, SPOT, IRS -1C), Classification of remote sensing data (Minimum distance classifier, Bayes classifier, parallelepiped classifier, multi-seed technique, Support Vector Machine), Application of remote sensing data.

Recommended Books:

Main Reading

1. Frank Y. Shih, Image Processing and Pattern Recognition: Fundamentals and Techniques, Wiley, 2010.

Rafael C. Gonza Lez, Richard E. Woods, Digital Image Processing,Fourth Edition, Pearson,