Course Curriculum

(Course Structure and Syllabi)

for

Minor Degree

in

Computer Science and Engineering

Department of Computer Science and Engineering

National Institute of Technology Hamirpur

Hamirpur (H.P) – 177 005 (India)

राष्ट्रीय प्रौद्योगिकी संस्थान हमीरपुर
हमीरपुर (हि॰प्र॰) – 177 005 (भारत)
NATIONAL INSTITUTE OF TECHNOLOGY HAMIRPUR
HAMIRPUR (H.P.) - 177 005 (INDIA)
(An Institute of National Importance under Ministry of HRD)

Department of Computer Science and Engineering

Teaching Scheme for Minor Degree in Computer Science and Engineering

For Minor Degree in Computer Science and Engineering the students are required to complete the following four courses with a total of twelve (12) credits.

S.no	Code	Subject	Semester	L	T	P	C
1.	CS-310	Theoretical Computer Science	5th	3	0	0	3
2.	CS-320	Computer System	6th	3	0	0	3
3.	CS-410	Programming Paradigms	7th	3	0	0	3
4.	CS-420	Machine Learning and Artificial Intelligence	8th	3	0	0	3
	CS-430	Computer Graphics and Image Processing					
	CS-440	Networked Systems					
Total Credits						**12**	

*** The students may opt for only one course at Serial no 4.**

Course Name: **Theoretical Computer Science**

Course Code: **CS-310**

Course Type: **Minor**

Contact Hours/Week: 3**L** Course Credits: **03**

Course Objectives

- To impart knowledge about disjunctive normal form and determine their validity by applying the rules and methods of propositional calculus.
- To enable the students to understand the logic recursion, basic structure and graph theory.
- To impart knowledge about the basic concept of finite automata and formal languages.
- To introduce the fundamental concepts relevant to context free grammars and ability to construct grammars for specific languages
- To introduce the fundamental concepts relevant to compiler design techniques

Unit Number	Course Content	Contact Hours
UNIT-01	**Foundations of Theoretical Computer Science:** Basic concepts of discrete mathematics and related problems, Propositions, predicates, disjunction and conjunction, tautologies and contradiction, laws of equivalence, rules of substitution and transitivity, normal forms. Introduction to sets, Venn Diagrams, set operations, power set, methods of proof for sets, Relations and ordering, Types of relations, Graph and matrix of a relation, properties of a relation, Poset, Lattice.	3L
UNIT-02	**Graph Theory:** Basic concepts of graph theory, multigraphs and weighted graphs, walk path and circuits, Warshall's algorithm: shortest path, Eulerian paths and circuits, Hamiltonian paths and circuits, Graph colorings, Binary trees and types of binary trees, traversing binary tree, binary search tree, Heaps.	3L
UNIT-03	**Machines:** Basic machine, FSM, Transition graph, Transition matrix, Deterministic and non-deterministic FSMS, Equivalence of DFA and NDFA, Mealy and Moore machines, minimization of finite automata, Two-way finite automata.	3L
UNIT-04	**Formal Languages and Automata Theory:** Alphabet, words, Operations, Regular sets, Basic definitions and examples of languages, Finite automata and regular expression Chomsky hierarchy, Regular grammars, context free & context sensitive grammars, context free languages, non-context free languages. binary operations on languages. Simplification of CFG, Elimination of Useless symbols, Unit productions, Null productions, Greiback Normal form, and Chomsky Normal form – Problems related to CNF and GNF.	3L
UNIT-05	**Introduction to Compilers:** Compiler and translators need of translators, structure of a compiler, lexical analysis, syntax Analysis. Basic Parsing Techniques: Parsers, shift-reduce parsing, predictive parsing.	3L
UNIT-06	**Constructions of Efficient Parsers:** LR parsers, canonical collection of LR(0) items, construction canonical LR parsing tables, construction LALR and SLR parsing tables using ambiguous grammars, an automatic parser generator, implementation of LR parsing tables, construction LALR sets of items.	3L

Course Outcomes

Upon successful completion of the course, the students will be able to:

CO1: Interpret statements presented in disjunctive normal form and determine their validity by applying the rules and methods of propositional calculus Design algorithms and flowcharts.

CO2: Understand and apply the properties of relations in computer science and engineering problems.

CO3: Understand graph problems and implement effective solutions.

CO4: Understand the concept of finite automata and formal languages, and demonstrate understanding of grammars and construct grammars for specific tasks.

CO5: Understand different phases of compilation process and analyze and implement various parsing techniques.

Text Books:

1. Discrete Mathematical structures with applications to Computer Science by J. P. Tremblay and R Manohar, McGraw Hill.
2. Introduction to Automata theory, Languages and Computation by John E. Hopcroft, Jeffery Ullman, Narosa Publishers.
3. Compilers Principles, Techniques and Tools by Alfred Aho, Monica S. Lam, Ravi Sethi, Jeffrey D Ullman, Pearson Education.

References Books:

1. Discrete Mathematics by Barnett, Steven, Addison Wesley.
2. An Introduction to Formal Languages and Automata by Peter Linz, Jones & Bartlett Learning
3. Engineering a Compiler by Keith D. Cooper and Linda Troczon, Morgan Kaufmann, Elsevier.

Course Name: **Computer System**
Course Code: **CS-320**
Course Type: **Minor**

Contact Hours/Week: **3L** **Course Credits: 03**

Course Objectives

- Understand fundamental principles of Computer Systems.
- To apply concepts and approaches used in Operating System, Computer Organization and DBMS to solve real world problems.
- To introduce the fundamental concepts relevant to design instruction set architectures and develop their micro architectures.
- To introduce the fundamental concepts scheduling of processes for a given problem instance.
- To enable the students to understand memory management techniques and implement replacement algorithms and understand and implement file systems.

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction to Computer System-** Stored Program control concept (Von-Neumann architecture principle), Flynn's Classification of computers (SIMD, MISD, MIMD), Structure organization (CPU, Caches, Main memory, Secondary memory unit & I/O), Register Transfer Operation, Micro-operation.	**6L**
UNIT-02	**General System Architecture:** Instruction Set Architecture (Instruction set based classification of processor i.e. RISC, CISC), Addressing Modes, Operation instruction set (Arithmetic & logical, Data transfer, Control flow), Instruction set format. Addition and Subtraction, Multiplication Algorithms (Booth's Multiplication Algorithm), Division Algorithm.	**6L**
UNIT-03	**Operating System Concepts-** Evolution of operating systems, Types of operating systems, Process concept, operating system services for process management., Process Synchronization, Deadlocks: Characterization, Prevention, Avoidance, Detection and Recovery, Combined approach to Deadlock Handling, precedence graphs.	**6L**
UNIT-04	**Operating System Security and Design Principles:** Network operating system, distributed operating system, external security, operational security, password protection, access control, security kernels, hardware security, layered approach, design principle.	**6L**
UNIT-05	**Database Concepts**- DBMS architecture & data independence, database languages & interfaces, Data Model, ER Models, Relational Models, Introduction to parallel, distributed, object oriented, NoSQL databases.	**6L**
UNIT-06	**Database Design:** ER Model based design, Functional dependences and Normalization for Relational Databases, normal forms based on primary keys, (1NF, 2NF, 3NF & BCNF), Query Languages.	**6L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Design and understanding of instruction set architecture.

CO2: Understand and analyze the concepts of operating system and its management.

CO3: Understand various digital arithmetic algorithms.

CO4: Design relational data model, entity-relationship model and SQL.

Text Books:

1. Computer Organization and Architecture, Designing for Performance by William Stallings, Pearson Education.
2. Database System Concepts by Abraham Silberschatz, Henry F. Korth and S. Sudarshan, McGraw-Hill.
3. Operating System Concepts by J.L. Peterson and A. Silberchatz, Addison Wesley.

References Books:

1. Structured Computer Organization by Andrew S. Tanenbaum and Todd Austin, Prentice Hall of India.
2. Database System Implementation by Hector Garcia–Molina, Jeffrey D.Ullman and Jennifer Widom, Pearson Education.
3. Operating systems by W. Stallings, Prentice Hall.

Course Name: **Programming Paradigms**
Course Code: **CS-410**
Course Type: **Minor**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the asymptotic notations to analyze the performance of algorithms.
- To impart knowledge about linear and non-linear data structures as the foundational base for computer solutions to problems.
- To introduce the fundamental concepts relevant to various data structures and perform related analysis to solve problems.
- To impart knowledge about the concept of Object-Oriented programing.
- To introduce the fundamental concepts relevant to Classes Objects, inheritance etc.

Unit Number	Course Content	Contact Hours
UNIT-01	**Algorithms Introduction:** Algorithm Design paradigms- motivation, concept of algorithmic efficiency, run time analysis of algorithms, Asymptotic Notations.	5L
UNIT-02	**Introductions to Data Structures:** Data types, data structures, abstract data types, arrays, Linked List, Stack, Queues, (Memory Representation and a few basic operations)	6L
UNIT-03	**Trees:** Basic terminology, General Trees, Binary Trees, Tree Traversing: in-order, pre-order and post-order traversal, building a binary search tree, Operations on Binary Trees **Graphs:** Basic definitions, representations of directed and undirected graphs, Representation of graphs, BFS, DFS.	6L
UNIT-04	**Sorting and Searching Techniques:** Bubble sorting, Insertion sort, Selection sort, Shell sort, Merge sort, Heap and Heap sort, Quick sort, Radix sort and Bucket sort.	6L
UNIT-05	**Concepts of Object-Oriented Programming:** Object Oriented Programming Paradigm, Basic concepts of OOP"s, Benefits of OOPS, Comparison of structured and object-oriented programming languages. **Classes and Objects:** Data types, operators, expressions, control structures, arrays, strings, Classes and objects, access specifiers, constructors, destructors.	7L
UNIT-06	**Polymorphism:** operator overloading, function overloading. **Inheritance:** Inheritance, single Inheritance, Multiple Inheritance, Multi-level inheritance, hierarchical inheritance, hybrid inheritance, Virtual functions**.**	6L

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Interpret and compute asymptotic notations of an algorithm to analyze the time complexity
CO2: Use of linear and non-linear data structures as the foundational base for computer solutions to problems
CO3: Implement various types of sorting & searching algorithms
CO4: Understand the concept of object-oriented paradigm and programming
CO5: Apply the concept of polymorphism and inheritance

Text Books:

1. Object Oriented programming with C++ by E. Balagurusamy, Tata McGraw Hill Hill.
2. Data structures, Algorithms ad Applications in C++ by Sartaj Sahni, WCB/McGraw Hill.
3. Fundamentals of Computer Algorithms by E. Horowitz and S. Sahni, Galgotia..

References Books:

1. The C++ programming Language by Bjarne Stroustrup, Addison Wesley.
2. Data Structures – A Pseudocode Approach with C by Richard F. Gilberg and Behrouz A. Forouzan, Thomson Brooks /COLE.
3. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, MIT Press, Cambridge.

Course Name: **Machine Learning and Artificial Intelligence**
Course Code: **CS-420**
Course Type: **Minor**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To understand the concepts of state space representation, exhaustive search, heuristic search together with the time and space complexities.
- To understand the applications of AI, namely game playing, theorem proving, and machine learning.
- To impart knowledge about the concepts of machine learning.
- To introduce the different types machine learning algorithms and their applications.
- Understand practical applications of NLP across diverse domains utilizing semantic analysis, and discourse understanding.

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction:** Artificial intelligence, computation, Cantor's diagonal argument, complexity theory, Decision problems, P and NP, Church–Turing Thesis, Von Neumann architecture.	**5L**
UNIT-02	**Problem characteristics:** Production system characteristics -Specialized production system- Problem solving methods – Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing-Depth first and Breath first, Constraints satisfaction – Measure of performance and analysis of search algorithms. - Game playing – Knowledge representation, Knowledge representation using Predicate logic	**7L**
UNIT-03	**Introduction to Machine Learning:** Introduction to Machine Learning, linear classification, perceptron update rule, Perceptron convergence, generalization, Maximum margin classification, Classification errors, regularization. Features extraction techniques PCA, LDA etc.	**6L**
UNIT-04	**Regression:** Linear regression, estimator bias and variance, active learning, Active learning, non-linear predictions, Kernel regression, kernel optimization, Model selection criteria, Description length, feature selection, expectation maximization.	**6L**
UNIT-05	**Classification:** Classification problems; decision boundaries; nearest neighbour methods, Probability and classification, Naive Bayes, Bayes' Rule and Naive Bayes Model, Hidden Markov models (HMMs), Bayesian networks, Learning Bayesian networks, Support Vector Machine (SVM). **Ensemble methods:** Bagging, random forests, boosting, Unsupervised learning: clustering, k-means, hierarchical agglomeration.	**7L**
UNIT-06	**Introduction to Natural Language Processing:** Introduction to NLP, Regular Expressions and Automata, Finite State Transducers, Word-level Morphology and Computational Phonology, HMMs, Part of Speech Tagging, Parsing with CFGs, Probabilistic Parsing, Representation of Meaning, Semantic Analysis, Lexical Semantics, Word Sense Disambiguation, Pragmatic Analysis, Discourse Understanding.	**7L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Learn the distinction between optimal reasoning Vs human like reasoning and formulate an efficient problem space for a problem expressed in natural language. Also select a search algorithm for a problem and estimate its time and space complexities.

CO2: Develop an understanding what is involved in learning models from data.

CO3: Understand a wide variety of learning algorithms and apply principles and algorithms to evaluate models generated from data.

CO4: Have an understanding of the strengths and weaknesses of many popular machine learning approaches.

CO5: Apply the algorithms to a real-world problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models. Demonstrate proficiency in applying NLP techniques, including state-of-the-art algorithms, to analyze and evaluate language models.

Text Books:

1. Introduction to Machine Learning by Ethem Alpaydin, PHI Learning.
2. Machine Learning: An Algorithmic Perspective by Stephen Marsland, Chapman and Hall/CRC.
3. Artificial Intelligence: A Modern Approach, Third Edition, Stuart Russell and Peter Norvig, Pearson Education.

Reference Books:

1. Machine Learning by Tom Mitchell, McGraw Hill Education.
2. Artificial Intelligence and Expert systems – Patterson, Pearson Education.
3. Pattern Classification. Richard Duda, Peter Hart and David Stock. Second Edition, Wiley-Interscience, 2000.

Course Name: **Computer Graphics and Image processing**
Course Code: **CS-430**
Course Type: **Minor**

Contact Hours/Week: **3L** Course Credits: **03**

Course Objectives

- To impart knowledge about the computer graphics and image processing technologies
- To introduce the fundamental concepts relevant to various 2D transformations, clipping algorithms to 2D primitives and demonstrate the 3D transformation concepts to model an object.
- Understand the principles and techniques used in computer graphics and image processing.
- Develop the skills necessary to implement graphics algorithms and image processing techniques.
- Gain hands-on experience with relevant software tools and libraries.

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction to Computer Graphics:** Overview of Graphics Systems, Display Devices, Interactive Input Devices, Display Processors, Graphics hardware: Display technology, random scan, raster scan display processing, graphics software and standards. **Raster Scan Graphics:** Points, lines, circles and ellipses as primitives, scan conversion algorithms for primitives, Fill area primitives including scan-line polygon filling, inside-outside test, boundary and flood-fill, character generation.	5L
UNIT-02	**Two-Dimensional and Three- Dimensional Transformation & Viewing:** Basic Transformations, Clipping Operations, Three Dimensional Display Methods. **Visible Lines and Visible Surfaces and Color models:** Visual Realism, Hidden line and hidden surface removal, properties of light, color models, modeling methods, Transparency, Refraction effects in transparent materials, Simple Transparency Models.	7L
UNIT-03	**Fundamentals of Digital Image Processing:** Digital image representation, Fundamental steps in Digital image processing, Elements of Digital Image processing systems, Image model, Sampling and quantization, Relationship between pixels, Imaging geometry. Basic Mathematical Tools Used in Digital Image Processing.	7L
UNIT-04	**Image Enhancement in Spatial Domain:** Enhancement by point processing, Sample intensity transformation. Restoration and Reconstruction, Color Image Processing, Image compression models, Image compression standards, Spatially dependent transform template and convolution, Window operations, 2- Dimensional geometric transformations. **Image Segmentation:** Detection of discontinuities, region based segmentation.	8L
UNIT-05	**Introduction to computer vision:** Digital image formation and low-level processing: Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean etc. Feature Extraction**:** Edges - Canny, LOG, DOG; Line detectors (Hough Transform).	5L
UNIT-06	**Pattern Analysis:** Basics of Probability and Statistics, Clustering: K-Means, Classification: Supervised, Un-supervised, Semi-supervised; Classifiers: KNN, ANN models. Applications: Image Classification, feature based methods, deep networks.	5L

Course Outcomes Upon successful completion of the course, the students will be able to

CO1: Understand the computer graphics display technologies.
CO2: Implement various 2D and 3D transformations.
CO3: Understand the concept of Image Processing and implement pattern recognition techniques
CO4: Understand and implement various techniques and algorithms used in computer vision.
CO5: Demonstrate awareness of the current key research issues in computer vision.

Text Books:

1. Procedural Elements for Computer Graphics by D.F. Rogers, McGraw Hill.
2. Digital Image Processing by Rafael C. Gonzalez and Richard E. Woods, Pearson Education.
3. Computer Vision Algorithms and Applications, Richard Szeliski, Springer.

References Books:

1. Computer Graphics, with OpenGL by Hearn and Baker, Pearson Education.
2. Digital Image Processing by W.K. Pratt, McGraw Hill.
3. Computer Vision: Models, Learning, and Inference by Simon J. D. Prince, Cambridge University Press.

Course Name: **Networked Systems**
Course Code: **CS-440**
Course Type: **Minor**

Contact Hours/Week: **3L** **Course Credits: 03**

Course Objectives

- To introduce the fundamental concepts of computer networks.
- To impart knowledge about the concepts of distributed systems and their relation with computer networks.
- To introduce the fundamental concepts of next generation networks like IoT, edge computing, fog and cloud computing.
- To impart knowledge of various security issues related to network and information shared on network.

Unit Number	Course Content	Contact Hours
UNIT-01	**Introduction:** Introduction to Computer Networks, LAN, MAN, WAN LAN, WAN, MAN, Wireless network, Network software: Protocol hierarchies, design issues of layers, Interfaces and services. Reference Model: The OSI reference model, TCP/IP reference model	**5L**
UNIT-02	**Introduction to Network Layers:** Physical layer, transmission media, switching etc.; Data Link Layer protocols, error control, flow control; various medium access control protocols; various issues with network, transport and other layers.	**7L**
UNIT-03	**Introduction to Distributed Systems:** Characterization and examples of distributed systems, Resource sharing and challenges and relation with computer networks. Client-Server Models, Proxy Server Models, Peer-to-Peer Models, Thin Clients, Mobile Codes, Mobile Agents, synchronization	**9L**
UNIT-04	**Distributed Resource Management:** Mutual exclusion, deadlocks, agreement protocols, distributed resource management and distributed shared memory architecture	**8L**
UNIT-05	**IoT and Cloud Computing Fundamentals:** Introduction to IoT and cloud computing. Communication and networking in IoT. Introduction to edge fog and cloud computing paradigms.	**7L**
UNIT-06	**Introduction to network and cyber security:** Cyber security fundamentals, server and network security, Introduction to firewalls, intrusion detection, various network attacks, Ip and Web Security, Introduction to information security and cryptography.	**4L**

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the basic concept of computer networks.
CO2: Understand concepts of various network layers and related issues.
CO3: Understanding concepts of distributed systems and their relation to computer networks.
CO4: Understanding basic concepts of IoT, edge, fog and cloud computing.
CO5: Understanding of network, cyber and information security fundamentals.

Text Books

1. Computer Networks by A.S. Tanenbaum, Prentice Hall of India.
2. Distributed Systems: Concepts and Design by G. Coulouris, J. Dollimore, and T. Kindberg, Pearson Education.
3. Internet of Things Principles and Paradigms by Rajkumar Buyya and Amir Vahid Dastjerdi, Elsevier.

References Books

1. Computer Networking: A Top-Down Approach Featuring the Internet by J. Kurose and K.W. Ross, Addison-Wesley.
2. Distributed Algorithms: Principles, Algorithms, and Systems by D. Kshemkalyani and M. Singhal, Cambridge University Press.
3. Cryptography and Network Security Principles and Practices, Fourth Edition, William Stallings, PHI(Pearson)