# Curriculum for Undergraduate Degree (B.Tech.) in Computer Science and Engineering (AI and ML) (w.e.f. AY: 2022-23)

## Part III: Detailed Curriculum

### Fourth Semester

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|---|---|---|---|
| **Course Name:** | **Computer Organization and Architecture** | | |
| **Course Code:** | PC-CS(D)401 | **Category:** | Professional Core Course |
| **Semester:** | 4th | **Credit:** | 3 |
| **L-T-P:** | 3-0-0 | **Pre-Requisites:** | Digital Electronics |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 70 | Continuous Assessment: 25 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | To introduce students how Computer Systems work & basics involved in data representation. |
| 2 | This course will also expose students to the basic organization of Processor and Memory System. |
| 3 | The students will be able to know how I/O devices are being accessed. |
| 4 | To learn the principles of pipelining |
| 5 | To distinguish between the concepts of serial, parallel, pipeline architecture. |

**Course Contents:**

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1 | **Basic Computer Organization and Data Representation**<br>Basic organization of the stored program computer and operation sequence for execution of a program. Role of operating systems and compiler/assembler. Fetch, decode and execute cycle, Commonly used number systems. Fixed- and floating-point representation of numbers Floating point - IEEE 754 standard, Overflow, Underflow | 3 |
| 2 | **Microoperation and Computer Arithmetic:**<br>Arithmetic Microoperations, Logic Microoperations, Shift Microoperation<br>Design of adders - Ripple carry adder, Serial Adder and Carry Look Ahead Adder, Arithmetic Circuit<br>Fixed point multiplication -Booth's algorithm. | 4 |
| 3 | **Central Processing Unit**<br>General Register Organization, Stack Organization<br>Instruction Formats, Addressing Modes, Instruction Set, CISC Characteristics, RISC Characteristics<br>Design of control unit - hardwired and microprogrammed control. | 3 |

| | | |
|---|---|---|
| 4 | **Memory Organization**<br>Static and dynamic memory, Memory hierarchy, Associative memory. Cache memory, Associative Mapping, Direct Mapping, Set Associative Mapping, Virtual memory, Paging, Segmentation, Page Replacement Algorithm, Memory unit design with special emphasis on implementation of CPU-memory interfacing. Data path design for read/write access. | 8 |
| 5 | **Input-Output Organization**<br>Peripheral Devices, Input-Output Interface, Asynchronous Data Transfer, Mode of Transfer, Priority Interrupt, Direct Memory Access | 3 |
| 6 | **Pipelining**<br>Basic concepts, instruction and arithmetic pipeline, data hazards, control hazards and structural hazards, techniques for handling hazards. Exception handling. Pipeline optimization techniques; Compiler techniques for improving performance. | 6 |
| 7 | **Instruction-level parallelism**<br>Basic concepts, techniques for increasing ILP, superscalar, super pipelined and VLIW processor architectures. Array and vector processors. | 4 |
| 8 | **Multiprocessor architecture**<br>Taxonomy of parallel architectures; Centralized shared- memory architecture: synchronization, memory consistency, interconnection networks. Distributed shared memory architecture. Cluster computers. Non von Neumann architectures: data flow computers, reduction computer architectures, systolic architectures. | 5 |
| **Total** | | **36L** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Describe Computer hardware, System, Instruction sets and Addressing Mode. |
| 2 | Design memory organization that uses banks for different word size operations. |
| 3 | Learn pipelining concepts with a prior knowledge of stored program methods |
| 4 | Study of parallel architecture and interconnection network |

| **Learning Resources:** | |
|---|---|
| 1 | Mano, M.M., "Computer System Architecture", PHI. |
| 2 | Hayes J. P., "Computer Architecture & Organisation", McGraw Hill, |
| 3 | Hamacher, "Computer Organisation", McGraw Hill, |
| 4 | William Stallings "Computer Organization and Architecture Designing for Performance", Pearson |
| 5 | J. L. Hennessy and D. A. Patterson, "Computer Architecture A Quantitative Approach", Morgan Kauffman, 2011. |
| 6 | Hwang & Briggs—Computer Architecture & Parallel Processing, TMH |
| 7 | B.Ram – "Computer Organization & Architecture", Newage Publications |
| 8 | Rajaraman – "Computer Organization & Architecture", PHI |
| 9 | Hwang, K. "Advanced Computer architecture with parallel programming", McGraw Hill, 1993 |

| **Course Name:** | **Operating System** | | |
|---|---|---|---|
| **Course Code:** | PC-CS402 | **Category:** | Professional Core Course |
| **Semester:** | 4th | **Credit:** | 3 |
| **L-T-P:** | 3-0-0 | **Pre-Requisites:** | Digital Electronics |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 70 | Continuous Assessment: 25 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | To learn UNIX commands and shell script |
| 2 | To gain the knowledge about process, thread, signal, semaphore and IPC |

**Course Contents:**

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1 | **Introduction:** Types of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine. | 3 |
| 2 | **Processes:** Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching<br>**Thread:** Definition, Various states, Benefits of threads, Types of threads, Concept of multi threads, Process Scheduling: Foundation and Scheduling objectives, Types of Schedulers, Scheduling criteria: CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time; Scheduling algorithms: Pre-emptive and Non pre-emptive, FCFS, SJF, RR | 6 |
| 3 | **Deadlocks:** Definition, Necessary and sufficient conditions for Deadlock, RAG, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery. | 4 |
| 4 | Inter-process Communication: Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, The Producer Consumer Problem, Semaphores, Event Counters, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem etc. | 6 |
| 5 | **Memory Management:** Basic concept, Logical and Physical address map, Memory allocation: Contiguous Memory allocation– Fixed and variable partition– Internal and External fragmentation and Compaction; Paging, Protection and sharing, Disadvantages of paging, segmentation | 6 |
| 6 | Virtual Memory: Basics of Virtual Memory – Hardware and control structures – Locality of reference, Page fault, Working Set, Dirty page/Dirty bit – Demand paging, Page Replacement algorithms: Optimal, First in First Out (FIFO), Not recently used (NRU) and Least Recently used (LRU). | 4 |
| 7 | **Disk Management:** Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C- SCAN, Boot-block, Bad blocks | 4 |
| 8 | **File Management:** Concept of File, Access methods, File types, File operation, Directory structure, File System structure, Allocation methods (contiguous, linked, indexed), Free-space management (bit vector, linked list, grouping), directory implementation (linear list, hash table). | 3 |
| **Total** | | **36** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Understand introductory concepts of operating system. |
| 2 | Apply process scheduling methods and deadlock handling schemes. |
| 3 | Understand inter process communication. |
| 4 | Apply memory management and disk management procedures. |

| **Learning Resources:** | |
|---|---|
| 1 | Operating System Concepts, Silberschatz, Galvin and Gagne, Wiley |
| 2 | Principles of Operating System, Naresh Chauhan, Oxford |
| 3 | Operating System, Deitel, Deitel, Pearson |

| **Course Name:** | **Design and Analysis of Algorithm** | | |
|---|---|---|---|
| **Course Code**: | PC-CS403 | **Category:** | Professional Core Course |
| **Semester**: | 4th | **Credit:** | 3 |
| **L-T-P**: | 3-0-0 | **Pre-Requisites:** | Data Structure, Discrete Mathematics, Basic Programming Ability |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 70 | Continuous Assessment: 25 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | The aim of this course is to learn how to develop efficient algorithms for simple computational tasks and reasoning about the correctness of them |
| 2 | Through the complexity measures, different range of behaviors of algorithms and the notion of tractable and intractable problems will be understood. |

**Course Contents:**

| **Module No.** | **Description of Topic** | **Contact Hrs.** |
|---|---|---|
| 1 | **Introduction:** Characteristics of algorithm. Analysis of algorithm: Asymptotic analysis of complexity bounds – best, average and worst- case behavior; Performance measurements of Algorithm, Time and space trade-offs, Analysis of recursive algorithms through recurrence relations: Substitution method, Method of Iteration, Recursion Tree method and Masters' theorem (Examples: Analysis of Binary Search, Merge Sort and Quick Sort using Recurrence) | 6 |
| 2 | **Fundamental Algorithmic Strategies:**<br>**Divide and Conquer Method:** Basic method, use, Example – Max-Min Problems and its complexity analysis.<br>**Greedy Method:** Basic method, use, Examples – Fractional Knapsack Problem, Job sequencing with deadlines, Activity Scheduling Problem, Travelling Salesperson Problem and their complexity analysis<br>**Dynamic Programming:** Basic method, use, Examples – Matrix Chain Manipulation, 0/1 Knapsack Problem and their complexity analysis<br>**Branch and Bound and Backtracking:** Basic method, use, Examples – 15 Puzzles Problem, N queens' problem, Graph Coloring problem, Hamiltonian Cycle Problem | 10 |
| 3 | **Graph and Tree Algorithms:** Traversal algorithms: Recapitulation of Depth First Search (DFS) and Breadth First Search (BFS); Shortest path Algorithms (Single Source and All Pairs with their Complexity Analysis), Transitive Closure, Minimum Spanning Tree (Prim's and Kruskal's Algorithms with their Complexity Analysis), Topological Sorting, Ford Fulkerson algorithm, Max-Flow Min-Cut theorem (Statement and Illustration). | 10 |

| | | |
|---|---|---|
| 4 | **Tractable and Intractable Problems:** Computability of Algorithms, Computability classes – P, NP, NP- complete and NP-hard. Satisfiability Problem, Cook's theorem, Clique decision problem | 6 |
| 5 | **Advanced Topics:** Approximation Algorithms: Introduction and Example - Vertex Cover Problem, Randomized Algorithms: Introduction and Example - Quick Sort | 4 |
| **Total** | | **36** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Understand the fundamental concepts of Asymptotic Notations and their mathematical significance. |
| 2 | Describe different algorithm design techniques like D&C, Greedy Method, DP, Backtracking, Branch and Bound, Graph Algorithms, NP etc and their implementations. |
| 3 | Apply appropriate algorithms and required Data Structure to construct the solution of a given problem. |
| 4 | Explain Randomized algorithms (expected running time, probability of error), and Approximation algorithm to compute approximation factors. |
| 5 | Analyze algorithms and determine the correctness. |

| **Learning Resources:** | |
|---|---|
| 1 | Introduction to Algorithms, 4TH Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill. |
| 2 | Fundamentals of Algorithms – E. Horowitz et al. |
| 3 | Algorithm Design, 1ST Edition, Jon Kleinberg and ÉvaTardos, Pearson. |
| 4 | Algorithm Design: Foundations, Analysis, and Internet Examples, Second Edition, Michael T Goodrich and Roberto Tamassia, Wiley. |
| 5 | Algorithms -- A Creative Approach, 3RD Edition, UdiManber, Addison-Wesley, Reading, MA |
| 6 | Design & Analysis of Algorithms, Gajendra Sharma, Khanna Publishing House (AICTE Recommended Textbook – 2018) |
| 7 | Algorithms Design and Analysis, Udit Agarwal, Dhanpat Rai |

| **Course Name**: | **Discrete Mathematics** | | |
|---|---|---|---|
| **Course Code**: | PC-CS404 | **Category:** | Professional Core Course |
| **Semester**: | 4th | **Credit:** | 3 |
| **L-T-P**: | 3-0-0 | **Pre-Requisites:** | Some concepts from basic math – algebra, geometry, pre-calculus |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 70 | Continuous Assessment: 25 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | To use mathematical logics and Boolean algebra in the field of computer applications. |
| 2 | To know about Set-Relation-Function and Group theory. |
| 3 | To learn counting techniques and number theory. |
| 4 | To use the concept of graph theory in engineering problems. |

**Course Contents:**

| **Module No.** | **Description of Topic** | **Contact Hrs.** |
|---|---|---|
| 1 | **Module-1:**<br>**Sets-Relation-Function**<br>• Operations and Laws of Sets<br>• Cartesian Products, Binary Relation, Equivalence Relation, Partial Ordering Relation, Lattice<br>**Number Theory**<br>• Proofs by Mathematical Induction<br>• The Division Algorithm, Prime Numbers, The Greatest Common Divisor, Euclidean Algorithm, The Fundamental Theorem of Arithmetic | 10 |
| 2 | **Module-2:**<br>**Combinatorics**<br>• Basic Counting Techniques, Inclusion and Exclusion Theorem<br>• Permutation and Combination<br>• Pigeon-Hole Principle | 6 |
| 3 | **Module-3:**<br>**Propositional Logic and Proofs**<br>• Basic Connectives and Truth Tables of propositional logics, Disjuntive and Conjuntive Normal Form using truth table, Argument<br>• Quantifiers and their uses<br>• Proofs; Forward Proof, Proof by Contradiction, Proof by Contraposition, Proof by Mathematical Induction<br>• The Laws of Logic, Logical Implication, Rules of Inference | 8 |
| | **Module-4:**<br>**Algebraic Structures and Boolean Algebra**<br>• Algebraic Structures with one Binary Operator<br>• Group, Subgroup, Cyclic group, Permutation group, Symmetric group. | |

| | | |
|---|---|---|
| 4 | • Coset, Lagrange's Theorem, Normal Subgroup, Quotient group<br>• Homomorphism and Isomorphism of groups<br>**Algebraic Structures with two Binary Operators**<br>• Rings, Integral Domain and Fields<br>**Boolean Algebra**<br>• Identities of Boolean Algebra, Duality, Representation of Boolean Function, Disjuntive and Conjuntive Normal Form<br>• Switching network from Boolean expression using Logic Gates<br>• Karnaugh Map | 10 |
| 5 | **Module-5:**<br>**Advanced Graph Theory**<br>• Planar and Dual graph: Kuratowski's graphs, Euler's formulae for connected and disconnected planar graphs, Detection of planarity<br>• Graph Coloring: Vertex coloring, Chromatic number of complete graphs, circuit and bipartite graph, Chromatic polynomial<br>• Connectivity and matching | 6 |
| **Total** | | **40** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Express a logic sentence in terms of predicates, quantifiers, and logical connectives |
| 2 | Derive the solution for a given problem using deductive logic and prove the solution based on logical inference |
| 3 | Classify its algebraic structure for a given a mathematical problem, |
| 4 | Evaluate Boolean functions and simplify expressions using the properties of Boolean algebra |
| 5 | Develop the given problem as graph networks and solve with techniques of graph theory |

| **Learning Resources:** | |
|---|---|
| 1 | Russell Merris, Combinatorics, Wiley-Interscience series in Discrete Mathematics and Optimisation |
| 2 | N. Chandrasekaran and M. Umaparvathi, Discrete Mathematics, PHI |
| 3 | Gary Haggard, John Schlipf and Sue Whitesides, Discrete Mathematics for Computer Science, CENGAGE Learning |
| 4 | Gary Chartrand and Ping Zhang – Introduction to Graph Theory, TMH |
| 5 | J.K. Sharma, Discrete Mathematics, Macmillan |
| 6 | Winfried Karl Grassmann and Jean-Paul Tremblay, Logic and Discrete Mathematics, PRSEAON. |
| 7 | S. K. Chakraborty and B. K. Sarkar, Discrete Mathematics, OXFORD University Press. |
| 8 | Douglas B. West, Introduction to graph Theory, PHI |
| 9 | C. L. Liu, Elements of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 2000. |
| 10 | R. C. Penner, Discrete Mathematics: Proof Techniques and Mathematical Structures, World Scientific, 1999. |
| 11 | R. L. Graham, D. E. Knuth, and O. Patashnik, Concrete Mathematics, 2nd Ed., Addison- Wesley, 1994. |
| 12 | N. Deo, Graph Theory, Prentice Hall of India, 1974. |
| 13 | S. Lipschutz and M. L. Lipson, Schaum's Outline of Theory and Problems of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 1999. |

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|---|---|
| 14 | J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer Science, Tata McGraw-Hill, 1997. |
| 15 | Higher Algebra- S.K. Mapa |
| 16 | N. Chandrasekaran and M. Umaparvathi, Discrete Mathematics, PHI |
| 17 | S.B. Singh, Discrete Structures – Khanna Publishing House (AICTE Recommended Textbook – 2018) |
| 18 | S.B. Singh, Combinatorics and Graph Theory, Khanna Publishing House (AICTE Recommended Textbook – 2018) |

| **Course Name**: | **Formal Language and Automata Theory** | | |
|---|---|---|---|
| **Course Code**: | PC-CS405 | **Category:** | Professional Core Courses |
| **Semester**: | 4th | **Credit:** | 3 |
| **L-T-P**: | 3-0-0 | **Pre-Requisites:** | Mathematics II (BS M 201), Mathematics III (BS M 305), Digital Electronics (ES EC 302) |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 70 | Continuous Assessment: 25 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | To give an overview of the theoretical foundations of computer science from the perspective of formal languages |
| 2 | To acquire insights into the relationship among formal languages, formal grammars, and automata |
| 3 | To illustrate finite state machines to solve problems in computing |
| 4 | To develop the ability to design of PDA and Turing Machine |

**Course Contents:**

| **Module No.** | **Description of Topic** | **Contact Hrs.** |
|---|---|---|
| 1 | **Fundamentals:**<br>Introduction: Basic Mathematical Notation and techniques, Strings, Alphabet, Language, Grammar, Productions and Derivation, Chomsky hierarchy of languages.<br>Basic definition of sequential circuit, block diagram, concept of transition table and transition diagram (Relating of Automata concept to sequential circuit concept), Design of sequence detector,<br>Finite state machine: Definitions, capability & state equivalent, kth-equivalent concept | 4L |
| 2 | **Finite Automata:**<br>Finite automaton model, acceptance of strings, and languages, Deterministic finite automaton and non-deterministic finite automaton. Transition diagrams and Language recognizers.<br>NFA with λ transitions - Significance, acceptance of languages.<br>Conversions and Equivalence: Equivalence between NFA with and without λ transitions, NFA to DFA conversion, minimization of Finite Automata, Finite Automata with output- Moore and Mealy machines | 7L |
| 3 | **Regular Languages and Regular Grammar:**<br>Regular sets, Regular expressions, identity rules. Arden's theorem state and proof, constructing finite Automata for a given regular expressions, Conversion of Finite Automata to Regular expressions. Regular grammars-right linear and left linear grammars, equivalence between regular linear grammar and FA<br>Closure properties of regular languages, pumping lemma for regular languages | 7L |

| | | |
|---|---|---|
| 4 | **Context-free languages and Pushdown Automata:**<br>Context Free Grammars, Parse three, Ambiguity in context free grammars, Minimization of Context Free Grammars. Chomsky and Greibach normal forms.<br>Pumping Lemma for Context Free Languages, Closure property of CFL Push down automata: Definition, Acceptance of CFL, Acceptance by final state and acceptance by empty state and its equivalence, equivalence of CFL and PDA, interconversion. (Proofs not required), introduction to DCFL and DPDA | 10L |
| 5 | **Context Sensitive Languages:**<br>Context-sensitive languages: Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG. | 2L |
| 6 | **Turing Machine:**<br>Turing Machine, definition, model, Design of TM, Computable functions, Recursively Enumerable Languages, Unrestricted Grammar, Church- Turing thesis, Variants of Turing machines, Universal Turing Machine, Halting problem | 6L |
| **Total** | | **36L** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Understand the concept of abstract machines and their power to recognize the languages |
| 2 | Construct automata for any given pattern and find its equivalent regular expressions |
| 3 | Design context free grammars for formal languages. |
| 4 | Design PDA and Turing Machine. |

| **Learning Resources:** | |
|---|---|
| 1 | Peter Linz, "An Introduction to Formal Language and Automata", Third Edition, Narosa Publishers, New Delhi, 2002. |
| 2 | Mishra K L P and Chandrasekaran N, "Theory of Computer Science – Automata, Languages and Computation", Third Edition, Prentice Hall of India, 2004. |
| 3 | Harry R Lewis and Christos H Papadimitriou, "Elements of the Theory of Computation", Second Edition, Prentice Hall of India, Pearson Education, New Delhi, 2003. |
| 4 | Hopcroft H.E. and Ullman J. D., "Introduction to Automata Theory Language and Computation", Pearson Education. |
| 5 | John C Martin, "Introduction to languages and the Theory of Computation", TMH |
| 6 | C.K.Nagpal, "Formal Languages and Automata Theory", Oxford |
| 7 | ZVI Kohavi, "Switching & Finite Automata", Tata McGraw Hill |

| **Course Name**: | **Economics for Engineers** | | |
|---|---|---|---|
| **Course Code**: | HM-HU 401 | **Category:** | Management Science & Humanities |
| **Semester**: | 4th | **Credit:** | 3 |
| **L-T-P**: | 3-0-0 | **Pre-Requisites:** | Mathematics |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 70 | Continuous Assessment: 25 | Attendance: 5 |

| **Course Objectives:** | |
|---|---|
| 1 | Understand the role and scope of Engineering Economics and the process of economic decision making along with the different concepts of cost and cost estimation techniques. |
| 2 | Familiarization with the concepts of cash flow, time value of money and different interest formulas |
| 3 | Appreciation of the role of uncertainty in future events and using different concepts from probability to deal with uncertainty |
| 4 | Understand the concepts of Depreciation and Replacement analysis along with their methods of calculation and familiarization with the phenomenon of inflation and the use of price indices in engineering Economics |
| 5 | Introduction to basic concepts of Accounting and Financial Management |

**Course Contents:**

| Module No. | Description of Topic | Contact Hrs. |
|---|---|---|
| 1 | Economic Decisions Making: Overview, Problems, Role, Decision making process.<br>Engineering Costs & Estimation – Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types Of Estimate, Estimating Models - PerUnit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve, Benefits. | 9 |
| 2 | Cash Flow, Interest and Equivalence: Cash Flow – Diagrams, Categories & Computation, Time Value of Money, Debt repayment, Nominal& Effective Interest.<br>Cash Flow & Rate of Return Analysis – Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate of Return, Calculating Rate of Return, Incremental Analysis; Best Alternative Choosing an Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity and Breakeven Analysis. Economic Analysis In The Public Sector -Quantifying And Valuing Benefits & drawbacks. | 9 |

| | | |
|---|---|---|
| 3 | Inflation and Price Change – Definition, Effects, Causes, Price Change with Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates.<br>Present Worth Analysis: End-Of-Year Convention, Viewpoint Of Economic Analysis Studies, Borrowed Money Viewpoint, Effect Of Inflation & Deflation, Taxes, Economic Criteria, Applying Present Worth Techniques, Multiple Alternatives.<br>Uncertainty In Future Events - Estimates and Their Use in Economic Analysis, Range Of Estimates, Probability, Joint Probability Distributions, Expected Value, Economic Decision Trees, Risk, Risk vs Return, Simulation, Real Options. | 9 |
| 4 | Depreciation: Basic Aspects, Deterioration & Obsolescence, Depreciation And Expenses, Types Of Property, Depreciation Calculation Fundamentals, Depreciation And Capital Allowance Methods, Straight-Line Depreciation Declining Balance Depreciation, Common Elements Of Tax Regulations For Depreciation And Capital Allowances.<br>Replacement Analysis - Replacement Analysis Decision Map, Minimum Cost Life of a New Asset, Marginal Cost, Minimum Cost Life Problems.<br>Accounting – Function, Balance Sheet, Income Statement, Financial Ratios Capital Transactions, Cost Accounting, Direct and Indirect Costs, Indirect Cost Allocation. | 9 |
| **Total** | | **36** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Discuss fundamentals of economic analysis. |
| 2 | Describe rate of return and profitability analysis, Present, Future, Annuity, Risk and return, BEP and Sensitivity Analysis, Bayesian joint probability and quantitative decision making, basic accounting system and balance sheet and P & L accounts etc. |
| 3 | Apply decision making skills in terms of Economic, financial considerations in practice. |
| 4 | Apply knowledge to take right financial decision at the right point in time in real world situation. |

| **Learning Resources:** | |
|---|---|
| 1 | James L.Riggs, David D. Bedworth, Sabah U. Randhawa : Economics for Engineers 4e, Tata McGraw-Hill |
| 2 | Donald Newnan, Ted Eschembach, Jerome Lavelle: Engineering Economics Analysis, OUP |
| 3 | R.Paneer Seelvan: Engineering Economics, PHI |
| 4 | Sullivan and Wicks: Engineering Economy, Pearson |
| 5 | John A. White, Kenneth E. Case, David B. Pratt : Principle of Engineering Economic Analysis,<br>John Wiley |

| **Course Name:** | **Object Oriented Programming Lab** | | |
|---|---|---|---|
| **Course Code**: | PC-CS(AM)491 | **Category:** | Professional Core |
| **Semester**: | 4th | **Credit:** | 2 |
| **L-T-P**: | 0-1-2 | **Pre-Requisites:** | Basic understanding of programming |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 60 | Continuous Assessment: 35 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | To build software development skills using java programming for real-world applications. |
| 2 | To understand and apply the concepts of classes, packages, interfaces, array list, exception handling and file processing. |
| 3 | To develop applications using generic programming and event handling. |

| **Course Contents:** | | |
|---|---|---|
| **Module No.** | **Description of Topic** | **Contact Hrs.** |
| 1 | Assignments on class, constructor, overloading, inheritance, overriding | 3 |
| 2 | Assignments on wrapper class, arrays | 3 |
| 3 | Assignments on developing interfaces- multiple inheritance, extending interfaces | 6 |
| 4 | Assignments on creating and accessing packages | 6 |
| 5 | Assignments on multithreaded programming | 9 |
| 6 | Assignments on generic class and array list | 6 |
| 7 | Assignments on applet programming | 3 |
| **Total** | | **36** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Implement Java programs for simple applications that make use of classes, packages and interfaces. |
| 2 | Implement Java programs with array list, exception handling and multithreading. |
| 3 | Design applications using generic programming, applet and event handling. |

| **Learning Resources:** | |
|---|---|
| 1 | P. J. Deitel, H. M. Deitel, "Java for Programmers", Pearson Education, PHI, 4th Edition, 2007. |
| 2 | P. Radha Krishna, "Object Oriented Programming through Java", Universities Press, 2nd |
| 3. | Bruce Eckel, "Thinking in Java", Pearson Education, 4th Edition, 2006. |
| 4. | Sachin Malhotra, Saurabh Chaudhary, "Programming in Java", Oxford University Press, |

| **Course Name**: | **Operating System Lab** | | |
|---|---|---|---|
| **Course Code**: | PC-CS(AM) 492 | **Category:** | Professional Core |
| **Semester**: | 4th | **Credit:** | 1 |
| **L-T-P**: | 0-0-2 | **Pre-Requisites:** | Digital Electronics |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 60 | Continuous Assessment: 35 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | To learn UNIX commands and shell script |
| 2 | To gain the knowledge about process, thread, signal, semaphore and IPC |

| **Course Contents:** | | |
|---|---|---|
| **Module No.** | **Description of Topic** | **Contact Hrs.** |
| 1 | UNIX Commands | 2 |
| 2 | Creating a bash shell script, making a script executable, shell syntax (variables, conditions, control structures, functions, CLA) | 6 |
| 3 | C programs for parent process, child process, orphan process, sleeping process, running process, zombie process. | 4 |
| 4 | Multithreaded C program using PThread API | 2 |
| 5 | C programs for Signal handling | 2 |
| 6 | C programs regarding Semaphores | 4 |
| 7 | C programs regarding Pipes and Named Pipes | 4 |
| **Total** | | **24** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Understand UNIX commands and applications of shell script. |
| 2 | Apply Process and Thread execution. |
| 3 | Apply Signal and Semaphore. |
| 4 | Apply IPC related concepts. |

| **Learning Resources:** | |
|---|---|
| 1 | UNIX Concepts and Applications, Sumitabha Das, McGrawhill |
| 2 | Vijay Mukhi's The C Odyssey UNIX – The Open Boundless C, BPB Publications |

| **Course Name**: | **Design and Analysis of Algorithm Lab** | | |
|---|---|---|---|
| **Course Code**: | PC-CS493 | **Category:** | Professional Core Course |
| **Semester**: | 4th | **Credit:** | 1.5 |
| **L-T-P**: | 0-0-3 | **Pre-Requisites:** | Data Structure, Basic Programming Ability |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 60 | Continuous Assessment: 35 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | The aim of this course is to study about various designing paradigms of algorithms for solving real world problems. |
| 2 | Through this course one can apply appropriate algorithms and methods of analysis. |
| 3 | To pick an appropriate data structure for a design situation is also under consideration. |

| **Course Contents:** | | |
|---|---|---|
| **Module No.** | **Description of Topic/ Experiment** | **Contact Hrs.** |
| The contents should include about 10 assignments with the focus given as outlined below: | | |
| **UNIT - I Divide and Conquer, Greedy Method, Dynamic Programming** | | |
| 1 | Implement Binary Search, Merge Sort, Implement Quick Sort, Find Maximum and Minimum Element from an Array of Elements<br>Implement Knapsack Problem, Job sequencing with deadlines, Traveling Salesman Problem<br>Find the minimum number of scalar multiplications needed for Chain of Matrix | 15 |
| **UNIT - II Graph Traversal Algorithm, Minimum Cost Spanning Tree Generation Algorithms, Shortest Path Algorithms** | | |
| 2 | Implement Breadth First Search (BFS), Depth First Search (DFS)<br>Implement Minimum Cost Spanning Tree by Prim's and Kruskal's Algorithm<br>Implement Single Source shortest Path for a graph (Dijkstra, Bellman Ford Algorithm) and All pair of Shortest path for a graph (Floyd- Warshall Algorithm) | 15 |
| **UNIT - III Backtracking and Branch and Bound** | | |
| 3 | Implement N Queen problem<br>Implement Graph Coloring Problem<br>Implement Hamiltonian Problem<br>Implement 15-Puzzle Problem | 6 |
| **Total** | | **36** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Implement Binary Binary Search, Merge Sort, Quick Sort, and Max-min 1 Problem using D&C Algorithm Design Techniques. |
| 2 | Implement Fractional Knapsack, Job Sequencing with Deadline, TSP, Matrix Chain, Graph Traversals, MST problems, Shortest Path, N- Queens, Graph Coloring, Hamiltonian Cycle, and 15 Puzzles using proper Algorithm Design Techniques. |
| 3 | Apply suitable algorithm for solving a particular problem. |
| 4 | Analyze the complexities and memory usage of different algorithms. |

| **Learning Resources:** | |
|---|---|
| 1 | Introduction to Algorithms, 4TH Edition, Thomas H Cormen, Charles E Lieserson, Ronald L Rivest and Clifford Stein, MIT Press/McGraw-Hill. |
| 2 | Fundamentals of Algorithms – E. Horowitz et al. |
| 3 | Algorithms Design and Analysis, Udit Agarwal, Dhanpat Rai |
| 4 | Design and Analysis of Algorithm, Biswas and Dey, JBBL |

| **Course Name**: | **Soft Skill Development Lab** | | |
|---|---|---|---|
| **Course Code**: | HM-HU491 | **Category:** | Management Science and Humanities Courses |
| **Semester**: | 4th | **Credit:** | 1 |
| **L-T-P**: | 0-0-2 | **Pre-Requisites:** | Students must have basic knowledge of English Language. |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination: 60 | Continuous Assessment: 35 | Attendance: 05 |

| **Course Objectives:** | |
|---|---|
| 1 | To equip the students with good communication skills. |
| 2 | Enable the students to think and speak effectively on everyday topics, including topics related to technical concepts. |
| 3 | To prepare them for interviews and future job environments. |
| 4 | Developing an industry-ready attitude towards professional communication. |

**Course Contents:**

| **Module No.** | **Description of Topic** | **Contact Hrs.** |
|---|---|---|
| 1. | Conversation Practice Sessions - General Conversation - Warm-up sessions - Basics of Communication, verbal and non-verbal communication. | 4 |
| 2. | Group Discussion - Group Discussion & Debates, Do's & Don'ts, etc., Intensive Practice Sessions. | 8 |
| 3. | Interview sessions: Principles and practices of Personal Interview • Do's and Don'ts of facing an interview. • SWOC Analysis • Rigorous practices of mock interviews. | 6 |
| 4. | Presentations: Fundamentals of presentation skills, Secrets of an effective presentation, Presentation Practice Sessions with the help of PowerPoint presentations and other audio-visual aids, Face question-answer sessions at the end of their presentation. | 6 |
| **Total** | | **24** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Honing over all Communicative Competence. |
| 2 | Develop Team Building and Leadership Quality. |
| 3 | Deliver an enthusiastic and well-practiced presentation |
| 4. | Communicate with clarity and confidence thereby enhancing employability skills of the students. |

| Learning Resources: | |
|---|---|
| 1 | Soft Skills: Key to success in Workplace and Life, Meenakshi Raman and Shalini Upadhyay |
| 2 | Communication Skills. Sanjay Kumar and Pushpalata, Oxford University Press, 2011. |
| 3 | Monipally: Business Communication, Tata McGraw Hill |
| 4 | Madhukar: Business Communications; Vikas Publishing House |
| 5 | Senguin J: Business Communication; Allied Publishers |
| 6. | Business Communication: Rajendrapal & Korlahalli |

| **Course Name:** | **Constitution of India** | | |
|---|---|---|---|
| **Course Code:** | MC472 | **Category:** | Mandatory Course |
| **Semester:** | 4th | **Credit:** | Zero |
| **L-T-P:** | 2-0-0 | **Pre-Requisites:** | |
| **Full Marks:** | 100 | | |
| **Examination Scheme:** | Semester Examination of 100 marks | | |

| **Course Objectives:** | |
|---|---|
| 1 | Develop an understanding of the nation's constitution. |
| 2 | Develop knowledge about the various levels of governance in the country. |

| **Course Contents:** | | |
|---|---|---|
| **Module No.** | **Description of Topic** | **Contact Hrs.** |
| 1 | **Introduction:** Sources and Constitutional history. Preamble, Fundamental Rights and Duties, Directive Principles of State Policy. | 3 |
| 2 | **Union Government and its Administration:** Structure of the Indian Union: Federalism, Centre-State relationship, President: Role, power and position, PM and Council of ministers, Lok Sabha, Rajya Sabha, Supreme Court | 6 |
| 3 | **State Government and its Administration** Governor. Role and Position, CM and Council of ministers High Court | 6 |
| 4 | **Local Administration District's Administration head:** Role and Importance, Municipalities: Introduction, Mayor, and role of Elected Representative. Pachayati raj: Introduction, Zila Pachayat, Elected officials and their roles. Importance of grass root democracy | 6 |
| 5 | **Election Commission Election Commission:** Role and Functioning, Chief Election Commissioner | 2 |
| **Total** | | **23** |

| **Course Outcomes:** | |
|---|---|
| After completion of the course, students will be able to: | |
| 1 | Gain an understanding of the constitution of India. |
| 2 | Become aware of the various levels of governance in the country. |

| **Learning Resources:** | |
|---|---|
| 1 | 'Indian Polity' by Laxmikanth |
| 2 | 'Indian Administration' by Subhash Kashyap |
| 3 | 'Indian Constitution' by D.D. Basu |
| 4 | 'Indian Administration' by Avasti and Avasti |