TECHNO INDIA UNIVERSITY

WEST BENGAL

Department of Computer Science and Engineering

Syllabus Book

for

4-Years B.Tech.

in

Computer Science and Engineering
(Specialization in Artificial Intelligence)

Academic Year: 2022-2023

Course Curriculum

First Semester

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit	Page No.
			L	T	P		
THEORY							
1	TIU-UEN-S103	Career Advancement & Skill Development - I Communication Skill	2	0	0	2	
2	TIU-UMA-T101	Mathematics – I	3	1	0	4	
3	TIU-UPH-T104/ TIU-UCH-T104	Chemistry / Physics	3	1	0	4	
4	TIU-UCS-T105	Introduction to Computing	3	0	0	3	
PRACTICAL							
1	TIU-UCH-L104/ TIU-UPH-L104	Chemistry Lab/Physics Lab	0	0	3	1.5	
2	TIU-UCS-L105	Introduction to Computing Lab	0	0	3	1.5	
3	TIU-UME-S103	Engineering Drawing & Graphics	0	0	3	1.5	
SESSIONAL							
1	TIU-UES-S199	Entrepreneurship Skill Development	0	0	2	2	
TOTAL CREDIT						19.5	

Second Semester

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit	Page No.
			L	T	P		
THEORY							
1	TIU-UEN-S102	Career Advancement & Skill Development - II Communication Skill	2	0	0	2	
2	TIU-UMA-T102	Mathematics-II	3	1	0	4	
3	TIU-UCH-T104 / TIU-UPH-T104	Chemistry / Physics	3	1	0	4	
4	TIU-UME-T102	Engineering Mechanics	3	0	0	3	
5	TIU-UCS-T106	Problem Solving Techniques	3	0	0	3	
6	TIU-UEE-T102	Basic Electrical & Electronics Engineering	3	1	0	4	

PRACTICAL							
1	TIU-UCH-L104 / TIU-UPH-L104	Chemistry Lab / Physics Lab	0	0	3	1.5	
2	TIU-UME-L104	Introduction to Manufacturing Process Lab	0	0	3	1.5	
3	TIU-UCS-L106	Problem Solving using C	0	0	3	1.5	
4	TIU-UEE-L104	Basic Electrical & Electronics Engineering Lab & Simulation	0	0	3	1.5	
SESSIONAL							
1	TIU-UES-S299	Entrepreneurship Skill Development	0	0	2	2	
TOTAL CREDIT						28	

Third Semester

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit	Page No.
			L	T	P		
THEORY							
1	TIU-UEN-T20#	Career Advancement & Skill Development-III-Communication Skill	2	0	0	2	
2	TIU-UMA-T209	Mathematics-III (Discrete Mathematics)	3	0	0	3	
3	TIU-UMB-T20#	Environmental Science	2	0	0	0	
4	TIU-UEC-T207	Digital Electronics	3	0	0	3	
5	TIU-UCS-T201	Data Structure And Algorithms	3	0	0	3	
6	TIU-UCS-T20#	Computer Organization	3	0	0	3	
PRACTICAL							
1	TIU-UCS-L20#	Computer Organization Lab	0	0	3	1.5	
2	TIU-UEC-L207	Digital Electronics Lab	0	0	3	1.5	
3	TIU-UCS-L201	Data Structure And Algorithms Lab	0	0	5	1.5	
SESSIONAL							
1	TIU-UES-S299	Entrepreneurship Skill Development	0	0	2	2	
TOTAL CREDIT						20.5	

Fourth Semester

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit	Page No.
			L	T	P		
THEORY							
1	TIU-UEN-T20#	Career Advancement & Skill Development-IV-Communication Skill	2	0	0	2	
2	TIU-UMA-T206	Mathematics-IV	4	0	0	4	
3	TIU-UEC-T21#	Computer Architecture	3	0	0	3	
4	TIU-UCS-T21#	Graph Theory and Combinatories	3	0	0	3	
5	TIU-UCS-T204	Object Oriented Programming	3	0	0	3	
6	TIU-UCS-T208	Microprocessor and Microcontroller	3	0	0	3	
PRACTICAL							
1	TIU-UCS-L206	Numerical Lab	0	0	3	1.5	
2	TIU-UEC-L21#	Computer Architecture Lab	0	0	3	1.5	
3	TIU-UCS-L20#	Object Oriented Programming Lab	0	0	3	1.5	
4	TIU-UCS-L204	Microprocessor and Microcontroller Lab	0	0	3	1.5	
SESSIONAL							
1	TIU-UES-S298	Entrepreneurship Skill Development	0	0	2	2	
TOTAL CREDIT						26	

Fifth Semester

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit	Page No.
			L	T	P		
THEORY							
1	TIU-UTR-T30#	Career Advancement & Skill Development-V SAP	2	0	0	2	
2	TIU-UMB-T30#	Design and Analysis of Algorithms	3	0	0	3	
3	TIU-UCS-T301	Database Management System	3	0	0	3	
4	TIU-UCS-T303	Operating Systems	3	0	0	3	

5	TIU-UEC-T30#	Automata Theory	3	0	0	3	
6	TIU-UEC-T30#	Image Processing and Pattern Recognition	3	0	0	3	
PRACTICAL							
1	TIU-UCS-L301	Database Management System Lab	0	0	3	1.5	
2	TIU-UEC-L30#	Design and Analysis of Algorithms Lab	0	0	3	1.5	
3	TIU-UCS-L301	Object Oriented Systems Lab	0	1	2	2	
4	TIU-UEC-L30#	Operating Systems Lab	0	0	3	1.5	
5	TIU-UEC-L30#	Image Processing and Pattern Recognition Lab	0	0	3	1.5	
SESSIONAL							
1	TIU-UES-S298	Entrepreneurship Skill Development	0	0	2	2	
TOTAL CREDIT						27	

Sixth Semester

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit	Page No.
			L	T	P		
THEORY							
1	TIU-UEN-T30#	Career Advancement & Skill Development-VI Aptitude and Soft Skill	2	0	0	2	
2	TIU-UMA-T302	Operations Research & Optimization Techniques	3	0	0	3	
3	TIU-UCS-T304	Computer Networks	3	0	0	3	
4	TIU-UCS-T30#	Compiler Design	3	0	0	3	
5	TIU-UCS-T314	Software Engineering	3	0	0	3	
6	TIU-UCS-E30#	Artificial Intelligence	3	0	0	3	
PRACTICAL							
1	TIU-UCS-L304	Computer Networks Lab	0	0	3	1.5	
2	TIU-UCS-L30#	Software Engineering Lab	0	0	3	1	
3	TIU-UCS-L30#	Artificial Intelligence Lab	0	0	3	1.5	

SESSIONAL							
1	TIU-UES-S298	Entrepreneurship Skill Development	0	0	3	2	
TOTAL CREDIT						24.5	

Seventh Semester

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit	Page No.
			L	T	P		
THEORY							
1	TIU-UCS-T40#	Career Advancement & Skill Development-VII-Managerial Commerce	2	0	0	2	
2	TIU-UCS-E40#	Machine Learning	3	0	0	3	
3	TIU-UCS-E40#	Natural Language Processing	3	0	0	3	
4	TIU-UEC-E4##	Elective-I	3	0	0	3	
PRACTICAL							
1	TIU-UCS-L40#	Machine Learning Lab	0	0	3	1.5	
2	TIU-UCS-P499	Project -I	0	2	4	4	
SESSIONAL							
1	TIU-UES-S298	Entrepreneurship Skill Development	0	0	3	2	
TOTAL CREDIT						18.5	
ELECTIVE-I							
1	TIU-UCS-E40#	Knowledge Discovery and Data Mining (KDD)	3	0	0	3	
2	TIU-UCS-E40#	Big Data Analytics	3	0	0	3	
3	TIU-UCS-E40#	Computer Vision	3	0	0	3	
4	TIU-UEC-T40#	Artificial Neural Network	3	0	0	3	

Eighth Semester

S. No	Course Code	Course Title	Contact Hrs. / Week			Credit	Page No.
			L	T	P		
THEORY							
1	TIU-UMG-T40#	Career Advancement & Skill Development-VIII-Values and Ethics	2	0	0	2	
2	TIU-UCS-E40#	Elective-II	3	0	0	3	
PRACTICAL							
1	TIU-UCS-D498	Project-II (Final Thesis / Dissertation)	0	4	8	8	
2	TIU-UCS-G498	Grand Viva	0	0	0	3	
SESSIONAL							
1	TIU-UES-S298	Entrepreneurship Skill Development	0	0	2	2	
TOTAL CREDIT						18	
ELECTIVE-V							
1	TIU-UCS-E40#	Bioinformatics	3	0	0	3	
2	TIU-UCS-E40#	Deep Learning	3	0	0	3	
3	TIU-UCS-E40#	Information Retrieval	3	0	0	3	
4	TIU-UCS-E40#	Game Theory for AI and Data Science	3	0	0	3	

Detailed Syllabus

Introduction to Computing (TIU-UCS-T105)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 1st Yr., 1st Sem.
Course Title: Introduction to Computing	**Subject Code:** TIU-UCS-T105
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content

Module-1:
An overview of a computer system, Input devices, Output devices, Storage Units, Central processing unit, memory and Processor, Classification of Computers.
Communicating with a Computer: Binary Number System, Binary to Decimal Conversion, and vice-versa, BCD Code, ASCII Code, An overview of Computer Arithmetic, von Neumann Architecture.

Module-2:
Overview of Operating System: What is an operating system? Role of operating systems. Name of some operating systems. An overview of DOS, Windows, Linux environments: Their workings, Commands.
Overview of Hardware / Software Interface: From machine language to high level language. An overview of processor instruction set, and assembly language. Role of various system software in executing an application. Name of some high level languages. An overview of how Computer Applications are developed.

Module-3:
Problem Solving Skill: Deriving logic from the computational problem, drawing flowchart and writing algorithm

Module-4:
C Fundamentals: The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements
Operators & Expressions: Arithmetic operators, relational and logical operators, type, conversion, increment and decrement Operators, bit wise operators, assignment operators and expressions, precedence and order of evaluation. Input and Output: Standard input and output, formatted output -- printf, formatted input scanf.
Flow of Control: Statement and blocks, if - else, switch, loops - while, for do while, break and continue, go to and labels.

Recommended Books:

Main Reading

1. Computer Organization and Design, 5th Ed, D.A Patterson and J.L Hennessy
2. R. G. Dromey, How to Solve it by Computer, Pearson, 2014

3. Ravi Kant Taxali, Computer Course, McGraw Hill Education.
4. B W Kernighan and D.M. Ritchie, the C Programming Language, Prentice Hall of India.

Supplementary Reading

1. Turban, Mclean and Wetherbe, Information Technology and Management, Second Edition, 2001, John Wiley & Sons.
2. 2. H. Scheldt, C: The Complete Reference, 4th Edition, McGrawHill
3. 3. Anita Goel, "Computer Fundamentals",Pearson Education India.

Problem Solving Techniques (TIU-UCS-T106)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 1st Yr., 2nd Sem.
Course Title: Problem Solving Techniques	**Subject Code:** TIU-UCS-T106
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3
Prerequisite Course: Introduction to Computing (TIU-UCS-T105)	

Course Content

Module 1:

Introduction to C Language: Character set, Variables and Identifiers, Built-in Data Types, Variable Definition, Arithmetic operators and Expressions, Constants and Literals, Simple assignment statement, Basic input/output statement, Simple 'C' programs.

Conditional Statements and Loops: Decision making within a program Conditions, Relational Operators, Logical Connectives, if statement, if-else statement. Loops: while loop, do while, for loop, Nested loops, Infinite loops, switch statement, Structured Programming.

Module 2:

Arrays: One dimensional arrays: Array manipulation, Searching, Insertion, and Deletion of an element from an array, finding the largest/smallest element in an array; Two dimensional arrays, Addition/multiplication of two matrices, transpose of a matrix.

Strings: General concept of string, String declaration and initialization, String input and output functions, Different in-build string functions – strlen(), strcmp(), strcpy(), strcat() etc.

Module 3:

Functions: Top-down approach of problem solving; Modular programming and functions; Standard Library of C functions; Prototype of a function Formal parameter list, Return Type, Function call, Block structure; Passing arguments to a Function Call by reference, Call by value, Recursive Functions, Arrays as function arguments.

Module 4:

Structures and Unions: Structure variables, Initialization, Structure assignment, Nested structure, Structures and Functions, Structures and arrays: Arrays of structures, Structures containing arrays, Unions.

Module 5:

Pointers: Address operators, Pointers type declaration, Pointer assignment, Pointer initialization, Pointer arithmetic, Functions and pointers, Arrays and Pointers, Pointer arrays.

Module 6:
File Processing: Concept of Files, File opening in various modes and closing of a file, Reading from a file, writing onto a file.

Recommended Books:

Main Reading
1. H. Scheldt, C: The Complete Reference, 4th Edition, McGrawHill
2. B W Kernighan and D.M. Ritchie, The C Programming Language, Prentice Hall of India.

Supplementary Reading
1. Jones, Robin and Stewart, The Art of C Programming, Narosa Publishing House.
2. A Kenneth, C Problem solving and Programming, Prentice Hall International.
3. R G Dromey, How to solve it by Computer, Prentice Hall in India.
4. H. Schildt, C Made easy, McGraw Hill Book Company.
5. Kr. Venugopal and Sudeep R Prasad, Programming with C, Mc-Grow Hill

Data Structures and Algorithms (TIU-UCS-T201)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Data Structure And Algorithms	**Subject Code:** TIU-UCS-T201
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3
Prerequisite Course: Introduction to Computing (TIU-UCS-T105); Problem Solving Techniques (TIU-UCS-T106)	

Course Content

Module 1:
Basic Concepts of Data Representation: Abstract Data Types, Fundamental and Derived Data Types, Representation, Primitive Data Structures.
Introduction to Algorithm Design and Data Structures: Algorithm Definition, Comparison of Algorithms, Top-Down and Bottom Up Approaches to Algorithm Design, Analysis of Algorithm, Complexity Measures in Terms of Time and Space, Structured Approach to Programming.

Module 2:
Arrays: Representation of Arrays, Single and Multidimensional Arrays, Address Calculation Using Column and Row Major Ordering, Various Operations on Arrays, Application of Arrays Matrix Multiplication, Sparse Polynomial Representation and Addition.

Module 3:
Stacks and Queues: Representation of Stacks and Queues using Arrays and Linked List, Circular Queues, Priority Queue and D-Queue. Applications of Stacks, Conversion from Infix to Postfix and Prefix Expressions, Evaluation of Postfix Expression Using Stacks.
Linked Lists: Single Linked List, Operations on List, Linked Stacks and Queues, Polynomial Representation and Manipulation Using Linked Lists, Circular Linked Lists, Doubly Linked Lists.

Module 4:
Trees: Binary Tree, Traversal Methods: Preorder, In-Order, Post-Order Traversal (Recursive And Non-Recursive), Algorithms for Above Mentioned Traversal Methods. Representation of Trees and Its

Applications. Binary Tree. Binary Search Tree, Height Balanced (AVL) Tree, B-Trees, B+ Tree, Min Heap, Max Heap Graphs: Graph Representation, Adjacency Matrix, Adjacency Lists, Traversal Schemes, Depth First Search, Breadth First Search.

Module 5:
Searching, Sorting and Complexity: Searching: Sequential and Binary Searches, Indexed Search, Hashing Schemes. Sorting: Insertion, Selection, Bubble, Quick, Merge.

Recommended Books:

Main Reading

1. 1. Seymour Lipschutz, Data Structures, Revised First Edition, McGraw-Hill Education.
2. Aaron M. Tenenbaum, Data Structures Using C , Prentice Hall.

Supplementary Reading

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, Eastern Economy Edition, PHI Learning Pvt. Ltd., 2010.
2. Donald Knuth, Art of Computer Programming, The: Volume 1: Fundamental Algorithms, Addison-Wesley, 1997.

Computer Organization (TIU-UCS-T20#)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 2nd Yr., 3rd Sem.
Course Title: Computer Organization	**Subject Code:** TIU-UCS-T20#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content

Module 1:
Basic Functional Blocks of a Computer: Von Neumann machines, Harvard Architecture, SISD, MISD, MIMD, Single instruction multiple data stream (SIMD) architectures, concept of operating systems and processes, processor register sets, processor instruction sets, processor architecture, memory hierarchy, Parallel Processor and Pipeline Architecture.

Module 2:
Data Representation: Signed number representation, fixed and floating-point representations, Computer arithmetic - integer addition and subtraction, ripple carry adder, carry look-ahead adder, etc. multiplication -Booth multiplier,. Division - non-restoring and restoring techniques.

Module 3:
CPU and Control Unit Design: CPU, memory, input-output subsystems, control unit. Instruction set architecture of a CPU - registers, instruction execution cycle, Basic Instruction format, Immediate, Direct address, Indirect address, Effective addresses. Instruction Formats : Memory/ Register/Input-Output reference, Types of Instruction: Data Transfer/ Data Manipulation/ Program Control, Zero/One/Two/Three address instructions, RISC instructions, RTL interpretation of instructions, Addressing modes, instruction set. Case study - instruction sets of some common CPUs.

Module 4:
Memory organization: Concept of hierarchical memory organization, Memory interleaving, Semiconductor memory technologies, primary memory and concept of cache memory.

Module 5:
Peripheral Devices and Their Characteristics: Input-output subsystems, I/O transfers – program controlled, interrupt driven and DMA.

Module 6:
Pipelining: Basic concepts of pipelining, throughput and speedup, pipeline hazards. (Parallel Processor)

Recommended Books:

Main Reading

1. David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, Elsevier.
2. Carl Hamachar, Zvonco Vranesic and Safwat Zaky, Computer Organization, McGraw Hill.

Supplementary Reading

1. John P. Hayes, Computer Architecture and Organization, McGraw Hill.
2. William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson Education.
3. Vincent P. Heuring and Harry F. Jordan, Computer Systems Design and Architecture, Pearson Education.

Computer Architecture (TIU-UCS-T21#)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Computer Architecture	**Subject Code:** TIU-UCS-T220
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3
Prerequisite Course: Computer Organization (TIU-UCS-T20#)	

Course Content

Module-1: Overview of von Neumann architecture
Instruction set architecture; The Arithmetic and Logic Unit, The Control Unit, Memory and I/O devices and their interfacing to the CPU; Measuring and reporting performance; CISC and RISC processors.

Module-2: Pipelining
Basic concepts of pipelining, data hazards, control hazards, and structural hazards; Techniques for overcoming or reducing the effects of various hazards.

Module-3: 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.

Module-4: Instruction-level parallelism
Concepts of instruction-level parallelism (ILP), Techniques for increasing ILP; Superscalar, super-pipelined and VLIW processor architectures; Vector and Array processors.

Module-5: Multiprocessor Architecture
Taxonomy of parallel architectures; Centralized shared-memory architecture, synchronization, memory consistency, interconnection networks; Distributed shared-memory architecture, Cluster computers.

Module-6: Non von Neumann Architectures
Data flow Computers, Reduction computer architectures, Systolic Architectures.

Recommended Books:

Main Reading
1. John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann.
2. Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw-Hill.

Supplementary Reading
1. John Paul Shen and Mikko H. Lipasti, Modern Processor Design: Fundamentals of Superscalar Processors, Tata McGraw-Hill.
2. M. J. Flynn, Computer Architecture: Pipelined and Parallel Processor Design, Narosa Publishing House.

Graph Theory and Combinatorics (TIU-UCS-T21#)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Graph Theory and Combinatorics	**Subject Code:** TIU-UCS-T224
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content

Module 1:
Binary relation on set, concepts and definition of graph; undirected, directed, weighted graphs, and simple graphs; complete graphs, sparse graphs, and dense graphs. adjacency of vertices and degree of vertices; relationship between number of vertices and number of edges; incidence between vertices and edges.

Module 2:
Operations on graph; graph isomorphism; Path connectivity and connected components in a graph, properties and computation. Euler's Tour, Hamiltonian path, Topological sorting, Traveling salesman's problem. strongly connected graph and components. representations of a graph in computer; graph exploration techniques: Breadth-first search (BFS) and Depth-first search (DFS) and their applications.

Module 3:
Spanning tree of a graph, minimum spanning tree (MST) of a weighted graph, its properties and computation (Kruskal's and Prim's algorithms). Concepts of shorted paths in a graph, their properties and computation. Concepts of planar graphs and their properties; dual graph of a planar graph; bipartite graphs; tree as a graph and its properties; graph coloring.

Module 4:
Recapitulation of concepts from previous discrete mathematics course; the rules of sum and product; permutations, combinations, selection; The pigeonhole principle and its variants; The Binomial theorem, combinations with repetition, the Catalon numbers; The multinomial theorem. Combinatorial problems in discrete probability.

Module 5:
Principles of inclusion and exclusion, and its variants; derangements; generating functions; recurrence relations. Problem solving with these principles.

Recommended Books:

Main Reading

1. Narsingh Deo. Graph Theory with Applications to Engineering and Computer Science. Prentice-Hall, Inc.
2. Douglas B. West. Introduction to Graph Theory. Second Edition. Pearson Education Inc., 2002.
3. John M. Harris, Jeffry L. Hist, Michael J. Mossinghoff. Combinatorics and Graph Theory. Second Edition, Springer, 2008.
4. Robert A. Beeler. How to Count: An Introduction to Combinatorics and Its Applications. First Edition, Springer, 2015.

Supplementary Reading

1. Reinhard Diestel. Graph Theory. Fifth Edition, Springer, 2017.
2. Chen Chuan-Chong, Koh Khee-Meng. Principles and Techniques of Combinatorics. World Scientific Publishing Co. Pte. Ltd., 1992.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. Introduction to Algorithms. Third Edition, The MIT Press, 2009
4. Michael T. Goodrich and Roberto Tamassia. Algorithm Design: Foundations, Analysis, and Internet Examples. Second Edition, 2006, John Wiley and Sons. Inc.

Object Oriented Programming (TIU-UCS-T20#)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 2nd Yr., 4th Sem.
Course Title: Object Oriented Programming	**Subject Code:** TIU-UCS-T202
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3
Prerequisite Course: Introduction to Computing (TIU-UCS-T105); Problem Solving Techniques (TIU-UCS-T106)	

Course Content

Module-1:
Introduction to Object Oriented Paradigm, Need of object oriented design, Drawbacks of Procedure Oriented Programming, Features of object-oriented languages, POP Vs OOP, Benefits & Applications of OOP, Difference between C and C++.

Module-2:
Basic Concepts of Object-Orientation. Class, Object, Data abstraction, Encapsulation, Inheritance, Polymorphism, Message Passing, Dynamic binding.

Module-3:
Fundamentals of OOPs: Class & Objects, Constructors & Destructor. Different perspectives on inheritance, Types of inheritance, Polymorphism: Compile Time & Run time Polymorphism, Virtual functions, Virtual table construction, Overloading, Overriding, Abstract Class, Virtual Class.

Module-4:
Class and Function Templates, Standard Template Libraries in C++: lists, vectors,sets, maps. Exceptions Handling.

Recommended Books:

Main Reading

1. Robert Lafore, Object-Oriented Programming in C++, Fourth Edition, Pearson.
2. Herbert Schildt, C++: The Complete Reference, Fourth Edition, Mc-Graw Hill Education, India, 2003.

Supplementary Reading

1. Bjarne Stroustrup, The C++ Programming Language, Third Edition, Pearson, 2000.
2. E. Balagurusamy, Object-Oriented Programming with C++, 8th Edition, Mc-Graw Hill Education India, 2021.
3. Scott Meyers, Effective Modern C++, O'Reilly Media, Inc., 2014.
4. Scott Meyers, Effective STL: 50 Specific Ways to Improve Your Use of the Standard Template Library, Addison-Wesley Professional Computing Series,2001.

Design and Analysis of Algorithms (TIU-UCS-T30#)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 3rd Yr., 5th Sem.
Course Title: Design and Analysis of Algorithms	**Subject Code:** TIU-UCS-T30#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

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,Algorithm Design,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,Computer Algorithms: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)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 3rd Yr., 5th Sem.
Course Title: Database Management System	**Subject Code:** TIU-UCS-T301
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

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-T30#)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 3rd Yr., 5th Sem.
Course Title: Operating Systems	**Subject Code:** TIU-UCS-T30#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

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 calls, 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. (for Interprocess 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)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 3rd Yr., 5th Sem.
Course Title: Automata Theory	**Subject Code:** TIU-UCS-T323
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

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-UEC-T30#)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 3rd Yr., 5th Sem.
Course Title: Image Processing and Pattern Recognition	**Subject Code:** TIU-UCS-T30#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

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.
2. Rafael C. Gonza Lez, Richard E. Woods, Digital Image Processing,Fourth Edition, Pearson, 2018

Computer Networks (TIU-UCS-T304)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 3rd Yr. 6th Sem.
Course Title: Computer Networks	**Subject Code:** TIU-UCS-T304
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Prerequisite Course: Data Structures and Algorithms (TIU-UCS-T201)

Course Content

Module-1:
Network hardware, Network software, OSI, TCP/IP Reference models, Example Networks: ARPANET, Internet. Physical Layer: Guided Transmission media: twisted pairs, coaxial cable, fiber optics, Wireless transmission.

Module-2:
Data link layer: Design issues, framing, Error detection and correction. Elementary data link protocols: simplex protocol, A simplex stop and wait protocol for an error-free channel, A simplex stop and wait protocol for noisy channels. Sliding Window protocols: A one-bit sliding window protocol, A protocol using Go-Back-N, A protocol using Selective Repeat, Example data link protocols. Medium Access sublayer: The channel allocation problem, Multiple access protocols: ALOHA, Carrier sense multiple access protocols, collision free protocols. Wireless LANs, Data link layer switching.

Module-3:
Network Layer: Design issues, Routing algorithms: shortest path routing, Flooding, Hierarchical routing, Broadcast, Multicast, distance vector routing, Congestion Control Algorithms, Quality of Service, Internetworking, The Network layer in the internet.

Module-4:
Transport Layer: Transport Services, Elements of Transport protocols, Connection management, TCP and UDP protocols.

Module-5:
Application Layer –Domain name system, SNMP, Electronic Mail; the World WEB, HTTP, Streaming audio and video.

Recommended Books:

Main Reading

1. Data Communications and Networking – Behrouz A. Forouzan. Third Edition TMH.

Supplementary Reading

1. An Engineering Approach to Computer Networks-S. Keshav, 2nd Edition, Pearson Education
2. Computer Networks -- Andrew S Tanenbaum, David. j. Wetherall, 5th Edition. Pearson Education

Compiler Design (TIU-UCS-T30#)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 3rd Yr., 6th Sem.
Course Title: Compiler Design	**Subject Code:** TIU-UCS-T30#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content

Module-1: Compiler Structure
Analysis-synthesis model of compilation, various phases of a compiler, tool based approach to compiler construction.

Module-2: Lexical analysis
Interface with input, parser and symbol table, token, lexeme and patterns, difficulties in lexical analysis, error reporting, and implementation. Regular definition, Transition diagrams, LEX.

Module-3: Syntax analysis
Context free grammars, ambiguity, associativity, precedence, top down parsing, recursive descent parsing, transformation on the grammars, predictive parsing, Bottom up parsing, operator precedence grammars, LR parsers (SLR, LALR, LR), YACC.

Module-4: Syntax directed definitions
Inherited and synthesized attributes, dependency graph, evaluation order, bottom up and top down evaluation of attributes, L- and S-attributed definitions.

Module-5: Type checking
Type system, type expressions, structural and name equivalence of types, type conversion, overloaded functions and operators, polymorphic functions.

Module-6: Run time system
Storage organization, activation tree, activation record, parameter passing Symbol table, dynamic storage allocation. Intermediate code generation: Intermediate representations, translation of declarations, assignments Intermediate Code generation for control flow, Boolean expressions and procedure calls, implementation issues.

Module-7: Code generation and instruction selection
Issues, basic blocks and flow graphs, register allocation, code generation DAG representation of programs, code generation from DAGs, peep-hole optimization, code generator generators, specifications of machine.

Module-8: Code optimization
Source of optimizations, and optimization of basic blocks, loops, global dataflow analysis, and solution to iterative data flow equations. Code improving transformations, dealing with aliases, data flow analysis of structured flow graphs.

Recommended Books:

Main Reading

1. Aho, Ullman,Sethi and Lam, Principles of Compiler Design, Pearson Education
2. Holub, Compiler Design in C, PHI

Supplementary Reading

1. Andrew L. Appel,Modern Compiler Implementation in C, Foundation Books, Delhi
2. Dick Gruneet. Al., Modern Compiler Design, Wiley Dreamtech
3. S. Chattopadhyay, Compiler Design, PHI
4. S. Pal: Systems Programming, Oxford University Press

Software Engineering (TIU-UCS-T314)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 3rd Yr., 6th Sem.

Course Title: Software Engineering	**Subject Code:** TIU-UCS-T314
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content

Module-1:
Introduction to software engineering: Software and software engineering, phases in software development, software development process models, role of management in software development, role of metrics and measurement.

Module-2:
Software requirement specifications: Role of SRS, problem analysis, requirement specification, validation, metrics, monitoring and control.

Planning a software project: Cost estimation, project scheduling, staffing, personal planning, team structures, SCM, quality assurance plans, project-monitoring plans, risk management, Knowledge driven approach and development.

Module-3:
System design: Design objectives, design principles, module level concepts, design methodology, structured design, design specifications, verification metrics, monitoring and control.
Detailed design: Module specification, detailed design and process design language, verification.

Module-4:
Coding: Programming practice, verification, and metrics.
Testing: Testing fundamentals, functional testing, structural testing, testing process, comparison of different V & V techniques.

Module-5:
Software quality; Garvin's quality dimensions, McCall's quality factor, ISO 9126 quality factor; Software Quality Dilemma; Introduction to Capability Maturity Models (CMM and CMMI); Introduction to software reliability, reliability models and estimation.

Recommended Books:

Main Reading:
1. Software Engineering, Ian Sommerville

Supplementary Reading:
1. R. Mall, "Fundamentals of Software Engineering", Prentice Hall of India
2. R. S. Pressman, "Software Engineering: a Practitioner's Approach", Tata McGraw Hill
3. D. Bell, "Software Engineering for Students", Pearson

Artificial Intelligence (TIU-UCS-T30#)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 3rd Yr., 6th Sem.
Course Title: Artificial Intelligence	**Subject Code:** TIU-UCS-E30#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content

Module-1: Basics of AI
Introduction: Overview of Artificial intelligence- Problems of AI, AI technique, Tic - Tac - Toe problem., Intelligent Agents: Agents & environment, nature of environment, structure of agents, goal-based agents, utility-based agents, learning agents., Learning: Forms of learning, inductive learning, learning decision trees, explanation-based learning, learning using relevant information, neural net learning & genetic learning.

Module 2: Different types of searching algorithms, Problem Solving
Problems, Problem Space & search: Defining the problem as state space search, production system, constraint satisfaction problems, issues in the design of search programs, Search techniques: Solving problems by searching: Problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies, Heuristic search strategies: Greedy best-first search, A* search, memory bounded heuristic search: local search algorithms & optimization problems: Hill climbing search, simulated annealing search, local beam search, genetic algorithms; constraint satisfaction problems, local search for constraint satisfaction problems, Adversarial search: Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening.

Module 3: Knowledge & Reasoning, Knowledge & Reasoning
Knowledge representation issues, representation & mapping, approaches to knowledge representation, issues in knowledge representation, Using predicate logic: Representing simple fact in logic, representing instant & ISA relationship, computable functions & predicates, resolution, natural deduction, Representing knowledge using rules: Procedural vs declarative knowledge, logic programming, forward vs backward reasoning, matching, control knowledge, Probabilistic reasoning: Representing knowledge in an uncertain domain, the semantics of Bayesian networks, Fuzzy sets, and fuzzy logics, belief propagation. Markov processes, and Hidden Markov models.

Module 4: Different fields of AI, Natural Language Processing
Introduction, Syntactic processing, semantic analysis, discourse, and pragmatic processing., Expert Systems: Representing and using domain knowledge, expert system shells, and knowledge acquisition. Basic knowledge of programming language like Prolog.

Recommended Books:

Main Reading

1. Artificial Intelligent e: Elaine Rich, Kevin Knight, Mc-Graw Hill.
2. Introduction to AI & Expert System: Dan W. Patterson, PHI.
3. Artificial Intelligent by Luger (Pearson Education)
4. Russel & Norvig, Artificial Intelligent e: A Modern Approach, Pearson Education

Machine Learning (TIU-UCS-E40#)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 4th Yr., 7th Sem.
Course Title: Machine Learning	**Subject Code:** TIU-UCS-E40#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content :

Module-1: Introduction
Definition - Types of Machine Learning - Examples of Machine Learning Problems - Training versus Testing - Characteristics of Machine learning tasks - Predictive and descriptive tasks - Machine learning Models: Geometric Models, Logical Models, Probabilistic Models. Features: Feature types - Feature Construction and Transformation - Feature Selection.

Module-2: Classification and Concept Learning
Classification: Binary Classification- Assessing Classification performance - Class probability Estimation - Multiclass Classification - Regression: Assessing performance of Regression - Error measures - Overfitting-Theory of Generalization: Effective number of hypothesis - Bounding the Growth function.

Module-3: Linear and Probabilistic Models
Least Squares method - Multivariate Linear Regression - Perceptron, Multiple Layer Perceptron - Support Vector Machines - Obtaining probabilities from Linear classifiers - Kernel methods for non-Linearity - Probabilistic models for categorical data – Naïve Bayes Classifier

Module-4: Distance Based Models
Distance Based Models: Neighbors and Examples - Nearest Neighbors Classification - Distance based clustering – K-Means Algorithm - K-Medoids Algorithm - Hierarchical clustering - Vector Quantization, Self-Organizing Feature Map - Principal Component Analysis

Module-5: Rule Based and Tree Based Models
Rule Based Models: Rule learning for subgroup discovery - Association rule mining - Tree Based Models: Decision Trees - Ranking and Probability estimation Trees - Regression trees - Classification and Regression Trees (CART)

Module-6: Trends in Machine Learning
Ensemble Learning, - Bagging and Boosting - Random Forest - Meta learning - Deep Learning - Reinforcement Learning – Applications.

Recommended Books:

Main Reading

1. P. Flach, "Machine Learning: The art and science of algorithms that make sense of data", Cambridge University Press, 2012, ISBN-10: 1107422221, ISBN-13: 978-1107422223.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Second Edition (Springer Series in Statistics), 2016, ISBN-10: 0387848576, ISBN-13: 978-0387848570.

Supplementary Reading

1. Christopher Bishop, "Pattern Recognition and Machine Learning (Information Science and Statistics)", Springer, 2007.
2. Kevin Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012, ISBN-10: 0262018020, ISBN-13: 978-0262018029
3. Y. S. Abu-Mostafa, M. Magdon-Ismail, and H.-T. Lin, "Learning from Data", AMLBook Publishers, 2012 ISBN 13: 978-1600490064.
4. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997, ISBN-10: 0071154671, ISBN-13: 978-0071154673.
5. Jiawei Han, Micheline Kamber, "Data Mining Concepts and Techniques", Chris Ullman, Morgan Kaufmann Publishers,Third Edition, 2011, ISBN 0123814790, ISBN-13 9780123814791.

Natural Language Processing (TIU-UCS-E40#)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 4th Yr., 7th Sem.
Course Title: Natural Language Processing	**Subject Code:** TIU-UCS-E40#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content

Module-1: Introduction to NLP

Natural language processing issues and strategies. Tools of NLP, Linguistic organization of NLP, NLP as an Application domain.

Word Classes: Regular Expressions: Chomsky hierarchy, CFG and different parsing techniques, ◦ Morphology: Inflectional, derivational, parsing and parsing with FST, Combinational Rules, Joint and conditional probability. Probabilistic Language modeling and it's Applications.

Module-2: Language Modeling and Naïve Bayes

Markov models, N- grams. Estimating the probability of a word and smoothing. Counting words in Corpora, simple N-grams, smoothing (Add One, Written-Bell, Good-Turing).

Part of Speech Tagging and Hidden Markov Models: Part of Speech tagging, Indian Language on focus Morphology Analysis, Accuracy Measure and Probability, HMM, Viterbi algorithm for finding most likely HMM Path. HMM tagging, transformation based tagging.

Probabilistic Context Free Grammars: Weighted context free grammars.

Module-3: Semantics:

Representing Meaning: Unambiguous representation, canonical form, expressiveness, meaning structure of language

Semantic Analysis: NLP and IR, How NLP has used IR Towards Latent Semantic.

Lexical Semantics: Lexemes(synonymy, hyponymy etc), WordNet, metonymy and their computational approaches Supervised and Unsupervised methods

Word Sense Disambiguation: Selectional restriction based, machine learning based and dictionary based approaches.

Module-4: Pragmatics

◦ Information Theory: Entropy, Cross-entropy, information gain. Reference resolution and phenomena, syntactic and semantic constraints. Pronoun resolution algorithm, text coherence, and discourse structure

◦ Natural Language Generation: Introduction to language generation, architecture, discourse planning (text schemata, rhetorical relations).

◦ Resource Constrained WSD, Parsing Algorithms, Parsing Ambiguous Sentences, Probabilistic Parsing Algorithms.

Recommended Books:

Main Reading

1. D. Jurafsky & J. H. Martin – "Speech and Language Processing – An introduction to Language processing, Computational Linguistics, and Speech Recognition", Pearson Education

Supplementary Reading:

1. Allen, James. 1995. – "Natural Language Understanding". Benjamin/Cummings, 2ed.
Bharathi, A., Vineet Chaitanya and Rajeev Sangal. 1995.

2. Natural Language Processing- “A Pananian Perspective”. Prentice Hall India, Eastern Economy Edition.
3. Eugene Cherniak: “Statistical Language Learning”, MIT Press, 1993.
3. Manning, Christopher and Heinrich Schutze. 1999. “Foundations of Statistical Natural Language Processing”. MIT Press.
4. Cognitively Inspired Natural Language Processing Abhijit Mishra, Pushpak Bhattacharyya Springer.

Knowledge Discovery & Data Mining (KDD) (TIU-UEC-E40#)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 4th Yr., 7th Sem.
Course Title: Natural Language Processing	**Subject Code:** TIU-UCS-E40#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content

Module-1:
Introduction and Rule-based Classification: What is Data Mining? Why do we need data mining? Data Mining System
- Architecture and Processes. Challenges in Data Mining.
Decision Tree: General approach for solving a classification problem, Decision Tree Induction, Overfitting Pruning.
Rule-based Classification: How a rule-based classifier works, rule-ordering schemes, how to build a rule-based classifier, direct and indirect methods for rule extraction.

Module-2:
Advanced Classification Techniques: Bayes’ Classifier: Bayes’ theorem, Naïve Bayes classifier.
Support Vector Machines (SVM): Maximum margin hyperplanes, Linear SVM: separable case, non-separable case, Non-linear SVM.

Module-3:
Ensemble Methods, Association Rule Mining: Ensemble Methods: Bagging, Boosting, Random Forests
Association Rule Mining: Introduction, Frequent itemset generation, (Apriori principle, candidate generation and pruning), Rule generation, Compact representation of frequent item sets, FP-growth algorithm, Sub-graph mining.

Module-4:
Cluster Analysis: Introduction: Motivations, objectives and applications of clustering. Different types of clustering.
Partitional Clustering: K-means, Bisecting K-means, PAM.
Hierarchical Clustering: Agglomerative, Divisive, MIN, MAX, dendrogram representation.
Density-based Clustering: DBSCAN. Cluster evaluation, further reading – OPTICS, DENCLUE, CHAMELEON, BIRCH, CURE, ROCK.

Recommended Books:

Main Reading

1. Data Mining Concepts and Techniques, 3rd, Edition, J. Han and M. Kamber, Morgan Kaufmann Publishers, July 2011.

Supplementary Reading:

1. Introduction to Data Mining, P. N. Tan, M. Steinbach and V. Kumar, Pearson Publishers.
2. Pattern Recognition and Machine Learning, First Edition, C. Bishop, Springer, 2006.
3. Neural Networks and Learning Machines, Third Edition, S. Haykin, PHI Learning, 2009.
4. Pattern Classification, Second Edition, R. Duda, P. Hart and D. Stock, Wiley-Interscience, 2000.

Big Data Analytics (TIU-UCS-E30#)

Program: B. Tech. in CSE-AI (BCS)	**Year, Semester:** 4th Yr.,7th Sem.
Course Title: Big Data Analytics	**Subject Code:** TIU-UCS-E30#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content

Module-1:
Intelligent Information Retrieval Learning from user interactions. Rating and voting, emailing and link forwarding, bookmarking, purchasing items, reviews. Extracting intelligence from tags. Tag related metadata. Tag generation. Leveraging tags: dynamic navigation, using tag clouds, targeted search, recommendations based on tags. Extracting intelligence from content: Blogs, Wikis, Message boards.

Module-2:
Clustering, Classification and Recommendations Clustering and web intelligence. Overview of clustering algorithms. Classification and Web Intelligence. Need for classification. Overview. Automatic categorization of emails and spam filtering. Classification and fraud detection. Combining classifiers. Creating Suggestions and Recommendations. Concepts of distance and similarity. Recommendations based on similar users. Recommendations based on similar items. Recommendations based on content.

Module-3:
Introduction to Hadoop Starting Hadoop. Components of Hadoop. HDFS. Working with files in HDFS. Introduction to MapReduce. Streaming in Hadoop. Advanced MapReduce: Chaining MapReduce jobs, Joining data from different sources. Developing MapReduce programs in local mode and pseudo-distributed mode. Moving data into and out of Hadoop. Data input and output in MapReduce. Applying MapReduce patterns to Big Data. Streamlining HDFS for big data.

Module-4:
Algorithms Using MapReduce Matrix-Vector Multiplication by MapReduce. Relational-Algebra Operations. Computing Selections by MapReduce. Computing Projections by MapReduce. Union, Intersection, and Difference by MapReduce. Computing Natural Join by MapReduce. Grouping and Aggregation by MapReduce. Matrix Multiplication.

Recommended Books:

Main Reading

1. Algorithms of the Intelligent Web. H. Marmanis and D. Babenko. Manning Publishers, 2009.
2. Collective Intelligence in Action. S. Alag. Manning Publishers, 2009.
3. Hadoop in Action by Chuck Lam. Manning Publishers. 2011.

4. Hadoop in Practice by Alex Holmes. Manning Publishers. 2012.
5. Mining of Massive Datasets by Jure Leskovec, Anand Rajaraman, Jeff Ullman. Cambridge University Press. 2011.

Supplementary Reading:

1. Mining the Web: Discovering Knowledge from Hypertext Data. S. Chakrabarti, Morgan-Kaufmann Publishers, 2002.
2. Recommender Systems Handbook: Francesco Ricci, Lior Rokach, Bracha Shapira, Paul B. Kantor, Springer, 2011

Computer Vision (TIU-UEC-T40#)

Program: B. Tech. in CSE-AI(BCS)	**Year, Semester:** 4th Yr.,7th Sem.
Course Title: Big Data Analytics	**Subject Code:** TIU-UCS-E30#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content:

Module-1:
Image Formation Models, Monocular imaging system, Orthographic & Perspective Projection, Camera model and Camera calibration, Image representations (continuous and discrete), Edge detection. Image Processing and Feature Extraction: Harris corner detector, SIFT, HoG descriptor;

Module-2:
Displacement and Motion models, Global motion estimation: Affine and Projective; Motion Estimation: Optical flow computation, Laplacian and Gaussian pyramids, Robust optical flow estimation; KLT tracker, Advanced Trackers such as KCF;

Module-3:
Structure from motion; Depth estimation, Active stereo: Fringe projection techniques; Binocular imaging systems, Stereo Vision, Fundamental matrix estimation, RANSAC, Image rectification and disparity estimation;

Module-4:
Viola Jones face detection, Face representation: Eigen faces and 2D PCA. Deformable curves and surfaces, Snakes and active contours; Image Segmentation. Machine Learning and Deep Learning paradigms for Computer vision.

Recommended Books:

Main Reading

1. Shah M., Fundamentals of Computer Vision, 1997.
2. Szeliski R., Computer Vision: Algorithms and Applications, Springer, 2011.

Supplementary Reading:

1. Forsyth D. & Ponce J., Computer Vision - A Modern Approach, Prentice Hall, 2002.

Artificial Neural Network (TIU-UEC-T40#)

Program: B. Tech. in CSE-AI(BCS)	**Year, Semester:** 4th Yr.,7th Sem.
Course Title: Artificial Neural Network	**Subject Code:** TIU-UEC-T40#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content:

Module1:
Introduction to neural networks, The human brain, Introduction to Neural Networks, Models of a neuron, Feedback and network, architectures, Knowledge representation, Prior information and invariance, Learning processes, Perceptron, Batch perceptron algorithm.

Module2:
Linear, non-linear regression, and multilayer perceptron (MLP), Linear regression, Logistic regression, Gradient Descent Algorithm, Multi-layer perceptron, Nonlinear Activation Units and Learning Mechanisms, XOR problem, Back propagation, Practical, Consideration in Back Propagation Algorithm, Heuristics For Back-Propagation, Multi-Class, Classification Using Multi-layered Perceptrons.

Module-3:
Radial Basis Function (RBF), Multivariate interpolation problem, Radial basis functions (RBF), Recursive least squares algorithm, Comparison of RBF with MLP, Kernel regression using RBFs, Kernel Functions, Basics of constrained optimization, Comparison Between MLP and RBF.

Module-4:
Introduction to Fuzzy Neural Networks, Overview of Fuzzy system, Integration of fuzzy logic and neural networks, Fuzzy neurons, Hybrid neural nets, Trainable neural nets for fuzzy IF-THEN rules , Tuning fuzzy control parameters by neural nets , Fuzzy rule extraction from numerical data, Neuro-fuzzy classifiers, FULLINS , Applications of fuzzy neural systems.

Module-5:
Introduction to Deep learning and Convolution Neural Network, Layers and Blocks , Parameter Management , Deferred Initialization , Custom Layers , GPUs , From Fully-Connected Layers to Convolutions , Convolutions for Images , Padding and Stride , Multiple Input and Multiple Output Channels , Pooling , Batch Normalization, Convolutional Neural Networks (LeNet) ,Deep Convolutional Neural Networks (AlexNet) , Residual Networks (ResNet) , Densely Connected Networks (DenseNet) , Networks with Parallel Concatenations (GoogLeNet).

Recommended Books:

Main Reading

1. An introduction to neural networks (Kevin Gurney University of Sheffield)
2. Neural Fuzzy Systems (Robert Full´er)
3. Foundations of Neural Networks, Fuzzy Systems, and Knowledge Engineering (Nikola K. Kasabov)
4. Dive into Deep Learning (Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola)

Bioinformatics (TIU-UCS-E40#)

Program: B. Tech. in CSE-AI(BCS)	**Year, Semester:** 4th Yr.,8th Sem.
Course Title: Bioinformatics	**Subject Code:** TIU-UCS-E40#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content:

Module-1: Introduction
Introduction to bioinformatics; Bioinformatics Applications; Central Dogma of Molecular Biology; Genome projects; Sequence analysis, Homology and Analogy;

Module-2: Biological Resources
Protein Information Resources: Biological databases; Primary Sequence Databases; Composite Protein Sequence Databases; Secondary Databases; Composite protein pattern databases; Structure classification databases;
Genome Information Resources: Introduction; DNA sequence databases; Specialized Genomic Resources;

Module-3: DNA sequence analysis
Gene structure and DNA sequence; Features of DNA sequence analysis; Issues in interpretation of EST searches; Different approaches to EST analysis; Effects of EST data on DNA databases.

Module-4: Pairwise Sequence Alignment
Database searching; Alphabet and Complexity; Algorithms and Programs; Comparing two sequences; Identity and Similarity; Local and global similarity; Global alignment: the Needleman and Wunsch algorithm; Local alignment: the Smith-Waterman algorithm; Dynamic Programming; Pairwise database searching; Basic Local Alignment Search Tool (BLAST).

Module-5: Multiple Sequence alignment:
Goal of Multiple Sequence Alignment (MSA); Purpose of MSA; Dynamic programming solution for multiple alignment; Methods of alignment.

Module-6: Protein Secondary Structure Predictions
Structure of protein; Different level of protein structure; Basics of machine learning; Methods for predicting secondary structure: Chou-Fasman method, Garnier-Osguthorpe-Robson method, Neural Network based method.

Module-7: Biomedical Text Mining
Named entity recognition; Document classification and clustering; Relationship discovery; Information extraction; Information retrieval and question answering; Applications of biomedical text mining.

Recommended Books:

Main Reading

1. T K Attwood, D J Parry-Smith, Samiron Phukan; Introduction to bioinformatics, Pearson
2. S. C. Rastogi, P. Rastogi, N. Mendiratta; Bioinformatics Methods And Applications: Genomics Proteomics and Drug Discovery, PHI.
3. Bryan Bergeron, Bioinformatics Computing, Pearson

Supplementary Reading:

2. S. Harisha, Fundamentals of Bioinformatics, I.K International

Deep Learning (TIU-UCS-E40#)

Program: B. Tech. in CSE-AI(BCS)	**Year, Semester:** 4th Yr.,8th Sem.
Course Title: Deep Learning	**Subject Code:** TIU-UCS-E40#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content:

Module-1:
Feature Selection vs Feature Extraction, Introduction to TensorFlow and Keras Framework: Computational Graph, Creating a Graph, Regression example, Gradient Descent, Modularity, Sharing Variables.

Module-2:
Activation Functions Sigmoid, ReLU, Hyperbolic Fns, Softmax
Artificial Neural Networks: Introduction, Perceptrons , Gradient Descent Rule: Stochastic Gradient Descent, Backpropagation, ANN Optimization and Regularization :Overfitting and Capacity, Cross Validation,Bias Variance Tradeoff, Regularization, Hyperparameters.

Module-3:
Deep Learning applications: Image Processing, Natural Language Processing, Speech Recognition, Introduction to Convolutional Neural Networks, Kernel, Multiple Filters, CNN applications, Introduction to Recurrent Neural Networks: Introduction to RNNs, Unfolded RNNs, Seq2Seq RNNs, Vanishing vs Exploding Gradient Problem in RNN, LSTM, RNN applications.

Module-4:
Auto Encoder: Types of Auto Encoder(Stacked AE, Denoising AE, Convolutional AE, Deep Autoencoders),

Module-5:
Concept of Transfer Learning in Text(BERT) and Image Processing(ALEXNET, VGG16,VGG19).

Recommended Books:

Main Reading

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.

Supplementary Reading:

1. Bishop, C. ,M., Pattern Recognition and Machine Learning, Springer, 2006.
2. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
3. Golub, G.,H., and Van Loan,C.,F., Matrix Computations, JHU Press,2013.
4. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.

Information Retrieval (TIU-UCS-E40#)

Program: B. Tech. in CSE-AI(BCS)	**Year, Semester:** 4th Yr.,8th Sem.
Course Title: Information Retrieval	**Subject Code:** TIU-UCS-E40#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content:

Module-1: Overview of text retrieval systems
Boolean retrieval, The term vocabulary and postings lists, Dictionaries and tolerant retrieval, Index construction and compression.

Module-2: Retrieval models and implementation
Vector Space Models, Vector Space Model, TF-IDF Weight, Evaluation in information retrieval.

Module-3: Query expansion and feedback
Relevance feedback, Pseudo relevance feedback, Query Reformulation

Module-4: Probabilistic models and statistical language models
Okapi/BM25, Language models, KL-divergence, Smoothing

Module-5: Text classification & Text clustering
The text classification problem, Naive Bayes text classification, k- nearest neighbors, Support vector Machine, Feature Selection, Vector-space clustering, K-means algorithm, Hierarchical clustering, DBSCAN algorithm, PAM and PAMK, EM algorithm

Module-6: Web search basics
Crawling, Indexes, Link analysis, Web Characteristic, Crawling, Web As a graph, Page Rank, Hubs and Authorities

Module-7: IR applications
Information extraction, Question answering, Opinion summarization, Social Network

Recommended Books:

Main Reading

1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Introduction to Information Retrieval, Cambridge University Press. 2008.
2. Statistical Language Models for Information Retrieval (Synthesis Lectures Series on Human Language Technologies), Morgan & Claypool Publishers, 2008.

Game Theory for AI and Data Science (TIU-UCS-E40#)

Program: B. Tech. in CSE-AI(BCS)	**Year, Semester:** 4th Yr.,8th Sem.
Course Title: Game Theory for AI and Data Science	**Subject Code:** TIU-UCS-E40#
Contact Hours/Week: 3–0–0 (L–T–P)	**Credit:** Theory–3

Course Content:

Module-1: Basics of Machine Learning and Game Theory
Introduction to Linear Programming, Introduction to Game Theory, Introduction to Different types of Learning including Reinforcement Learning.

Module-2: Introduction to Linear Programming
Linear Programming Models, The Simplex Method, Concepts of Duality and Sensitivity, Relationship between Linear Programming and Game Theory.

Module-3: Deep Dive into Game Theory
Terminologies of Game Theory, Different types of games and their strategies, Methods of solving games with mixed strategies, Decision Making in Game Theory.

Module-4: Multi Agent AI Systems
Multiagent framework, Representation of Games, Computing strategies, Group decision making, Belief networks and other Knowledge-based systems

Module-5: Reinforcement Learning
Fundamentals of Reinforcement Learning, Value Based and Policy Based, Multi-Agent Reinforcement Learning, Markov Decision Process & Dynamic Programming, Application of Game Theory in Deep Reinforcement Learning

Module-6: GANs
Generative Models, Discriminative models, Different types of GANs, Application of Game Theory in GAN

Recommended Books:

Main Reading

1. An Introduction to Linear Programming and Game Theory - Paul R. Thie, G. E. Keough, A JOHN WILEY & SONS, INC., PUBLICATION
2. A Gentle Introduction to Game Theory – Saul Stahl, American Mathematical Society
3. Reinforcement Learning Algorithms with Python – Andrea Lonza, Packt Publishing
4. GANs in Action: Deep learning with Generative Adversarial Networks - Jakub Langr, Vladimir Bok, Manning Publications