NATIONAL INSTITUTE OF TECHNOLOGY MIZORAM

COURSE STRUCTURE AND SYLLABUS

OF

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY MIZORAM

CHALTLANG, AIZAWL MIZORAM-796012

B. Tech Degree Programme

Curriculum

Bachelor of Technology in Computer Science and Engineering

Course Credits – Semester Wise

SEMESTER	I	II	III	IV	V	VI	VII	VIII	TOTAL
CSE	20.5	21.5	22.5	22.5	21	20.5	14.5	18	161

SEMESTER-III

Sl. No	Course Code	Course Title	L-T-P	Credit
1	CSL 1301	Data Structures	3-0-0	3
2	CSL 1302	Discrete Mathematics	3-0-0	3
3	CSL 1303	Object Oriented Programming	3-0-0	3
4	MAL 1301	Linear Algebra and Application	3-0-0	3
5	ECL 1302	Digital Logic Design	3-0-0	3
6	HUL 1xxx	HSS/Management/Environmental Science	3-0-0	3
Laboratory				
1	CSP 1301	Data Structures Laboratory	0-0-3	1.5
2	CSP 1303	Object Oriented Programming Laboratory	0-0-3	1.5
3	ECP 1302	Digital Logic Design Laboratory	0-0-2	1.5
TOTAL			**18-0-8**	**22.5**

SEMESTER-IV

Sl. No	Course Code	Course Title	L-T-P	Credit
1	CSL 1401	Computer Organization and Architecture	3-0-0	3
2	CSL 1402	Design and Analysis of Algorithms	3-0-0	3
3	CSL 1403	Theory of Computation	3-0-0	3
4	EEL 1402	Signals and Systems	3-0-0	3
5	MAL 1404	Probability Theory and Stochastic Processes	3-0-0	3
6	MAL 1405	Convex Optimization: Theory and Algorithms	3-0-0	3
Laboratory				
1	CSP 1401	Computer Organization and Architecture Laboratory	0-0-3	1.5
2	CSP 1404	Systems Programming Laboratory	0-0-3	1.5
3	CSP 1405	Embedded Systems Laboratory	0-0-3	1.5
TOTAL			**18-0-8**	**22.5**

SEMESTER-V

Sl. No	Course Code	Course Title	L-T-P	Credit
1	CSL 1501	Computer Networks	3-0-0	3
2	CSL 1502	Operating Systems	3-0-0	3
3	ECL 1502	Microprocessors and Microcontrollers	3-0-0	3
4	CSL 1504	Database Management System	3-0-0	3
5	CSL 1505	Principles of Programming Languages	2-1-0	3
Laboratory				
1	CSP 1501	Computer Networks Laboratory	0-0-3	1.5
2	CSP 1502	Operating Systems Laboratory	0-0-3	1.5
3	ECL 1502	Microprocessors and Microcontrollers Laboratory	0-0-3	1.5
4	CSP 1504	Database Management System Laboratory	0-0-3	1.5
TOTAL			**14-1-12**	**21**

SEMESTER-VI

Sl. No	Course Code	Course Title	L-T-P	Credit
1	CSL 1601	Principles of Compiler Design	3-0-0	3
2	CSL 1602	Software Engineering	3-0-0	3
3	CSL 1603	Computer Graphics	3-0-0	3
4	CSL 1604	Artificial Intelligence	3-0-0	3
5	HUL 1xxx	HSS/Management	3-0-0	3
Laboratory				
1	CSP 1601	Compiler Design Laboratory	0-0-3	1.5
2	CSP 1602	Software Engineering Laboratory	0-0-3	1.5
3	CSP 1603	Computer Graphics Laboratory	0-0-3	1.5
4	CSS 1601	Industrial Training and Seminar	0-0-2	1
TOTAL			**15-0-11**	**20.5**

SEMESTER-VII

Sl. No	Course Code	Course Title	L-T-P	Credit
1	CSL 17xx	Elective - I	3-0-0	3
2	CSL 1702	Machine Learning	3-0-0	3
3	CSL 17xx	Elective - II	3-0-0	3
4	CSD 1701	Project Phase-I	0-0-8	4
Laboratory				
1	CSP 1702	Machine Learning Laboratory	0-0-3	1.5
TOTAL			**9-0-10**	**14.5**

SEMESTER-VIII

Sl. No	Course Code	Course Title	L-T-P	Credit
1	HUL 1xxx	HSS/Management/Environmental Science	2-0-0	2
2	XXX xxxx	Open Elective	3-0-0	3
3	CSL 18xx	Elective - III	3-0-0	3
4	CSD 1802	Project Phase -II	0-0-16	8
5	CSG 1801	Grand Viva	0-0-2	1
6	CSS 1801	Seminar	0-0-2	1
TOTAL			**8-0-20**	**18**

GV-Grand Viva
CS-Computer Sc S-Seminar L-Lecture T-Tutorial P-practical

LIST OF ELECTIVES

Sl No	Course Code	Course Title	Category	L-T-P	Credit
1	CSL1XXX	Advanced Computer Architecture	DE	3-0-0	3
2	CSL1XXX	Pattern Recognition	DE	3-0-0	3
3	CSL1XXX	Artificial neural network	DE	3-0-0	3
4	CSL1XXX	Natural language processing	DE	3-0-0	3
5	CSL1XXX	Real Time Systems	DE	3-0-0	3
6	CSL1XXX	Bioinformatics	DE	3-0-0	3
7	CSL1XXX	Information Theory and Coding	DE	3-0-0	3
8	CSL1XXX	Parallel Algorithms	DE	3-0-0	3
9	CSL1XXX	Real Time Operating System	DE	3-0-0	3
10	CSL 1XXX	Mobile Computing	DE	3-0-0	3
11	CSL1XXX	Advanced Data Structures	DE	3-0-0	3
12	CSL1XXX	Distributed computing	DE	3-0-0	3
13	CSL1XXX	Robotics	DE	3-0-0	3
14	CSL1XXX	Cloud Computing	DE	3-0-0	3
15	CSL1XXX	Information Retrieval and storage	DE	3-0-0	3
16	CSL1XXX	Soft Computing	DE	3-0-0	3
18	CSL1XXX	Optimization Techniques	DE	3-0-0	3
19	CSL1XXX	Computational Complexity	DE	3-0-0	3
20	CSL1XXX	Advanced Algorithms	DE	3-0-0	3
21	CSL1XXX	Computational Number Theory and Cryptography	DE	3-0-0	3
22	CSL1XXX	Wireless Networks	DE	3-0-0	3
23	CSL1XXX	Applied Graph Theory	DE	3-0-0	3
24	CSL1XXX	Computational Geometry	DE	3-0-0	3
25	CSL1XXX	Big Data and Analytics	DE	3-0-0	3

26	CSL1XXX	Image Processing	DE	3-0-0	3
27	CSL1XXX	Web Technology	DE	3-0-0	3
28	CSL1XXX	Network security and Cryptography	DE	3-0-0	3
29	CSL1XXX	Data Mining and Data Warehousing	DE	3-0-0	3

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1ST YEAR BTECH, SYLLABI

COMPUTER SCIENCE & ENGINEERING

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***INTRODUCTION TO COMPUTER PROGRAMMING***

L	T	P	Course Code: *CSL 1201*	Credit:3
3	0	0		

Computer Basics: Introduction, Characteristics of a Computer, Criteria for Using Computers, History of Computers, Generations of Computer, Classification of Computers, Applications of Computer, Basic Components of PC, Computer Architecture. Computer Hardware, Computer Software, Internet. **Lecture: 3**

Number System: Binary number, Octal number, Hexadecimal number system and their conversion among them.
Programming basics: Assembly language, High level language, Compiler and assembler.
Lecture: 4

Keyword & Identifiers: History & Importance of C, Basic structure of C programs, C fundamentals: The C character set identifier, Constants and keywords, Data types & size, Variable names declaration statement, C token, symbolic constant. **Lecture: 4**

Operators and Expression: Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Increment & Decrement operators, Condition Operators, Bitwise Operators, Special operators, precedence of arithmetic operators. Managing Input & output operations: using of printf() & scanf( ). **Lecture: 4**

Decision making: Simple If statement, if-else statement, nested if else statement, Switch statement, nested switch, the ? operator, goto statement. **Lecture: 4**

Decision making & branching: while statement, do- while statement, for statement. **Lecture: 2**

Array, String & pointer: One-dimension array, Two-dimension array and multi dimension array. String: Operation on String without using library function and using library function. Pointer: Declaration of pointer variables, accessing the variable by using pointer, pointer increment and decrement operator, pointer and array.
Functions: Basic functions, function type, function with no argument & no return value, function with no argument but return value, function with argument & return value, Storage class identifier, Call by value and Call by reference, Recursive function. Pointer to function. **Lecture: 9**

Structure & Union: Defining a structure, accessing of structure variable, structure and array, array within structure. Nested structure, structure & functions, Pointer & structure, Unions. **Lecture: 4**

File management system: Advantage of using files, Open, close, read. Write in the files, Operation on files.
Lecture: 4

Dynamic memory Allocation: use of Malloc, calloc, realloc, free library functions, linked list concept, the preprocessor: macro statements. **Lecture: 3**
Introduction to programming paradigm. **Lecture: 1**
TOTAL LECTURE: 42

Text Book:
1. Balaguruswamy," Programming with 'C'".
2. Kerninghan and Ritchie," The 'C' programming language".
Reference Book:
1. Govil, Agrawal, Mathur & Pathak, "Computer Fundamentals and Programming in C".
2. Sinha & Sinha," Foundations of Computing", BPB.

Department of Computer Science & Engineering

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Subject: ***INTRODUCTION TO COMPUTER PROGRAMMING***

L	**T**	**P**	**Course Code**: ***CSP 1201***	**Credit**:**1.5**
0	0	3		

Programming Lab will be set in consonance with the material covered in CSL1201.

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3RD SEMESTER

BTECH, SYLLABI

COMPUTER SCIENCE & ENGINEERING

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***DATA STRUCTURES***

L **T** **P** **Course Code**: ***CSL1301*** **Credit**:3
3 0 0

Introduction: Basic Terminology, Elementary Data Organization, Structure operations, Algorithm Complexity and Time-Space trade- off Arrays: Array Definition, Representation and Analysis, Single and Multidimensional Arrays, address calculation, application of arrays, Character String in C, Character string operation, Array as Parameters, Ordered List, Sparse Matrices and Vectors.

Lecture:4

Stacks: Array Representation and Implementation of stack, Operations on Stacks: Push & Pop, Array Representation of Stack, Linked Representation of Stack, Operations Associated with Stacks, and Application of stack: Conversion of infix to Prefix and Postfix Expressions, Evaluation of postfix expression using stack. Recursion: Recursive definition and processes, recursion, example of recursion, Tower of Hanoi Problem, simulating recursion, Backtracking, recursive algorithms

Lecture: 5

Queues: Array and linked representation and implementation of queues, Operations on Queue: Create, Add, Delete, Full and Empty, Circular queues, D- queues and Priority Queues.

Lecture: 5

Linked list: Representation and Implementation of Singly Linked Lists, Two-way Header List, Traversing and Searching of Linked List, Overflow and Underflow, Insertion and deletion to/from Linked Lists, insertion and deletion Algorithms, Doubly linked list, Linked List in Array, Polynomial representation and addition, Garbage Collection and Compaction.

Lecture: 6

Trees: Basic terminology, Binary Trees, Binary tree representation, algebraic Expressions, Complete Binary Tree, Extended Binary Trees, Array and Linked Representation of Binary trees, Traversing Binary trees, Threaded Binary trees, path length algorithm. Huffman Algorithm. Binary Search Trees: Binary Search Tree (BST), insertion and Deletion in BST, Complexity of Search Algorithm

Lecture:8

Searching and Hashing: Sequential search, binary search, comparison and analysis, Hash Table, Hash Functions, Collision Resolution Strategies, Hash Table Implementation. Sorting: insertion Sort, Bubble Sort, Quick Sort, Two Way Merge Sort, Heap Sort, Sorting on Different Keys.

Lecture:8

File Structures: Physical Storage Media File Organization, Organization of records into Blocks, Sequential Files, Indexing and Hashing, Primary indices, Secondary indices, Introduction to index Files.

Lecture:4

TOTAL LECTURE: 40

Text Book:

1. Data Structures & Program Design in C: Robert Kruse, G. L. Tondo and B. Leung PHI-EEE.
2. R .Sedgewick,Algorithms in C++ parts 5'3rd Ed.pearson Education,2002
3. Data Structures By E.Horowitz and s.sahni, Galgotri Publication

Reference Books:

1. Data Management & File Structures, 2e, by Mary E.S. Loomis, PHI
2. Data Structures by Lipschutz & Pai, Tata McGraw Hill.
3. C and Data Structures by P.S. Despande, Wiley India
4. T.H Cormen C.E Leiserson, R.L Rivest and c Stein, Introduction to Algorithms, MIT Press,2001

Department of Computer Science & Engineering

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Subject: ***DATA STRUCTURES LABORATORY***

L	**T**	**P**	**Course Code**: ***CSP1301***	**Credit**:1.5
0	0	3		

Programming Lab will be set in consonance with the material covered in CSL1301.This will include assignment in programming language like C++/JAVA

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***DISCRETE MATHEMATICS***

L	T	P	Course Code: *CSL1302*	Credit:3
3	0	0		

Set Theory: Definition of sets, countable and uncountable sets, Venn Diagrams, proofs of some general identities on sets. **Relation:** Definition, types of relation, composition of relations, Pictorial representation of relation, equivalence relation, partial ordering relation. **Function:** Definition, type of functions, one to one, into and onto function, inverse function, composition of functions, recursively defined functions. Theorem proving Techniques: mathematical induction (simple and strong), pigeonhole principle, prove by contradiction.

Lecture:10

Algebraic Structures: Definition, Properties, types: Semi Groups, monoid, Groups, abelian group, properties of groups, Subgroup, cyclic groups, cosets, factor group, Permutation groups, normal subgroup, Homomorphism and isomorphism of Groups, example and standard results, Rings and Fields: definition and standard results. **Lecture:8**

Posets, Hasse Diagram and Lattices: Introduction, ordered set, hasse diagram of partially, ordered set, isomorphic ordered set, well ordered set, properties of Lattices, bounded and complemented lattices. **Lecture:8**

Propositional Logic: Proposition, First order logic, Basic logical operation, truth tables, tautologies, Contradictions, Algebra of Proposition, logical implications, logical equivalence, predicates, universal and existential quantifiers.

Lecture:6

Graphs: Graphs, Sub graphs, some basic properties, various example of graphs & their sub graphs, walks, trails, path & circuits, connected graphs, disconnected graphs and component, various operation on graphs, Euler graphs, Hamiltonian paths and circuits, the traveling salesman problem, directed graphs, some types of directed graphs, directed paths and connectedness, Hamiltonian and Euler digraphs. Trees and fundamental circuits, distance diameters, radius and pendent vertices, rooted and binary trees, on counting trees, spanning trees, fundamental circuits, finding all spanning trees of a graph and a weighted graph, trees with directed edges, fundamental circuits in digraph. **Lecture:8**

TOTAL LECTURE:40

Text Books:

1. Liptschutz, Seymour, "Discrete Mathematics", McGraw Hill.
2. C. L. Liu, D. P. Mohapatra, Elements of Discrete Mathematics: A computer Oriented Approach, Tata-McGraw Hill,
3. Deo, N: Graph theory, PHI

Reference Books:

1. Discrete Mathematical Structures: Theory & Applications by D. S Malik & M.K. Sen, Thomson India Edition
2. Trembley, J.P & R. Manohar, "Discrete Mathematical Structure with Application to Computer Science", McGraw Hill, Reprint 2010
3. Bondy and Murthy: Graph theory and application. Addison Wesley

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Subject: ***OBJECT ORIENTED PROGRAMMING***

L	**T**	**P**	**Course Code**: ***CSL1303***	**Credit**:3
3	0	0		

Object Modelling: Objects and classes, links and association, generalization and inheritance, aggregation, abstract class, multiple inheritance, meta data, candidate keys, constraints. Dynamic Modeling: Events and states, operations, nested state diagrams and concurrency, advanced dynamic modeling concepts, a sample dynamic model.

Lecture:10

Functional Modelling: Data flow diagram, specifying operations, constraints, a sample functional model.OMT (object modeling techniques) methodologies, Introduction to UML, examples and case studies to demonstrate methodologies, comparisons of methodologies, SA/SD, JSD.

Lecture-8

Java Programming: Introduction, Operator, Data types, Variables, Methods & Classes, Multithread Programming, I/O, Java Apple.

Lecture-8

Java Library: String Handling, input/output exploring Java.io, Networking, Exception Handling, Event Handling, Introduction to AWT, Working with window, Graphics, AWT Controls, Layout Manager and Menus, Images.

Lecture-8

Software Development using Java: Java Swing, Application of java, JDBC. Characteristic of Different object oriented language

Lecture-6

TOTAL LECTURE:40

Text Books:

1. Herbert Schieldt, "The Complete Reference: Java", TMH, 7th Edition
2. James Rumbaugh etal, "Object Oriented Modeling and Design", PHI

Reference Books:

1. Nino," An Introduction to Programming and Object Oriented Design using Java, w/CD", Wiley India
2. Horstmann, Big Java, Wiley India

Department of Computer Science & Engineering

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Subject: ***OBJECT ORIENTED PROGRAMMING LABORATORY***

L	**T**	**P**	**Course Code**: ***CSP1303***	**Credit**:1.5
0	0	3		

Programming Lab will be set in consonance with the material covered in CSL1303.This will include assignment in programming language like JAVA

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4TH SEMESTER

BTECH, SYLLABI

COMPUTER SCIENCE & ENGINEERING

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***COMPUTER ORGANIZATION AND ARCHITECTURE***

L	**T**	**P**	**Course Code**: ***CSL1401***	**Credit**:3
3	0	0		

Introduction: Computer architecture, Vonneuman architecture Register Transfer Language, Bus and Memory Transfers, Bus Architecture, Bus Arbitration, Arithmetic Logic, Shift Microoperation, Arithmetic Logic Shift Unit, Design of Fast address, Arithmetic Algorithms (addition, subtraction, Booth Multiplication), IEEE standard for Floating point numbers

Lecture-3

Processor Design: Processor Organization: General register organization, Stack organization, Addressing mode, Instruction format, Data transfer & manipulations, Program Control, Reduced Instruction Set Computer

Lecture-5

Control Design: Hardwired & Micro Programmed (Control Unit): Fundamental Concepts (Register Transfers, performing of arithmetic or logical operations, fetching a word from memory, Storing a word in memory), Execution of a complete instruction, Multiple- Bus organization, Hardwired Control, Micro programmed control(Microinstruction, Micro program sequencing, Wide- Branch addressing, Microinstruction with Next-address field, Prefetching Microinstruction). **Lecture-8**

Memory Organization: Memory Hierarchy, Main Memory (RAM and ROM Chips), organization of Cache Memory, Auxiliary memory, Cache memory, Virtual Memory,

Lecture-8

Input-Output: I/O Organization: I/O Interface, Modes of transfer, Interrupts & Interrupt handling, Direct Memory access, Input-Output processor, Serial Communication, introduction to storage.

Lecture-8

Parallel Processing, Pipelining- Arithmetic Pipelining, Instruction Pipelining, RISC Pipelining, Vector Processing, Array Processor. Multiprocessor: Characteristic of Multiprocessor, Interconnection Structure, Interprocessor Arbitration, Cache Coherence. **Lecture-8**

TOTAL LECTURE:40

Text Books:

1. V. C. Hamacher, Z. G. Veranesic, and S. G. Zaky, Computer Organization, Tata McGraw Hill, 5th Ed, 2002.
2. Computer Organization & Design: A hardware/software interface by David A. Patterson and John L. Hennessy, Morgan Kaufmann Publishers
3. Computer Architecture: A Quantitative Approach by John L. Hennessy, Morgan Kaufmann Publishers

Reference Books:

1. M. M. Mano, Computer System Architecture, Pearson, 3rd Ed, 2004.
2. W. Stallings, Computer Organization and Architecture –Designing for Performance, Prentice Hall of

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Subject: ***COMPUTER ORGANIZATION AND ARCHITECTURE LABORATORY***

L	**T**	**P**	**Course Code**: ***CSP1401***	**Credit**:**1.5**
0	0	3		

Problem will be set in consonance with the material covered in CSL1401

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National Institute of Technology, Mizoram

Subject: ***DESIGN AND ANALYSIS OF ALGORITHMS***

L	T	P	Course Code: *CSL1402*	Credit:3
3	0	0		

Introduction: Definition, Asymptotic notations and complexity analysis (best, worst, and average case), notions of optimality, Medians and order statistics, Minimum and maximum, selection in expected linear time, Selection in worst-case linear time. **Lecture:5**

Algorithm design techniques: Greedy Algorithm: Introduction Set of Intervals, Fractional Knapsack and 0-1 knapsack problems, Huffman coding**,** Divide and Conquer: Introduction, Sorting, Median Finding**,** Dynamic Programming: combinatorial Search, 0-1 knapsack, longest common subsequence, matrix chain multiplication, optimal search trees, scheduling problem.

Lecture:12

Miscellaneous algorithms: Integer, matrix and polynomial multiplication, convex hull, closest pairs, string matching, FFT, extended Euclid's algorithm. **Lecture-5**

Graphs and graph algorithms: Definition, Representations of graphs, Depth first search, Breadth first search. Kruskal's and Prim's algorithm for minimum spanning tree, single source shortest path algorithm, all-pairs shortest path algorithms**.** **Lecture-10**

Computational complexity: The classes P and NP, Introduction to NP Completeness-Matching, search/ Decision examples of NP complete problems, Polynomial Reduction, NP Hard and NP Complete Problems, Introduction to branch-and-bound, backtracking, and approximation algorithms.

Lecture-8

TOTAL LECTURE:40

Text Books:

1. T.H. Cormen, C.E. Leiserson,R.L. Rivest, C.Stein : Introduction to algorithms -, PHI,2002
2. Fundamentals of Algorithm-by Horowitz & Sahani, 2nd Edition, Universities Press.

Reference Books:

1. Algorithms By Sanjay Dasgupta, Umesh Vazirani – McGraw-Hill Education
2. Algorithms – Berman, Cengage Learning

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Subject: ***THEORY OF COMPUTATION***

L	**T**	**P**	**Course Code**: ***CSL1403***	**Credit**:3
3	0	0		

Introduction: Alphabets, strings, languages and grammar **Lecture: 2**

Finite automata: Introduction to finite automata, deterministic and non-deterministic finite automata, application of finite automata, equivalence and minimization of automata **Lecture: 6**

Regular Expression: Regular expression, finite automata and regular expressions, applications of regular expressions, Arden's Theorem, algebraic laws of regular expressions. **Lecture: 6**

Properties of Regular Language: Pumping lemma, closure properties. **Lecture: 4**

Context-free Grammars and Languages: Parse trees, Applications of context free grammars, Ambiguity. **Lecture: 3**

Pushdown Automata: Pushdown automation (PDA), the language of PDA, equivalence of PDA's and CFG's, deterministic pushdown automata. **Lecture: 4**

Properties of Context-Free Languages: Normal forms, pumping lemma, closure properties. **Lecture: 5**

Turing Machine: Definition, variants, recursively enumerable (r.e.) sets, recursive sets, programming techniques for Turing machine, restricted Turing Machines, Turing machines and Computers, decidability and undecidability, Halting Problem, reductions, Undecidable Problem about Turing Machine, Post 's Correspondence Problem. **Lecture: 7**

Intractable Problem: The Classes *P* & *NP,* NP-Complete Problem, Example of *P*& *NP* Problem. **Lecture: 3**

TOTAL LECTURE:40

Text Books:

1. Introduction to Automata Theory, Languages, and Computation, by John E. Hopcroft, Rajeev Motwani, and Jeffery D. Ullman, Pearson Education

Reference Books:

1. Introduction to languages and the theory of computation, Martin John, TMH
2. Theory of Computer Science (Automata, Languages and Computation*)*, K. L. P. Mishra and N. Chandrasekharan, PHI

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Subject: ***SYSTEMS PROGRAMMING LABORATORY***

L	**T**	**P**	**Course Code**: ***CSP1404***	**Credit**:**1.5**
0	0	3		

Experiments must cover the following topics:

1. Assembler

2. Macros and Macro Processor

3. Loaders & Linkers

4. Software Tools**:** Software Tools for Program Development, Editors, document writing and slides preparation using latex, Debug Monitors, Programmes, Environments user Interfaces. Overview of Unix system, commands and utilities and program maintenance: make, sccs, debugging with gdb and ddd. archieving: shar, tar; shell use: redirection, c-shell and bash shell, shell programming, scripts, regular expression parsing: grep, egrep, awk. Scripting languages: perl, python, java script etc.

Text Book:

1. "Computer Systems: A Programmer's Perspective", by Bryant and O'Hallaron.
2. "Linker and Loaders", by John R. Levine.
3. Systems Programming by John J Donovan (McGraw-Hill Education).
4. Systems Programming by D M Dhamdhere (McGraw-Hill Education)
5. Kochan and P. Wood, Unix Shell programming SAMS,2003

Reference Book:

1. System Software: An Introduction to Systems Programming (3rd Edition) by Leland L. Beck, Pearson Education
2. System Software: Nityashri,(McGraw-Hill Education)
3. System Programming with C and Unix. - Hoover (Pearson Education)
4. Latex:A Document preparation systems edition wisely ,L. lamport

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National Institute of Technology, Mizoram

Subject: ***EMBEDDED SYSTEMS LABORATORY***

L	**T**	**P**	**Course Code**: ***CSP1405***	**Credit**:**1.5**
0	0	3		

Experiments must cover the following topics:

1. Analog to Digital Converter
2. Digital to Analog Converter
3. Experiments on embedded system with Arduino board

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5TH SEMESTER

BTECH, SYLLABI

COMPUTER SCIENCE & ENGINEERING

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***COMPUTER NETWORKS***

L	T	P	Course Code: *CSL1501*	Credit:3
3	0	0		

Review of Computer Network Architecture and the Subnet layers. **Lecture: 2**

Physical Layer: Data communication basics, guided transmission media, wireless transmission, communication satellites, public switched telephone network.

Data link layer: Framing, HDLC, PPP, sliding window protocols, medium access control, Token Ring, Wireless LAN Virtual circuit switching: Frame relay, ATM. **Lecture: 8**

Network Layer: Network layer and its functionalities, Subnets, Circuit Switching, Packet Switching, Virtual Circuit, datagram, Routing, IP, ARP, RARP, DHCP, ICMP, Queuing Disciplines, RIP, OSPF, Subnetting, CIDR, Interdomain routing –BGP, IPv6, Multicasting, Congestion avoidance in Network layer. **Lecture: 10**

Data Transport: Connection management, Quality of Service, TCP/IP Protocol, UDP, TCP, Congestion Control, Flow Control, Congestion Avoidance, QoS **Lecture: 7**

Network security: Message Security and Authentication Techniques, Encryption algorithms, PGP, SSH, Firewall. **Lecture: 7**

Applications: HTTP, E-mail (SMTP, MIME, IMAP, POP3), DNS, Remote login (Telnet, SSH), File transfer (FTP), Network file system, Overlay Networks, P2P Networks, Network management (SNMP). UNIX network programming with TCP/IP **Lecture: 8**

TOTAL LECTURE: 42

Text Books:

1. "Computer Networks", Tanenbaum A. S., PHI
2. "Computer Networks", Peterson, Davie, Elsevier

Reference Books:

1. "Data Communication and Network", Farouzan, Mc Graw Hill
2. "Communication Systems", Simon Haykin, John Wiley
3. "Computer Networks and Internets", Douglas Comer, Addison Wesley
4. "Computer Networks: A Systems Approach", Peterson, Simon, Pearson Education, Asia

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***COMPUTER NETWORKS LABORATORY***

L	**T**	**P**	**Course Code**: ***CSP1501***	**Credit**:1.5
0	0	3		

Problem will be set in consonance with the material covered in CSL1501

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***OPERATING SYSTEMS***

L	T	P	Course Code: *CSL1502*	Credit:3
3	0	0		

Introduction: Introduction and history of Operating systems, structure and operations; processes and files. **Lecture: 6**

Process management: process, process states, synchronization, mutual exclusion, semaphores, inter process communication, scheduling algorithms, critical sections, threads, multithreading. **Lecture:7**

Memory management: contiguous memory allocation, dynamic partitioning management, virtual memory, paging, page table, demand fetching, place and replacement policies, thrashing, segmentation. **Lecture:8**

Concurrency Control: Shared resources, resource allocation and scheduling, resource graph models, deadlock Detection, deadlock avoidance, deadlock prevention algorithms. **Lecture:8**

Device management: devices and their characteristics, device drivers, device handling, disk scheduling algorithms, scan, c-scan, c-look , storage RAID. **Lecture:5**

File management: file concept, types and structures, directory structure, access methods and matrices, file security, user authentication. **Lecture:6**

UNIX operating system as a case study. **Lecture:2**

TOTAL LECTURE:42

Text Books:

1. Tanenbaum A, "Modern Operating Systems", PHI
2. Silberchatz & Galvin, "Operating System Concepts", Addison Wesley

Reference Books:

1. Dhamdhere, "Systems Programming and Operating System", Tata Mc Graw Hill
2. Operating Systems by Stalling, Pearson

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***OPERATING SYSTEMS LABORATORY***

L	**T**	**P**	**Course Code**: ***CSP1502***	**Credit**:1.5
0	0	3		

Problem will be set in consonance with the material covered in CSL1502

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***DATABASE MANAGEMENT SYSTEM***

L	**T**	**P**	**Course Code**: ***CSL1504***	**Credit**:3
3	0	0		

Introduction: Introduction to database system, Database model, Database management system, Types and Examples (RDBMS, OODBMS, etc), Three-schema architecture of a database, Design Challenges, Components. **Lecture: 5**

Entity-Relationship Model: Conceptual data modeling - motivation, Entities, Attributes, Relationships, E-R diagram, Examples: Concept of relations, Schema, Instances, Integrity constraints and Keys, EER. **Lecture:5**

Relational algebra: Selection, Projection, Cross product, Joins, Division, Example queries, Tuple relation calculus, Domain relational calculus, Converting the database specification in ER notation to the relational schema and vice versa. **Lecture: 4**

SQL: Introduction, Data definition, Table, key and foreign key, Update behaviors, SQL Query-basic queries, semantics and Nested queries. **Lecture: 6**

Dependencies and Normal forms: schema design, Importance and problems with bad designs, normal forms, dependency theory – functional dependencies, Armstrong's axioms, Closure set, Minimal covers, 1NF, 2NF, 3NF and BCNF, Decomposition, Multi-valued dependencies, Join dependencies, Introduction to 4NF and 5NF. **Lecture: 8**

File organization: Indexing, Index structures, Hashing, Dynamic hashing techniques, Multi-level indexing, B+ trees and its variances. **Lecture: 6**

Transaction processing and Error recovery: Concepts of transaction processing, ACID properties, Concurrency control, Locking protocols, Error recovery, backups. **Lecture: 4**

Query Optimizations. **Lecture: 2**

TOTAL LECTURE:40

Text Books:

1. Database System Concepts, by A.Silberschatz, H. F. Korth, & S. Sudhatshan, McGraw Hill.

Reference Books:

1. Fundamental of Database Systems, by Elmasri, Navathe, Somayajulu, and Gupta, Pearson Edcation
2. Introduction to Database Management system by ISRD Group, Tata McGraw Hill
3. An Introduction to database system by C.J. Date, A. Kanana, S. Swamynathan, Pearson Education

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***DATABASE MANAGEMENT SYSTEM LABORATORY***

L	**T**	**P**	**Course Code**: ***CSP1504***	**Credit**:1.5
0	0	3		

Problem will be set in consonance with the material covered in CSL1504.

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***PRINCIPLES OF PROGRAMMING LANGUAGES***

L	T	P	Course Code: *CSL1505*	Credit:3
2	1	0		

Introduction: Characteristics of programming Languages, Factors influencing the evolution of programming language, developments in programming methodologies, desirable features and design issues. Programming language processors: Structure and operations of translators, software simulated computer, syntax, semantics, structure, virtual computers, binding and binding time Elementary and Structured Data Types, Structured data type and objects, Sub Program. **Lecture:8**

Programmer defined data types: Evolution of data types, abstractions, encapsulations, information hiding, sub programs, abstract data types. Sequence Control; Implicit and Explicit sequence control, sequence control with within expression and statements, recursive sub programs, exception handling, co-routines, Scheduled sub programs, concurrent execution. **Lecture:8**

Data control referencing environments, static and dynamic scope, local data local data referencing environment, shared data: Explicit common environment dynamic scope parameter passing mechanism. **Lecture:6**

Storage Management: Major run time requirements, storage management phases, static storage management, stack based, heap based storage management. **Lecture:8**

Syntax and translation: General syntactic criteria, syntactic element of a language, stages in translation, formal syntax and semantics. Introduction to Functional Programming, Lambda calculus, Data flow language and Object Oriented language, Comparison in various general and special purpose programming languages e.g. Fortran, C, Pascal, Lisp, etc. **Lecture:12**

TOTAL LECTURE:42

Text Books:

1. Terrance W Pratt, "Programming Languages: Design and Implementation" PHI.
2. Programming Languages: Principles and Paradigms: Tucker, Tata McGraw Hill.

Reference Books:

1. Sebesta, "Concept of Programming Language", Addison Wesley.
2. E Horowitz , "Programming Languages", Addison Wesley.

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6TH SEMESTER

BTECH, SYLLABI

COMPUTER SCIENCE & ENGINEERING

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***PRINCIPLES OF COMPILER DESIGN***

L	T	P	Course Code: *CSL1601*	Credit:3
3	0	0		

Introduction to Compilers: Compilers and translators, the phases of a compiler, Compiler writing tools, The Lexical and Syntactic structure of a language, operators.

Lecture: 4

Lexical Analysis: The role of the lexical analyzer, Specification of tokens, lexical analysis tool. **Lecture: 4**

Syntax Analysis: Role of Parser, CFG, Top-down parsing, bottom-up parsing, Operator-precedence parsing, LR Parsers, SLR, Canonical LR and LALR parsing, Ambiguous grammars, Parser generator. **Lecture: 10**

Syntax Directed Translation: Syntax tree, Bottom-up evolution of S-attributed definitions, L-attributed definition, top-down translation, Bottom-up evaluation of inherited attribute, Recursive evaluators.

Lecture: 5

Type Checking: Static vs. Dynamic Checking, Type expression, Type Equivalence, Type Conversion. **Lecture: 2**

Symbol Tables: Structure of Symbol Table, Scoped Symbol Table. **Lecture: 3**

Intermediate Code Generation: Intermediate Language, Intermediate representation Technique, Three-address code, triples and quadruples, Translation of assignment statements, Boolean expressions, Control Flow, Case Statement, and Function Call. **Lecture: 4**

Code Generation: Factors affecting code generation, Basic Block, Code generation for tree, Register Allocation and assignment, DAG, Code generation using dynamic programming, code-generator generators.

Lecture: 3

Code Optimization: Optimization of Basic Blocks, Loops, Optimizing transformations, Local Optimization, Global Optimization. **Lecture: 5**

TOTAL LECTURE:40

Text Books:

1. Compilers: Principles, Techniques, and Tools by Alfered V. Aho, Ravi Sethi, Jeffery D. Ullman, Pearson Education.

Reference Books:

1. Compiler Design by Santanu Chattopadhyay, PHI
2. Modern Compiler Design by Dick Grune, E. Bal, Ceriel J.H. Jacobs, and Koen G. Langendoen, Wiley Dreamtech

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***COMPILER DESIGN LABORATORY***

L	**T**	**P**	**Course Code**: ***CSP1601***	**Credit**:1.5
0	0	3		

Problem will be set in consonance with the material covered in CSL1601. Tools like LEX/ FLEX and YACC/BISON will be used.

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***SOFTWARE ENGINEERING***

L	**T**	**P**	**Course Code**: ***CSL1602***	**Credit**:3
3	0	0		

Introduction - Systems engineering, Software project planning, Cost estimation, Project scheduling. **Lecture: 3**

Software Life Cycle Models: Waterfall, Prototyping, Evolutionary, Spiral models and their comparisons. **Lecture: 3**

Software Project Management: Project Planning, Project estimation Metrics, Project estimation techniques, COCOMO, Staffing Level Estimation, Scheduling, Organization & Team Structures, Risk Management, S/W Configuration Management. **Lecture: 6**

Requirements Analysis and Specification: Requirement Gathering, SRS, Formal System Development Techniques, Axiomatic and Algebraic Specification. **Lecture: 4**

Analysis and Design: Software design fundamentals, Data structure oriented design - JS, LCP, etc. Data flow oriented design, Object oriented life cycle models. **Lecture: 8**

Object Modelling: Overview, UML, UML Diagrams: Use Case Model, Class Diagrams etc**.** **Lecture: 5**

Object-Oriented Software Development: Design Patterns, Object-Oriented analysis and Design Process, OOD Goodness Criteria. **Lecture: 4**

Software Testing: Testing objectives, Black box & white box testing, testing strategies: verification and validation, debugging. **Lecture: 4**

Maintenance: Re-engineering, Reverse engineering, Reliability, Software audit, Audit trails. **Lecture: 3**

TOTAL LECTURE:40

Text Books:

1. R.S.PRESSMAN, "Software Engineering - A practitioners approach", McGraw Hill International editions, 1992

Reference Books:

1. STEPHEN R. SCHACH, "Object oriented and classical software Engineering", McGraw Hill, 2002

2. An Integrated Approach to Software Engineering, Pankaj Jalote, Narosa Publishing House.

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***SOFTWARE ENGINEERING LABORATORY***

L	**T**	**P**	**Course Code**: ***CSP1602***	**Credit**:1.5
0	0	3		

Problem will be set in consonance with the material covered in CSL1602. Various Case-Tools will be used.

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***COMPUTER GRAPHICS***

L	**T**	**P**	**Course Code**: ***CSL1603***	**Credit**:3
3	0	0		

Graphics Hardware: Introduction and organization of an Introductive graphic system, Display devices, Hard copy devices, Hardware interaction tasks. **Lecture: 4**

Basic Raster Graphics Algorithms: Scan conversion- Line, Circle and Ellipse; Filling- rectangle, polygon, ellipse and arc; Clipping – Line, circle, ellipse and polygon; Anti-aliasing – Unweighted and weighted aliasing and GUPTA-SPROULL methods. **Lecture: 10**

2D and 3D Transformations: Homogeneous coordinates composite and window to viewport transformations, 3D View - Projections, Specification and Implementation of 3D view. **Lecture: 6**

Curves and Surfaces: Polygon, meshes parametric cubic curves and bi-cubic surfaces, hermite Bezier, B-splines curves and surfaces, quadric surfaces. **Lecture: 6**

Solid Modeling: Boolean set operations, spatial partitioning methods (occupancy enumeration, octree and binary space partitioning tree) **Lecture:4**

Hidden line and surface removal: Z-Buffer, Lists-Priority and scan lines algorithms, Algorithms for binary space partitioning trees and octress, and Ray tracing. **Lecture:5**

Shading: Illumination model, polygon shading, texture mapping, shadow determination (scan line and z-buffer algorithms), transparency, global illumination model. **Lecture:5**

Introduction to GPU and Animation **Lecture:2**

TOTAL LECTURE:42

Text Books:

1. Computer Graphics with Open GL, D. Hearn and M.P. Baker (C Version), Pearson Education
2. Computer Graphics: Algorithms and Implementations, D.P Mukherjee & Debasish Jana (PHI)

Reference Books:

1. Computer Graphics with Virtual Reality System, Rajesh K.Maurya, Wiley-Dreamtech
2. Computer Graphics Principle and Practice, J.D. Foley, A.Dam, S.K. Feiner, Addison, Wesley
3. Procedural Elements of Computer Graphics- David Rogers (TMH)

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***COMPUTER GRAPHICS LABORATORY***

L	**T**	**P**	**Course Code**: ***CSP1603***	**Credit**:1.5
0	0	3		

Problem will be set in consonance with the material covered in CSL1603. Using Open GL.

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***ARTIFICIAL INTELLIGENCE***

L	T	P	Course Code: *CSL1604*	Credit:3
3	0	0		

Introduction: Introduction and techniques of AI, Importance of AI, Intelligent agent, LISP, Prolog for AI. **Lecture: 3**

Search strategies: Search space, Uninformed Search technique- Bread First Search, Depth first search, Informed Search- Heuristic Search technique, constraint satisfaction problems, stochastic search methods, Hill climbing, backtracking, graph search, Properties of A* algorithm, monotone restriction - Specialized production systems - AO* algorithm. **Lecture: 8**

Searching game trees: MINIMAX procedure, alpha-beta pruning **Lecture: 3**

Knowledge representation: Knowledge representation and reasoning, Propositional logic, First order logic, Situation calculus. Theorem Proving in First Order Logic, STRIPS robot problem solving system, Structured representations of knowledge (Semantic Nets, Frames, Scripts). **Lecture: 10**

Uncertain Knowledge and Reasoning: Non monotonic & monotonic reasoning, Confidence factors, Bayes theorem, Dempster & Shafer's Theory of evidence, Probabilistic inference, Belief Network. **Lecture: 6**

Introduction to Neural Network: Perceptron, multi-layer perceptron, back propagation algorithm.

Lecture:4

Natural Language Processing: An Introduction to Natural Language Understanding, Perception, Learning. **Lecture: 4**

Applications: AI in E-commerce, E-tourism, Industry, Medicine, etc. **Lecture: 2**

TOTAL LECTURE: 40

Text Books:

1. Artificial Intelligence by Rich & Knight, Tata Mcgraw Hills
2. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvik, Pearson Education

Reference Books:

1. Introduction to Artificial Intelligence by Eugene Charniak, Pearson Education
2. Artificial Intelligence by G.LUGER, W.A. STUBBLEFIELD, Addison- Wesley Longman, 1998
3. Artificial Intelligence application programming by M. Tim Jones, Dreamtech Press Programming Lab (AI) Implementation in all algorithms in LISP/Prolog
4. Introduction to Artificial Intelligence by Rajendra Akerkar, PHI

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7TH SEMESTER

BTECH, SYLLABI

COMPUTER SCIENCE & ENGINEERING

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***MACHINE LEARNING***

L	**T**	**P**	**Course Code**: ***CSL1702***	**Credit**:3
3	0	0		

Introduction: Basic definitions, types of learning, hypothesis space and inductive bias, evaluation, cross-validation. **Lecture - 3**

Linear regression, Decision trees, overfitting. **Lecture - 4**

Instance based learning, Feature reduction, Collaborative filtering based recommendation. **Lecture - 3**

Probability and Bayes learning. **Lecture- 5**

Logistic Regression, Support Vector Machines, Kernel function and Kernel SVM. **Lecture - 8**

Neural networks: Perceptron, multilayer network, backpropagation, introduction to deep neural network (DNN). **Lecture - 8**

Computational learning theory, PAC learning model, Sample complexity, VC Dimension, Ensemble learning. **Lecture -6**

Clustering: k-means, adaptive hierarchical clustering, Gaussian mixture models (GMM). **Lecture – 5**

TOTAL LECTURE: 42

Text Books:

3. Machine Learning by Mitchell Tom M., Mcgraw Hills.
4. J. Shavlik and T. Dietterich (Ed), Readings in Machine Learning, Morgan Kaufmann, 1990.
5. P. Langley, Elements of Machine Learning, Morgan Kaufmann, 1995.

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Subject: ***MACHINE LEARNING LABORATORY***

L	**T**	**P**	**Course Code**: ***CSP1702***	**Credit**:1.5
0	0	3		

Problem will be set in consonance with the material covered in CSL1702.

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LIST OF ELCETIVES
BTECH, SYLLABI

COMPUTER SCIENCE & ENGINEERING

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***ADVANCED COMPUTER ARCHITECTURE***

L	T	P	Course Code: *CSL1XXX*	Credit:3
3	0	0		

Performance: CPU Performance, Evaluating Performance. **Lecture: 2**

Instruction Set: Instruction Set Architectures, Operand Addressing, MIPS Instruction Set Architecture. **Lecture: 4**

Pipelining: Datapath and Control, Linear, Non linear pipelining, arithmetic pipelining, Processor pipelining, Instruction pipeline, Pipeline scheduling, Pipeline hazards: Structural hazard, Data hazard, Control hazard, Branch prediction, Speculation: control speculation, data speculation, Exceptions. **Lecture:10**

Parallelism: Instruction Level Parallelism: Concepts and Challenges, Basic Compiler Techniques for Exposing ILP, Exploiting ILP Using Multiple Issue and Scheduling: Superscalar, VLIW, Super Pipelining. **Lecture: 6**

Memory: Caches and Memory Hierarchy, Improving Cache Performance: miss rate reduction, optimizing miss penalty, improving hit ratio, cache coherence, Snoopy protocols, Directory based protocols. **Lecture: 5**

Multiprocessors and Clusters: Multiprocessors, Flynn's classification, Interconnection network, Processor clusters, SMPS multiprocessors, Chip Multiprocessors and Multithreading. **Lecture: 7**

Storage: Storage systems, RAID. **Lecture: 2**

Data Flow Machines: Static dataflow model, Dynamic DFM **Lecture: 2**

TOTAL LECTURE: 40

Text Books:

1. "Computer Architecture: A Quantitative Approach" by John L Hennessy & David A Patterson, Morgan Kaufmann Publishers
2. "Advanced Computer Architecture, Parallelism, Scalability, Programmability" by K.HWANG, McGraw Hills

Reference Books:

1. "Computer Organization & Design: A Harware/Software Interface", by David A Patterson & John L Hennessy, Morgan Kaufmann Publishers
2. "Advance Computer Architecture" by DezsoSima, Terence Foutain, and Peter Kacsuk, Peareson Education
3. "Computer architecture and parallel processing" by Kai Hwang and Briggs, McGraw Hills

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***PATTERN RECOGNITION***

L	T	P	Course Code: *CSL1XXX*	Credit:3
3	0	0		

Introduction: Overview, Different Paradigms of Pattern Recognition. Representations of Patterns and Classes **Lecture: 4**

Feature Extraction and Recognition: Metric and non-metric proximity measures, Feature extraction, Statistical Pattern Recognition**,** The Gaussian case and Class Dependence Discriminate Functions, Extensions, Classifier Performance, RISK and Errors. **Lecture: 7**

Learning: Parametric Estimation and Supervised Learning, Maximum Likelihood Estimation Approach, Non-Parametric Approaches. Nearest Neighbor Rule. Linear Discriminate Functions and discrete and Binary Feature Cases: Discrete and Binary Classification Problems, Techniques to Directly Obtained Linear Classifiers. **Lecture: 12**

Syntactic Pattern Recognition: Overview Quantifying Structure in Pattern Description and Recognitions, Grammar Based Approach and Application, String Generation as Pattern Description. Recognition by String Matching and Parsing.The Cocke-Younger Kasami (CYK) parsing algorithm. **Lecture: 10**

Neural Pattern Recognition: Neural Network Structure from Pattern Recognition Applications. Physical Neural Network. The Artificial Neural Network Model, Neural Network based Pattern Associators. **Lecture: 7**

TOTAL LECTURE: 40

Text Books:

1. "Pattern Recognition and Image Analysis" by Arl Gose, Johnsonbaugh, Jost, PHI

Reference Books:

1. "Pattern Recognition: Technique and Applications" by Rajjan Shinghal, Oxford
2. "Pattern Recognition Principles" by J.T. Tou and R.C. Gonzalez, Addison Wesley

Department of Computer Science & Engineering

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Subject: ***ARTIFICIAL NEURAL NETWORK***

L	**T**	**P**	**Course Code**: ***CSL1XXX***	**Credit**:3
3	0	0		

Introduction: Basic Concepts of Neural Networks, Inference and Learning, Models-Classification Models, Association Model, Optimization Models, Self-Organization Models. **Lecture: 5**

Learning: Supervised and Unsupervised Learning, AI Learning, Neural Network Learning, and Genetic Algorithms. **Lecture:7**

Neural Networks: Rule -Based Neural Networks, Radial Basics Function Networks (RBFN), Network Training, Network Revision, Issues, Example of Theory Revision, Decision of Theory Revision, Decision Tree-Based Neural Networks, Constraint-Based Neural Networks, Learning Rules. **Lecture: 10**

Mathematical Modeling: Mathematical Modeling in General, The Applications of Neural Networks, Neural Networks as Mathematical Models, Knowledge-Based Approaches. **Lecture: 6**

Methods: Introduction, Symbolic Methods and Neural Network Methods. **Lecture: 4**

Structures and Sequences: Introduction, Connectionist Representation, A Hybrid Network Approach. **Lecture: 3**

Learning Spatiotemporal Patterns: Introduction, Spatio-temporal Neural Networks, Learning Procedures, and Knowledge Procedures **Lecture: 5**

TOTAL LECTURE: 40

Text Books:

1. "Neural Networks" by Simon Haykin, Pearson Education/PHI
2. "Neural Networks Algorithms, Applications, and Programming Techniques" by James A. Freeman, David M. Skapura, PHI

Reference Books:

1. "Neural Network using MATLAB 6.0", by Sivanandam, Tata McGraw Hill
2. "Neural Network: A classroom Approach", by Satish Kumar, Tata McGraw Hill

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***NATURAL LANGUAGE PROCESSING***

L	T	P	**Course Code**: ***CSL1XXX***	**Credit**:3
3	0	0		

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 **Lecture:8**

Syntax: Word classes and part-of-speech tagging –Rule-based part-of-speech tagging – Stochastic part-of-speech tagging – Transformation-based tagging. Context-Free Grammars for English: Constituency – Context-Free rules and trees – Sentence-level constructions – The noun phrase – Coordination – Agreement – The 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 – A Basic Top-Down parser – Problems with the basic Top-Down parser – The early algorithm – Finite-State parsing methods. **Lecture:8**

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 **Lecture: 8**

Semantic: 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 – WorldNet: A database of lexical relations – The Internal structure of words – Creativity and the lexicon **Lecture: 10**

Applications: 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 – The transfer metaphor – The Interlingua idea: Using meaning – Direct translation – Using statistical techniques – Usability and system development. **Lecture: 6**

TOTAL LECTURE: 40

Text Book:

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

Reference book:

1. C.Manning and H. Schutze, "Foundation of statistical Natural Language Processing"

Department of Computer Science & Engineering

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Subject: ***REAL TIME SYSTEMS***

L	T	P	Course Code: *CSL1XXX*	Credit:3
3	0	0		

Introduction: Introduction to Real-Time systems, applications of Real-Time systems, basic model of Real-Time systems, characteristics of Real-Time systems, types of Real-Time systems: hard, firm, soft, timing constraints, modeling timing constraints **Lecture-6**

Real-Time task scheduling: basic concepts, clock driven scheduling, table driven scheduling, cyclic, schedulers, hybrid schedulers, event driven scheduling, EDF Scheduling, RMA **Lecture-6**

Resource sharing: DMA, resource sharing among RT tasks, Priority inversion, Priority Inheritance Protocol, Highest Locker Protocol, Priority Ceiling Protocol **Lecture-5**

Scheduling Real-Time Tasks: Scheduling Real-Time tasks in multiprocessor and distributed systems, Fault-tolerant scheduling of tasks, clocks in distributed Real-Time systems, Commercial Real-Time Operating Systems, timers, UNIX and Windows as RT OS, POSIX, PSOS, VRTX, QNX, RT Linux, Lynx, other Real Time OS, benchmarking Real Time OS, Real Time communications, QoS framework, models **Lecture-12**

Real-Time Communication: Real-Time Communication in a LAN, IEEE 802.4, RETHER, Communication over Packet switched Networks, Routing algorithms, RSVP, rate control **Lecture-6**

Real-time Database: RT databases, Applications, characteristics of temporal data, Concurrency control, Commercial RT databases **Lecture-5**

TOTAL LECTURE: 40

Text Book:

1. "Real-time Systems", by C.M. Krishna, Tata McGraw-Hill Education.
2. "Real-Time Systems", by R. Mall, Pearson.

Reference Books:

1. "Real-time Systems", J. W. S.Liu, Pearson Education.
2. "Real-Time Systems Design & Analysis", P. A. Laplante, Willey.

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***BIOINFORMATICS***

L	T	P	Course Code: *CSL1XXX*	Credit:3
3	0	0		

Fundamental Ideas: Genetics, Cell and Molecular Biology & Biochemistry **Lecture: 8**

Introduction; Databases: Mapping, sequence, structure, non-redundant; Sequence alignment -pair wise and multiple; phylogenetic **Lecture:10**

Structure prediction methods - homology, threading, abi nitio, Sequence analysis - class and secondary structure prediction; motifs - PROSITE; detecting functional sites in DNA; OR Finder **Lecture:12**

Perspective: pattern recognition, hidden Markov models; Data Mining using Soft computing Techniques **Lecture:10**

TOTAL LECTURE: 40

Text Books:

1. "Bioinformatics", A. D. Baxevanis & B. F. F. Ouellette, Wiley Interscience.
2. "Introduction to bioinformatics", A. M. Lesk, OXFORD University Press.

Reference Books:

1. "Computational methods in molecular biology", S. L. Salzberg, D. B. Searls and S.Kasif eds, Elsevier.
2. "Computer methods for macromolecular sequence analysis", R. F. Doolittle, Academic Press
3. "Guide to human genome computing", M. Bishop, Academic Press

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***INFORMATION THEORY AND CODING***

L	T	P	**Course Code**: ***CSL1XXX***	**Credit**:3
3	0	0		

Information Entropy Fundamentals: Introduction to information Theory, Information and entropy, properties of entropy of a binary memory less source, Measure of Information, Source Coding, Entropy, Shannon Fano coding, Huffman coding, Lempel Ziv coding, Polynomial code and Galois field, channel coding, Channel capacity, noisy channel coding theorem for DMC. **Lecture:10**

Introduction to Transformations: Transform domain, Characteristics, Study of various transformations-DFT, DCT, Web lets, Z. **Lecture: 4**

Error Control Coding: Linear block codes, generator matrices, parity check matrices, encoder syndrome and error detection minimum distance, error correction and error detection capabilities, cyclic codes, coding and decoding. Coding convolutional codes, encoder, generator matrix, transform domain representation state diagram, distance properties, maximum likelihood decoding, Viterbi decoding, sequential decoding, interleaved convolutional codes **Lecture:12**

Compression Techniques: Principles, Text compression, Static Huffman Coding, Dynamic Huffman coding, Arithmetic coding, Image JPEG standards. **Lecture:6**

Audio and Video Coding : Linear Predictive coding, code excited LPC, Perceptual coding, MPEG audio coders, Dolby audio coders, Video compression, Principles, Introduction to H.261 & MPEG Video standards. **Lecture:8**

TOTAL LECTURE: 40

Text Books:

1. R. Bose, “Information Theory Coding and Cryptography”, Tata McGraw Hill.
2. Simon Haykin, “Communication Systems”, John Wiley and Sons.

Reference Books:

1. Fred Halsall, “Multimedia Communications, Applications Networks Protocols and Standards”, Pearson Education.
2. Mark Nelson, “Data Compression Book”, BPB Publication.
3. Watkinson J, “Compression in Video and Audio”, Focal Press, London.

Department of Computer Science & Engineering

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Subject: ***PARALLEL ALGORITHMS***

L	**T**	**P**	**Course Code**: ***CSL1XXX***	**Credit**:3
3	0	0		

Parallel Models: SIMD, MISD, MIMD, PRAMs, Interconnection Networks. **Lecture: 5**

Performance Measures: Time, Processors, Space, Work. **Lecture: 4**

Interconnection Architectures: Linear Array, Meshes, Trees, Mesh of Trees, Hypercube, Butterfly Networks, Cube Connected Cycles, Benes Networks **Lecture: 8**

Different Techniques: Balanced Trees, Pointer Jumping, Divide and Conquer, Partitioning, Pipelining, Systolic Computation, Accelerated Cascading, Prefix Computation, List Ranking, Euler Tour, Tree Contraction, Sorting, Searching, Merging; Matrix Operations **Lecture: 10**

Graph Algorithms: Connected Components, Maximal independent set, Spanning Trees, Shortest Paths **Lecture: 8**

Algorithm Complexity: Lower bounds, NC Class and P-Completeness **Lecture: 5**

TOTAL LECTURE: 40

Text Books:

1. B. Wilkinson & M. Allen, "Parallel Programming", Pearson.
2. R. Greenlaw, H.J. Hoover, W.L. Ruzzo, "Limits to Parallel Computation: P-Completeness Theory", Oxford University Press, New York.

Reference Books:

1. W. Groop, E. Lusk & A. Skjellum, "Using MPI: Portable Parallel Programming with the Message passing Interface", MIT Press.
2. S. G. Akl, "The Design and Analysis of Parallel Algorithms", Prentice Hall.
3. M. J. Quinn, "Parallel Computing", McGraw Hill.

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***REAL TIME OPERATING SYSTEM***

L	**T**	**P**	**Course Code**: ***CSL1XXX***	**Credit**:3
3	0	0		

Introduction to Operating System: Basic Organization, BIOS and Boot Process, Processes, Thread, Multi-threading, Scheduling. **Lecture: 4**

Real-time concepts: RTOS concepts and definitions, real-time design issues, examples, Hardware Considerations: logic states, CPU, memory, I/O, Architectures, RTOS building blocks, Real-Time Kernel **Lecture: 8**

Process Management: Concepts, scheduling, IPC, RPC, CPU Scheduling, scheduling criteria, scheduling algorithms **Lecture: 5**

Threads: Multi-threading models, threading issues, thread libraries **Lecture: 4**

Mutex: creating, deleting, prioritizing mutex, mutex internals **Lecture: 4**

Inter-process communication: buffers, mailboxes, queues, semaphores, deadlock, priority inversion, Pipes **Lecture: 5**

Memory Management: process stack management, run-time buffer size, swapping, overlays, block/page management, replacement algorithms, real-time garbage collection **Lecture: 7**

Kernel Design Issues: structure, process states, data structures, inter-task communication mechanism, Linux Scheduling **Lecture: 4**

TOTAL LECTURE: 40

Text Book:

1. "MicroC/OS-II : The Real-Time Kernel" by J. J. Labrosse, CRC Press.
2. "Real-Time and Embedded Guide" by Herman B

Reference Book:

1. "Real-Time System Design and Analysis" by Philips A. Laplante
2. "Linux for Embedded and Real-Time Applications" by Doug Abbott

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Subject: ***MOBILE COMPUTING***

L	T	P	Course Code: *CSL1XXX*	Credit:3
3	0	0		

Introduction: Introduction to mobile computing, digital communication and computer networks. Sharing of wireless channels: FDMA, TDMA, CDMA. MAC layer issues in wireless communication. **Lecture:3**

Mobile Computing Architecture: Architecture for mobile computing, Three-tier architecture, Design consideration for mobile computing, Mobile computing through Internet. **Lecture:3**

Wireless PAN: Bluetooth User scenarios, Physical layer, MAC layer, Networking. Security, Link management. **Lecture:3**

Cellular CDMA: Narrowband & Wideband wave propagations, Key elements in designing cellular, Spectrum techniques in modulation, Capacities of multiple-access schemes. DS- CDMA, FH-CDMA, TH-CDMA. **Lecture:4**

Network Layer Mobile IP: Goals, assumptions and requirements, Entities and Terminology, IP packet delivery, Agent advertisement and discovery, Registration, Tunneling and Encapsulation, Optimizations, Reverse tunneling, Ipv6; Dynamic host configuration protocol, Ad hoc networks**:** Routing. **Lecture: 8**

Transport Layer Traditional TCP: Congestion control, Slow start, Fast retransmit/fast recovery, Implications on mobility; Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit/fast recovery, Transmission/timeout freezing, Selective retransmission, Transaction oriented TCP. **Lecture: 7**

WAP: WAP architecture, Wireless Markup language, WML Script, MMS **Lecture: 4**

Mobile agent and Security Issues: Mobile agents, Wireless security Traditional security issues, mobile and wireless security issues, Problems in ad hoc networks **Lecture: 4**

TOTAL LECTURE: 40

Text Books:

1. "Mobile Computing" by Asoke K Talukder, Roopa R Yavagal, Tata McGraw Hill
2. "Mobile Communication" by Jochen Schiller, Pearson Education
3. "Wireless and Mobile All-IP Network" by Yi-Bing Lin, Ai Chun Pang, Wiley India

Reference Books:

1. "Mobile Computing" by Hansmann, Wiley India
2. "Mobile and Personal Communication system & services" by Raj Pandya, PHI
3. "Mobile and Wireless Design Essentials" by Martyn Mallick, Wiley Dreamtech

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National Institute of Technology, Mizoram

Subject: ***DISTRIBUTED COMPUTING***

L	T	P	**Course Code**: CSL1XXX	**Credit**:3
3	0	0		

Introduction: Goals – Types of Distributed systems – Architecture styles – System Architecture. Architectures Versus Middleware – Self Management in distributed systems - Processes – Threads – Virtualization – Clients – Servers – Code Migration. **Lecture-8**

Communication: Fundamentals - Remote Procedure Call – Streamoriented communication – Message oriented communication – Multicast communication. Naming– Names, Identifiers, and addresses – Flat Naming - Structured Naming – Attribute based Naming. **Lecture-10**

Synchronization: Clock Synchronization – Logical clocks - Mutual Exclusion – Global positioning of nodes - Election Algorithms. Consistency and Replication: Introduction – Data centric consistency models – Client centric consistency models – Replica management– Consistency protocols. **Lecture-10**

Fault Tolerance: Introduction –Process resilience – Reliable client server communication–Reliable group communication – distributed commit - Recovery Security – Introduction – Secure channels – Access control – Security management. **Lecture-8**

Distributed File Systems – Distributed web based systems– Distributed object based systems. **Lecture-4**

TOTAL LECTURE: 40

Text Book:

1. Andrew S. Tanenbaumand Maarten Van Steen, "Distributed Systems – Principles and Paradigms", Prentice- Hall of India, Pvt. Ltd.

References:

1. Pradeep K Sinha, "Distributed Operating Systems", Prentice-Hall of India.
2. Jean Dollimore, TimKindberg, George Coulouris, "Distributed Systems-Concepts and Design", Pearson Education.
3. M.L. Liu, "Distributed Computing Principles and Applications", Pearson Education.

Department of Computer Science & Engineering

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Subject: ***ROBOTICS***

L	T	P	**Course Code**: CSL1XXX	**Credit**:3
3	0	0		

Fundamentals of robot: Robot – Definition – Robot Anatomy – Co-ordinate Systems, Work Envelope, types and classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and Functions – Need for Robots – Different Applications. **Lecture-8**

Robot drive systems and end effectors: Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors –Salient Features, Applications and Comparison of Drives End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations. **Lecture-8**

Sensors and machine vision: Requirements of a sensor, Principles and Applications of the following types of sensors – Position of sensors (Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, Pneumatic Position Sensors), Range Sensors (Triangulation Principle, Structured, Lighting Approach, Time of Flight Range Finders, Laser Range Meters), Proximity Sensors (Inductive, Hall Effect, Capacitive, Ultrasonic and Optical Proximity Sensors), Touch Sensors, (Binary Sensors, Analog Sensors), Wrist Sensors, Compliance Sensors, Slip Sensors. Camera, Frame Grabber, Sensing and Digitizing Image Data – Signal Conversion, Image Storage, Lighting Techniques. Image Processing and Analysis – Data **Reduction:** Edge detection, Feature Extraction and Object Recognition -Algorithms. Applications – Inspection, Identification, Visual Serving and Navigation.

Lecture-12

Robot kinematics and robot programming: Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) – Deviations and Problems. Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End effecter commands, and Simple programs **Lecture-8**

Implementation and robot economics: RGV, AGV; Implementation of Robots in Industries – Various Steps; Safety Considerations for Robot Operations; Economic Analysis of Robots – Pay back Method, EUAC Method, Rate of Return Method. **Lecture-4**

TOTAL LECTURE: 40

Text Book:

1. M.P.Groover, “Industrial Robotics – Technology, Programming and Applications”, McGraw- Hill.

References:

1. Fu.K.S. Gonzalz.R.C., and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw-Hill.
2. Yoram Koren, “Robotics for Engineers”, McGraw- Hill.
3. Janakiraman.P.A, “Robotics and Image Processing”, Tata McGraw- Hill.

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Subject: ***CLOUD COMPUTING***

L	**T**	**P**	**Course Code**: CSL1XXX	**Credit**:3
3	0	0		

Cloud Computing Basics - Cloud Computing Overview, Applications, Intranets and the Cloud, First Movers in the Cloud. Organization and Cloud Computing - When You Can Use Cloud Computing, Benefits, Limitations, Security Concerns, Regulatory Issues. Cloud Computing with the Titans – Google, EMC, NetApp, Microsoft, Amazon, Salesforce.com, IBM, Partnerships, The Business Case for Going to the Cloud - Cloud Computing Services, How Those Applications Help Your Business, Deleting Your Datacenter, Salesforce.com, Thomson Reuters. **Lecture-12**

Hardware and Infrastructure – Clients, Security, Network, Services.Accessing the Cloud – Platforms, Web Applications, Web APIs, Web Browsers.Cloud Storage – Overview, Cloud Storage Providers,Standards – Application, Client, Infrastructure, Service. **Lecture-8**

Software as a Service – Overview, Driving Forces, Company Offerings, Industries Software plus Services – Overview, Mobile Device Integration, Providers, Microsoft Online.Developing Applications – Google, Microsoft, Intuit QuickBase, Cast Iron Cloud, Bungee Connect,Development, Troubleshooting, Application Management. **Lecture-8**

Local Clouds and Thin Clients - Virtualization in Your Organization, Server Solutions, Thin Clients,Case Study: McNeilus Steel.Migrating to the Cloud - Cloud Services for Individuals, Cloud Services Aimed at the Mid-Market,Enterprise-Class Cloud Offerings, Migration.Best Practices and the Future of Cloud Computing-Analyze Your Service, Best Practices, How Cloud Computing Might Evolve. **Lecture-12**

TOTAL LECTURE: 40

Text Books

1. "Cloud Computing-A Practical Approach" Anthony T. Velte, Toby J. Velte, Robert Elsenpeter. McGraw-Hill

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Subject: ***INFORMATION RETRIEVAL AND STORAGE***

L	**T**	**P**	**Course Code**: CSL1XXX	**Credit**:3
3	0	0		

Introduction: Information retrieval, Significance of information retrieval and storage, Definition**,** .Function overview, Relationships between Digital library and IRS, Abstraction, Algorithm, Data structure, Measure of information systems, Logical organization, Physical organization, Components of information retrieval systems, Comparisons among different information systems. **Lecture:6**

Data control and data presentation: Query, differences between documents and queries, type of documents, types of data structure, document surrogates, vocabulary control, structure of a thesaurus, structural representation. **Lecture:4**

Vector retrieval system/model : Vector model, document-term matrix, methods for designing weights to terms, query in the vector model, spatial representation of a document in vector model, Similarity between a query and a document. **Lecture:5**

Automatic indexing and abstracting: Indexing, automatic indexing, purpose of indexing, why use automatic indexing, stop list approach, raw term frequency approach, normalized term frequency approach, inverse term frequency approach, and other considerations. **Lecture:5**

Similarity measure algorithms: Data fusion, term association, general similarity measures, similarity measures in the vector retrieval model, comparisons of the two kinds of similarity approaches, extended user profile, current awareness systems. **Lecture:5**

Automatic clustering approaches: Definition of automatic clustering, criteria of clustering, differences between clustering and classification, significance of a clustering approach in IR, categorization of clustering algorithms, non- hierarchical clustering algorithm, the K-means clustering algorithm, K-means in SPSS, hierarchical clustering algorithm, hierarchy cluster in SPSS. **Lecture:5**

Internet Information Retrieval : Challenge in the Web, language distribution, centralized architecture, crawlers, breadth first approach, depth first approach, web page ranking, meta-search, considerations for meta-search engines, trends. **Lecture:5**

Image retrieval: Content-based image retrieval, image feature description, order system, texture, Shape, characteristics of image queries, image system applications, image retrieval systems. **Lecture:5**

TOTAL LECTURE: 40

Text Books

1. Christopher D. Manning, Prabhakar Raghavan and H. Schtze, “Introduction to Information Retrieval”, Cambridge University Press.
2. Ricardo Baeza-Yates and B. Ribeiro-Neto, “Modern Information Retrieval”, Addition Wesley.

Reference Books:

1. S. Chakrabarti, “Minning the Web” Morgan-Kaufmann Publishers.
2. B.Liu, “Web Data Mining: Exploring Hyperlinks, contents and Usage Data”, Springer Edition
3. David A. Grossman, Ophir Frieder, “Information Retrieval: Algorithm and Heuristics” Springer Edition

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Subject: ***SOFT COMPUTING***

L	**T**	**P**	**Course Code**: CSL1XXX	**Credit**:3
3	0	0		

Unit-I: Machine Learning & AI - Introduction, hierarchical perspective and foundations. Rote Learning, Learning by Advice, learning in problem solving: inductive learning, explanation based learning, learning from observation and discovery, learning by analogy, and introduction to formal learning theory. Biological neurons and brain, models of biological neurons, artificial neurons and neural networks, Early adaptive nets Hopfield nets, back error propagation competitive learning lateral inhibition and feature maps, Stability - Plasticity and noise saturation dilemma, ART nets, cognition and recognition. **Lecture: 12**

Unit-II: Neural nets as massively parallel, connectionist architecture, Application in solving problems from various are as e.g. AI, Computer Hardware, networks, pattern recognition sensing and control etc. **Lecture: 8**

Unit –III: Basics of Fuzzy Sets: Fuzzy Relations – Fuzzy logic and approximate reasoning – Design Methodology of Fuzzy Control Systems – Basic structure and operation of fuzzy logic control systems. **Lecture: 10**

Unit –IV: Networks – Feedback networks – Supervised and unsupervised learning approaches – Neural Networks in Control Systems. **Lecture: 7**

Unit- V: Basics of Genetic Algorithms: Evolution of Genetic Algorithm Applications. **Lecture: 3**

TOTALLECTURE: 40

Text Books:

1. P H Winston – "Artificial Intelligence" - Pearson Education
2. E Charniak and W Midermott – "Introduction to Artificial Intelligence" - Pearson Education

Reference Books:

1. Bishop, "Neural Networks for Pattern Recognition", OUP
2. Cohen, "Empirical Methods for AI", PHI
3. Haykin, "Neural Network", Pearson Education/PHI
4. "Artificial Neural Network", Vikas Bose
5. "Neural Network Fundamentals with graphs, Algorithms and Applications", – TMH

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Subject: ***OPTIMIZATION TECHNIQUES***

L	T	P	**Course Code**: CSL1XXX	**Credit**:3
3	0	0		

Introduction to Optimization: Engineering application of optimization, statement and classification of optimization problems, optimization techniques. **Lecture: 4**

Classical Optimization Techniques: single variable optimization, multi variable optimization with no constraints multivariable optimization with equality and inequality constraints. **Lecture: 8**

Linear programming: standard form and geometry of LP, motivation to the simplex method, simplex algorithm, Two-phase method. Revised simplex method, duality, decomposition principle, and sensitivity analysis. **Lecture: 10**

Non-linear Programmes: Introduction, unimodes function, elimination methods, unrestricted search, quadratic and cubic interpolation methods, Direct root method, Direct and Random Search method, The simplex method, Steepest Dissent method, Conjugate gradients method and Guass-newton method. **Lecture: 10**

Integer and Stochastic Programmes: Introduction, Integer linear programming, Methods for solving integer linear programming problems, Stochastic linear programming, Quadratic programming separable programming. **Lecture: 8**

TOTAL LECTURE: 40

Text Books:

1. **"**Optimization for Engineering Design: algorithm and example" by Kalyanmoy Deb, PHI

Reference Books:

1. V.Chavtal, "Linear Programming", W.H. Freeman and Company, New York
2. C.H.Papaddimitriou and K. Steiglitz, "Combinatorial Optimization: Algorithms and Complexity", Dover Publication Inc. New York.

Department of Computer Science & Engineering

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Subject: ***COMPUTATIONAL COMPLEXITY***

L	**T**	**P**	**Course Code**: CSL1XXX	**Credit**:3
3	0	0		

Resources for computation (time, space, no determinism, randomness) and their associated complexity classes. **Lecture: 6**

Relationships among resources (P vs. NP and more) Reductions & completeness ,Provably intractable problems: hierarchy thms, EXPSPACE-completeness **Lecture: 8**

Space complexity: PSPACE, L, NL, Randomized computation: RP, BPP, Alternation: the polynomial hierarchy (PH), time-space tradeoffs for SAT Relativization (why diagonalization can't resolve P vs NP), Basic circuit complexity (P/poly, NC)Interactive proofs (AM, MA, IP), Probabilistically checkable proofs (PCP) and non approximability **Lecture: 14**

Unique Games Conjecture, Parity not in AC^0, Average-case complexity, Counting: #P, Toda's Thm, approximate counting, Communication complexity and applications, Algebraic complexity: VNP, VP, Permanent vs. Determinant, Quantum computation: BQP, Shor's Factoring algorithm **Lecture: 12**

TOTAL LECTURE: 40

Text Books:

1. "Computational Complexity: A Modern Approach", by Sanjeev Arora and Boaz Barak
2. C.H.Papaddimitriou, "Computational Complexity" Addision Wesley

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Subject: ***ADVANCED ALGORITHMS***

L	T	P	Course Code: *CSL1XXX*	Credit:3
3	0	0		

Algorithmic paradigms: Dynamic Programming, Greedy, Branch-and-bound; Asymptotic complexity, Amortized analysis; **Lecture: 8**

Graph Algorithms : Shortest paths, Flow networks; NP-completeness; Approximation algorithms; Randomized algorithms; **Lecture: 8**

Linear Programming: Special topics: Geometric algorithms (range searching, convex hulls, segment intersections, closest pairs), Numerical algorithms (integer, matrix and polynomial multiplication, FFT, extended Euclid's algorithm, modular exponentiation, primality testing, cryptographic computations) **Lecture: 10**

Internet Algorithms : Text pattern matching, tries, information retrieval, data compression, web caching. **Lecture: 6**

Quantum Algorithms : Qubits, superposition, and measurement, quantum Fourier transform, Periodicity Quantum circuits, Factoring as periodicity quantum algorithm for factoring. **Lecture: 8**

TOTAL LECTURE: 40

Text Books

1. S. Dasgupta, C. H. Papadimitriou, and U. V. Vazirani, “Algorithms” TMH Education.

2. Udi Manber, "Introduction to Algorithms: A Creative Approach", Addison Wesley

Reference Books

1. M. H. Alsuwaiyel, “Algorithms: Design Techniques and Analysis", World Scientific

2. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, “Introduction to Algorithms”, Prentice Hall of India.

3. Rajeev Motwani and Prabhakar Raghavan, “Randomized Algorithms”, Cambridge University Press

Department of Computer Science & Engineering

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Subject: ***COMPUTATIONAL NUMBER THEORY AND CRYPTOGRAPHY***

L	T	P	**Course Code**: ***CSL1XXX***	Credit:3
3	0	0		

Computational Complexity: Input Size, Complexity Classes etc. **Lecture: 2**

GCD Computation: Euclid's Algorithm, Extended Euclid's Algorithm. **Lecture: 3**

Modular Arithmetic: Groups, Solving Modular Linear Equations. Chinese Remainder Theorem. Modular Exponentiation, Discrete Logarithm Problem. **Lecture:8**

Key Exchange: Diffie Hellman, ElGamal, Massey-Omura. Computation of Generators of Primes. **Lecture: 4**

Public Key Cryptosystem: RSA, Different Attacks & Remedies. **Lecture: 6**

Primality Testing: Pseudoprimality Testing, Quadratic Residues, Randomized Primality Test & Deterministic Polynomial Time Algorithm. **Lecture: 5**

Factorization: Quadratic-Sieve Factoring Algorithm, Pollard-Rho Method. **Lecture: 2**

Elliptic Curve Cryptosystem: Theory of Elliptic Curves, Elliptic Curve Encryption & Decryption Algorithms, Security of Elliptic Curves Cryptography, Elliptic Curve Factorization. **Lecture: 7**

Digital Signatures: Authentication Protocols, Digital Signature Standards (DSS). Proxy Signatures. **Lecture:3**

TOTAL LECTURE: 40

Text Books

1. "A Course in Number Theory and Cryptography", Neal Koblitz, Springer- Verlag, New York Inc.
2. "Introduction to Cryptography with Coding Theory", W. Trappe and L. C. Washington, Pearson Education
3. "Cryptography: Theory and Practice", Douglas R. Stinson, CRC Press.

Reference Books

1. "Introduction to Algorithms", T. H. Cormen, C. E. Leiserson, R. Rivest and C. Stein Prentice Hall
2. "Cryptography and Network security: Principles and Practice", William Stallings, Pearson Education,
3. "Randomized Algorithms", R. Motwani and P. Raghavan, Cambridge University Press.

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Subject: ***WIRELESS NETWORKS***

L	T	P	Course Code: *CSL1XXX*	Credit:3
3	0	0		

Wireless Transmission: History, Overview, Signals, Antennas, Signal Propogation, Mulpiplexing, Modulation, Spread Spectrum. Media Access Control: MAC, SDMA, TDMA, CDMA. Spread Aloha Multiple Access. **Lecture:12**

Telecommunication System: GSM, DECT, TETRA. **Lecture:4**

Wireless LAN: Infrared Vs Radio Transmission, IEEE 802.11 standard, Concept of HIPERLAN and Bluetooth technology. **Lecture:8**

Mobile Technology: Mobile-IP, Mobile transport layer, Mobile TCP, Concept of WAP and WML. **Lecture:6**

J2ME: Overview, Small computing technology. Its architecture and development environment, Lifecycle, MIDP, Commands, Items and Event processing, High level display screen and low level display screen. **Lecture:10**

TOTAL LECTURE: 40

Text Books:

1. "Mobile Communications" by Schiler (Pearson Education)
2. "J2ME : The Complete Reference" by Keogh (Tata McGraw-Hill)
3. "Beginning J2ME from Novice to Professional", by Singli Jonathan (Wiley India)

Reference Books:

1. "Wireless Communications & Network", By Stallings (Pearson Education)
2. "Wireless and Mobile All- IP Networks", By Lin & Pang(Wiley India)
3. "Core J2ME Technology and MIDP", Muchow (Pearson Education Asia - Sun)
4. "Beginning Mobile Phone Game Programming", Morrison (Pearson Education)

Department of Computer Science & Engineering

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Subject: ***APPLIED GRAPH THEORY***

L	**T**	**P**	**Course Code**: ***CSL1XXX***	**Credit**:3
3	0	0		

Fundamental concepts: basic definitions, operations, properties, proof styles **Lecture:5**

Trees: properties, distances and centroids, spanning trees, enumeration **Lecture:5**

Matchings: bipartite graphs, general graphs, weighted matching **Lecture:4**

Connectivity: vertex and edge connectivity, cuts, blocks, k-connected graphs, network flows **Lecture:6**

Traversibility: Eulerian tours, Hamiltonian cycles); Coloring (vertex and edge coloring, chromatic number, chordal graphs **Lecture:8**

Planarity: duality, Euler's formula, characterization, 4-color theorem. **Lecture:4**

Advanced topics: perfect graphs, matroids, Ramsay theory, extremal graphs, random graphs and Applications. **Lecture:8**

TOTAL LECTURE: 40

Text Books:

1. Douglas B. West, “Introduction to Graph Theory”, Prentice Hall of India
2. Narsingh Deo, “Graph Theory with Applications to Engineering and Computer Science”, Prentice-Hall.

Reference Books:

1. Frank Harary, “Graph Theory”, Narosa.
2. R. Ahuja, T. Magnanti, and J. Orlin, “Network Flows: Theory, Algorithms, and Applications”, Prentice-Hall.

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Subject: ***COMPUTATIONAL GEOMETRY***

L	**T**	**P**	**Course Code**: ***CSL1XXX***	**Credit**:3
3	0	0		

Basic Geometric Concepts: points, lines, polygons; subdivisions; arrangements; polytopes; cell complexes; different applications of computational geometry. **Lecture: 4**

Geometric Searching: in 1D, 2D, and higher dimensions: fractional cascading; Kd-tree; interval tree; range tree. **Lecture: 4**

Point Location: slab method; trapezoid method; chain method; bridged chain method. **Lecture: 3**

Plane-Sweep Algorithms: intersection of segments; intersection of rectangles; trapezoidation. **Lecture: 2**

Arrangements and duality: computing the discrepancy; duality and dual transforms; arrangement of lines; zone theorem. **Lecture: 3**

Convex Hulls: 2-dimensional convex hull; degeneracies and robustness; dynamic convex hull; Graham Scan algorithm, Jarvis March algorithm, Kirkpatrick-Seidel's algorithm; higher dimensional convex hulls, Proximity-closest pair; furthest pair. **Lecture: 6**

Linear Programming: half-plane intersection; incremental linear programming; randomized linear programming. **Lecture: 2**

Voronoi diagrams: examples and applications, e.g. Post-Office problem; Doubly Connected Edge List; Fortune's Algorithm; Voronoi diagram in higher dimension. **Lecture: 4**

Art Gallery Problem: monotone polygons; polygon triangulation. **Lecture: 2**

Visibility Graphs: shortest paths; computing visibility graphs; robot motion planning. Graph Algorithms, Review: Connected Components, Minimum spanning tree, strongly connected components, Single source & All pair shortest path, Transitive closure Planarity testing Algorithms, Polynomial time algorithms for planar graphs, Network flow algorithms, Algorithms for bipartite and general graph matching. **Lecture: 6**

Perfect graphs: Notion of perfect graphs, Lovasz.s theorem, Strong perfect graph conjecture, Polynomial Time algorithms for elementary graph problems Interval, Chordal, Comparability Graphs. Tree Structured graphs and algorithms for elementary graph problems on these graphs. **Lecture: 4**

TOTAL LECTURE: 40

Text Books:

1. **F.P.Preparata and M.I.Shamos, "Computation Geometry and Introduction", Springer Verlag**

Reference Books:

1. **J.O'Rourke, "Computational Geometry in C", Cambridge University Press.**
2. **M. De Berg, M. Van Kreveld, M. Overmars, O.Schwarzkopf, "Computational Geometry: Algorithms and Applications", Springer Verlag**

Department of Computer Science & Engineering

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Subject: ***BIG DATA AND ANALYTICS***

L	**T**	**P**	**Course Code**: ***CSL1XXX***	**Credit**:3
3	0	0		

Introduction: Big Data Overview, what is data sciences, The rising and importance of data sciences, Big data analytics in industry verticals. **Lecture: 5**

Data Analytics Lifecycle and methodology: Business Understanding, Data Understanding, Data Preparation, Modeling, Evaluation, Communicating results, Deployment. **Lecture: 10**

Data exploration & preprocessing. **Lecture: 5**

Measures and evaluation **Lecture: 3**

Data Analytics: Theory & Methods: Supervised learning (Linear/Logistic regression, Decision Trees, Naïve Bayes), Unsupervised Learning (K-means clustering, Association Rules) **Lecture: 8**

Unstructured Data Analytics: Technologies & tools; Text mining, Web mining **Lecture: 5**

Operationalizing an Analytics project **Lesson: 2**

Data Visualization Techniques & Creating Final Deliverables. **Lesson: 2**

TOTAL LECTURE: 40

Text Books:

1. Big Data: A Revolution that will transform how we live, work and think by Victor Mayer- Schonbergen

Reference Books:

1. Big Data Now, 2012 Edition (ebook) by O'Reilly Media
2. Big Data (ebook) By Nathan Marz

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Subject: ***IMAGE PROCESSING***

L	T	P	Course Code: *CSL1XXX*	Credit:3
3	0	0		

The digital image processing field: Introduction, definitions, and applications, Image fundamentals: Models, sampling, quantization, and basic operations, image representation and formats. **Lecture: 4**

Image Enhancement: Background, Point processing, Histogram equalization and specification, spatial domain filtering: Smoothing, Median, & Sharpening. 1-D and 2-D Discrete Fourier Transform (DFT), Properties of DFT. Frequency Domain Filtering: Low & high-pass, Color and Multichannel image processing: Color fundamentals, models, transformation, and enhancement **Lecture: 10**

Image restoration: Degradation and observation models, Inverse filtering, Geometric transformation **Lecture: 4**

Image compression: Fundamentals, information theory and entropy concept, Huffman and run-length coding. Compression Standards, Compression of frame Sequences and color images, GIF and JPEG **Lecture: 6**

Image segmentation: Detection of discontinuities, point, line and edge detection, Image segmentation: Thresholding, global and optimal. Region-oriented and Motion-based segmentation. **Lecture: 8**

Representation and Description, Computer Vision principles **Lecture: 2**

Practical Applications: Videoconferencing and Internet applications. Ethics and legal issues in DIM **Lecture: 6**

TOTAL LECTURE: 40

Text Books:

1. "Digital Image Processing", Gonzalez R.C.& Woods R.E, Pearson

References Books:

1. "Fundamental of Digital Image Processing", Jain A.K; PHI/ Pearson.
2. "Image Processing, Principles and applications", T. Acharya and Ajoy K.Ray, Wiley InterScience
3. "Computer Vision and Image Processing", Tim Morris, Palgrave Macmillan.

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***WEB TECHNOLOGY***

L	T	P	**Course Code**: ***CSL1XXX***	**Credit**:3
3	0	0		

Internet Principles and Components: History of the Internet and World Wide Web-HTML; protocols – HTTP, SMTP, POP3, MIME, IMAP. Domain Name Server, Web Browsers and Web Servers.

Lecture:6

HTML, DHTML and XML: List, Tables, Images, Forms, Frames, CSS Document type definition, Dynamic HTML, XML schemes, Object Models, Presenting XML, Using XML Processors: DOM and SAX, Introduction to Java Script, Object in Java Script, Dynamic HTML with Java Script, PHP.

Lecture:10

Web Services: Introduction to Web Services, UDDI, SOAP, WSDL, Web Service Architecture, Developing and deploying web services. Ajax – Improving web page performance using Ajax, Programming in Ajax. CORBA, **Lecture:8**

Web 2.0: Interactive and social web: Blogs, wikis, and social networking sites – The technology behind these applications- AJAX, RSS and syndication, Ruby on Rails, Open APIs. **Lecture:8**

Web 3.0: Semantic Web, Widgets, drag & drop mashups (iGoogle) - The technology behind these applications- RDF Web based Information Systems, Search engines, Recommender Systems, Web Mining. **Lecture:8**

TOTAL LECTURE:40

Text Books:

1. Burdman, "Collaborative Web Development" Addison Wesley
2. Chris Bates, "Web Programing Building Internet Applications", 2nd Edition, WILEY, Dreamtech

Reference Books:

1. Joel Sklar , "Principal of web Design" Vikash and Thomas Learning
2. Jon Duckett, "Beginning Web Programming with HTML, XHTML, and CSS", Wiley India Pvt Ltd (June 2008)

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***NETWORK SECURITY AND CRYPTOGRAPHY***

L	**T**	**P**	**Course Code**: ***CSL 1XXX***	**Credit**:3
3	0	0		

Introduction: security attacks, services and mechanism, introduction to cryptography. Conventional Encryption: Conventional encryption model, classical encryption techniques substitution ciphers and transposition ciphers, cryptanalysis, stereography, stream and block ciphers. Modern Block Ciphers: Block ciphers principals, Shannon's theory of confusion and diffusion, fiestal structure, data encryption standard(DES), strength of DES, differential and linear crypt analysis of DES, block cipher modes of operations, triple DES, IDEA encryption and decryption, strength of IDEA, ADES, confidentiality using conventional encryption, traffic confidentiality, key distribution, random number generation. **Lecture:10**

Mathematics of Cryptography: Introduction to graph, ring and field, prime and relative prime numbers, modular arithmetic, Fermat's and Euler's theorem, primality testing, Euclid's Algorithm, Chinese Remainder theorem, discrete logarithms. Principals of public key crypto systems, RSA algorithm, security of RSA, key management, Diffle-Hellman key exchange algorithm, introductory idea of Elliptic curve cryptography, Elgamel algorithm. **Lecture: 10**

Message Authentication and Hash Function: Authentication requirements, authentication functions, message authentication code, hash functions, birthday attacks, security of hash functions and MACS, MD5 message digest algorithm, Secure hash algorithm(SHA), Digital Signatures: Digital Signatures, authentication protocols, digital signature standards (DSS). PKI **Lecture: 6**

Authentication Applications: Kerberos and X.509, directory authentication service, electronic mail security-pretty good privacy (PGP), S/MIME. **Lecture: 6**

IP Security: Architecture, Authentication header, Encapsulating security payloads, combining security associations, key management. Web Security: Secure socket layer and transport layer security, secure electronic transaction (SET). System Security: Intruders, Viruses and related threads, firewall design principals, trusted systems. **Lecture: 8**

TOTAL LECTURE:40

Text Books:

1. B. Forouzan, "Cryptography and Network Security", TMH.

Rreference books:

1. William Stallings, "Cryptography and Network Security: Principals and Practice", Prentice Hall.
2. Johannes A. Buchmann, "Introduction to Cryptography", Springer.
3. "Applied Crytography" by Bruce Schneier, John Wiley and Sons.
4. "Cryptography and Network Security" by Atul Kahate, Tata McGraw Hill

Department of Computer Science & Engineering

National Institute of Technology, Mizoram

Subject: ***DATA MINING AND DATA WAREHOUSING***

L	**T**	**P**	**Course Code**: ***CSL1XXX***	**Credit**:3
3	0	0		

Data Mining: Data Mining definition, tools and applications, Data Mining Functionalities, Classification of Data Mining Systems, data mining query languages and Architectures of Data Mining Systems., Data Mining issues. **Lecture:5**

Data warehousing: Definition, usage and trends**,** , Data Warehouse Architecture, Data Warehouse Implementation, Development of Data cube technology, Data Warehousing to Data Mining. **Lecture:6**

Architecture: OLTP vs. OLAP, ROLAP vs. MOLAP, types of OLAP, servers, 3-Tier data warehouse architecture, distributed and virtual data warehouses, data warehouse manager**.** **Lecture:6**

Implementation: Data warehouse implementation, computation of data cubes, modeling OLAP data, OLAP queries manager, data warehouse back end tools, complex aggregation at multiple granularities, tuning and testing of data warehouse. **Lecture:5**

Mining Association rules: Data mining techniques, Association rules, Mining single-dimensional Boolean Association rules from transaction databases, Mining multi level Association rules from transaction databases, Mining multidimensional Association rules from relational databases and Data warehouses, Association Mining to correlation analysis, Constraint based association mining. **Lecture:10**

Cluster Analysis What is cluster analysis, Types of data in cluster analysis, A categorization of major clustering methods, Partitioning methods, Hierarchical Methods, Density based methods, Grid based methods, Modal based clustering methods. **Lecture:8**

Applications in Data Mining Data mining in market analysis, medical etc. **Lecture:2**

TOTAL LECTURE: 44

Text Books:

1. "Data Mining Concepts and Techniques" by Jiawei Han, Micheline Kamber, Elesevier
2. "Data Warehousing, Data Mining and OLTP" by Alex BersonMcGraw Hill

Reference Books:

1. Data warehousing System by Mallach,McGraw Hill
2. "Data Warehousing in the Real World" by Sam Anahory & Dennis Murray, Pearson
3. "Building the Data Warehouse" by W.H. Inman, John Wiley & Sons
4. "Data Mining: A tutorial-based Primer", by Richard J. Roiger, Michael W. Geatz, Pearson Education

Department of Computer Science & Engineering

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Subject: ***ADVANCE DATASTRUCTURES***

L	**T**	**P**	**Course Code**: ***CSL1XXX***	**Credit**:3
3	0	0		

Unit I: Basic Concepts of OOPs, Templates Function and class templates, Algorithms: performance analysis, time complexity and space complexity, ADT, List (Singly, Doubly and Circular), Array, Pointer, Cursor. **Lecture:4**

Unit II: Stacks and Queues, ADT, Trees: Binary Tree, Binary Search Tree, AVL, Tries, Red Black trees, Splay tree, B Trees, Skip List, Fibonacci Heap, Augmented data structures. **Lecture:10**

Unit III: Set, Implementation, Operations on Set, Priority Queue, Graphs: Directed Graphs, Shortest Path Problem, Undirected Graph, Spanning Trees, Graph Traversals: hash table representation, hash functions, collision resolution, separate chaining, open addressing, linear probing, quadratic probing, double hashing, rehashing. **Lecture:8**

Unit IV: Equal Sized Blocks, Garbage Collection Algorithms, Storage Allocation with Mixed Sizes object, Buddy Systems, Storage Compaction **Lecture:4**

Unit V: Searching Techniques, Internal sorting: Quick sort, Heap sort, Bin sort, Radix sort, External Sorting: Multiway Merge Sort, Polyphase Sorting, Design Techniques, Divide and Conquer, Dynamic Programming, Greedy Algorithm, Backtracking, Local Search Algorithms. **Lecture:14**

TOTAL LECTURE: 40

Text Books:

1. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Pearson Education.

2. Aho Hopcroft Ullman, "Data Structures and Algorithms", Pearson Education.

3. T.H. Cormen, C.E. Leiserson,R.L. Rivest, C.Stein "Introduction to algorithms", PHI.

Reference Books:

1. Horowitz Sahni, Rajasekaran, "Computer Algorithms", Galgotia.

2. Tanenbaum A.S, Langram Y, Augestien M.J, "Data Structures using C & C++", Prentice Hall of India,

3. "Data structures, Algorithms and Applications in C++", S.Sahni, University Press (India) Pvt.Ltd, Universities Press Orient Longman Pvt. Ltd.

4. "Data structures and Algorithms in C++", Michael T.Goodrich, R.Tamassia and Mount, Wiley student edition, John Wiley and Sons.

5. "Data structures using C and C++", Langsam, Augenstein and Tanenbaum, PHI.