Haldia Institute of Technology (Autonomous)

B. Tech in Computer Science & Engineering (Artificial Intelligence and Machine Learning)

PROGRAM OUTCOMES (ALIGNED WITH GRADUATE ATTRIBUTES) (POs)

At the end of this program, graduates will be able to

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Curriculum Structure

Semester III (Second year)								
Sl. No.		**Type of Course**	**Code**	**Course Title**	**Hours per week**			**Credits**
					L	T	P	
1	Theory	Engineering Science Course	ESC-AIML-301	Digital Electronics	3	0	0	3
2		Professional Core	PCC-AIML-301	Data Structure and	3	1	0	4

		Course		Algorithms				
3		Professional Core Course	PCC-AIML-302	Computer Organization & Architecture	3	1	0	4
4		Basic Science Course	BSC-AIML-301	Linear Algebra	3	0	0	3
5		Humanities Social Science including Management Course	HSMC-AIML-301	Economics for Engineers	2	0	0	2
6	Practical	Engineering Science Course	ESC-AIML-391	Digital Electronics Lab	0	0	3	1.5
7		Professional Core Course	PCC-AIML-391	Data Structure and Algorithms Lab	0	0	3	1.5
8		Professional Core Course	PCC-AIML-392	Computer Architecture Lab	0	0	3	1.5
9		Professional Core Course	PCC-AIML-393	IT Workshop (Python)	0	0	3	1.5
Total Credits								22

Semester IV (Second year)								
Sl. No.		**Type of Course**	**Code**	**Course Title**	**Hours per week**			**Credits**
					L	T	P	
1	Theory	Engineering Science Course	ESC-AIML-401	Probability and Statistics	3	0	0	3
2		Professional Core Course	PCC-AIML-401	Object Oriented Programming & Java	3	0	0	3
3		Professional Core Course	PCC-AIML-402	Formal Language and Automata Theory	3	0	0	3
4		Professional Core Course	PCC-AIML-403	Design and Analysis of Algorithm	3	1	0	4
5		Engineering Science Course	ESC-AIML-402	Signals and Systems	3	0	0	3
6		Mandatory Course	MC-AIML-401	Environmental Sciences	2	0	0	0
7	Practical	Professional Core Course	PCC-AIML-491	Object Oriented Programming & Java Lab	0	0	3	1.5
8		Professional Core Course	PCC-AIML-492	Design and Analysis of Algorithm Lab	0	0	3	1.5
Total Credits								19

Semester V (Third year)								
Sl. No.		**Type of Course**	**Code**	**Course Title**	**Hours per week**			**Credits**
					L	T	P	
1	Theo	Basic Science Course	BSC-AIML-501	Discrete Mathematics	3	0	0	3

2		Professional Core Course	PCC-AIML-501	Operating System	3	0	0	3
3		Professional Core Course	PCC-AIML-502	Database Management Systems	3	0	0	3
4		Professional Core Course	PCC-AIML-503	Machine Learning Foundations	3	0	0	3
5		Professional Core Course	PCC-AIML-504	Computer Networks	3	0	0	3
6		Professional Core Course	PCC-AIML-505	Artificial Intelligence	3	0	0	3
7	Practical	Professional Core Course	PCC-AIML-591	Operating System Lab	0	0	3	1.5
8		Professional Core Course	PCC-AIML-592	Database Management Systems Lab	0	0	3	1.5
9		Professional Core Course	PCC-AIML-593	Machine Learning Foundations Lab	0	0	3	1.5
Total Credits								22.5

Semester VI (Third year)								
Sl. No.		**Type of Course**	**Code**	**Course Title**	**Hours per week**			**Credits**
					L	T	P	
1	Theory	Professional Core Course	PCC-AIML-601	Machine Learning Applications	2	0	0	2
2		Professional Core Course	PCC-AIML-602	Deep Learning	3	0	0	3
3		Humanities and Social Sciences including Management	HSMC-AIML-601	Human Values and Professional Ethics	3	0	0	3
4		Professional Elective -I	PEC-AIML-601 (A/B/C/D)	Soft Computing Cloud Computing Pattern Recognition Graph Theory	3	0	0	3
5		Professional Elective - II	PEC-AIML-602 (A/B/C/D)	Big Data Analytics Data Mining Distributed System Digital Signal Processing	3	0	0	3
6		Open Elective - I	OEC-AIML-601 (A/B/C/D)	Advanced Computer Architecture Human Computer Interaction Artificial Neural Network Cryptography and Network Security	3	0	0	3
7	Practical	Professional Core Course	PCC-AIML-691	Machine Learning Applications Lab	0	0	3	1.5
8		Professional Core Course	PCC-AIML-692	Artificial Intelligence Lab	0	0	3	1.5
9		Professional Core	PCC-AIML-693	Computer Networks Lab	0	0	3	1.5

		Course						
Total Credits								21.5

Semester VII (Fourth year)								
Sl. No.		**Type of Course**	**Code**	**Course Title**	**Hours per week**			**Credits**
					L	T	P	
1	Theory	Professional Elective Course - III	PEC-AIML-701 (A/B/C/D)	Social Network Analysis Computer Vision Software Engineering Data Warehousing	3	0	0	3
2		Professional Elective Course - IV	PEC-AIML-702 (A/B/C/D)	Ecommerce and ERP Information Theory and Coding Data Visualization Mobile Computing	3	0	0	3
3		Open Elective Course - II	OEC-AIML-701 (A/B/C/D)	Internet of Things Bio Informatics Robotics Compiler Design	3	0	0	3
4		Humanities and Social Sciences Including Management	HSMC-AIML-701	Principles of Management	3	0	0	3
5	Sesional	Project	PROJ-AIML-781	Project I	0	0	10	5
6		Summer Internship	SI-AIML-781	Internship - I				3
Total Credits								20

Semester VIII (Fourth year)								
Sl. No.		**Type of Course**	**Code**	**Course Title**	**Hours per week**			**Credits**
					L	T	P	
1	Theory	Professional Elective Course - V	PEC-AIML-801 (A/B/C/D)	Natural Language Processing Ethical Issues in AI Digital Image Processing Applications of AI in Biomedical Engineering	3	0	0	3
2		Open Elective Course - III	OEC-AIML-801 (A/B/C/D)	Operation Research Economic Policies in India Microelectronics and VLSI Quantum Computing	3	0	0	3
3		Open Elective Course - IV	OEC-AIML-802 (A/B/C/D)	Organizational Behaviour Human Resource Management Research Methodology	3	0	0	3

				Soft skill and Interpersonal Communication				
4	Session	Project	PROJ-AIML-881	Project II	0	0	10	5
5		Winter Internship	WI-AIML-881	Internship-II				3
Total Credits								17

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Semester - III

ESC-AIML-301: Digital Electronics
Contacts: 3L per week Credits: 3

Course Outcomes (COs):

At the end of this course, students will demonstrate the ability to

1. Understand working of logic families and logic gates.
2. Convert a number from one base system to another.
3. Understand Boolean algebra and represent digital circuits from Boolean expressions.
4. Design and implement many Combinational circuits.
5. Design and implement various Sequential logic circuits.
6. Understand the process of Analog to Digital conversion and Digital to Analog conversion.

Prerequisites:

1. Number Systems

Detailed Content:

Module	***Content***	***Hours/ Module***
1	Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Binary Number System & Boolean Algebra (recapitulation); BCD, ASCII, EBDIC, Gray codes and their conversions; Signed binary number representation with 1's and 2's complement methods, Binary arithmetic, Venn diagram,	4
2	Boolean algebra (recapitulation); Representation in SOP and POS forms; Minimization of logic expressions by algebraic method. K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions.	5
3	Combinational Circuits - Adder and Subtractor circuits (half & full adder & subtractor); Encoder, Decoder, Comparator, Multiplexer, De-multiplexer and Parity Generator. Error detecting and correcting codes. Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder	7
4	Sequential Circuits - Basic Flip-flop & Latch, Flip-flops -SR, JK, D, T and JK Master-slave Flip Flops, Registers (SISO, SIPO, PIPO, PISO) Ring counter, Johnson counter Basic concept of Synchronous and Asynchronous counters (detail design of circuits excluded), Design of Mod N Counter. Counters design using flip-flops	8
5	A/D and D/A conversion techniques – Basic concepts (D/A :R-2-R only [2L] A/D: successive approximation [2L]) Logic families- TTL, ECL, MOS and CMOS - basic concepts. (2L)	6

Text book and Reference books:

1. Microelectronics Engineering –Sedra & Smith-Oxford.
2. Analog Electronics, A.K. Maini, Khanna Publishing House (AICTE Recommended -2018)
3. Analog Electronics, L.K. Maheswari, Laxmi Publications (AICTE Recommended -2018)
4. Principles of Electronic Devices & circuits—B L Thereja & Sedha—S Chand
5. Digital Electronics – Kharate – Oxford
6. Digital Electronics – Logic & Systems by J.Bigmell & R.Donovan; Cambridge Learning.
7. Digital Logic and State Machine Design (3rd Edition) – D.J.Comer, OUP
8. Electronic Devices & Circuit Theory – Boyelstad & Nashelsky - PHI
9. Bell-Linear IC & OP AMP—Oxford
10. P.Raja- Digital Electronics- Scitech Publications
11. Morries Mano- Digital Logic Design- PHI
12. R.P.Jain—Modern Digital Electronics, 2/e ,McGraw Hill
13. H.Taub & D.Shilling, Digital Integrated Electronics- McGraw Hill.
14. D.RayChaudhuri- Digital Circuits-Vol-I & II, 2/e- Platinum Publishers
15. Tocci, Widmer, Moss- Digital Systems,9/e- Pearson
16. J.Bignell & R.Donovan-Digital Electronics-5/e- Cenage Learning.
17. Leach & Malvino—Digital Principles & Application, 5/e, McGraw Hill
18. Floyed & Jain- Digital Fundamentals-Pearson.

PCC-AIML-301: Data Structure and Algorithms
Lecture per week (L – T): 3-1 Credits: 4

Course Outcomes (COs)

At the end of the course, the students will be able to:

1. **Create and Design** programs using a variety of data structures such as stacks, queues, hash tables, binary trees, heaps, graphs.
2. **Evaluate** and choose appropriate data structures to represent data items in real world.
3. **Analyze** the time and space complexities of algorithms.
4. **Implement and apply** sorting algorithms for problem solving.
5. **Understand** the concept of dynamic memory management.
6. **Identify and remember** user defined data types, linear data structures for solving real world problems.

Prerequisites

- Programming for Problem Solving

Detailed Content:

Module	***Content***	***Hours/ Module***
1	**Introduction:** Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space tradeoff. **Searching:** Linear Search and Binary Search techniques and their complexity analysis.	9
2	**Stacks and Queue:** ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation– Correspondingalgorithmsandcomplexityanalysis.ADTqueue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each type of Queues:	10

	Algorithms and their analysis.	
3	**Linked Lists**: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.	6
4	**Trees**: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. BTree, B+Tree: definitions, algorithms and analysis.	6
5	**Sorting and Hashing**: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing.	6
6	**Graph:** Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.	3

Text book and Reference books:

1) Data Structures and Program Design in C, 2/E by Robert L.Kruse, Bruce P.Leung.
2) Data Structure & Algorithms Using C, 5th Ed., Khanna Publishing House (AICTE Recommended -2018)
3) Fundamentals of Data Structures of C by Ellis Horowitz, Sartaj Sahni, Susan Andersonfreed.
4) Data Structures in C by Aaron M. Tenenbaum.
5) Data Structures by S. Lipschutz.
6) Data Structures Using C by Reema Thareja.
7) Data Structure Using C, 2/e by A.K.Rath, A.K.Jagadev.
8) Introduction to Algorithms by Thomas H.Cormen, Charles E.Leiserson, Ronald L.Rivest, Clifford Stein.
9) Data Structures through C by Yashwant Kanetkar, BPB Publications.
10) Expert Data Structures with C++ by R.BPatel, Khanna Publishing House.

PCC-AIML-302: Computer Organization & Architecture
Contacts: 3L+1T per week Credits: 4

Course Outcomes (COs):

At the end of this course, students will demonstrate the ability to

1. Demonstrate how Computer Systems work & the basic principles
2. Understand Instruction Level Architecture and Instruction Execution
3. Understand the current state of art in memory system design
4. Demonstrate how I/O devices are accessed and its principles.
5. Impart the knowledge on micro programming control unit
6. Understand concepts of pipelining techniques.

Prerequisites:

1. Number Systems
2. Digital Electronics

Detailed Content:

Module	*Content*	*Hours/ Module*
1	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, Concept of operator, operand, registers and storage. Commonly used number systems. Fixed and floating point representation of numbers. Overflow and underflow. Floating point - IEEE 754 standard.	9
2	Fixed point multiplication –Booth's algorithm. Fixed point division - Restoring and non-restoring algorithms. Design of adders – serial adder, ripple carry and carry look-ahead principles. Design of ALU.	7
3	Instruction set architecture: Instruction format. Instruction length. 0-, 1-, 2-, 3-address instructions. Instruction cycle. Instruction sets and addressing modes. Introduction to RISC architectures. RISC vs CISC architectures.	7
4	Memory organization: Performance parameters, Memory unit design with special emphasis on implementation of CPU-memory interfacing. Memory hierarchy, hard disk, static and dynamic memory, associative memory. Cache memory, Virtual memory.	9
5	Design of control unit - hardwired and microprogrammed control. Introduction to instruction pipelining. Throughput and speedup, pipeline hazards.	6
6	I/O operations - Concept of handshaking, Polled I/O, interrupt and DMA.	4

Text book and Reference books:

1. Mano, M.M., "Computer System Architecture", PHI.
2. Behrooz Parhami "Computer Architecture", Oxford University Press
3. Hayes J. P., "Computer Architecture & Organisation", McGraw Hill,
4. Hamacher, "Computer Organisation", McGraw Hill,
5. T.K. Ghosh, "Computer Organization" 2nd Ed., TMH
6. Chaudhuri P. Pal, "Computer Organisation & Design", PHI,
7. P N Basu- "Computer Organization & Architecture", Vikas Pub
8. Rajaraman – "Computer Organization & Architecture", PHI
9. B.Ram – "Computer Organization & Architecture", New Age Publications

BSC-AIML-301: Linear Algebra
Lecture per week (L – T): 3-0 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Formulate** elementary row and column operation.
2. **Evaluate** matrix algebra and related matrices to linear transformation.
3. **Analyze** singular value decomposition.
4. **Solve** systems of linear equations.
5. **Use** matrix algebra and the related matrices to linear transformations.
6. **Understand** the basic ideas of linear mapping.

Prerequisites:

- Mathematics-I
- Mathematics-II

Detailed Content:

Module	***Content***	***Hours/ Module***
1	Systems of linear equations, Matrices, Elementary row operations, Row-reduced echelon matrices. Vector spaces, Subspaces, Bases and dimension, Ordered bases and coordinates.	9
2	Linear transformations, Rank-nullity theorem, Algebra of linear transformations, Isomorphism, Matrix representation, Linear functionals, Annihilator, Double dual, Transpose of a linear transformation.	10
3	Characteristic values and characteristic vectors of linear transformations, Diagonalizability, Minimal polynomial of a linear transformation, Cayley-Hamilton theorem, Invariant subspaces, Direct-sum decompositions, Invariant direct sums, The primary decomposition theorem, Cyclic subspaces and annihilators, Cyclic decomposition, Rational, Jordan forms.	10
4	Inner product spaces, Orthonormal bases, Gram-Schmidt process.	7

Text books and Reference books:

1. E Kreyszig, Advanced Engineering Mathematics, Wiley-India
2. S. K. Mapa, Higher Algebra, Levant Books.
3. Chakravorty and Ghosh, Advanced Higher Algebra, U N Dhar Pvt. Ltd.
4. K.Hoffman and R.Kunze, Linear Algebra, 2nd Edition, Prentice- Hall of India, 2005.
5. M.Artin, Algebra, Prentice-Hall of India, 2005.
6. S.Axler, Linear Algebra Done Right, 2nd Edition, John-Wiley, 1999.
7. S. Lang, Linear Algebra, Springer UTM, 1997.
8. S.Kumaresan, Linear Algebra: A Geometric Approach, Prentice-Hall of India, 2004.
9. Jim Defranza, Daniel Gagliardi, Introduction to Linear Algebra with Application, Tata McGraw-Hill
10. Anton and Rorres, Elementary Linear Algebra, Applications version, Wiley India Edition

HSMC-AIML-301: Economics for Engineers
Contacts: 2L per week Credits: 2

Course Outcomes (COs):

At the end of the course, the students will be able to:

- Evaluate the economic theories, cost concepts and pricing policies.
- Understand the market structures and integration concepts.
- Understand the measures of national income, the functions of banks and concepts of globalization.
- Apply the concepts of financial management for project appraisal.
- Understand accounting systems and analyze financial statements using ratio analysis.
- Understand the impact of inflation, taxation, depreciation. Financial planning, economic basis for replacement, project scheduling, and legal and regulatory issues are introduced and applied to economic investment and project-management problems

Detailed Content:

Module	*Content*	*Hours/ Module*
1	1. Economic Decisions Making – Overview, Problems, Role, Decision making process. 2. 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 – Per Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve, Benefits.	9
2	3. Cash Flow, Interest and Equivalence: Cash Flow – Diagrams, Categories & Computation, Time Value of Money, Debt repayment, Nominal& Effective Interest. 4. 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	5. 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. 6. 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. 7. 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	8. 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. 9. Replacement Analysis - Replacement Analysis Decision Map, Minimum Cost Life of a New Asset, Marginal Cost, Minimum Cost Life Problems. 10. Accounting – Function, Balance Sheet, Income Statement, Financial Ratios Capital Transactions, Cost Accounting, Direct and Indirect Costs, Indirect Cost Allocation.	9

Text books and Reference books:

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. John A. White, Kenneth E. Case, David B. Pratt: Principle of Engineering Economic Analysis, John Wiley
4. Sullivan and Wicks: Engineering Economy, Pearson
5. R.Paneer Seelvan: Engineering Economics, PHI
6. Michael R Lindeburg : Engineering Economics Analysis, Professional Pub

7. Premvir Kapoor, Sociology & Economics for Engineers, Khanna Publishing House (AICTE Recommended Textbook – 2018)

ESC-AIML-391: Digital Electronics Lab
Contacts: 3P per week Credits: 1.5

Course Outcomes (COs):

At the end of this course, students will demonstrate the ability to

1. Acquire knowledge about basics of digital electronics.
2. Explain about how to solve problems related to number systems and Boolean algebra.
3. Identify, analyze and design combinational circuits.
4. Design BCD to Excess-3 and Binary to gray code conversion circuit.
5. Compare various synchronous and asynchronous sequential circuits.
6. Analyze sequential digital circuits like flip-flops, registers, counters.

Laboratory Experiments:	
1	Design a Half Adder and Full Adder using basic gates and verify outputs.
2	Design a Half Subtractor and Full Subtractor circuit using basic gates and verify outputs.
3	Construction of simple Multiplexer circuits using logic gates.
4	Construction of simple De-multiplexer circuits using logic gates.
5	Construction of simple Decoder using logic gates.
6	Construction of simple Encoder using logic gates.
7	Realization of RS / JK / D flip flops using logic gates
8	Design of Shift Register using J-K / D Flip Flop
9	Realization of Synchronous Up/Down counter
10	Design of MOD- N Counter
11	Study of DAC

PCC-AIML-391: Data Structure and Algorithms Lab
Labs per week (P): 3 Credits: 1.5

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Design and solve** programs using a variety of data structures such as stacks, queues, hash tables, binary trees, heaps, graphs.
2. **Evaluate** and choose appropriate data structures to represent data items in real world.
3. **Analyze** the time and space complexities of algorithms.
4. **Implement** sorting and searching algorithms for problem solving.
5. **Understand** the concept of dynamic memory management.
6. **Identify and remember** user defined data types, linear data structures for solving real world problems.

Prerequisites:

- Programming for Problem Solving
- Data Structure and Algorithms

Detailed Content:

1. Implementation of array operations
2. Stacks and Queues: adding, deleting elements Circular Queue: Adding & deleting elements
3. Application of Stack: Expression Evaluation, Expression Conversion
4. Implementation of linked lists: inserting, deleting, and inverting a linked list. Implementation of stacks & queues using linked lists
5. Polynomial addition, Polynomial multiplication
6. Recursive and Non-recursive traversal of Trees
7. Threaded binary tree traversal. AVL tree implementation
8. Implementation of different searching & sorting techniques.

Text book and Reference books:

1) Data Structures and Program Design in C, 2/E by Robert L.Kruse, Bruce P.Leung.
2) Data Structure & Algorithms Using C, 5th Ed., Khanna Publishing House (AICTE Recommended -2018)
3) Fundamentals of Data Structures of C by Ellis Horowitz, Sartaj Sahni, Susan Andersonfreed.
4) Data Structures in C by Aaron M. Tenenbaum.
5) Data Structures by S. Lipschutz.
6) Data Structures Using C by Reema Thareja.
7) Data Structure Using C, 2/e by A.K.Rath, A.K.Jagadev.
8) Introduction to Algorithms by Thomas H.Cormen, Charles E.Leiserson, Ronald L.Rivest, Clifford Stein.
9) Data Structures through C by Yashwant Kanetkar, BPB Publications.
10) Expert Data Structures with C++ by R.BPatel, Khanna Publishing House.

PCC-AIML-392: Computer Architecture Lab
Contacts: 3P per week Credits: 1.5

Course Outcomes:
At the end of this course, students will demonstrate the ability to

- **Summarize** Xilinx/ Altera (VHDL) foundation tools and Hardware Description Language.
- **Demonstrate** different concepts and methods of digital system design techniques through hands-on projects.
- **Build** various combinational and sequential digital systems.
- **Identify** knowledge, techniques required to design, implement and test modern day digital systems.
- **Evaluate** and **interpret** the results of logic and timing simulations.
- **Analyze** digital systems through hands-on experiments on the Xilinx/ Altera tools.

Laboratory Experiments:

1 Write VHDL codes for various logic gates.
2 Using VHDL, design a half adder in data flow model.
3 Using VHDL, design a full adder in data flow model.
4 Using VHDL, design a half subtractor.
5 Using VHDL, design a full subtractor.
6 Using VHDL, design 1-bit comparator.
7 Using VHDL, design 4:1 Multiplexer in data flow model.
8 Using VHDL, design 2:4 Decoder in data flow model.

9 Using VHDL, design 1:4 DEMUX in data flow model.
10 Write VHDL code for basic gates: 2 i/p AND Gate (Multiple Bit Handling)
11 Using VHDL, design 4:1 Multiplexer using when-else structure.
12 Using VHDL, design 2: 4 Decoder using when-case structure.
13 Using VHDL, design 2: 4 Decoder in behavioral model.
14 Write VHDL code for 4-bit Up Counter
15 Write VHDL code for 4-bit Down Counter
16 Write VHDL code for 4-bit Up-Down Counter
17 Using VHDL, design SR-flip flop in behavioral model.
18 Write VHDL code for D Flip Flop
19 Using VHDL, design JK-flip flop in behavioral model.
20 Write VHDL code for T Flip Flop

PCC-AIML-393: IT Workshop (Python)
Labs per week: 3 Credits: 1.5

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Develop** algorithmic solutions to simple computational problems.
2. **Identify** and repair coding errors in a program.
3. **Demonstrate** programs using simple Python statements and expressions**.**
4. **Explain** control flow and functions concept in Python for solving problems**.**
5. **Use** Python data structures – lists, tuples & dictionaries for representing compound data.
6. **Explain** files, exception, modules and packages in Python for solving problems.

Prerequisites:

- Programming for Problem Solving

Detailed Content:

Module	*Content*	*Hours/ Module*
1	**Introduction:** History, Features, Setting up path, Working with Python, Basic Syntax, Variable and Data Types, Operator	3
2	**Conditional Statements:** If, If- else, Nested if-else, Looping, For, While, Nested loops	3
3	**Control Statements:** Break, Continue, Pass	3
4	**String Manipulation:** Accessing Strings, Basic Operations, String slices, Function and Methods	3
5	**Lists:** Introduction, Accessing list, Operations, Working with lists, Function and Methods	3
6	**Tuple:** Introduction, Accessing tuples, Operations, Working, Functions and Methods.	3
7	**Dictionaries:** Introduction, Accessing values in dictionaries, Working with dictionaries, Properties	3
8	**Functions:** Defining a function, Calling a function, Types of functions, Function Arguments, Anonymous functions, Global and local variables	3
9	**Modules:** Importing module, Math module, Random module, Packages, Composition, Input-Output Printing on screen, Reading data from keyboard,	3

	Opening and closing file, Reading and writing files, Functions	
10	**Exception Handling:** Exception, Exception Handling, Except clause, Try abd finally clause, User Defined Exceptions.	3

Laboratory Experiments:	
1	Practical Assignments related with implementation of PCC-AIML-393

Text book and Reference books:

1. Martin C. Brown "Python: The Complete Reference", McGraw Hill Education
2. Reema Thareja., "Python Programming: Using Problem Solving Approach", Oxford University Press.
3. Ashok Namdev Kamthane and Amit Ashok Kamthane, "Programming and Problem Solving with Python", McGraw Hill,
4. Vishwajit K. Barbudhe," Introduction of Python", Notion Press
5. TanejaSheetal and Kumar Naveen, "Python Programming |A modular approach", Pearson Education,

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Semester - IV

ESC-AIML-401: Probability and Statistics
Lecture per week (L – T): 3-0 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Understand basic notions of probability arising in a variety of uncertain situations which are nontraditional in areas of science and engineering.
2. Understand the concepts of Binomial and Poisson distributions – Normal distribution, Exponential distributions, Weibull distribution.
3. Analyze the Random variables, one dimensional Random Variables, Discrete and Continuous RV-Density and Distribution function of RV.
4. Discuss the basic ideas of Statistics.
5. Explain the ideas of Correlation and regression.
6. Illustrate the concepts on Test of Significance, Test of Hypothesis.

Prerequisites:

- Basic Mathematics.

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Probability Theory: Introduction to probability concepts, Random experiments, Events, Conditional probability, Independent events, Theorem of Total Probability, Baye's theorem Sample space	5
2	Random variables (RV):	12

	Introduction to Random variables, - One dimensional Random Variables, Discrete and Continuous RV- Density and Distribution function of RV, Expectation, Variance, and its properties, Covariance, and Moments. Moment Generating function. Special Distributions: Binomial and Poisson distributions – Normal distribution, Exponential distributions, Weibull distribution	
3	Correlation and regression: Two dimensional random variables, Joint distribution and Joint density functions - Marginal, Conditional Distribution and Density functions. Regression and Correlation. – Partial and Multiple Correlation- Multiple Regression.	9
4	Test of Significance: Testing of hypothesis – Introduction - Types of errors, critical region, procedure of testing hypothesis. Large sample tests - Z test for Single Proportion, Difference of Proportion, Single mean and difference of means. Small sample tests - Student's t-test, F-test - Chi-square test - Goodness of fit - Independence of Attributes	10
5	Design of Experiments: Analysis of variance – One and Two way classifications – Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD)	4

Text books and Reference books:

1. Probability and Statistics for engineers and scientists by R.E.Walpole, R.H.Mayers, S.L.Mayers and K.Ye, 9th Edition, Pearson Education (2012).
2. Probability, Statistics and Reliability for Engineers and Scientists by Bilal M. Ayub and Richard H. McCuen, 3rd edition, CRC press (2011).
3. Mathematical Statistics by M. Ray, H S Sharma, and S Chaudhary, RP & Sons Education.
4. Fundamental of Mathematical Statistics by T Veerarajan, Yes Dee Publishing Pvt Ltd.
5. Probability and Statistics for Engineers by R.A.Johnson, Miller & Freund's, 8th edition, Prentice Hall India (2010)

PCC-AIML-401: Object Oriented Programming & Java
Lecture per week (L – T): 3-0 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Create and explain** GUI and thread based application.
2. **Evaluate** the complexity of procedural language by using the concept of polymorphism, inheritance, abstraction, and encapsulation.
3. **Analyze** any real world problem with object oriented approach and formulate a solution for the same.
4. **Implement and apply** object oriented approach to relate to real world problem.
5. **Understand, describe** and illustrate the features of object oriented programming.
6. **Recall** the knowledge of procedural language and map it to paradigm of Object Oriented concept.

Prerequisites:

- Programming for Problem Solving

Detailed Content:

Module	*Content*	*Hours/ Module*
1	**Basics of OOP and Introduction to JAVA:** Properties of object oriented programming language, Object, Class, relationships among objects. Aggregation, Association, Generalization, meta-class. Class, object, message passing, inheritance, encapsulation, polymorphism. Basic concept of JAVA programming– advantages of java, byte-code & JVM, data types, operators, control statements & loops, array, creation of class, object, constructor, finalize and garbage collection.	8
2	**Class & Object proprieties**: Different types of access specifiers, method overloading, this keyword, use of objects as parameter & methods returning objects, call by value & call by reference, static variables, methods and block nested & inner classes, Inbuilt classes like String, Character, StringBuffer, basic string handling concepts, concept of mutable and immutable string. **Reusability properties**: Super class & subclasses including multilevel hierarchy, process of constructor calling in inheritance, use of super and final keywords with super() method, dynamic method dispatch, abstract classes & methods, interfaces. Creation of packages, importing packages, member access for packages, UTIL package.	10
3	**Exception handling and I/O:** Exception handling basics, different types of exception classes, use of try & catch with throw, throws & finally, creation of user defined exception classes. Input Output stream structure, Wrapper class, command line arguments, basics of I/O operations – keyboard input using Buffered Reader& Scanner classes. File copy programming using command line arguments.	6
4	**Multithreading and Applet & Swing Programming**: Basics of multithreading, main thread, thread life cycle, creation of multiple threads, thread priorities, thread synchronization, inter-thread communication, deadlocks for threads, suspending & resuming threads. Introduction to Microservices. Basics of applet programming, applet life cycle, difference between application & applet programming, parameter passing in applets. Basic of swing programming, Difference between applet and swing,	7

Text book and Reference books:

1) Object Oriented Modelling and Design, Rambaugh, James Michael, Blaha, Prentice Hall, India.
2) Object Oriented System Development Ali Bahrami,McGraw Hill.
3) The complete reference-Java2, Patrick Naughton, Herbert Schildt, TMH.
4) Core Java For Beginners, R.KDas,VIKAS PUBLISHING.
5) Java How to Program, Deitel and Deitel, 6th Ed. – Pearson.
6) Beginning Java 2 SDK, IvorHorton's,Wrox.
7) Programming With Java: A Primer,E. Balagurusamy, 3rd Ed.,TMH.

PCC-AIML-402: Formal Language & Automata Theory
Contacts: 3L Credit: 3

Course Outcomes (COs):

After completion of the course, students will be able to:

1. **Design** finite automata to accept a set of strings of a language.
2. For a given language **evaluate** whether the given language is regular or not.
3. **Develop** context free grammars to generate strings of context free language.

4. **Determine** equivalence of languages accepted by Push down Automata and languages generated by context free grammars.
5. **Implement** the hierarchy of formal languages, grammars and machines.
6. **Distinguish** between computability and non-computability and Decidability and undecidability.

Pre-Requisite:

NIL

Detailed Content:

Unit	*Content*	*Hrs/Unit*
1	Introduction: Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages.	6
2	Regular languages and finite automata: Regular expressions and languages, deterministic finite automata (DFA) and equivalence with regular expressions, nondeterministic finite automata(NFA) and equivalence with DFA, regular grammars and equivalence with finite automata, properties of regular languages, pumping lemma for regular languages, minimization of finite automata)	7
	Context-free languages and pushdown automata: Context-free grammars (CFG) and languages (CFL),Chomsky and Greibach normal forms, nondeterministic pushdown automata (PDA) and equivalence with CFG, parse trees, ambiguity in CFG, pumping lemma for context-free languages, deterministic push down automata, closure properties of CFLs.	
	Context-sensitive languages: Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.	
	Turing machines: The basic model for Turing machines (TM), Turing recognizable(recursively enumerable) and Turing-decidable (recursive)languages and their closure properties, variants of Turing machines, nondeterministic TMs and equivalence with deterministic TMs, unrestricted grammars and equivalence with Turing machines, TMs as enumerators	
	Undecidability: Church-Turing thesis, universal Turing machine, the universal and diagonalization languages, reduction between languages and Rice s theorem, undecidable problems about languages	

Text books and reference books:

1. John E. Hopcroft, Rajeev Motwani and Jeffrey D. Ullman, Introduction to Automata Theory, Languages, and Computation, Pearson Education Asia.
2. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theory of Computation, Pearson Education Asia.
3. Dexter C. Kozen, Automata and Computability, Undergraduate Texts in Computer Science, Springer.
4. Michael Sipser, Introduction to the Theory of Computation, PWS Publishing.
5. John Martin, Introduction to Languages and The Theory of Computation, TataMcGraw Hill., PEARSON.
6. Dr. R.B.Patel, Theory of Computation, Khanna Publishing House.

PCC-AIML-403: Design and Analysis of Algorithm

Contacts: 3L + 1T per week Credits: 4

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Prove** the correctness and analyze the running time of the basic algorithms for those classic problems in various domains.
2. **Apply** the algorithms and design techniques to solve problems.
3. **Analyze** the complexities of various problems in different domains.
4. **Apply** design and development principles in the construction of software systems of varying complexity.
5. **Design** and development principles in the construction of software systems of varying complexity.
6. **Adapt** current techniques, skills, and tools necessary for computing practice.

Prerequisites:

- Basics of C programming
- Data Structure and Algorithms

Detailed Content:

Module	***Content***	***Hours/ Module***
1	**Models of computation:** RAM,TM etc. time and space complexity **Asymptotic Notation Big**-O, omega, theta etc.; finding time complexity of well-known algorithms like- heapsort, search algorithm etc. **Algorithm Design techniques** Recursion- Definition, Use, Limitations, Examples: Hanoi problem. Tail Recursion	7
2	**Divide and Conquer** Basic method, use, Examples: Merge sort, Quick Sort, Binary Search, **Dynamic Programming** Basic method, use, Examples: matrix-chain multiplication, All pair shortest paths, single-source shortest path, Travelling Salesman problem	8
3	**Branch and Bound** : Basic method, use, Examples: The 15-puzzle problem **Backtracking :** Basic method, use, Examples: Eight queens problem, Graph coloring problem, Hamiltonian problem	6
4	**Greedy Method :** Basic method, use, Examples: Knapsack problem, Job sequencing with deadlines, minimum spanning tree (Prim's and Kruskal's algorithms) **Lower Bound Theory:** Bounds on sorting and sorting techniques using partial and total orders. **Disjoint Set Manipulation:** Set manipulation algorithm like UNION-FIND, union by rank, Path compression	7
5	**Properties of graphs and graph traversal algorithms :**BFS and DFS **Matrix manipulation algorithms:** Different types of algorithms and solution of simultaneous equations, DFT & FFT algorithm; integer multiplication schemes	6
6	**Notion of NP-completeness:** P class, NP-hard class, NP-complete class, Circuit Satisfiability problem, Clique Decision Problem. **Approximation algorithms:** Necessity of approximation scheme, performance guarantee, Polynomial time	6

	approximation schemes: 0/1 knapsack problem.	

Text book and Reference books:

1. A. Aho, J. Hopcroft and J.Ullman "The Design and Analysis of algorithms"
2. D.E.Knuth "The Art of Computer Programming", Vol. I & Vol.2
3. Horowitz Ellis, Sahani Sartaz, R. Sanguthevar "Fundamentals of Computer Algorithms".
4. Goodman: Introduction to Design and Analysis of Algorithms, TMH.
5. K.Mehlhorn, "Data Structures and algorithms- Vol. I & Vol. 2"
6. S. Baase "Computer algorithms"
7. E.M.Reingold, J.Nievergelt and N.Deo- "Combinational algorithms- Theory and Practice", Prentice Hall, 1997
8. A.Borodin and I.Munro, "The computational complexity of Algebraic and Numeric problems"

ESC-AIML-402: Signals and Systems
Contacts: 3L per week Credits: 3

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Analyze different types of signals
- Represent continuous and discrete systems in time and frequency domain using different transforms
- Analyse systems in complex frequency domain.
- Understand sampling theorem and its implications.
- Investigate whether the system is stable
- Sampling and reconstruction of a signal

Prerequisites:

- Linear Algebra

Detailed Content:

Module	***Content***	***Hours/ Module***
1	Signals and systems as seen in everyday life, and in various branches of engineering and science. Energy and power signals, continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability.	5
2	Linear shift-invariant (LSI) systems, impulse response and step response, convolution, input output behavior with aperiodic convergent inputs. Characterization of causality and stability of linear shift-invariant systems. System representation through differential equations and difference equations.	6
3	Periodic and semi-periodic inputs to an LSI system, the notion of a frequency response and its relation to the impulse response, Fourier series representation, the Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem. The idea of signal space and orthogonal bases	7

4	The Laplace Transform, notion of eigen functions of LSI systems, a basis of eigen functions, region of convergence, poles and zeros of system, Laplace domain analysis, solution to differential equations and system behavior. The z-Transform for discrete time signals and systems- eigen functions, region of convergence, z-domain analysis.	8
5	State-space analysis and multi-input, multi-output representation. The state-transition matrix and its role. The Sampling Theorem and its implications- Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold, and so on. Aliasing and its effects. Relation between continuous and discrete time systems.	6

Text book and Reference books:

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Prentice Hall, 1983.
2. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall, 1998.
3. Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980.
4. B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, c1998.
5. Douglas K. Lindn, "Introduction to Signals and Systems", McGraw Hill International Edition: c1999.
6. Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited, c1998.
7. Robert A. Gabel, Richard A. Roberts, "Signals and Linear Systems", John Wiley and Sons, 1995.
8. M. J. Roberts, "Signals and Systems - Analysis using Transform methods and MATLAB", TMH, 2003.
9. J. Nagrath, S. N. Sharan, R. Ranjan, S. Kumar, "Signals and Systems", TMH New Delhi, 2001.
10. Ashok Ambardar,"Analog and Digital Signal Processing", 2nd Edition, Brooks/ Cole Publishing Company (An international Thomson Publishing Company), 1999.

MC-AIML-401: Environmental Sciences
Contacts: 2L per week Credits: 0

Course Outcomes (COs):

At the end of this course, students will demonstrate the ability to

- Acquire fundamental knowledge of different aspects of environment and local, regional and global environmental problems.
- Get the information about ecosystem and also about its functions like Food chain, Ecological pyramids etc.
- Obtain the knowledge about the different types of resources like land, water, mineral and energy and also about the effects of environment by the usage of these resources.
- Gain the knowledge about the ecosystem diversity, its values and also about the importance of the endemic species and different techniques involved in its conservation.
- Gain the knowledge about the different types of pollutions and their control technologies, Waste water treatment, Bio medical waste management etc.,
- Acquire the complete information about EIA- Environmental Impact Assessment, Sustainable developmental activities, environmental policies and regulations, awareness among people about protection of wild life, forest and other natural resources.

Prerequisites:

- Basics of Chemistry

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Basic ideas of environment, basic concepts, man, society & environment, their interrelationship (1L) Mathematics of population growth and associated problems, Importance of population study in environmental engineering, definition of resource, types of resource, renewable, non-renewable, potentially renewable, effect of excessive use vis-à-vis population growth, Sustainable Development. (2L) Materials balance: Steady state conservation system, steady state system with non-conservative pollutants, step function. (1L) Environmental degradation: Natural environmental Hazards like Flood, earthquake, Landslide-causes, effects and control/management; Anthropogenic degradation like Acid rain-cause, effects and control. Nature and scope of Environmental Science and Engineering. (2L)	6
2	Elements of ecology: System, open system, closed system, definition of ecology, species, population, community, definition of ecosystem- components types and function. (1L) Structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems, Mangrove ecosystem (special reference to Sundarban); Food chain [definition and one example of each food chain], Food web.(2L) Biogeochemical Cycle- definition, significance, flow chart of different cycles with only elementary reaction [Oxygen, carbon, Nitrogen, Phosphate, Sulphur]. (1L) Biodiversity- types, importance, Endemic species, Biodiversity Hot-spot, Threats to biodiversity, Conservation of biodiversity.(2L)	6
3	Atmospheric Composition: Troposphere, Stratosphere, Mesosphere, Thermosphere, Tropopause and Mesopause. (1L) Energy balance: Conductive and Convective heat transfer, radiation heat transfer, simple global temperature model [Earth as a black body, earth as albedo], Problems.(1L) Green house effects: Definition, impact of greenhouse gases on the global climate and consequently on sea water level, agriculture and marine food. Global warming and its consequence, Control of Global warming. Earth's heat budget.(1L) Lapse rate: Ambient lapse rate Adiabatic lapse rate, atmospheric stability, temperature inversion (radiation inversion).(2L) Atmospheric dispersion: Maximum mixing depth, ventilation coefficient, effective stack height, smokestack plumes and Gaussian plume model.(2L) Definition of pollutants and contaminants, Primary and secondary pollutants: emission standard, criteria pollutant. Sources and effect of different air pollutants Suspended particulate matter, oxides of carbon, oxides of nitrogen, oxides of sulphur, particulate, PAN. (2L) Smog, Photochemical smog and London smog. Depletion Ozone layer: CFC, destruction of ozone layer by CFC, impact of other green-house gases, effect of ozone modification. (1L) Standards and control measures: Industrial, commercial and residential air quality standard, control measure (ESP. cyclone separator, bag house, catalytic converter, scrubber (ventury), Statement with brief reference). (1L)	11
4	Hydrosphere, Hydrological cycle and Natural water. Pollutants of water, their origin and effects: Oxygen demanding wastes, pathogens, nutrients, Salts, thermal application, heavy metals, pesticides, volatile organic compounds. (2L) River/Lake/ground water pollution: River: DO, 5-day BOD test, Seeded BOD test, BOD reaction rate constants, Effect of oxygen demanding wastes on river [deoxygenation, reaeration], COD, Oil, Greases, pH. (2L) Lake: Eutrophication [Definition, source and effect]. (1L) Ground water: Aquifers, hydraulic gradient, ground water flow (Definition only)(1L) Standard and control: Waste water standard [BOD, COD, Oil, Grease], Water Treatment system [coagulation and flocculation, sedimentation and filtration, disinfection, hardness and alkalinity, softening] Waste water treatment system, primary and secondary treatments [Trickling filters, rotating biological contractor, Activated sludge, sludge treatment,	9

	oxidation ponds] tertiary treatment definition. (2L) Water pollution due to the toxic elements and their biochemical effects: Lead, Mercury, Cadmium, and Arsenic (1L)	
5	Lithosphere; Internal structure of earth, rock and soil (1L) Solid Waste: Municipal, industrial, commercial, agricultural, domestic, pathological and hazardous solid wastes; Recovery and disposal method- Open dumping, Land filling, incineration, composting, recycling. Solid waste management and control (hazardous and biomedical waste).(2L)	3
6	Definition of noise, effect of noise pollution, noise classification [Transport noise, occupational noise, neighbourhood noise] (1L) Definition of noise frequency, noise pressure, noise intensity, noise threshold limit value, equivalent noise level, L10 (18hr Index) ,n Ld.Noise pollution control. (1L)	3
7	Environmental impact assessment, Environmental Audit, Environmental laws and protection act of India, Different international environmental treaty/ agreement/ protocol. (2L)	2

Text book and Reference books:

1. M.P. Poonia & S.C. Sharma, Environmental Studies, Khanna Publishing House (AICTE Recommended Textbook – 2018)
2. Masters, G. M., "Introduction to Environmental Engineering and Science", Prentice-Hall of India Pvt. Ltd., 1991.
3. De, A. K., "Environmental Chemistry", New Age International

PCC-AIML-491: Object Oriented Programming & Java Lab
Lab per week (P): 3 Credits: 1.5

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Create** multithreaded programs.
2. **Evaluate** the complexity of procedural language by using the concept of polymorphism, inheritance, abstraction, and encapsulation.
3. **Experiment** any real world problem with object oriented approach and formulate a solution for the same.
4. **Implement and apply** object oriented approach to relate to real world problem.
5. **Understand** and develop graphical user interface using AWT.
6. **Recall** the knowledge of event handling mechanism.

Prerequisites:

- Programming for Problem Solving
- Object Oriented Programming & Java

Detailed Content:

- Implement all problems abiding by features of object oriented programming (Abstraction, Encapsulation, Reusability, Data Hiding, Generalization, and Specialization.)
- Familiarization on object oriented approach of programming: use of class, object, and reference.
- Use of constructor, static, final, array, date, access specifiers.
- Familiarization with String, StringBuffer, ArrayList and LinkedList classes.
- Familiarization on Inheritance and Dynamic Method Dispatch.
- Familiarization on Abstract Class, Interface and Package Java Exception Handling.

- Familiarization on Java IO using Scanner, BufferedReader, PrintWriter. File handling in Java.
- Exploring Java multithreading concept.
- Familiarization on Java Applet, AWT Event Handling.
- Basics of Java Swing: Different Layouts, Event Handling.

Text books and Reference books:

1) Object Oriented Modelling and Design, Rambaugh, James Michael, Blaha, Prentice Hall, India.
2) Object Oriented System Development Ali Bahrami, McGraw Hill.
3) The complete reference-Java2, Patrick Naughton, Herbert Schildt, TMH.
4) Core Java For Beginners, R.KDas, VIKAS PUBLISHING.
5) Java How to Program, Deitel and Deitel, 6th Ed. – Pearson.
6) Beginning Java 2 SDK, IvorHorton's, Wrox.
7) Programming With Java: A Primer,E. Balagurusamy,3rd Ed., TMH.

PCC-AIML-492: Design and Analysis of Algorithm Lab
Lab per week (P): 3 Credits: 1.5

Course Outcomes (COs):

After completion of this course, the students are able to:

1) **Solve** problems by applying appropriate algorithms.
2) **Analyze** the efficiency of various algorithms.
3) **Apply** techniques of stacks and queues to solve problems.
4) **Develop** a program that can be solved in many ways using different techniques.
5) **Identify** and evaluate complex problems using principles of mathematics and engineering science
6) **Design** a novel solution for real life problem

Prerequisites:

- Basics of C programming
- Data Structure and Algorithms

Lab Experiments List:

1. Design, develop and implement the specified algorithms for the following problems using C/C++ Language in LINUX environment.
2. Write a C/C++ program to sort the elements by using quick sort method.
3. Write a C/C++ program to sort the elements by using merge sort method.
4. Obtain the Topological ordering of vertices in a given digraph.
5. From a given vertex in a weighted connected graph, find shortest paths to other vertices using Dijkstra'salgorithm.
6. Implement 0/1 Knapsack problem using Dynamic Programming.
7. Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's algorithm.
8. Find Minimum Cost Spanning Tree of a given undirected graph using Prim's algorithm.
9. Compute the transitive closure of a given directed graph using Warshall's algorithm.
10. Implement All-Pairs Shortest Paths Problem using Floyd's algorithm.
11. Print all the nodes reachable from a given starting node in a digraph using BFS method.
12. Check whether a given graph is connected or not using DFS method.
13. Implement N Queen's problem using Back Tracking

Text/ Reference Books:

1. Anany Levitin: "Introduction to the Design and Analysis of Algorithms", Pearson Education, Delhi, 2nd Edition, 2007, ISBN: 9780321358288.
2. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran: "Fundamentals of Computer Algorithms", Universities Press, Hyderabad, 2nd Edition, 2007, ISBN-10: 8173716129.

E-Resources:

1. http://cs.gmu.edu/~pwiegand/cs483-Spring06/lecturenotes/cs483-l1pf.pdf
2. http://www.cs.cornell.edu/~kozen/papers/daa.pdf

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Semester - V

BSC-AIML-501: Discrete Mathematics
Lecture per week (L – T): 3-0 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Apply mathematical logic to solve problems.
2. Understand sets, relations, functions and discrete structures.
3. Use logical notations to define and reason about fundamental mathematical concepts such as sets relations and functions.
4. Identify functions and determine their properties.
5. Formulate problems and solve recurrence relations.
6. Model and solve real world problems using graphs and trees.

Prerequisites:

1. Basic Mathematics
2. Probability and Statistics

Detailed Content:

Module No	*Content*	*Hours/ Module*
1	Introduction: Objective, scope and outcome of the course.	1
2	Set Theory: Definition of sets, countable and uncountable sets, Set operations, Partition of set, Cardinality (Inclusion-Exclusion & Addition Principles) 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, Job- Scheduling problem. Function: Definition, type of functions, one to one, into and onto function, inverse function, composition of functions, recursively defined functions, pigeonhole principle. Theorem proving Techniques: Mathematical induction, Proof by contradiction. Composition of Functions. The Pigeonhole and Generalized Pigeonhole Principles.	8
3	Propositional Logic: Proposition, First order logic, Basic logical operation, truth tables, tautologies, Contradictions, Algebra of Proposition, logical implications,	6

	logical equivalence, predicates, Normal Forms, Universal and existential quantifiers. 2-way predicate logic. Introduction to finite state machine Finite state machines as models of physical system equivalence machines, Finite state machines as language recognizers.	
4	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. Combinatorics: Introduction, Permutation and combination, Binomial Theorem, Multimodal Coefficients Recurrence Relation and Generating Function: Introduction to Recurrence Relation and Recursive algorithms, linear recurrence relations with constant coefficients, Homogeneous solutions, Particular solutions, Total solutions, Generating functions, Solution by method of generating functions.	6
5	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.	5
6	Graph Theory: Introduction and basic terminology of graphs, Planer graphs, Multigraphs and weighted graphs, Isomorphic graphs, Paths, Cycles and connectivity, Shortest path in weighted graph, Introduction to Eulerian paths and circuits, Hamiltonian paths and circuits, Graph colouring, chromatic number, Isomorphism and Homomorphism of graphs, matching, vertex/edge covering.	6
	Total	32

Text/Reference Books:

1. Discrete Mathematics with Applications, Koshy,Elsevier
2. Discrete Mathematical Structures ByLipshutz& Lipson, TMH
3. Discrete Mathematical Structures, Kolmanet.al,Pearson
4. Fundamentals of Discrete Mathematical Structures, K R Chowdhary, 3ed, PHI

PCC-AIML-501: Operating System
Contacts: 3L per week Credits: 3

Course Outcomes:
At the end of this course, students will demonstrate the ability to

- Understand the mechanisms of OS to handle processes and threads and their communication
- Develop algorithms for process scheduling for a given specification of CPU utilization, Throughput, Turnaround Time, Waiting Time, Response Time.
- Demonstrate the mechanisms involved in memory management in contemporary OS
- Understand the components and management aspects of concurrency management
- Develop the techniques for optimally allocating memory to processes by increasing memory utilization and for improving the access time.
- Design and implement file management system.

Prerequisites:

- Digital Electronics
- Computer Organization & Architecture
- Programming Concepts

Detailed Content:

Module	*Content*	*Hours/ Module*
1	**Introduction:** Concept of Operating Systems, Generations of Operating systems, Types of Operating Systems, OS Services, System Calls, Structure of an OS - Layered, Monolithic, Microkernel Operating Systems, Concept of Virtual Machine. Case study on UNIX and WINDOWS Operating System.	3
2	**Processes:** Definition, Process Relationship, Different states of a Process, Process State transitions, Process Control Block (PCB), Context switching **Thread:** Definition, Various states, Benefits of threads, Types of threads, Concept of multithreads, **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; Multiprocessor scheduling: Real Time scheduling: RM and EDF.	8
3	**Inter-process Communication:** Critical Section, Race Conditions, Mutual Exclusion, Hardware Solution, Strict Alternation, Peterson's Solution, The Producer-Consumer Problem, Semaphores, Event Counters, Monitors, Message Passing, Classical IPC Problems: Reader's & Writer Problem, Dinning Philosopher Problem etc.	6
4	**Deadlocks:** Definition, Necessary and sufficient conditions for Deadlock, Deadlock Prevention, Deadlock Avoidance: Banker's algorithm, Deadlock detection and Recovery.	4
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: Principle of operation – Page allocation – Hardware support for paging, Protection and sharing, Disadvantages of paging. **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), Second Chance (SC), Not recently used (NRU) and Least Recently used (LRU).	8
6	**I/O Hardware:** I/O devices, Device controllers, Direct memory access Principles of I/O Software: Goals of Interrupt handlers, Device drivers, Device independent I/O software, Secondary-Storage Structure: Disk structure, Disk scheduling algorithms **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), efficiency and performance. **Disk Management:** Disk structure, Disk scheduling - FCFS, SSTF, SCAN, C-SCAN, Disk reliability, Disk formatting, Boot-block, Bad blocks	6

Text book and Reference books:

1. Operating System Concepts Essentials, 9th Edition by Avi Silberschatz, Peter Galvin, Greg Gagne, Wiley Asia Student Edition.
2. Operating Systems: Internals and Design Principles, 5th Edition, William Stallings, Prentice Hall of India.
3. Operating System: A Design-oriented Approach, 1st Edition by Charles Crowley, Irwin Publishing
4. Operating Systems: A Modern Perspective, 2nd Edition by Gary J. Nutt, Addison-Wesley

5. Design of the Unix Operating Systems, 8th Edition by Maurice Bach, Prentice-Hall of India
6. Understanding the Linux Kernel, 3rd Edition, Daniel P. Bovet, Marco Cesati, O'Reilly and Associates

PCC-AIML-502: Database Management Systems
Contacts: 3L per week Credits: 3

Course Outcomes (COs):

On completion of the course students will be able to:

1. Describe the fundamental elements of relational database management systems
2. Explain the basic concepts of relational data model, entity-relationship model, relational database design, relational algebra and SQL.
3. Design ER-models to represent simple database application scenarios
4. Convert the ER-model to relational tables, populate relational database and formulate SQL queries on data.
5. Improve the database design by normalization.
6. Understand the basic database storage structures and access techniques: file and page organizations, indexing methods including B tree, and hashing.

Prerequisites:
NIL

Detailed Content:

Unit	Content	Hrs/ Unit
1	**Database system architecture:** Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML). Data models: Entity-relationship model, network model, relational and object oriented data models, integrity constraints, data manipulation operations.	9
2	**Relational query languages**: Relational algebra, Tuple and domain relational calculus, SQL3, DDL and DML constructs, Open source and Commercial DBMS - MYSQL,ORACLE, DB2, SQL server. Relational database design: Domain and data dependency, Armstrong's axioms, Normal forms, Dependency preservation, Lossless design. Query processing and optimization: Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimization algorithms.	13
3	**Storage strategies:** Indices, B-trees, hashing.	3
4.	**Transaction processing:** Concurrency control, ACID property, Serializability of scheduling, Locking and timestamp based schedulers, Multi-version and optimistic Concurrency Control schemes, Database recovery.	5
5	**Database Security**: Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection, SQL injection.	3
6	**Advanced topics:** Object oriented and object relational databases, Logical databases, Web databases, Distributed databases, Data warehousing and data mining.	3

Text book and Reference books:

1. "Database System Concepts", 6th Edition by Abraham Silberschatz, HenryF. Korth, S. Sudarshan, McGraw-Hill.
2. "Principles of Database and Knowledge – Base Systems", Vol 1 by J. D. Ullman, Computer Science Press.
3. "Database Management Systems", R.P. Mahapatra, Khanna Publishing House, NewDelhi (AICTE Recommended Textbook – 2018)
4. "Fundamentals of Database Systems", 5th Edition by R. Elmasri and S. Navathe, Pearson Education
5. "Foundations of Databases", Reprint by Serge Abiteboul, Richard Hull, Victor Vianu, Addison-Wesley

PCC-AIML-503: Machine Learning Foundation
Lecture per week: 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Develop** an appreciation for what is involved in learning models from data.
2. **Understand** a wide variety of learning algorithms.
3. **Understand** how to evaluate models generated from data.
4. **Apply** the algorithms to a real problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.
5. **Understand** the foundation of generative models.
6. **Understand** algorithms for learning Bayesian networks.

Prerequisites:

- Design and Analysis of Algorithm
- Probability and Statistics

Detailed Content

Module	***Content***	***Hours/ Module***
1	**Introduction to Machine Learning** Classical machine vs Adaptive Machine, Different Learning strategies, Supervised, Unsupervised, Semi Supervised, Reinforcement learning, Transfer learning (TL). Basic of Training and Testing Phase Training and testing data, Over fitting and Under fitting	4
2	**Feature Selection Techniques** Filter Methods- Information gain, Chi-Square test, Correlation and coefficient. Wrapper methods- Recursive feature elimination, Genetic Algorithm. Embedded method- Decision trees Principal Component Analysis (PCA)	3
3	**Regression Analysis** Dependent vs Independent variable. Introduction, Confusion Matrix, Curse Of	7

	Dimensionality, Managing Missing Features, Managing Categorical Data. Explain Linear regression, Logistic regression,Polynomial regression, Ridge regression, Lasso regression, Elastic Net regression	
4	**Classification** Binary vs Multiclass Classification, K Nearest Neighbor (kNN), Conditional Probability, Bayes Theorem. Naive Bayes Classifier. Naive Bayes Variants: Bernoulli Naive Bayes, Multinomial Naive Bayes, Gaussian Naive Bayes. Support Vector Machine (SVM), Non-Linear Support Vector Machine (SVM) And Kernel Function. Decision Tree Algorithm, Random Forest (RF), ROC Curve.	8
5	**Clustering** K-means Clustering, DBSCAN, Hierarchical Clustering : Agglomerative Clustering and Divisive Clustering	4
6	**Ensemble Learning** Ensemble Method: Bagging (Bootstrap Aggregation), Boosting, Voting Classifier: Hard Voting and Soft Voting.	3
7	Gradient Descent Algorithm, Introduction of Back Propagation Algorithm. Artificial Neural Network, Recurrent Neural Network (RNN)	3

Text book and Reference books:

1. Tom M. Mitchell, Machine Learning, McGraw Hill Education.
2. Jeeva Jose, Introduction to Machine Learning, Khanna Book Publishing.
3. Saikat Dutta, Subramanian Chandramouli, Machine Learning, Pearson Education.
4. ShaiShalev-Shwartz, Shai Ben-David, Understanding Machine Learning: From Theory To Algorithms, Cambridge University Press.
5. S. Rogers and M. Girolami, A first course in Machine Learning, CRC Press, 2011.

PCC-AIML-504: Computer Networks
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Design and investigate** why network needs flow control and error control techniques.
2. **Evaluate** the performance of the different routing protocol (RIP, OSPF) based on routing cost, convergence rate and complexity to find the shortest path.
3. **Analyze** the pieces of hardware (hub, bridge, switch, router) to make networks more efficient, faster, more secure, easier to use, able to transmit several simultaneous messages, and able to interconnect with other networks.
4. **Demonstrate** different LLC protocols, Internet Protocol, and usage of the IP address and subnet mask to setup a network.
5. **Understand** various techniques (open loop and close loop) used for congestion control and quality of service (traffic scheduling and shaping).
6. **Identify and remember** importance of existing protocols (DNS, DHCP, FTP, WWW, HTTP) running in application layer.

Prerequisites:

- Programming for Problem Solving
- Data Structure and Algorithms
- Computer Organization & Architecture

Detailed Content:

Module	*Content*	*Hours/ Module*
1	**Introduction:** Data communications, Direction of data flow - Simplex, Half-duplex, Full-duplex, Topology –Bus, Ring, Mesh. Star & Hybrid, Types of Network - LAN, MAN 7 WAN, Protocols, and Reference models – OSI & TCP/IP reference model & comparative study.	5
2	**Physical Layer:** Transmission media - Guided & Unguided, Switching – Circuit, Packet & Message, Telephone Network, Network Devices: Repeaters, Hubs, Bridges, Switches, Router and Gateway. **Data link Layer:** Types of Errors, Error Detection – Parity, CRC & Checksum, Error Correction – Hamming Code	6
3	**Data Link Layer and MAC Sublayer**: Flow Control – Stop-n-Wait & Sliding Window Protocol, ARQ Techniques – Stop-n-Wait, Go-Back- N & Selective Repeat, Framing, Bit & Byte Oriented Protocol, HDLC, Point to Point Protocol (PPP), Token Ring, FDDI and Ethernet Protocols, Reservation, Polling, Multiple access protocols - Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA.	8
4	**Network Layer**: Internet Protocol (IP), IPv4 vs IPv6, ARP & RARP, IP Addressing – Classful & Classless, Subnetting, VLSM, CIDR. Routing - Techniques, Static, Dynamic & Default Routing, Unicast Routing Protocols - RIP, OSPF, BGP.	5
5	**Transport Layer**: Process to Process delivery; UDP; TCP; Congestion Control - Open Loop, Closed Loop, Quality of service, Techniques to improve QoS - Leaky bucket & Token bucket algorithm.	4
6	**Application Layer Protocols**: DNS, SMTP, FTP & DHCP. **Modern Topic**: Introduction to wireless LAN and Bluetooth, Mobile IP, Mobile TCP.	4

Text book and Reference books:

1) Computer Networks (4th Ed.) – A. S. Tanenbaum –Pearson Education/PHI
2) Data Communications and Networking (3rd Ed.) – B. A. Forouzan –TMH
3) Data and Computer Communications (5th Ed.) – W. Stallings –PHI/ Pearson Education
4) Computer Networking -A top down approach featuring the internet– Kurose and Rose –Pearson Education
5) Internetworking with TCP/IP, vol. 1, 2, 3(4th Ed.) – Comer –Pearson Education/PHI

PCC-AIML-505: Artificial Intelligence
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Understand the various searching techniques, constraint satisfaction problem and example problems-game playing techniques.
2. Apply these techniques in applications which involve perception, reasoning and learning.

3. Explain the role of agents and how it is related to environment and the way of evaluating it and how agents can act by establishing goals.
4. Acquire the knowledge of real-world Knowledge representation.
5. Analyze and design a real-world problem for implementation and understand the dynamic behaviour of a system.
6. Use different machine learning techniques to design AI machine and enveloping applications for real world problems.

Prerequisites:

1. Data Structures
2. Probability

Detailed Content:

MODULE NO	*CONTENT*	*HOURS/ MODULE*
1	Introduction: Objective, scope and outcome of the course	1
2	Meaning and definition of artificial intelligence, Physical Symbol System Hypothesis, production systems, Characteristics of production systems; Breadth first search and depth first search techniques. Heuristic search Techniques: Hill Climbing, Iterative deepening DFS, bidirectional search. Analysis of search methods. A* algorithm, and their analysis. Introduction to Genetic Algorithms.	6
3	Knowledge Representation, Problems in representing knowledge, knowledge representation using propositional and predicate logic, logical consequences, syntax and semantics of an expression, semantic Tableau. Forward and backward reasoning. Proof methods, substitution and unification, conversion to clausal form, normal forms, resolution, refutation, deduction, theorem proving, in refencing, monotonic and non-monotonic reasoning. Introduction to prolog.	8
4	Network-based representation and reasoning, Semantic networks, Conceptual Graphs, frames. Description logic (DL), concept language, reasoning using DL. Conceptual dependencies (CD), scripts, reasoning using CD. Introduction to natural language processing.	6
5	Adversarial search and Game theory, classification of games, game playing strategies, prisoner's Dilemma. Game playing techniques, minimax procedure, alpha-beta cut-offs. Complexity of alpha-beta search. Automated planning, classical planning problem, forward planning, partial order planning, planning with proposal logic, hierarchical task planning, multiagent planning	7
6	Reasoning in uncertain environments, Fuzzy logic, fuzzy composition relation, operations on fuzzy sets. Probabilistic reasoning, Bayes theorem, construction of Bayesian networks, belief propagation. Markov processes and Hidden Markov models	6
	Total	34

Text/Reference Books:

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

PCC-AIML-591: Operating System Lab
Contacts: 3P per week Credits: 1.5

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Demonstrate shell programming which include shell scripts and explaining shell syntax (variables, conditions, control structure, and functional commands).
- Execute programs like, creating a new process, creating orphan process and zombie process, synchronizing parent and child process.
- Analyze synchronization of co-operating processes with semaphore (semctl(), semget(), semop(), set semvalue, del semvalue, semaphore p and semaphore v).
- Adapt concept of signals with sending signals, signal interface, and signal handling.
- Apply POSIX threads using pthread_create, pthread_join and pthread_exit.
- Understand Inter-Process Communication (IPC) with use of pipes, message queue etc.

Detailed Content:

Module	***Content***	***Hours/ Module***
1	**Shell programming**: creating a script, making a script executable, shell syntax (variables, conditions, control structures, functions, commands).	3
2	**Process**: starting new process, replacing a process image, duplicating a process image, waiting for a process, zombie process.	2
3	**Signal**: signal handling, sending signals, signal interface, signal sets.	3
4	**Semaphore**: programming with semaphores (use functions semctl, semget, semop, set_semvalue, del_semvalue, semaphore_p, semaphore_v).	2
5	**POSIX Threads**: programming with pthread functions(viz. pthread_create, pthread_join, pthread_exit, pthread_attr_init, pthread_cancel)	3
6	**Inter-process communication**: pipes(use functions pipe, popen, pclose), named pipes(FIFOs, accessing FIFO)	3

Text and Reference Books:

1. UNIX Shell Programming by Yashavant Kanetkar, BPB Publication
2. UNIX: Concepts and Applications, 4th Edition by Sumitabha Das, McGraw Hill
3. UNIX and Shell Programming by Forouzan & Gilberg

PCC-AIML-592: **Database Management System Lab**
Contacts: 3P per week Credits: 1.5

Course Outcomes (COs):

At the end of the course the students are able to:

1. **Apply** the basic concepts of Database Systems and Applications.
2. **Define** the basics of SQL and construct queries using SQL in database creation and interaction.
3. **Design** a commercial relational database system (Oracle, MySQL) by writing SQL using the system.
4. **Analyze** and Select storage and recovery techniques of database system.
5. **Understand** various advanced queries execution such as relational constraints, joins, set operations, aggregate functions, trigger, views and embedded SQL.

6. **Construct** various software to design and build ER Diagrams, UML, Flow chart for related database systems.

Prerequisites:

- Data Base Management Systems

Detailed Content:

Laboratory Experiments:
Structured Query Language **1. Creating Database** • Creating a Database • Creating a Table • Specifying Relational Data Types • Specifying Constraints • Creating Indexes **2. Table and Record Handling** • INSERT statement • Using SELECT and INSERT together • DELETE, UPDATE, TRUNCATE statements • DROP, ALTER statements **3. Retrieving Data from a Database** • The SELECT statement • Using the WHERE clause • Using Logical Operators in the WHERE clause Using IN, BETWEEN, LIKE , ORDER BY, GROUP BY and HAVING Clause • Using Aggregate Functions • Combining Tables Using JOINS • Subqueries **4. Database Management** • Creating Views • Creating Column Aliases • Creating Database Users • Using GRANT and REVOKE **5. Cursors in Oracle PL / SQL** **6. Writing Oracle PL / SQL Stored Procedures**

PCC-AIML-593: Machine Learning Foundations Lab
Labs per week: 3 Credits: 1.5

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Recognize the characteristics of machine learning that make it useful to real-world problems.
2. Implement machine learning algorithms using toolboxes.
3. Develop suitable machine learning model for real life problem solving.
4. Analyze the performance of different classifiers.
5. Analyze the performance of different clustering algorithms.
6. Evaluate the machine learning models pre-processed through various feature engineering algorithms by python programming.

Prerequisites:

- IT Workshop (Python)

Detailed Content:

List of Assignments:

Lab 1: Write a program to demonstrate the working of Decision Tree algorithms. Use an appropriate dataset for building the decision trees and apply this knowledge to classify a new sample.
Lab 2: Write a program to demonstrate the working of Support Vector Machine (SVM) algorithms. Use an appropriate dataset and apply this knowledge to classify a new sample.
Lab 3: Write a program to implement k-Nearest Neighbor algorithm to classify a real life dataset. Print both correct and wrong predictions. Python ML library classes may be used for this problem.
Lab 4: Write a program to implement Random Forest algorithm to classify real life dataset.
Lab 5: Write a program to implement Naïve Bayes algorithm in real life dataset classification.
Lab 6: Write a program to implement K-means algorithm on real life dataset.
Lab 7: Write a program to implement linear and Logistic Regression in real life dataset.
Lab 8: Write a python program to implement Deep Learning in real life dataset.
Lab 9: Write a python program to implement PCA in real life dataset.
Lab10**:** Implementation of Artificial Neural Network.

Text book and Reference books:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009.
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.
4. Tom M. Mitchell, Machine Learning, McGraw-Hill, 1997.

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Semester - VI

PCC-AIML-601: Machine Learning Applications
Lectures per week: 2 Credits: 2

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Describe** few Machine Learning systems like recommendation systems, social graph mining.

2. **Implement** ML algorithms to solve real world problems.
3. **Compare** different solutions for a given problem in the context of performance.
4. **Design** a machine learning system by incorporating various components of ML and evaluate the performance.
5. **Develop** machine learning model for bio informatics.
6. **Understand** the concept of Hidden Markov model.

Prerequisites:

- Machine Learning Foundations

Detailed Content:

Module	***Content***	***Hours/ Module***
1	Review of machine learning Concepts, Design of ML system – Model selection, bias, variance, learning curves, and error analysis	4
2	Recommendation Systems – Model for Recommendation Systems, Utility Matrix, Content- Based Recommendations, Discovering Features of Documents, Collaborative Filtering.	5
3	Mining Social network graphs – Clustering of Social Network Graphs, Partitioning of Graphs, and Finding Overlapping Communities	5
4.	Application of Machine learning algorithms in Bio- Informatics. Analyze the Biological data. Biological model development.	6
5.	Sparse models, State space models, Markov random Fields, Hidden Markov model, Review of Inference for graphical models, Latent Linear and Variable models for discrete data.	5

Text book and Reference books:

1. Anand Rajaraman, Jure Leskovec and J.D. Ullman, "Mining of Massive Data sets", e-book, Publisher, 2014.
2. Kevin P. Murphey, "Machine Learning, a Probabilistic Perspective", The MIT Press Cambridge, Massachusetts, 2012,

PCC-AIML-602: Deep Learning
Lectures per week: 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Recognize** the characteristics of deep learning models that are useful to solve real-world problems.
2. **Understand** different methodologies to create application using deep nets.
3. **Identify** and apply appropriate deep learning algorithms for analyzing the data for variety of problems.
4. **Implement** different deep learning algorithms.
5. **Design** the test procedures to assess the efficacy of the developed model.
6. **Combine** several models in to gain better results.

Prerequisites:

- Machine Learning Foundations

Detailed Content:

Module	*Content*	*Hours/ Module*
1	**Introduction:** Various paradigms of learning problems, Perspectives and Issues in deep learning framework, review of fundamental learning techniques	2
2	**Feed forward neural network:** Artificial Neural Network, activation function, multi-layer neural network. cardinality, operations, and properties of fuzzy relations	5
3	**Training Neural Network:** Risk minimization, loss function, back propagation, regularization, model selection, and optimization.	5
4	**Conditional Random Fields:** Linear chain, partition function, Markov network, Belief propagation, Training CRFs, Hidden Markov Model, Entropy.	4
5	**Transfer Learning** Transfer learning Techniques, Variants of CNN: DenseNet, PixelNet.	3
6	**Deep Learning:** Deep Feed Forward network, regularizations, training deep models, dropouts, Convolutional Neural Network, Deep Belief Network	7
7	**Auto Encoders** Under complete Auto encoder, Regularized Auto encoder, stochastic Encoders and Decoders, Contractive Encoders	4

Text book and Reference books:

1. Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
2. Bishop, C. M., Pattern Recognition and Machine Learning, Springer, 2006.
3. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
4. Golub, G. H., and Van Loan, C. F., Matrix Computations, JHU Press,2013.
5. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004.
6. Rajiv Chopra, Deep Learning, Khanna Publishing House, 2018.

HSMC-AIML-601: Human Values and Professional Ethics
Contacts: 3L per week Credits: 3

Course Outcomes:
At the end of this course, students will demonstrate the ability to

- Understand Engineering and Technology as social and professional activities.
- Demonstrate the effects of technological growth, crisis of global resources and possible way out.
- Understand knowledge development for ethics in profession.
- Dissect development of professional and human values.
- Explain development of inner core and initiation of lifelong learning and survival process in professional arena.
- Demonstrate development of Moral character and thought of development of the country.

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Science, Technology and Engineering as knowledge and as Social and Professional Activities ***Effects of Technological Growth:*** Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Limits of growth: sustainable development. Energy Crisis: Renewable Energy Resources. Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations, Environmental Ethics. Appropriate Technology Movement of Schumacher; later developments. Technology and developing notions. Problems of Technology transfer, Technology assessment impact analysis. Human Operator in Engineering projects and industries. Problems of man, machine, interaction, Impact of assembly line and automation. Human centered Technology.	10
2	***Ethics of Profession:*** Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond, Case studies.	8
3	***Profession and Human Values:*** Values Crisis in contemporary society. Nature of values: Value Spectrum of a good life. Psychological values: Integrated personality; mental health. Societal values: The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution. Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity. Moral and ethical values: Nature of moral judgments; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility.	10

Text book and Reference books:

1. Stephen H Unger, Controlling Technology: Ethics and the Responsible Engineers, John Wiley & Sons, New York 1994 (2nd Ed)
2. Deborah Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, New Jersey 1991.
3. A N Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996.

PEC-AIML-601A: Soft Computing
Lectures per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Characterize supervised and unsupervised learning neural networks based on its architecture, training and testing mechanism.
2. Apply the concept of fuzzification and defuzzification in fuzzy systems.
3. Classify the architecture and working principles of specialized neural networks.
4. Analyze the fundamental concepts of genetic algorithm and classify its types.
5. Design, implement and evaluate a system / computer-based system, process, component or program to meet desired needs.
6. Apply soft computing techniques to solve real time problems.

Prerequisites:

1. Mathematics
2. Data Structure & Algorithms
3. Programming and problem solving skills.

Detailed Content:

Module	Content	Hours/ Module
1	Introduction: Introduction to soft computing; introduction to fuzzy sets and fuzzy logic systems; introduction to biological and artificial neural network; introduction to Genetic Algorithm.	2
2	Fuzzy sets and Fuzzy logic systems: Classical Sets and Fuzzy Sets and Fuzzy relations: Operations on Classical sets, properties of classical sets, Fuzzy set operations, properties of fuzzy sets, cardinality, operations, and properties of fuzzy relations. Membership functions: Features of membership functions, standard forms and boundaries, different fuzzification methods. Fuzzy to Crisp conversions: Lambda Cuts for fuzzy sets, fuzzy Relations, Defuzzification methods. Classical Logic and Fuzzy Logic: Classical predicate logic, Fuzzy Logic, Approximate reasoning and Fuzzy Implication Fuzzy Rule based Systems: Linguistic Hedges, Fuzzy Rule based system – Aggregation of fuzzy Rules, Fuzzy Inference System- Mamdani Fuzzy Models – Sugeno Fuzzy Models. Applications of Fuzzy Logic: How Fuzzy Logic is applied in Home Appliances, General Fuzzy Logic controllers, Basic Medical Diagnostic systems and Weather forecasting	10
3	Neural Network Introduction to Neural Networks: Advent of Modern Neuroscience, Classical AI and Neural Networks, Biological Neurons and Artificial neural network; model of artificial neuron. Learning Methods: Hebbian, competitive, Boltzman etc., Neural Network models: Perceptron, Adaline and Madaline networks; single layer network; Back-propagation and multi layer networks. Competitive learning networks: Kohonen self organizing networks, Hebbian learning; Hopfield Networks. Neuo-Fuzzy modelling: Applications of Neural Networks: Pattern Recognition and classification	10
4	Genetic Algorithms: Simple GA, crossover and mutation, Multi-objective Genetic Algorithm (MOGA). Applications of Genetic Algorithm: genetic algorithms in search and optimization, GA based clustering Algorithm, Image processing and pattern Recognition	10
5	Other Soft Computing techniques: Simulated Annealing, Tabu search, Ant colony optimization (ACO), Particle Swarm Optimization (PSO)	4
6	Applications of Soft Computing: Image Fusion - Neural network classification - Traveling salesman problem using Genetic algorithm - Genetic algorithm based Internet searching technique.	4

Text book and Reference books:

1. Fuzzy logic with engineering applications, Timothy J. Ross, John Wiley and Sons.
2. S. Rajasekaran and G.A.V.Pai, “Neural Networks, Fuzzy Logic and Genetic
1. Algorithms”, PHI

2. Principles of Soft Computing , S N Sivanandam, S. Sumathi, John Wiley & Sons
3. Genetic Algorithms in search, Optimization & Machine Learning by David E. Goldberg
4. Neuro-Fuzzy and Soft computing, Jang, Sun, Mizutani, PHI
5. Neural Networks: A Classroom Approach,1/e by Kumar Satish, TMH,
6. Genetic Algorithms in search, Optimization & Machine Learning by David E. Goldberg, Pearson/PHI
7. A beginners approach to Soft Computing, Samir Roy & Udit Chakraborty, Pearson

PEC-AIML-601B: Cloud Computing
Lectures per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Discuss the core concepts of cloud computing paradigm.
2. Analyze services, systems, platforms, frameworks to support cloud computing.
3. Illustrate the concepts of cloud storage system services.
4. Assess virtualization technology services in open source cloud computing environment.
5. Understand data center technology from industry centric perspective.
6. Identify cloud security issues to demonstrate real time applications.

Prerequisites:

1. Basic knowledge of Programming.
2. DBMS
3. Basics of security and privacy.
4. Operating System.

Detailed Content:

Module	***Content***	***Hours/ Module***
1	Definition of Cloud Computing and Basics: Defining a Cloud, Cloud types- NIST Model, Cloud Cube model, Deployment models (Public, Private, Hybrid and Community Clouds), Service Platform as a Service, Software as a Service with examples of services/service providers, models – Infrastructure as a Service, Cloud Reference model, Characteristics of Cloud Computing – a shift in paradigm Benefits and advantages of Cloud Computing, A brief introduction on Composability, Infrastructure, Platforms, Virtual Appliances, Communication Protocols, Applications, Connecting to the Cloud by Clients, IaaS – Basic concept, Workload, partitioning of virtual private server instances, Pods, aggregations, silos PaaS – Basic concept, tools and development environment with examples SaaS - Basic concept and characteristics, Open SaaS and SOA, examples of SaaS platform Identity as a Service (IDaaS) Compliance as a Service (CaaS)	9
2	Use of Platforms in Cloud Computing: Concepts of Abstraction and Virtualization, Virtualization technologies : Types of virtualization (access, application, CPU, storage), Mobility patterns (P2V, V2V, V2P, P2P, D2C, C2C, C2D, D2D) Load Balancing and Virtualization: Basic Concepts, Network resources for load balancing, Advanced load balancing (including Application Delivery Controller and Application Delivery Network), Mention of The Google Cloud as an example of use of load balancing Hypervisors: Virtual machine technology and types, VMware vSphere Machine Imaging (including mention of Open Virtualization Format – OVF) Porting of applications in	12

	the Cloud: The simple Cloud API and AppZero Virtual Application appliance, Concepts of Platform as a Service, Definition of services, Distinction between SaaS and PaaS (knowledge of Salesforce.com and Force.com), Application development Use of PaaS Application frameworks, Discussion of Google Applications Portfolio – Indexed search, Dark Web, Aggregation and disintermediation, Productivity applications and service, Adwords, Google Analytics, Google Translate, a brief discussion on Google Toolkit (including introduction of Google APIs in brief), major features of Google App Engine service., Discussion of Google Applications Portfolio – Indexed search, Dark Web, Aggregation and disintermediation, Productivity applications and service, Adwords, Google Analytics, Google Translate, a brief discussion on Google Toolkit (including introduction of Google APIs in brief), major features of Google App Engine service, Windows Azure platform: Microsoft's approach, architecture, and main elements, overview of Windows Azure AppFabric, Content Delivery Network, SQL Azure, and Windows Live services	
3	Cloud Infrastructure: Cloud Management: An overview of the features of network management systems and a brief introduction of related products from large cloud vendors, Monitoring of an entire cloud computing deployment stack – an overview with mention of some products, Lifecycle management of cloud services (six stages of lifecycle). Concepts of Cloud Security: Cloud security concerns, Security boundary, Security service boundary Overview of security mapping Security of data: Brokered cloud storage access, Storage location and tenancy, encryption, and auditing and compliance Identity management (awareness of Identity protocol standards)	7
4	Concepts of Services and Applications: Service Oriented Architecture: Basic concepts of message-based transactions, Protocol stack for an SOA architecture, Event-driven SOA, Enterprise Service Bus, Service catalogs, Applications in the Cloud: Concepts of cloud transactions, functionality mapping, Application attributes, Cloud service attributes, System abstraction and Cloud Bursting, Applications and Cloud APIs Cloud-based Storage: Cloud storage definition – Manned and Unmanned Webmail Services: Cloud mail services including Google Gmail, Mail2Web, Windows Live Hotmail, Yahoo mail, concepts of Syndication services	8
5	Data Center Technology: Server Virtualization – Automation – Remote Operation and Management –Data Center virtualization: Computing – Storage – Network – Carrier and External Network Interconnection – Web Tier Load Balancing and Acceleration. Case Study implementation of OpenNebula - OpenStack.	4

Text book and Reference books:

1. Cloud Computing Bible by Barrie Sosinsky, Wiley India Pvt. Ltd, 2013
2. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach", McGraw-Hill, 2010.
3. Kai Hwang, Fox and Dongarra, Morgan Kaufmann, "Distributed and Cloud Computing", 1st Edition, Elseiver, 2012.
4. Thomas Erl , Ricardo Puttini , Zaigham Mahmood, "Cloud Computing: Concepts, Technology & Architecture", Prentice –Hall, 2013.
5. Rajkumar Buyya, James Broberg, Andrzej Goscinski, "Cloud Computing Principles and Paradigms", John Wiley & Sons, Inc Publications, 2011
6. Cloud Computing – Second Edition by Dr. Kumar Saurabh, Wiley India

PEC-AIML-601C: Pattern Recognition
Contact: 3L Credits: 3

Course Outcomes:

At the end of this course, students will be able to:

1. Realize the clustering concepts and algorithms
2. Explain and compare a variety of pattern classification, structural pattern recognition, and pattern classifier combination techniques.
3. Summarize, analyze, and relate research in the pattern recognition area verbally and in writing.
4. Apply performance evaluation methods for pattern recognition, and critique comparisons of techniques made in the research literature.
5. Execute pattern recognition techniques to real-world problems such as document analysis and recognition.
6. Implement simple pattern classifiers, classifier combinations, and structural pattern recognizers.

Prerequisites:

1. Probability and linear algebra.
2. Data Mining.
3. Working knowledge of Matlab or Python

Detailed Content:

Unit	*Content*	*Hrs/ Unit*
1	Basics of pattern recognition	2
2	Bayesian decision theory Classifiers, Discriminant functions, Decision surfaces Normal density and discriminant functions Discrete features	8
3	Parameter estimation methods Maximum-Likelihood estimation Gaussian mixture models Expectation-maximization method Bayesian estimation	6
4.	Hidden Markov models for sequential pattern classification Discrete hidden Markov models Continuous density hidden Markov models	8
5	Dimension reduction methods. Fisher discriminant analysis Principal component analysis. Parzen-window method K-Nearest Neighbour method	3
6	Non-parametric techniques for density estimation	2
7	Linear discriminant function based classifier Perceptron Support vector machines	5
8	Non-metric methods for pattern classification Non-numeric data or nominal data Decision trees	4
9	Unsupervised learning and clustering Criterion functions for clustering Algorithms for clustering: K-means, Hierarchical and other methods	2

Text book and Reference books:

1. R. O. Duda, P. E. Hart and D. G. Stork: Pattern Classification, John Wiley, 2001.
2. S. Theodoridis and K. Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009.
3. C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

PEC-AIML-601D: Graph Theory
Contact: 3L Credits: 3

Course Outcomes (COs):

Upon completion of this course, the students should be able to:

1. Understand the various types of graph Algorithms and graph theory properties.
2. Analyze the NP – complete problems.
3. Distinguish the features of the various tree and matching algorithms
4. Appreciate the applications of digraphs and graph flow.
5. Understand the linear programming principles and its conversion.
6. Apply suitable graph model and algorithm for solving applications.

Prerequisites:

1. Mathematical proof technique (induction, proof by contradiction)
2. Linear algebra (determinants, eigen values).

Detailed Content:

Unit	*Content*	*Hrs/ Unit*
1	Introduction - Graph Terminologies - Types of Graphs - Sub Graph- Multi Graph - Regular Graph - Isomorphism - Isomorphic Graphs - Sub-graph - Euler graph - Hamiltonian Graph - Related Theorems.	9
2	Trees -Properties- Distance and Centres - Types - Rooted Tree-- Tree Enumeration- Labeled Tree - Unlabeled Tree - Spanning Tree - Fundamental Circuits- Cut Sets - Properties - Fundamental Circuit and Cut-set- Connectivity- Separability -Related Theorems.	9
3	Network Flows - Planar Graph - Representation - Detection - Dual Graph - Geometric and Combinatorial Dual - Related Theorems - Digraph - Properties - Euler Digraph.	9
4	Matrix Representation - Adjacency matrix- Incidence matrix- Circuit matrix - Cut-set matrix - Path Matrix- Properties - Related Theorems - Correlations. Graph Coloring - Chromatic Polynomial - Chromatic Partitioning - Matching - Covering - Related Theorems.	9
5	Graph Algorithms- Connectedness and Components- Spanning Tree- Fundamental Circuits- Cut Vertices- Directed Circuits- Shortest Path - Applications overview.	9

Text Books and Reference Books:

1. Narsingh Deo, "Graph Theory with Application to Engineering and Computer Science", Prentice-Hall of India Pvt. Ltd, 2003.
2. L.R.Foulds , "Graph Theory Applications", Springer ,2016.
3. Bondy, J. A. and Murty, U.S.R., "Graph Theory with Applications", North Holland Publication, 2008.
4. West, D. B., ―Introduction to Graph Theory, Pearson Education, 2011.
5. John Clark, Derek Allan Holton, ―A First Look at Graph Theory, World Scientific Publishing Company, 1991.
6. Diestel, R, "Graph Theory", Springer, 3rd Edition, 2006.
7. Kenneth H.Rosen, "Discrete Mathematics and Its Applications", Mc Graw Hill, 2007.

PEC AIML-602A: Big Data Analytics
Lecture per week: 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Understand** the concept of data management and evolution of Big Data.
2. **Understand** and implement various big data technology foundations.
3. **Apply** the fundamentals of Hadoop ecosystem and its components for data analysis.
4. **Analyze** the optimization techniques in data bases.
5. **Analyze** the storage techniques in data bases.
6. **Explore** the understanding of text, sentiment analytics.

Prerequisites:

- Database Management System
- C/C++ or Java in Linux
- Data Structures and Algorithms

Detailed Content:

Module	*Content*	*Hours/ Module*
1	**Introduction to Big Data and Hadoop** Types of Digital Data, Introduction to Big Data, Big Data Analytics, History of Hadoop, Apache Hadoop, Analysing Data with Unix tools, Analysing Data with Hadoop, Hadoop Streaming, Hadoop Echo System, IBM Big Data Strategy, Introduction to Infosphere Big Insights and Big Sheets	5
2	**HDFS(Hadoop Distributed File System)** The Design of HDFS, HDFS Concepts, Command Line Interface, Hadoop file system interfaces, Data flow, Data Ingest with Flume and Scoop and Hadoop archives, Hadoop I/O: Compression, Serialization, Avro and File-Based Data structures.	7
3	**Map Reduce** Anatomy of a Map Reduce Job Run, Failures, Job Scheduling, Shuffle and Sort, Task Execution, Map Reduce Types and Formats, Map Reduce Features.	7
4	**Hadoop Eco System** **Pig :** Introduction to PIG, Execution Modes of Pig, Comparison of Pig with Databases, Grunt, Pig Latin, User Defined Functions, Data Processing operators. **Hive** : Hive Shell, Hive Services, Hive Metastore, Comparison with Traditional Databases, HiveQL, Tables, Querying Data and User Defined Functions. **Hbase** :HBasics, Concepts, Clients, Example, Hbase Versus RDBMS. **Big SQL** : Introduction	7
5	**Data Analytics with R** Machine Learning: Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR	6

Text book and Reference books:

1. Big Data, Black Book, DT Editorial Services, Dreamtech Press, 2015
2. Big Data and Analytics, Seema Acharya, Subhashini Chellappan, Infosys Limited, Publication: Wiley India Private Limited,1st Edition 2015
3. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with advanced analystics, John Wiley & sons, 2012.
4. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007 Pete Warden, Big Data Glossary, O'Reilly, 2011.
5. Big Data For Dummies, Judith Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman, Wiley 2013

PEC-AIML-602B: Data Mining
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Understand what Is Data Mining, what kinds of data can be mined, what kinds of patterns can be mined, and what kinds of applications are targeted.
2. Explain major Issues in data mining.
3. Apply machine learning, pattern recognition, statistics, visualization, algorithm, database technology and high-performance computing in data mining applications.
4. Identify what kinds of technologies are used for different application.
5. Manipulate data preprocessing, data Warehouse and OLAP technology, data cube technology; mining frequent patterns and association, classification, clustering, and outlier detection.
6. Discover interesting patterns from large amounts of data to analyze for predictions and classification.

Prerequisites:

- Basic understanding of DBMS
- Engineering Mathematics
- Data Structure and Algorithm

Detailed Content:

Module	***Content***	***Hours/ Module***
1	Introduction: Evolution and Importance of Data Mining-Types of Data and Patterns Mined-Technologies-Applications-Major Issues in Data Mining. Knowing about Data-Data Pre-processing: Cleaning– Integration–Reduction–PCA, Data Transformation and Discretization. Mining Frequent Patterns: Basic Concept – Frequent Item Set Mining Methods – Mining Association Rules – Association to Correlation Analysis.	8
2	Classification and Prediction: Issues – Decision Tree Induction – Bayesian Classification – Rule Based Classification – k-Nearest-Neighbor Classification – Linear SVM – Regression – Linear, Logistic – Accuracy and Error measures – Introduction to Ensemble methods	6
3	Clustering: Overview of Clustering – Types of Data in Cluster Analysis – Major Clustering Methods-Partitioning Methods- k-Means, k-Medoids. Hierarchical Methods-Agglomerative and Divisive hierarchical clustering. Density-Based Methods-DBSCAN, Graph-based clustering (CHAMELEON), Evaluation in Clustering	6

4	Mining Data Streams- Mining Time-Series Data- Mining Sequence Patterns in Biological Data- Graph Mining – Social network Analysis – Text Mining – Mining the World Wide Web, Applications and Trends in Data Mining Tools: Implementation of Data mining algorithms using Latest Open-Source Data mining Tools. TensorFlow, python, R	5
5	Advanced techniques, Data Mining software and applications, Text mining: extracting attributes (keywords), structural approaches (parsing, soft parsing). Bayesian approach to classifying text ,Web mining: classifying web pages, extracting knowledge from the web ,Data Mining software and applications	5

Text book and Reference books:

1. Jiawei Han, Micheline Kamber and Jian Pei, "Data mining concepts and Techniques", Third Edition, Elsevier Publisher, 2006.
2. K.P.Soman, Shyam Diwakar and V.Ajay, "Insight into data mining Theory and Practice", Prentice Hall of India, 2006.
3. Yanchang Zhao, "R and Data Mining", Elsevier, 2013
4. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn and TensorFlow, O'Reilly Media, 2017
5. Itay Lieder, Yehezkel Resheff, Tom Hope, Learning TensorFlow, O'Reilly Media, 2017

PEC-AIML-602C: Distributed System
Lecture per week: 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Understand the** basic knowledge of Distributed Computing.
2. **Understand** the Distributed Models.
3. **Compare** interposes communication and remote communication.
4. **Remember** the concept of service oriented architecture**.**
5. **Apply different** emerging techniques in distributed computing.
6. **Design** Distributed Shared Memory and File System.

Prerequisites:

- Computer Networks
- Operating System

Detailed Content:

Module	***Content***	***Hours/ Module***
1	Introduction Distributed System Concepts: Introduction. Distributed Computing Models, Software Concepts, Issues in Designing Distributed Systems, Client-Server Model, Case Studies: WWW 1.0 , 2.0 , 3.0	4
2	Basic Network Communication: LAN and WAN Technologies, Classification of Networks, Protocols for Network Systems, ATM, Protocols for Distributed Systems	4
3	Inter process and Remote Communication:	5

	Message Passing, IPC in Mach, CBCAST protocol in ISIS, RPC Introduction and Basics, RPC Implementation and Communication, Sun RPC, RMI Implementation	
4	Distributed System Synchronization: Introduction, Clock Synchronization, Logical and Global state, Mutual Exclusion, Election Algorithms, Deadlocks in Distributed Systems, Deadlocks in Message Communication	5
5	Distributed System Management: Introduction, Resource Management, Task Assignment Approach, Load Balancing Approach Load Sharing Approach, Process Management and Migration, Threads, Fault Tolerance	5
6	Distributed Shared Memory: DSM Concepts, Hardware DSM, Design Issues in DSM Systems, Implementing Issues in DSM Systems, Heterogeneous and other DSM systems.	5
7	Distributed File System: Introduction DFS, File Models, DFS Design, Semantics File Sharing, DFS Implementation, File Caching in DFS, Replication in DFS, Sun Network File System, Google File System	4

Text book and Reference books:

1. Distributed Computing, Sunita Mahajan and Seema Shah, Oxford University
2. Distributed Operating Systems by P. K. Sinha, PHI
3. Advanced Concepts in Operating Systems, Mukesh Singhal, Niranjan Shivaratro, McGraw-Hill.
4. Distributed Systems: Principles and Paradigms, Taunenbaum
5. Distributed Computing, Fundamentals, Simulations and Advanced topics, 2nd Edition, Hagit Attiya and Jennifer Welch, Wiley India
6. Distributed Systems: Concepts and Design, G. Coulouris, J. Dollimore, and T. Kindberg,
7. Java Network Programming & Distributed Computing by David Reilly, Michael Reilly.

PEC-AIML-602D: Digital Signal Processing
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Design linear discrete-time systems and filters and analyse their behaviour.
2. Represent continuous-time signals and linear systems in discrete time, so that such signals can be recovered in continuous time when necessary.
3. Compute approximations to Fourier transforms of continuous-time signals with finite discrete time methods.
4. Understand the analytical tools such as Fourier transforms, Discrete Fourier transforms, Fast Fourier Transforms and Z-Transforms required for digital signal processing.
5. Design and realize various digital filters for digital signal processing.
6. Understand the applications of DSP in speech processing and spectrum analysis.

Prerequisites:

- Digital Electronics

Detailed Content:

Sl No	*Content*	*Hours/ Module*
1	Introduction: Objective, scope and outcome of the course.	1
2	Discrete-time signals: Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, sequences – periodic, energy, power, unit-sample, unit-step, unit-ramp, real & complex exponentials, arithmetic operations on sequences. LTI Systems: Definition, representation, impulse response, derivation for the output sequence, concept of convolution, graphical, analytical and overlap-add methods to compute convolution supported with examples and exercises, properties of convolution, interconnections of LTI systems with physical interpretations, stability and causality conditions, recursive and non-recursive systems.	8
3	Z-Transform: Definition, mapping between s-plane and z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples and exercises, characteristic families of signals along with ROCs, convolution, correlation and multiplication using Z-transform, initial value theorem, Perseval's relation, inverse Z-transform by contour integration, power series & partial-fraction expansions with examples and exercises. Discrete Fourier Transform: Concept and relations for DFT/IDFT, Twiddle factors and their properties, computational burden on direct DFT, DFT/IDFT as linear transformations, DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication of DFTs, circular convolution, computation of circular convolution by graphical, DFT/IDFT and matrix methods, linear filtering using DFT, aliasing error, filtering of long data sequences – Overlap-Save and Overlap-Add methods with examples and exercises. Fast Fourier Transform: Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithms, signal flow graphs, Butterflies, computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations and exercises.	11
4	Filter Design: Basic concepts of IIR and FIR filters, difference equations, design of Butterworth IIR analog filter using impulse invariant and bilinear transforms, design of linear phase FIR filters, no. of taps, rectangular, Hamming and Blackman windows.	5
5	Digital Signal Processor: Elementary idea about the architecture and important instruction sets of TMS320C 5416/6713 processor, writing of small programs in Assembly Language. FPGA: Architecture, different sub-systems, design flow for DSP system design, mapping of DSP algorithms onto FPGA.	5
	TOTAL	30

Text and reference books:

1. Digital Signal Processing – Principles, Algorithms and Applications, J.G.Proakis & D.G.Manolakis, Pearson Ed.
2. Digital Signal processing – A Computer Based Approach, S.K.Mitra, TMH Publishing Co.
3. Digital Signal Processing Signals, Systems and Filters, A. Antoniou, TMH Publishing Co.
4. VLSI Digital Signal Processing Systems Design and Implementation, Wiley International Publication.
5. Digital Signal Processing with Field Programmable Gate Arrays, U.Meyer-Baese, Springer.

OEC-AIML-601A: Advanced Computer Architecture
Contacts: 3L per week Credits: 3

Course Outcomes:
At the end of this course, students will demonstrate the ability to

- **Explain** various parameters to measure the performance of a processor.
- **Demonstrate** the parallel computing concepts and **compare** parallel computing with sequential computing.
- **Explain** the pipelining technique and its related issues.
- **Demonstrate** the vector processing, array processors and multiprocessors.
- **Outline** and **design** various types of interconnection networks for parallel computers.
- **Dissect** different techniques required to improve the performances of cache memory and main memory.

Prerequisites:
Computer Organization & Architecture

Detailed Content:

Module	***Content***	***Hours/ Module***
1	Introduction: Review of basic computer architecture (Revisited), Quantitative techniques in computer design, measuring and reporting performance.	3
2	Pipelining: 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.	9
3	Instruction-level parallelism: basic concepts, techniques for increasing ILP, superscalar, super-pipelined and VLIW processor architectures. Array and vector processors.	6
4	Multiprocessor architecture: taxonomy of parallel architectures; Centralized shared-memory architecture: synchronization, memory consistency, interconnection networks. Distributed shared-memory architecture. Cluster computers.	8
5	Non von Neumann architectures: data flow computers, reduction computer architectures, systolic architectures.	4
6	Hierarchical memory technology: Inclusion, Coherence and locality properties; Cache memory organizations, Techniques for reducing cache misses; Virtual memory organization, mapping and management techniques, memory replacement policies.	8

Text book and Reference books:

1. Computer Architecture and Parallel Processing by Hwang and Briggs (Mc-Graw Hill)
2. Advanced Computer Architecture by Hwang (Mc-Graw Hill)
3. Computer Architecture: A Qualitative Approach by Hennesey & Patterson (Morgan Kaufman)

OEC-AIML-601B: Human Computer Interaction
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Explain** the capabilities of both humans and computers from the viewpoint of human information processing.
2. **Describe** typical human–computer interaction (HCI) models, styles, and various historic HCI paradigms.
3. **Apply** an interactive design process and universal design principles for designing HCI systems.
4. **Analyze** and identify user models, user support, socio-organizational issues, and stakeholder requirements of HCI systems.
5. **Apply** design and development principles in the construction of HCI systems
6. **Use** current techniques, skills, and tools necessary for computing practice.

Prerequisites:

- Basics of programming
- Data Structure and Algorithms

Detailed Content:

Module	***Content***	***Hours/ Module***
1	Introduction to Human-Computer Interaction, Task-centered system design: task-centered process, development of task examples, evaluation of designs through a task-centered walk-through	6
2	User-centered design and prototyping: assumptions, participatory design, methods for involving the user, prototyping, low fidelity prototypes, medium fidelity	6
3	Methods for evaluation of interfaces with users: goals of evaluation, approaches, ethics, introspection, extracting the conceptual model, direct observation, constructive interaction, interviews and questionnaires, continuous evaluation via user feedback and field studies, choosing an evaluation method	8
4	Psychology of everyday things: psychopathology of everyday things, examples, concepts for designing everyday things, Beyond screen design: characteristics of good representations, information visualization, Tufte's guidelines, visual variables	5
5	Graphical screen design: graphical design concepts, Design principles and usability heuristics: design principles, principles to support usability, HCI design standards: process-oriented standards, product-oriented standards, Past and future of HCI: the past, present and future, perceptual interfaces, context-awareness and perception.	5

Text book and Reference books:

1. Dix A. et al., "Human-Computer Interaction", Harlow, England, Prentice Hall, 2004, ISBN-10: 0130461091
2. Yvonne Rogers, Helen Sharp, Jenny Preece, "Interaction Design: Beyond Human Computer Interaction", 3rd Edition, Wiley, 2011, ISBN-10: 04706657693.

OEC-AIML-601C: Artificial Neural Network
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Analyze** synaptic connectivity as the basis of neural computation and learning

2. **Evaluate** the ideological basics of artificial neural networks
3. **Understand** the origins of artificial neural networks
4. **Know** some application of artificial neural networks
5. **Identify** the different structures of artificial neural networks.
6. **Learn** perceptron and dynamical theories of recurrent networks including amplifiers, attractors, and hybrid computation.

Prerequisites:

- Higher Engineering Mathematics e.g. linear algebra, multivariate calculus and Probability theory,
- Data Structure and Algorithms
- Fundamental knowledge of signals and systems along with types, Mathematical representation of signals and system modelling in time as well as frequency domain.

Detailed Content:

Module	***Content***	***Hours/ Module***
1	Introduction to ANN Features, structure and working of Biological Neural Network, Trends in Computing Comparison of BNN and ANN	7
2	Basics of Artificial Neural Networks: History of neural network research, characteristics of neural networks terminology, models of neuron Mc Culloch – Pitts model, Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture	6
3	Backpropagation networks : (BPN) Architecture of feed forward network, single layer ANN, multilayer perceptron, back propagation learning, input - hidden and output layer computation, backpropagation algorithm, applications, selection of tuning parameters in BPN, Numbers of hidden nodes, learning.	6
4	Activation & Synaptic Dynamics: Introduction, Activation Dynamics models, synaptic Dynamics models, stability and convergence, recall in neural networks.	5
5	Basic functional units of ANN for pattern recognition tasks: Basic feed forward, Basic feedback and basic competitive learning neural network.	6

Text book and Reference books:

1. B. Yegnanarayana - Artificial neural network PHI Publication.
2. S. Raj sekaran, Vijayalakshmi Pari - Neural networks, Fuzzy logic and Genetic Algorithms
3. Kevin L. Priddy, Paul E. Keller – Artificial neural networks: An Introduction - SPIE Press, 2005
4. Mohammad H. Hassoun – Fundamentals of artificial neural networks - MIT Press, 1995
5. Nelson Morgan – Artificial neural network: Electronic Implementations – IEEE Press, 1990
6. Journal of Artificial neural networks, Volume 1 – Ablex Publishing Corporation, 1994

OEC-AIML-601D: Cryptography and Network Security
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Design** network application security schemes, such as PGP, S/MIME, SSL, HTTPS etc.
2. **Evaluate** concepts of Firewall (including types of Firewall), DMZ Network and comparing between different Firewall Configurations.
3. **Analyze** Biometric Authentication and differentiate between different types of Authentication tokens.
4. **Implement and apply** numerical module based on DES and RSA illustrating the concept of SSL, PGP, Authentication token, Digital Signature, Message Digest and Hash function.
5. **Understand** and Classify different kinds of Substitution techniques and Transposition techniques and discuss the concepts of Symmetric key cryptography and Asymmetric key cryptography.
6. **Define** the concepts of Network security and identifying different types of attack on Network security.

Prerequisites:

- Computer Networks
- Discrete Mathematics

Detailed Content:

Module	***Content***	***Hours/ Module***
1	**Network Security and Cryptography**: Concepts and Techniques, Need for Security, Security approaches, Principles of Security, Types of attack on security. Introduction to cryptography, Plaintext & Cipher text, Substitution Techniques, Transposition Techniques, Encryption & Decryption, Type of attacks on encrypted text, Symmetric & Asymmetric key Cryptography.	9
2	**Symmetric Key Algorithms:** Algorithm types & Modes, Overview of Symmetric Key Cryptography, Diffie-Hellman key exchange algorithm, Digital Envelope, DES(Data Encryption Standard) algorithm & its variant, IDEA(International Data Encryption Algorithm) algorithm, RC5(Rivest Cipher 5) algorithm.	8
3	**Asymmetric Key Algorithms**: Digital Signature and User Authentication, Overview of Asymmetric key Cryptography, RSA algorithm, Digital Signature, Basic concepts of Message Digest and Hash Function (Algorithms on Message Digest and Hash function not required), HMAC algorithm. Authentication Basics, Password, Authentication Token, Certificate based Authentication and Biometric Authentication.	9
4	**Electronic mail security, SSL and Firewall**: Basics of mail security, PEM, PGP, S/MIME, Secure Socket Layer (SSL) protocol. Introduction to Firewall, Types of firewall, Firewall Configurations and DMZ Network.	6

Text book and Reference books:

1. Cryptography and Network Security, William Stallings, 2nd Edition, Pearson Education Asia
2. Network Security private communication in a public world, C. Kaufman, R. Perlman and M. Speciner, Pearson
3. Cryptography & Network Security: Atul Kahate, TMH.
4. Network Security Essentials: Applications and Standards by William Stallings, Pearson.
5. Designing Network Security, Merike Kaeo, 2nd Edition, Pearson Books.

6. Building Internet Firewalls, Elizabeth D. Zwicky, Simon Cooper, D. Brent Chapman, 2nd Edition, Oreilly.
7. Practical Unix & Internet Security, Simson Garfinkel, Gene Spafford, Alan Schwartz, 3rd Edition, Oreilly.

PCC-AIML-691: Machine Learning Applications Lab
Labs per week: 3 Credits: 1.5

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Develop** Machine learning models.
2. **Apply** the knowledge of machine learning in various practical fields.
3. **Design** machine learning algorithms to solve real life problems.
4. **Understand** different machine learning techniques**.**
5. **Analyze** and compare the performance of different Machine learning algorithms.
6. **Remember** the concept of Machine learning model selection.

Prerequisites:

- Machine Learning Foundations
- Machine Learning Applications
- IT Workshop (Python)

Tentative List of Experiments:

1. Implementation of Recommendation Systems.
2. Predictive Analysis on real life data.
3. Social Network Analysis using python.

Text book and Reference books:

1. Anand Rajaraman, Jure Leskovec and J.D. Ullman, "Mining of Massive Data sets", e-book, Publisher, 2014.
2. Kevin P. Murphey, "Machine Learning, a Probabilistic Perspective", The MIT Press Cambridge, Massachusetts, 2012
3. Willi Richert, Luis Pedro Coelho, Building Machine Learning Systems with Python. Packt Publishing.

PCC-AIML-692: Artificial Intelligence Lab
Labs per week (L): 3 Credits: 1.5

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Demonstrate the applications of AI and agent-based approach to AI.
2. Obtain first-order predicate calculus, logical reasoning and problem solving using Python language.

3. Study and discuss various techniques and algorithms of AI used in general problem solving, optimization problems, constraint satisfaction problems, and game programming.
4. Familiarize students with various sub-areas of AI, such as expert systems, natural language processing and machine learning.
5. Study and discuss various techniques and algorithms of AI used in Genetic Algorithm.
6. Dissect various techniques and algorithms of AI used in Expert System.

Prerequisites:

- Data Structures
- Probability
- Python Programming Language

Detailed Content:

Sl No	*Content*
1	Anaconda: Learn how to use Anaconda to manage packages and environments for use with Python.
2	Jupyter Notebooks: Learn how to use Jupyter Notebooks to create documents combining code, text, images, and more.
3	Numpy Basics: • Learn the value of NumPy and how to use it to manipulate data for AI problems. • Mini-Project: Use NumPy to mean normalize anndarray and separate it into several smaller ndarrays.
4	Pandas Basics: • Learn to use Pandas to load and process data for machine learning problems. • Mini-Project: Use Pandas to plot and get statistics from stock data
5	Matplotlib Basics: Learn how to use Matplotlib to choose appropriate plots for one and two variables based on the types of data you have.

Text/ Reference Books:

1. Machine Learning for Absolute Beginners: A Plain English Introduction Author: Oliver Theobald Publisher — Scatterplot Press
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems (First Edition) Author: AurelienGeron Publisher — O'Reilly Media
3. Machine Learning (in Python and R) For Dummies Author: John Paul Mueller and Luca Massaron
4. Machine Learning in Action Author: Peter Harrington Publisher — Manning Publications

PCC-AIML-693: Computer Networks Lab
Labs per week (P): 3 Credits: 1.5

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Design** an application to execute command remotely using socket programming.
2. **Evaluate** file transfer application using socket programming.

3. **Analyze** the hardware (hub, bridge, switch, router) to make networks more efficient, faster, more secure, easier to use, able to transmit several simultaneous messages, and able to interconnect with other networks.
4. **Implement** error-control mechanism for data transmission.
5. **Understand** the concepts of NIC installation and configuration.
6. **Remember** to gather network information using socket programming.

Prerequisites:

- Programming for Problem Solving
- Data Structure and Algorithms
- Object Oriented Programming & Java
- Computer Networks

Detailed Content:

1. NIC Installation & Configuration
2. TCP/UDP Socket Programming – Introduction
3. Sockets – Operation, Socket types, Domains, Closing Sockets
4. Client/Server Models - Usage
5. Connection Based Services - Client and Server actions
6. Connectionless Services - Client and Server actions
7. Access Network Database - Host Information, Network Information, Protocol Information
8. Implement Multicasting / Broadcasting socket I/O.
9. Implement ARQ techniques.

Text book and Reference books:

1) Computer Networks (4th Ed.) – A. S. Tanenbaum –Pearson Education/PHI
2) Data Communications and Networking (3rd Ed.) – B. A. Forouzan –TMH
3) Data and Computer Communications (5th Ed.) – W. Stallings –PHI/ Pearson Education
4) Computer Networking -A top down approach featuring the internet– Kurose and Rose – Pearson Education
5) Internetworking with TCP/IP, vol. 1, 2, 3(4th Ed.) – Comer –Pearson Education/PHI

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Semester - VII

PEC-AIML-701A: Social Network Analysis
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Understand the concept of semantic web and related applications.
2. Learn knowledge representation using ontology.
3. Understand human behaviour in social web and related communities.
4. Learn visualization of social networks.
5. Develop semantic web related applications.
6. Represent knowledge using ontology.

Prerequisites:

- Basic Mathematics
- Probability and Statistics

Detailed Content:

Sl No	*Content*	*Hours/ Module*
1	Introduction: Objective, scope and outcome of the course.	1
2	Introduction to Semantic Web: Limitations of current Web - Development of Semantic Web - Emergence of the Social Web - Social Network analysis: Development of Social Network Analysis - Key concepts and measures in network analysis - Electronic sources for network analysis: Electronic discussion networks, Blogs and online communities - Web-based networks - Applications of Social Network Analysis.	5
3	Ontology and their role in the Semantic Web: Ontology-based knowledge Representation - Ontology languages for the Semantic Web: Resource Description Framework - Web Ontology Language - Modelling and aggregating social network data: State-of-the-art in network data representation - Ontological representation of social individuals - Ontological representation of social relationships - Aggregating and reasoning with social network data - Advanced representations.	7
4	Extracting evolution of Web Community from a Series of Web Archive - Detecting communities in social networks - Definition of community - Evaluating communities - Methods for community detection and mining - Applications of community mining algorithms - Tools for detecting communities social network infrastructures and communities - Decentralized online social networks - Multi-Relational characterization of dynamic social network communities.	8
5	Understanding and predicting human behaviour for social communities - User data management - Inference and Distribution - Enabling new human experiences - Reality mining - Context - Awareness - Privacy in online social networks - Trust in online environment - Trust models based on subjective logic - Trust network analysis - Trust transitivity analysis - Combining trust and reputation - Trust derivation based on trust comparisons - Attack spectrum and countermeasures.	6
6	Graph theory - Centrality - Clustering - Node-Edge Diagrams - Matrix representation - Visualizing online social networks, Visualizing social networks with matrix-based representations - Matrix and Node-Link Diagrams - Hybrid representations - Applications - Cover networks - Community welfare - Collaboration networks - Co-Citation networks.	6
	Total	33

Text/ References Books:

1. Peter Mika, ―Social Networks and the Semantic Web, First Edition, Springer 2007.
2. Borko Furht, ―Handbook of Social Network Technologies and Applications, 1st Edition, Springer, 2010.
3. Guandong Xu ,Yanchun Zhang and Lin Li, ―Web Mining and Social Networking – Techniques and applications, First Edition, Springer, 2011.
4. Dion Goh and Schubert Foo, ―Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively, IGI Global Snippet, 2008.
5. Max Chevalier, Christine Julien and Chantal Soule-Dupuy, ―Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling, IGI Global Snippet, 2009.

6. John G. Breslin, Alexander Passant and Stefan Decker, ―The Social Semantic Web, Springer, 2009.

PEC-AIML-701B: Computer Vision
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

Upon completion of the course, students will be able to

1. Understand and master basic knowledge, theories and methods in image processing and computer vision.
2. Identify, formulate and solve problems in image processing and computer vision.
3. Analyze, evaluate and examine existing practical computer vision systems.
4. Critically review and assess scientific literature in the field and apply theoretical knowledge to identify the novelty and practicality of proposed methods.
5. Design and develop practical and innovative image processing and computer vision applications or systems.
6. Conduct themselves professionally and responsibly in the areas of computer vision image processing and deep learning.

Prerequisites:

1. Mathematics (Linear algebra, vector calculus, and probability)
2. Data structures
3. Programming

Detailed Content:

Unit	*Contents*	*Hrs/ Unit*
1	Digital Image Formation and low-level processing: Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing, introduction to computer vision.	8
2	Feature Extraction: Shape, histogram, color, spectral, texture, Feature analysis, feature vectors, distance /similarity measures, data preprocessing, Edges - Canny, LOG, DOG; Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT; Line detectors (Hough Transform), Orientation Histogram, SIFT, SURF, GLOH, Corners - Harris and Hessian Affine.	8
3	Depth estimation and Multi-camera views: Perspective, Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Binocular Stereopsis: Camera and Epipolar Geometry; Auto-calibration. Image Segmentation: Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.	8
4	Motion Analysis: Optical Flow, KLT, Spatio-Temporal Analysis, Background Subtraction and Modeling, Dynamic Stereo; Motion parameter estimation.	6
5	Shape from X: Light at Surfaces; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges Albedo estimation; Photometric Stereo; Phong Model; Reflectance Map.	6

Text and Reference Books:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.
3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
4. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.
5. K. Fukunaga; Introduction to Statistical Pattern Recognition, Second Edition, Academic Press, Morgan Kaufmann, 1990.

PEC-AIML-701C: Software Engineering
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Describe the importance of software engineering lifecycle models in the development of software and apply the knowledge to the solution of complex engineering problems.
2. Analyze the requirements and develop SRS documents following the principles in modeling software based on real life applications.
3. Design and develop software which adheres to the standard software design guideline & benchmarks.
4. Create and apply appropriate techniques for software testing.
5. Demonstrate knowledge and understanding of engineering and management principles for software projects management.
6. Understand software matrices like size, effort and cost estimation, and software quality metrics.

Prerequisites:

- Basic knowledge of programming

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Software Engineering -Objectives, Definitions, Software Process models - Waterfall Model, Prototype model, RAD, Evolutionary Models, Incremental, Spiral, Software Project Planning- Feasibility Analysis, Technical Feasibility, Cost- Benefit Analysis, COCOMO model.	7
2	Structured Analysis, Context diagram and DFD, Physical and Logical DFDs, Data Modelling, ER diagrams, Software Requirements Specification.	5
3	Design Aspects: Top-Down and Bottom-Up design; Decision tree, decision table and structured English, Structure chart, Transform analysis Functional vs. Object-Oriented approach.	6
4	Unified Modeling Language Class diagram, interaction diagram: collaboration diagram, sequence diagram, state chart diagram, activity diagram, implementation diagram.	4
5	Coding & Documentation - Structured Programming, Modular Programming, Module Relationship- Coupling, Cohesion, OO Programming, Information Hiding, Reuse, System Documentation.	5
6	Testing - Levels of Testing, Integration Testing, System Testing, Software Quality,	9

	Quality Assurance, Software Maintenance, Software Configuration Management, Software Architecture.	

Text and Reference books:

1. Software Engineering: A practitioner's approach - Pressman (TMH)
2. Software Engineering- Pankaj Jalote (Wiley-India)
3. Software Engineering- Rajib Mall (PHI)
4. Software Engineering -Agarwal and Agarwal (PHI)

PEC-AIML-701D: Data Warehousing
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Define the knowledge of mathematics and science on data warehouse, building blocks, Data Mart and recall in independent and life-long learning of data warehouse.
2. Classify Data warehouse Architecture in the areas of Data acquisition, Data storage and Information delivery and illustrate the engineering principles.
3. Make use of the architecture and infrastructure of Database Software and model appropriate tools for database software by applying the knowledge of software development by individual or team.
4. Analyze Metadata types by functional areas and assume effective reports on Business metadata by understanding of the engineering principles of metadata.
5. Justify effective reports on Data acquisition, Data storage, and Information delivery and evaluate the ability for life-long learning on data storage.
6. Discuss Knowledge Discovery Process, OLAP, Different techniques by building the knowledge of mathematics and engineering fundamentals on OLAP and develop applications in societal, health, safety, legal and cultural issues.

Prerequisites:

1. Knowledge of Programming skill.
2. Basic Statistics and mathematics.

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Data Warehouse: Basic Concepts, Differences between Operational Database Systems and Data Warehouses- A Multitiered Architecture - Data Warehouse Models : Extraction, Transformation and Loading - Metadata Repository -Data Cube and OLAP -Data Warehouse Design and Usage – Data warehouse implementation.	7
2	Introduction To Data Mining: Introduction - The evolution of database system technology - Steps in knowledge discovery from database process - Architecture of a data mining systems - Data mining on different kinds of data - Different kinds of pattern - Technologies used - Applications - Major issues in data mining - Classification of data mining systems – Data mining task primitives - Integration of a data mining system with a database or data warehouse system.	8
3	Data Preprocessing: Data Objects and attribute types - Basic statistical description	8

	of data - Data visualization – Measuring data similarity and dissimilarity - Data cleaning - Integration - Data reduction – Data transformation and data discretization.	
4	Association Rule Mining: Basic concepts - Frequent itemset mining methods - Apriori algorithm, APattern growth approach for mining frequent itemsets, Mining frequent itemsets using vertical data format, Mining closed and max patterns - Pattern mining in multilevel and multidimensional space – Constraint based Frequent pattern mining - Mining High-Dimensional Data and Colossal Patterns	8
5	Classification And Clustering: Classification : Basic concepts - Decision tree induction - Bayes classification methods-Rule Based Classification- Model Evaluation and Selection - Techniques to Improve Classification Accuracy - Bayesian Belief Networks - Classification by Back propagation - Cluster Analysis – Partitioning methods- Hierarchical methods.	9

Text and Reference books:

1. Jiawei Han, Micheline Kamber and Jian Pai, Data Mining: Concepts and Techniques, Morgan Kauffman, 2013
2. Alex Berson and Stephen J Smith, Data Warehousing, Data Mining, and OLAP, Mcgraw- Hill,2008
3. David Hand, Heikki Manila, Padhraic Symth, Principles of Data Mining, MIT Press, 2004
4. Margaret H. Dunham, Data Mining: Introductory and Advanced Topics, Pearson Education 2008

PEC-AIML-702A: Ecommerce and ERP
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Understand fundamental concepts and technologies related to ERP.
2. Explain the different phases of ERP implementation life cycle.
3. Examine the modules, benefits and various tools of ERP.
4. Analyze the impact of e-commerce on business model and strategies.
5. Assess the electronic payment systems and software.
6. Identify and solve the security issues related to communication.

Prerequisites:

- Basic Mathematics

Detailed Content:

Sl No	*Content*	*Hours/ Module*
1	Introduction to E-Commerce Introduction What is E-Commerce, Forces behind E-Commerce Industry Framework, Brief history of E-Commerce, Inter Organizational E-Commerce Intra Organizational Commerce, and Consumer to Business Electronic Commerce, Architectural framework Network Infrastructure for E-Commerce Network Infrastructure for E-Commerce, Market forces behind I Way, Component of I way Access Equipment, Global Information Distribution Network, Broad band	6

	Telecommunication.	
2	Mobile Commerce and ERP Introduction to Mobile Commerce, Mobile Computing Application, Wireless Application Protocols, WAP Technology, Mobile Information Devices, Web Security Introduction to Web security, Firewalls & Transaction Security, Client Server Network, Emerging Client Server Security Threats, firewalls & Network Security.	6
3	E-Commerce Payment and Gateways Electronic Payments Overview of Electronics payments, Digital Token based Electronics payment System, Smart Cards, Credit Card I Debit Card based EPS, Emerging financial Instruments, Home Banking, Online Banking.	6
4	E-Commerce and EDA Net Commerce EDA, EDI Application in Business, Legal requirement in E - Commerce, Introduction to supply Chain Management, CRM, issues in Customer Relationship Management.	6
5	Internet and E-Commerce Internet and Electronic commerce, internet, extranet and enterprise solutions, information system for business operations, information system for managerial decision support, information system for strategic advantage.	6
	Total	30

Books Recommended:

1. Enterprise Resource Planning – A Managerial Perspective by D P Goyal, Tata McGraw Hill Education, 2011
2. Enterprise Resource Planning by Ashim Raj Singla, Cengage Learning, 2008
3. Enterprise Resource Planning, Alexis Leon, 2nd edition, Tata McGraw Hill
4. Enterprise Resource Planning, Ravi Shankar & S. Jaiswal, Galgotia

PEC-AIML-702B: Information Theory and Coding
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Apply various source coding techniques.
2. Design the channel performance using information theory.
3. Comprehend various error control code properties
4. Apply linear block codes for error detection and correction
5. Apply convolution codes for performance analysis & cyclic codes for error detection and correction.
6. Design BCH & RS codes for channel performance improvement against burst errors.

Prerequisites:

1. Basic Mathematics
2. Probability and Statistics

Detailed Content:

Sl No	*Content*	*Hours/ Module*

1	Introduction: Objective, scope and outcome of the course.	1
2	Source Coding Uncertainty and information, average mutual information and entropy, information measures for continuous random variables, source coding theorem, Huffman codes.	5
3	Channel Capacity And Coding Channel models, channel capacity, channel coding, information capacity theorem, The Shannon limit.	5
4	Linear And Block Codes For Error Correction Matrix description of linear block codes, equivalent codes, parity check matrix, decoding of a linear block code, perfect codes, Hamming codes.	5
5	Cyclic Codes Polynomials, division algorithm for polynomials, a method for generating cyclic codes, matrix description of cyclic codes, Golay codes.	5
6	BCH Codes Primitive elements, minimal polynomials, generator polynomials in terms of minimal polynomials, examples of BCH codes.	5
7	Convolutional Codes Tree codes, trellis codes, polynomial description of convolutional codes, distance notions for convolutional codes, the generating function, matrix representation of convolutional codes, decoding of convolutional codes, distance and performance bounds for convolutional codes, examples of convolutional codes, Turbo codes, Turbo decoding.	5
	Total	31

Text and Reference Books:

1. Andre Neabauer, "Coding Theory: Algorithms, Architectures & Applications", Wiley Publications, 2010.
2. Kennedy, "Electronic Communication systems", McGraw Hill, 4th Ed., 1999.
3. John Proakis, "Digital Communications", TMH, 5th Ed., 2008.
4. Simon Haykin, "Communication System", Wiley, 2008.
5. Jorge Castineira, Moreira, "Essentials of Error Control Coding", Wiley, 2006.

PEC-AIML702C: Data Visualization
Lecture per week: 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Identify the different data types, visualization types to bring out the insight.
2. Relate the visualization towards the problem based on the dataset to analyze and bring out valuable insight on large dataset.
3. Design visualization dashboard to support the decision making on large scale data.
4. Demonstrate the analysis of large dataset using various visualization techniques and tools.
5. Identify the different attributes and showcasing them in plots. Identify and create various visualizations for geospatial and table data.
6. Create and interpret plots using R/Python.

Prerequisites:

1. Data Mining

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Introduction to Data Visualization Overview of data visualization - Data Abstraction -Analysis: Four Levels for Validation- Task Abstraction - Analysis: Four Levels for Validation	4
2	Visualization Techniques Scalar and point techniques Color maps Contouring Height Plots - Vector visualization techniques Vector properties Vector Glyphs Vector Color Coding Stream Objects.	5
3	Visual Analytics Visual Variables- Networks and Trees - Map Color and Other Channels- Manipulate View	4
4	Visual Analytics Arrange Tables Geo Spatial data Reduce Items and Attributes	4
5	Visualization Tools and Techniques Introduction to data visualization tools- Tableau - Visualization using R	5
6	Diverse Types Of Visual Analysis Time- Series data visualization Text data visualization Multivariate data visualization and case studies	4
7	Visualization Dashboard Creations Dashboard creation using visualization tools for the use cases: Finance-marketing-insurance- healthcare etc.,	4

Text book and Reference books:

1. Tamara Munzer, Visualization Analysis and Design, CRC Press 2014
2. Alexandru Telea, Data Visualization Principles and Practice, CRC Press 2014
3. Paul J. Deitel, Harvey Deitel, Java SE8 for Programmers (Deitel Developer Series) 3rd Ed.

PEC-AIML-702D: Mobile Computing
Lecture per week: 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Understand the necessary knowledge of cellular communication, infrastructure-less networks
2. Analyze TCP, MAC protocols and their technical feasibility
3. Analyze device independent applications
4. Acquire knowledge about the basic concepts and principles in mobile computing
5. Understand techniques involved, in networks
6. Analyze systems issues for the design and implementation of mobile computing systems.

Prerequisites:

- Computer Networks

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Introduction to Personal Communications Services (PCS): PCS Architecture, Mobility management, Networks signaling. Global System for Mobile Communication (GSM) system overview: GSM Architecture, Mobility management, Network signaling.	4
2	General Packet Radio Services (GPRS): GPRS Architecture, GPRS Network Nodes. Mobile Data Communication: WLANs (Wireless LANs) IEEE 802.11 standard, Mobile IP	4
3	Wireless Application Protocol (WAP): The Mobile Internet standard, WAP Gateway and Protocols, wireless markup Languages (WML). Wireless Local Loop(WLL): Introduction to WLL Architecture, wireless Local Loop Technologies.	6
4	Third Generation (3G) Mobile Services: Introduction to International Mobile Telecommunications 2000 (IMT 2000) vision, Wideband Code Division Multiple Access (W-CDMA), and CDMA 2000, Quality of services in 3G.	6
5	Global Mobile Satellite Systems; case studies of the IRIDIUM and GLOBALSTAR systems. Wireless Enterprise Networks: Introduction to Virtual Networks, Blue tooth technology, Blue tooth Protocols.	6
6	Server-side programming in Java, Pervasive web application architecture, Device independent example application	4

Text book and Reference books:

1. Mobile Communications, Jochen Schiller, PHI/Pearson Education, Second Edition, 2003.
2. Fundamentals of Mobile Computing, Rajib Mall, PHI, Second Edition, 2015.
3. Wireless Communications and Networks, William Stallings, PHI/Pearson Education, 2002.
4. Principles of Wireless Networks, Kaveh Pahlavan, Prasanth Krishnamoorthy, PHI/Pearson Education, 2003.
5. Principles of Mobile Computing, Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, Springer, New York, 2003.
6. Mobile Communication Systems, Hazysztof Wesolowshi, John Wiley and Sons Ltd, 2002.

OEC-AIML-701A: Internet of Things
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Understand** the vision of IoT from a global context.
2. **Determine** the Market perspective of IoT.
3. **Design** Devices, Gateways and Data Management in IoT.
4. **Building** state of the art architecture in IoT.
5. **Apply** IoT in Industrial and Commercial Building Automation and Real-World Design
6. **Evaluate** the performance of IoT devices.

Prerequisites:

- Computer Network and Internet Technology
- Sensor Technology

Detailed Content:

Module	***Content***	***Hours/ Module***
1	M2M to IoT-The Vision-Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics.	5
2	Understand IoT Market perspective. M2M to IoT – A Market Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT- An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.	8
3	Data and Knowledge Management and use of Devices in IoT Technology. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management Understand State of the Art – IoT Architecture. IoT Architecture-State of the Art – introduction, State of the art, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model	8
4	Real World IoT Design Constraints, Industrial Automation and Commercial Building Automation in IoT IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control. Industrial Automation- Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial Building Automation – Introduction, Case study: phase one- commercial building automation today, Case study: phase two- commercial building automation in the future.	10

Text book and Reference books:

1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
2. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1stEdition, VPT, 2014.
3. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013

OEC-AIML-701B: Bioinformatics
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Design** basic algorithms used in Pairwise and Multiple alignments.
2. **Understand** the methodologies used for database searching, and determining the accuracies of database search.
3. **Application** of probabilistic model to determine important patterns.
4. **Prediction** of structure from sequence and subsequently testing the accuracy of predicted structures.
5. ***Determine*** the protein function from sequence through analyzing data.
6. **Analysis** and development of models for better interpretation of biological data to extract knowledge.

Prerequisites:

- Biological Science
- Basics of Data Structure and Programming

Detailed Content:

Module	***Content***	***Hours/ Module***
1	Introduction to Bioinformatics A word on Bioinformatics, Introduction, Branches of Bioinformatics, Aims of Bioinformatics, Scope/research areas of bioinformatics	5
2	Sequence and molecular file form and ats, Introduction, Sequence file formats, Sequence conversion tools, Molecular file formats, Molecular file format conversion Databases in bioinformatics & introduction: - Introduction, Biological databases, Classification schema of biological databases, Biological database retrieval system Biological sequence databases, National Centre for biotechnology information (NCBI), Introduction, Tools and databases of NCBI, Database retrieval tool, Sequence submission to NCBI, BLAST, PSI-BLAST, RPS-BLAST, Specialized tools, Nucleotide database, Literature database, Protein database, Gene expression database, GEO, Structural database, Chemical database, Other databases, EMBL Nucleotide Sequence Database, Introduction, Sequence retrieval, Sequence submission at EMBL, Resources of EMBL, Biological annotation and data curation, Sequence.	8
3	Introduction, Concept of alignment, Scoring Matrices, PAM, BLOSUM, Alignment of pairs of sequences, Alignment algorithms, Heuristic methods, Multiple sequence Alignment (MSA) Gene prediction methods: principles and challenges, Introduction, Biological overview, What is gene prediction? Computational methods of gene prediction, Combination of two methods, Why is gene prediction difficult.	7
4	Molecular Phylogeny Introduction, Phenotypic phylogeny and molecular phylogeny, Molecular clocks, Methods of phylogeny, Statistical Evaluation of the obtained phylogenetic trees or validation methods, Software for phylogenetic analysis, Reliability of molecular phylogenetic prediction Molecular Viewers, Introduction, A few molecular viewers, RasMol, Deep view- The Swiss-PDB viewer (SPDBV), Cn3D.	5
5	Protein and secondary structure prediction: Introduction, Levels of protein structure, Conformational parameter's Secondary structure of a protein, Secondary structure types, Secondary structure prediction, Software for secondary structure prediction, Limitations of secondary structure prediction. Protein modelling: Introduction, Methods of protein modelling, Homology or comparative modelling, Model	7

	refinement, Evaluation of the model.	

Text book and Reference books:

1. Bioinformatics: A Textbook, Wiley Online Library
2. Mount, D. W. (2001). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Bourne, P. E., &Gu, J. (2009). Structural Bioinformatics. Hoboken, NJ: Wiley-Liss.
4. Lesk, A. M. (2004). Introduction to Protein Science: Architecture, Function, and Genomics. Oxford: Oxford University Press.
5. Campbell, M &Heyer, L. J. (2006), Discovering Genomics, Proteomics and Bioinformatics, Pearson Education.
6. Oprea, T. (2005). Chemo informatics in Drug Discovery, Volume 23. Wiley Online Library.

OEC-AIML-701C: Robotics
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:
1. Perform kinematic and dynamic analyses with simulation.
2. Design control laws for a robot.
3. Apply sensor and vision system for controlling a robot.
4. Integrate mechanical and electrical hardware for a real prototype of robotic device.
5. Develop mathematical model to represent dynamic system.
6. Select a robotic system for given application.

Prerequisites:
- Basic Engineering Mathematics

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Introduction to Robotics: Types and components of a robot, Classification of robots, closed-loop and open loop control systems, Kinematics systems; Definition of mechanisms and manipulators, Social issues and safety.	3
2	Robot Kinematics and Dynamics: Kinematic Modelling: Translation and Rotation Representation, Coordinate transformation, DH parameters, Jacobian, Singularity, and Statics, Dynamic Modelling: Equations of motion: Euler-Lagrange formulation.	6
3	Sensors and Vision System: Sensor: Contact and Proximity, Position, Velocity, Force, Tactile etc. Introduction to Cameras, Camera calibration, Geometry of Image formation, Euclidean/Similarity/Affine/Projective transformations. Vision applications in robotics.	9
4	Robot Control: Basics of control: Transfer functions, Control laws: P, PD, PID Non-linear and advanced controls	10
5	Robot Actuation Systems: Actuators: Electric, Hydraulic and Pneumatic; Transmission: Gears, Timing Belts and Bearings, Parameters for selection of	3

	actuators.	
6	Control Hardware and Interfacing: Embedded systems: Architecture and integration with sensors, actuators, components, Programming for Robot Applications	9

Text book and Reference books:

1. Saha, S.K., "Introduction to Robotics, 2nd Edition, McGraw-Hill Higher Education, New Delhi, 2014.
2. Ghosal, A., "Robotics", Oxford, New Delhi, 2006.
3. Niku Saeed B., "Introduction to Robotics: Analysis, Systems, Applications", PHI, New Delhi.
4. Mittal R.K. and Nagrath I.J., "Robotics and Control", Tata McGraw Hill.
5. Mukherjee S., "Robotics and Automation", Khanna Publishing House, Delhi.
6. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Modelling and Control", John Wiley and Sons Inc, 2005
7. Steve Heath, "Embedded System Design", 2nd Edition, Newnes, Burlington, 2003
8. Merzouki R., Samantaray A.K., Phathak P.M. and Bouamama B. Ould, "Intelligent Mechatronic System: Modeling, Control and Diagnosis", Springer.

OEC-AIML-701D: Compiler Design
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Describe the compilation phases, input and output of each phases, recognizing different possible errors detected by different phases..
2. Design a DFA to recognize partial keywords of C programming language and lexical analyzer, automated lexical analyzer using LEX, and FLEX.
3. Understand the role of a parser, syntax analysis phase, top-down parsing and bottom-up parsing techniques and automated parser generation tool: YACC.
4. Realize and explain the role of semantic analysis phase with data type handling issues, associated actions with CFG rules using SDD and SDT.
5. Understand different ways of intermediate code generation techniques and intermediate representation of any high-level language code segment, and run-time environment issues during compilation.
6. Develop the knowledge of code optimization and code generation issues, construct flow graphs and DAG representation of basic blocks, and register allocation and assignment.

Prerequisites:

1. Automata Theory
2. Knowledge of Programming Language

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Introduction to Compiling Compilers, Analysis of the source program, The phases of the compiler, Cousins of the compiler.	2
2	Lexical Analysis	4

	The role of the lexical analyzer, Tokens, Patterns, Lexemes, Input buffering, Specifications of a token, Recognition of a tokens, Finite automata, From a regular expression to an NFA, From a regular expression to NFA, From a regular expression to DFA, Design of a lexical analyzer generator (Lex).	
3	Syntax Analysis The role of a parser, Context free grammars, Writing a grammar, Top down Parsing, Non-recursive Predictive parsing (LL), Bottom up parsing, Handles, Viable prefixes, Operator precedence parsing, LR parsers (SLR, LALR), Parser generators (YACC). Error Recovery strategies for different parsing techniques.	7
4	Syntax directed translation Syntax director definitions, Construction of syntax trees, Bottom-up evaluation of S attributed definitions, L attributed definitions, Bottom-up evaluation of inherited attributes.	4
5	Type checking Type systems, Specification of a simple type checker, Equivalence of type expressions, Type conversions.	2
6	Run time environments Source language issues (Activation trees, Control stack, scope of declaration, Binding of names), Storage organization (Subdivision of run-time memory, Activation records), Storage allocation strategies, Parameter passing (call by value, call by reference, copy restore, call by name), Symbol tables, dynamic storage allocation techniques.	5
7	Intermediate code generation Intermediate languages, Graphical representation, Three-address code, Implementation of three address statements (Quadruples, Triples, Indirect triples).	4
8	Code optimization Introduction, Basic blocks & flow graphs, Transformation of basic blocks, Dag representation of basic blocks, The principle sources of optimization, Loops in flow graph, Peephole optimization.	4
9	Code generations Issues in the design of code generator, a simple code generator, Register allocation & assignment.	3

Text book and Reference books:

1. Aho, Sethi, Ullman - “Compiler Principles, Techniques and Tools” - Pearson Education.
2. Holub - “Compiler Design in C” - PHI.
3. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, “Introduction to Automata Theory,Languages and Computation”, 3rd Edition, Pearson Education, 2014
4. Alfred V. Aho, Monica S Lam, Ravi Sethi, Jeffery D Ullman, “Compilers: Principles, Techniques, and Tools”, 2nd Edition, Pearson Education, 2015.
5. Michael Sipser, “Introduction to the Theory of Computation”, 2nd Edition, Wadsworth Publishing Co Inc, 3rd Edition, 2012.

HSMC-AIML-701: Principles of Management
Contacts: 3L per week Credits: 3

Course Outcomes:

At the end of this course, students will demonstrate the ability to

- Learn the basic concept of management, function of management, planning, organizational structure, and organizational effectiveness.
- Understand in depth relationship of management and society.
- Express knowledge of people management & managerial competency.
- Understand leadership theory, decision making process & knowledge development in economic, financial and quantitative analysis.
- Learn about market and customer management.
- Demonstrate in-depth knowledge of operation, technology management and different quality assurance drivers in the industry and their practical usage.

Detailed Content:

Module	***Content***	***Hours/ Module***
1	Basic concepts of management: Definition – Essence, Functions, Roles, Level. Functions of Management: Planning – Concept, Nature, Types, Analysis, Management by objectives; Organisation Structure – Concept, Structure, Principles, Centralization, Decentralization, Span of Management; Organisational Effectiveness.	7
2	Management and Society – Concept, External Environment, CSR, Corporate Governance, Ethical Standards. People Management – Overview, Job design, Recruitment & Selection, Training & Development, Stress Management. Managerial Competencies – Communication, Motivation, Team Effectiveness, Conflict Management, Creativity, Entrepreneurship.	8
3	Leadership: Concept, Nature, Styles. Decision making: Concept, Nature, Process, Tools & techniques. Economic, Financial & Quantitative Analysis – Production, Markets, National Income Accounting, Financial Function & Goals, Financial Statement & Ratio Analysis, Quantitative Methods – Statistical Interference, Forecasting, Regression Analysis, Statistical Quality Control.	8
4	Customer Management – Market Planning & Research, Marketing Mix, Advertising & Brand Management. Operations & Technology Management – Production & Operations Management, Logistics & Supply Chain Management, TQM, Kaizen & Six Sigma, MIS.	7

Text book and Reference books:

1. Management: Principles, Processes & Practices – Bhat, A & Kumar, A (OUP).
2. Essentials for Management – Koontz, Revised edition, Tata McGraw Hill (TMH)
3. Management – Stoner, James A. F. (Pearson)
4. Management - Ghuman, Tata McGraw Hill(TMH)

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Semester-VIII

PEC-AIML-801A: Natural Language Processing
Contacts: 3L per week Credits: 3

Course Outcomes (COs):

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

1. Justify the various steps necessary for processing natural language
2. Suggest appropriate lexical and parsing techniques for a given natural language

3. Apply appropriate statistical models for a given natural language application
4. Modify existing algorithms to suit any natural language for processing
5. Recommend appropriate pre-processing steps essential for the various applications involving natural language processing.
6. Design applications involving natural language

Prerequisites:

1. Linear algebra
2. Probability and Statistics
3. Artificial Intelligence and Neural Networks
4. Programming in any high level language, preferably python

Detailed Content:

Unit	*Content*	*Hrs/ Unit*
1	Regular Expressions and Automata (Recap) [2L] Introduction to NLP, Regular Expression, Finite State Automata Tokenization [5L] Word Tokenization, Normalization, Sentence Segmentation, Named Entity Recognition, Multi Word Extraction, Spell Checking - Bayesian Approach, Minimum Edit Distance. Morphology [4L] Morphology - Inflectional and Derivational Morphology, Finite State Morphological Parsing, The Lexiconand Morphotactics, Morphological Parsing with Finite State Transducers, Orthographic Rules and Finite State Transducers, Porter Stemmer	11
2	Language Modeling [4L] Introduction to N-grams, Chain Rule, Smoothing - Add-One Smoothing, Witten-Bell Discounting; Backoff, Deleted Interpolation, N-grams for Spelling and Word Prediction, Evaluation of language models. Hidden Markov Models and POS Tagging [4L] Markov Chain, Hidden Markov Models, Forward Algorithm, Viterbi Algorithm, Part of Speech Tagging - Rule based and Machine Learning based approaches, Evaluation	8
3	Text Classification [4L] Text Classification, Naïve Bayes' Text Classification, Evaluation, Sentiment Analysis - Opinion Mining and Emotion Analysis, Resources and Techniques Context Free Grammar [5L] Context Free Grammar and Constituency, Some common CFG phenomena for English, Top-Down and Bottom-up parsing, Probabilistic Context Free Grammar, Dependency Parsing	9
4	Computational Lexical Semantics [4L] Introduction to Lexical Semantics - Homonymy, Polysemy, Synonymy, Thesaurus - WordNet, Computational Lexical Semantics - Thesaurus based and Distributional Word Similarity. Information Retrieval [5L] Boolean Retrieval, Term-document incidence, The Inverted Index, Query Optimization, Phrase Queries, Ranked Retrieval - Term Frequency - Inverse Document Frequency based ranking, Zone Indexing, Query term proximity, Cosine ranking, Combining different features for ranking, Search Engine Evaluation, Relevance Feedback	9

Text Books and References:

1. Speech and Language Processing, Jurafsky and Martin, Pearson Education

2. Foundation of Statistical Natural Language Processing, Manning and Schutze, MIT Press

PEC-AIML-801B: Ethical Issues in AI
Contacts: 3L per week Credits: 3

Course Outcomes (COs):

At the end of the course, a student should be able to:

1. Describe knowledge of philosophical issues involved in ethics of artificial intelligence
2. Demonstrate familiarity with relevant examples of AI systems
3. Value the ability to work in a small team
4. Develop written work regularly to a deadline
5. Acquire ability to express arguments clearly and concisely
6. Construct skills in research, analysis and argumentation

Prerequisites:

1. Knowledge about Artificial Intelligence

Detailed Content:

Unit	*Contents*	*Hrs/ Unit*
1	AI, information transmission, information processing, and privacy: o Big data and privacy o Big data and human identity o Gender and cultural bias	6
2	Ethics of information and Ethics of AI o Ethical issues for different strengths/grades of AI and AI algorithms o Medium to strong AI: the moral relevance and effects of its ontological differences	5
3	Normative ethics proposals: advantages and disadvantages: o Rule consequentialism o Deontological approaches o Care ethics o Virtue Ethics o Problems with implementation o Problems with uptake and enforcement	9
4	Software qualities and normative ethics o Interpretability, transparency and normative ethics o Interpretability, transparency and policy making o Extensibility, usability, and communicability	8
5	Ethics of AI on the Web and in Web based applications The relationship between AI and the posthuman	4
6	Strong AIs as potential epistemic and moral agents o Models, representations, and introspection o Interventions and counterfactuals o Emulating plasticity: synaptic plasticity versus intrinsic plasticity o Imagination	8

Text Books/ Reference Books:

1. "Ethics of Artificial Intelligence" edited by S. Matthew Liao. Oxford University Press.
2. "The Oxford Handbook of Ethics of AI" edited by Frank Pasquale, Sunit Das, Markus Dirk Dubber. Oxford University Press.

PEC-AIML-801C: Digital Image Processing
Contacts: 3L per week Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

- Review the fundamental concepts of a digital image processing system.
- Analyze images in the frequency domain using various transforms.
- Evaluate the techniques for image enhancement and image restoration.
- Categorize various compression techniques.
- Interpret Image compression standards.
- Interpret image segmentation and representation techniques.

Prerequisites:

- Digital Signal Processing
- Linear Algebra
- Signals and Systems
- Discrete Mathematics

Detailed Content:

Module	***Content***	***Hours/ Module***
1	**Introduction:** Overview of Image Processing, Application area of image processing, Digital Image Representation, Sampling & quantization. Spatial and Intensity resolution, interpolation, Relationship between pixels – Neighbors, Adjacency, connectivity, Regions, Boundaries and Distance.	5
2	**Image Enhancement in Spatial Domain:** Image Quality and Need for image enhancement, Intensity transformation – negative, log, power-law and contrast stretching (linear and non-linear) Histogram based techniques, Spatial Filtering concepts, Spatial Convolution and Correlation, Image smoothing and Sharpening spatial filters. **Image Enhancement in Frequency Domain:** Properties of 1-D and 2-D Discrete Fourier Transform (DFT), Basic of filtering in the frequency domain. Image smoothing and sharpening in frequency domain.	9
3	**Image Restoration:** Introduction to degradation, Types of Image degradations, image degradation models, noise modeling, Estimation of degradation functions, Image restoration in presence of noise only – spatial filtering, Periodic noise and band – pass and band reject filtering.	5
4	**Image Compression:** coding redundancy, Image compression model, Compression Methods – Huffman coding, Arithmetic coding, LZW coding, Run-length coding, and Predicative coding and Vector quantization.	6

5	**Image Segmentation:** Introduction, Detection of Discontinuities, Point Detection, Line Detection and Edge Detection, Thresholding – Local, Global, Optimum, Multiple and Variable, Hough Transforms, Principle of region – growing, splitting and merging.	6

Text book and Reference books:

1. Rafael C. Gonzalez, Richard E woods, Digital Image Processing, Pearson.
2. S. Jayaraman, S. Esakkirajan, T. Veerakumar, Digital Image Processing, McGraw Hill
3. Anil K Jain "Fundamentals of Digital Image Processing", Pearson.
4. S. Sridhar, "Digital Image Processing", OXFORD University Press, Second Edition.
5. Bhabatosh Chanda, Dwijesh Dutta Majumder, Digital Image Processing and Analysis, Prentice Hall of India

PEC-AIML-801D: Applications of AI in Biomedical Engineering
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Understand models of human and artificial intelligence, specifically computational models of intelligence.
2. Comprehend a collection of machines learning models (identified and covered in the course), and their applications in medicine and healthcare.
3. Identify and apply appropriate intelligent system models and computational tools to specific problems in biomedicine and healthcare.
4. Analyze the performance of specific models as applied to biomedical problems, and justify their use and limitations.
5. Identify, understand, and interpret methods and evidence from artificial intelligence and other relevant literature.
6. Effectively communicate and disseminate knowledge in any science or engineering domain in the context of computing, systems, and/or biomedical applications.

Prerequisites:

1. Biology
2. Probability & Statistics

Detailed Content:

Sl No	*Content*	*Hours/ Module*
1	Foundations 1. Introduction to Human and Artificial Intelligence: terminologies, computational models of intelligence; conceptual frameworks from cognitive and educational psychology, neuroscience, information theory, and linguistics; philosophical foundations of AI 2. Review of relevant mathematical and statistical concepts: logarithmic loss, cross entropy optimizing cost functions; linear and logistic regression.	10

	3. Forms of Learning: supervised, semi-supervised, unsupervised, active, and transfer learning 4. Supervised Learning: (a) Decision trees, non-parametric methods for learning, support vector machines, (b) Bio-inspired Learning (from perceptron to deep learning): neural basis of computing, classical neural networks, deep neural networks, deep belief networks, recurrent neural networks, and convolutional neural networks. 5. Unsupervised Learning: basic and advanced clustering techniques, dimensionality reduction (feature selection and feature extraction) 6. Knowledge Representation and Reasoning: Prepositional logic, first-order logic, ontological engineering, probabilistic reasoning 7. Time-series analysis: temporal models (probabilistic reasoning over time) 8. Emerging paradigms and concepts in artificial social and emotional intelligence	
2	Applications 9. Unique characteristics and challenges in medicine and healthcare; History and status quo of intelligent and expert systems in medicine. 10. Risk stratification, patient outcome prediction, disease progression modelling 11. Clinical decision-making and intelligent systems to support evidence-based medicine 12. Phenotype and clinical/bio-marker discovery, Relevance to personalized medicine 13. Analysis of tissue morphology and other medical imaging applications	10
3	Implementation and Evaluation 14. Tools and Technologies for implementing AI methods 15. Model evaluation and performance metrics, cross-validation, model interpretability 16. Ethics of AI: bias, fairness, accountability, and transparency in machine learning; Ethical, Legal, and Social Issues of AI in medicine and healthcare	10
	TOTAL	30

Text/ Reference Books:

1. Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again. Amazon.
2. Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes.
3. Artificial Intelligence in Healthcare - 2nd Edition.

OEC-AIML-801A: Operation Research
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Design linear programming tools for optimal utilization of resources in various types of industries.
2. Evaluate transportation problems to minimize cost and understand the principles of assignment of jobs and recruitment polices.
3. Analyze decision making under certainty, uncertainty and conflicting situations.
4. Apply forecasting methods for predicting demands.
5. Understand the basic elements of a Queuing model.
6. Remember and Define PERT/CPM technique for project scheduling and resource allocation in an optimal way.

Prerequisites:

1. Probability and Statistics
2. Discrete Mathematics

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Introduction to Operations Research: Introduction, Historical Background, Scope of Operations Research, Features of Operations Research, Phases of Operations Research, Types of Operations Research Models, Operations Research Methodology, Operations Research Techniques and Tools.	3
2	Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Case Studies of LPP, Graphical Methods to Solve Linear Programming Problems, Applications, Advantages, Limitations. Graphical Analysis of Linear Programming Problems: Introduction, Graphical Analysis, Some Basic Definitions, Graphical Methods to Solve LPP, Some Exceptional Cases, Important Geometric Properties of LPP. Simplex Method: Introduction, Standard Form of LPP, Fundamental theorem of LPP, Solution of LPP - Simplex Method, The Simplex Algorithm, Penalty Cost Method or Big M-method, Two Phase Method, Solved Problems on Minimization. Duality in Linear Programming Problem: Introduction, Importance of Duality Concepts, Formulation of Dual Problem, Economic Interpretation of Duality, Sensitivity Analysis.	7
3	Transportation Problem: Introduction, Formulation of Transportation Problem (TP), Transportation Algorithm (MODI Method), the Initial Basic Feasible Solution, Moving Towards Optimality. Assignment Problem: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Travelling Salesman Problem.	5
4	Project Management Using CPM-PERT: Project Scheduling and PERT-CPM: Introduction, Basic Difference between PERT and CPM, PERT/CPM Network Components and Precedence Relationship, Project Management – PERT, Float calculation and its importance. Cost reduction by Crashing of activity	4
5	Queuing Theory: Basis of Queuing theory, elements of queuing theory, Operating characteristics of a queuing system, Queue discipline, Service Mechanism, Classification of Queuing models, [M/M/1]:{//FCFS} Queue System, numerical. Inventory Management: Inventory classification, Different costs associated to Inventory, Inventory models with deterministic demands (EOQ, EPQ and price discount models), inventory classification systems.	6
6	Job Sequencing: Introduction to sequencing and scheduling models: n job two machines problem, n job 3 machines problem. Decision Theory: Introduction, Decision under certainty, Decision under risk, Decision under uncertainty: Laplace criterion, MaxiMin criterion, MiniMax criterion, savage MiniMax regret criterion, Hurwicz criterion, Decision tree.	4
7	Replacement Theory: Introduction, Replacement of capital equipment which depreciated with time, replacement by alternative equipment, Group and individual replacement policy.	3

Text book and Reference books:

1. F.S. Hillier, G.J. Lieberman, B. Nag and P. Basu, Introduction to Operation Research, 10th Edition, McGraw Hill, 2017.
2. C. Mohan and K. Deep, Optimization Techniques, New Age, 2009.
3. N.D. Vohra, Quantitative Techniques in Management, 5th Edition, McGraw-Hill.
4. K.V. Mittal and C. Mohan, Optimization Methods in Operations Research and Systems Analysis, New Age, 2003.
5. H.A. Taha, Operations Research - An Introduction, 7th Edition, Prentice Hall, 2002.
6. Ravindran, D.T. Phillips and J.J. Solberg, Operations Research: Principles and Practice, 2nd Edition, John Willey and Sons, 2009.
7. K. Bedi, Production and Operations Management, Oxford University Press, 2004.
8. S.J. Chandra and A. Mehra, Numerical Optimization with Applications, Narosa, 2009.
9. J.K. Sharma, Operation Research: Theory and Applications, 5th Edition, Macmillan Pub., 2013.
10. L.W. Wayne, Operations Research Applications and Algorithms, 4th Edition, Brooks/Cole, USA.

OEC-AIML-801B: Economic Policies in India
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Assemble ideas of the basic characteristics of Indian economy, its potential on natural resources.
2. Evaluate land reforms and green revolutions.
3. Analyze critical assessment of Economic Reforms.
4. Interpret the importance, cause and impact of population growth and its distribution, translate and relate them with economic development.
5. Understand economic planning and developmental issues.
6. Remember WTO and Indian agriculture issues.

Prerequisites:

- Economics for Engineers

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Economic Development and its Determinants: Approaches to economic development and its measurement, sustainable development; Role of State, market and other institutions; Indicators of development – PQLI, Human Development Index (HDI), gender development indices. Planning in India: Objective and strategy of planning; Failures and achievements of Plans; Developing grass-root organizations for development – Panchayats, NGOs and pressure groups.	8
2	Demographic Features, Poverty and Inequality: Broad demographic features of Indian population; rural-urban migration; Urbanization and civic amenities; Poverty and Inequality. Resource Base and Infrastructure: Energy; social infrastructure – education and health; Environment; Regional imbalance; Issues and policies in financing	9

	Infrastructure development. The Agricultural Sector: Institutional Structure – land reforms in India; Technological change in agriculture – pricing of agricultural inputs and output; industry; Agricultural finance policy; Agricultural Marketing and Warehousing; Issues Terms of trade between agriculture and in food security – policies for sustainable agriculture.	
3	Industrial policy; Public Sector enterprises and their performance; Problem of sick units in India; Privatization and disinvestment debate; Growth and pattern of industrialization; Small-scale sector; Productivity in industrial sector; Exit policy – issues in labour market reforms; approaches for employment generation. Public Finances: Fiscal federalism – Centre-State financial relations; Finances of central government; Finances of state governments; Parallel economy; Problems relating to fiscal policy; Fiscal sector reforms in India.	6
4	Money, Banking and Prices: Analysis of price behaviour in India; Financial sector reforms; Interest rate policy; Review of monetary policy of RBI; Money and capital markets; Working of SEBI in India. External Sector: Structure and direction of foreign trade; Balance of payments; Issues in export-import policy and FEMA; Exchange rate policy; Foreign capital and MNCs in India; The progress of trade reforms in India. Economic Reforms: Rationale of internal and external reforms; Globalization of Indian economy; WTO and its impact on the different sectors of the economy; Need for and issues in good governance; Issues in competition and safety nets in Indian economy.	7

Text book and Reference books:

1. Ahluwalia, I.J. and I.M.D Little (Eds.) (1999), India's Economic Reforms and Development (Essays in honour of Manmohan Singh), Oxford University Press, New Delhi.
2. Bardhan, P. K. (9th Edition) (1999), The Political Economy of Development in India, Oxford University Press, New Delhi.
3. Bawa, R. s. and P. S. Raikhy (Ed.) (1997), Structural Changes in Indian Economy, Guru Nanak Dev University Press, Amritsar.
4. Brahmananda, P. R. and V. R. Panchmukhi (Eds.) (2001), Development Experience in the Indian Economy: Inter-State Perspectives, Book well, Delhi.
5. Chakravarty, S. (1987), Development Planning: The Indian Experience, Oxford University Press, New Delhi.
6. Dantwala, M. L. (1996), Dilemmas of Growth: The IndianExperience, Sage Publications, New Delhi.
7. Datt, R. (Ed.) (2001), Second Generation Economic Reforms in India, Deep Publications, New Delhi.
8. Government of India, Economic Survey (Annual), Ministry of Finance, New Delhi.
9. Jain, a. K. (1986), Economic Planning in India, Ashish Publishing House, New Delhi.
10. Jalan, B. (1992), The Indian Economy – Problems and Prospects, Viking, New Delhi.

OEC-AIML-801C: Microelectronics and VLSI
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Have a basic understanding of the MOS device physics, its working as well as its secondary effects.

2. Design a CMOS circuit for any logic function.
3. Design circuits using alternate logic styles
4. Design and analyze the circuit parameters like delay and power.
5. Draw the layout for combinational logic circuits manually and using tools.
6. Use modern simulation tools to verify the functionality of a circuit.

Prerequisites:

- Knowledge about MOS, MOS-Characteristics, MOS Capacitors, Short Channel MOS, CMOS inverters, MOS Gates.
- Basic knowledge on Analog Circuit Theory and Digital Circuits.

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Introduction to VLSI Design: VLSI Design Concepts, Moor's Law, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI – basic idea only), Types of VLSI Chips (Analog & Digital VLSI chips, General purpose, ASIC, PLA, FPGA) , Design principles (Digital VLSI – Concept of Regularity, Granularity etc), Design Domains (Behavioral, Structural)	6
2	Micro-electronic Processes for VLSI Fabrication: Silicon Semiconductor Technology- An Overview, Wafer processing, Oxidation, Epitaxial deposition, Ion-implantation & Diffusion, Cleaning, Etching, Photo-lithography – Positive & Negative photo-resist; Basic CMOS Technology – (Steps in fabricating CMOS), Basic n-well CMOS process, p-well CMOS process, Twin tub process, Silicon on insulator; Layout Design Rule: Stick diagram with examples, Layout rules .	10
3	CMOS for Digital VLSI Circuits: Recapitulation of MOS; CMOS, CMOS inverter characteristics; CMOS logic circuits, NAND & NOR Gates, Complex logic circuits, CMOS Full Adder, CMOS Transmission GATE, Advanced CMOS Logic circuits; Sequential CMOS logic circuits; SR Latch circuit, clocked JK Latch/ Master-Slave JK, CMOS D-latch & Edge triggered flip-flop	10
4	Analog VLSI Circuits: Analog VLSI design steps; Basic building blocks of Analog VLSI chips; MOS switch; Active load / resistors; Voltage dividers; CMOS Current source & sink; CMOS Voltage references/voltage dividers [Basic circuits only]; CMOS Differential amplifier; Output amplifiers [Basic circuits only]; CMOS OPAMP ; Switched capacitor filter	8
5	Sequential Circuit Design & Designing Arithmetic Building Blocks: Static and dynamic Latches and registers-Timing issues, pipelines, clock strategies. Data Path Circuits- Architectures for ripple carry adders-carry look ahead adders high speed adders-Multipliers-dividers-Barrel Shifters-speed and area tradeoff.	6

Text book and Reference books:

1. Digital Integrated Circuit, J.M.Rabaey, Chandrasan, Nicolic, Pearson Education.
2. CMOS Digital Integrated Circuit, S.M.Kang & Y.Leblebici, TMH.
3. Modern VLSI Design, Wayne Wolf, Pearson Education.
4. VHDL, Bhaskar, PHI.
5. Advance Digital Design Using Verilog , Michel D. Celliti, PHI
6. Digital Integrated Circuits, Demassa & Ciccone, John Willey & Sons.

7. Modern VLSI Design: system on silicon, Wayne Wolf; Addison Wesley Longman Publisher
8. Basic VLSI Design, Douglas A. Pucknell & Kamran Eshranghian, PHI
9. CMOS Circuit Design, Layout & Simulation, R.J.Baker, H.W.Lee, D.E. Boyee, PHI
10. CMOS Analog Circuit Design by P.E. Allen & D.R. Holberg; OUP

OEC-AIML-801D: Quantum Computing
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:
1. Explain the working of a Quantum Computing program, its architecture and program model.
2. Develop quantum logic gate circuits.
3. Design different mathematical foundation for quantum computing.
4. Develop quantum computing algorithm.
5. Program quantum algorithm on major toolkits.
6. Find different quantum computational complexity.

Prerequisites:
- Data Structure and Algorithm
- Programming in Python/C#

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Introduction to Quantum Computing: Motivation for studying Quantum Computing Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.), Origin of Quantum Computing Overview of major concepts in Quantum Computing: Qubits and multi-qubits states, Bracket notation. Bloch Sphere representation, Quantum Superposition, Quantum Entanglement	3
2	Math Foundation for Quantum Computing: Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors	8
3	Building Blocks for Quantum Program: Architecture of a Quantum Computing platform Details of q-bit system of information representation: Block Sphere, Multi-qubits States, Quantum superposition of qubits (valid and invalid superposition), Quantum Entanglement, Useful states from quantum algorithmic perceptive e.g. Bell State, Operation on qubits: Measuring and transforming using gates. Quantum Logic gates and Circuit: Pauli, Hadamard, phase shift, controlled gates, Ising, Deutsch, swap etc. Programming model for a Quantum Computing Program: Steps performed on classical computer, Steps performed on Quantum Computer, Moving data between bits and qubits.	8
4	Quantum Algorithms: Basic techniques exploited by quantum algorithms: Amplitude amplification,	10

	Quantum Fourier Transform, Phase Kick-back, Quantum Phase estimation, Quantum Walks. Major Algorithms: Shor's Algorithm, Grover's Algorithm, Deutsch's Algorithm, Deutsch -Jozsa Algorithm. OSS Toolkits for implementing Quantum program: IBM quantum experience Microsoft Q: Rigetti PyQuil (QPU/QVM)	
5	Quantum Computational Complexity and Error Correction: Computational complexity, Black-box model, Lower bounds for searching general, Black-box lower bounds, Polynomial method, Block sensitivity, Adversary methods, Classical error correction, Classical three-bit code, Fault tolerance, Quantum error correction Three- and nine-qubit quantum codes, Fault-tolerant quantum computation.	7

Text book and Reference books:

1. Michael A. Nielsen, "Quantum Computation and Quantum Information", Cambridge University Press.
2. David McMahon, "Quantum Computing Explained", Wiley.
3. IBM Experience: https://quantumexperience,ng,bluemix.net
4. Microsoft Quantum Development Kit: https://www.microsoft.com/en-us/quantum/development-kit
5. Forest SDK PyQuil: https://pyquil.readthedocs.io/en/stable/
6. P. Kaye, R. Laflamme, and M. Mosca, "An introduction to Quantum Computing", Oxford University Press, 1999.
7. V. Sahni, "Quantum Computing", Tata McGraw-Hill Publishing Company, 2007.

OEC-AIML-802A: Organizational Behaviour
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Discuss** the development of the field of organizational behaviour and explain the micro and macro approaches
2. **Analyze** and compare different models used to explain individual behaviour related to motivation and rewards
3. **Identify** the processes used in developing communication and resolving conflicts
4. **Explain** group dynamics and demonstrate skills required for working in groups (team building)
5. **Evaluate** the various leadership styles and the role of leaders in a decision making process.
6. **Design** the implementation of organizational change

Prerequisites:

- Soft Skill and Interpersonal Communication

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Definition, need and importance of organizational behaviour – Nature and scope –	5

	Frame work – Organizational behaviour models.	
2	Individual Behaviour: Personality – types – Factors influencing personality – Theories – Learning – Types of learners – The learning process – Learning theories – Organizational behaviour modification. Misbehaviour – Types – Management Intervention. Emotions - Emotional Labour – Emotional Intelligence – Theories. Attitudes – Characteristics – Components – Formation – Measurement- Values. Perceptions – Importance – Factors influencing perception – Interpersonal perception- Impression Management. Motivation – importance – Types – Effects on work behavior.	8
3	Group Behaviour: Organization structure – Formation – Groups in organizations – Influence – Group dynamics – Emergence of informal leaders and working norms – Group decision making techniques –Team building- Interpersonal relations – Communication – Control.	7
4	Leadership and Power: Meaning – Importance – Leadership styles – Theories – Leaders Vs Managers – Sources of power – Power centers – Power and Politics.	5
5	Dynamics of Organizational Behaviour Organizational culture and climate – Factors affecting organizational climate – Importance. Job satisfaction – Determinants – Measurements – Influence on behavior. Organizational change – Importance – Stability Vs Change – Proactive Vs Reaction change – the change process – Resistance to change – Managing change. Stress – Work Stressors – Prevention and Management of stress – Balancing work and Life. Organizational development – Characteristics – objectives –. Organizational effectiveness.	5

Text book and Reference books:

1. P. Robins, Organisational Behavior, PHI Learning / Pearson Education,11th edition, 2008.
2. Fred Luthans, Organisational Behavior, McGraw Hill, 11th Edition, 2001.
3. Schermerhorn, Hunt and Osborn, Organisational behavior, John Wiley, 9th Edition, 2008.
4. Udai Pareek, Understanding Organisational Behaviour, 2nd Edition, Oxford Higher Education, 2004.
5. Mc Shane & Von Glinov, Organisational Behaviour, 4th Edition, Tata Mc Graw Hill, 2007.
6. Hellrigal, Slocum and Woodman, Organisational Behavior, Cengage Learning, 11th Edition 2007.
7. Ivancevich, Konopaske &Maheson, Oranisational Behaviour & Management, 7th edition, Tata McGraw Hill, 2008.

OEC-AIML-802B: Human Resource Management
Lecture per week (L): 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. **Demonstrate** an understanding of key terms, theories/concepts and practices within the field of HRM
2. **Design** competence in development and problem-solving in the area of HRM
3. **Formulate** innovative solutions to problems in the fields of HRM

4. **Identify** and appreciate the significance of the ethical issues in HR
5. **Analyze** the problem and issues related to human resources in an organization.
6. **Integrate** the understanding of various HR concepts along with the domain concept in order to take correct business decisions.

Prerequisites:

1. Interpersonal and soft skill
2. English communication

Detailed Content:

Module	*Content*	*Hours/ Module*
1	HRD-Macro Perspective: HRD Concept, Origin and Need, HRD as a Total System; Approaches to HRD; Human Development and HRD; HRD at Macro and Micro Climate	5
2	HRD–Micro Perspective: Areas of HRD; HRD Interventions Performance Appraisal, Potential Appraisal, Feedback and Performance Coaching, Training, Career Planning, OD or Systems Development, Rewards, Employee Welfare and Quality of Work Life and Human Resource Information; Staffing for HRD: Roles of HR Developer; Physical and Financial Resources for HRD; HR Accounting; HRD Audit, Strategic HRD	7
3	Instructional Technology for HRD Learning and HRD; Models and Curriculum; Principles of Learning; Group and Individual Learning; Transactional Analysis; Assessment Centre; Behaviour Modeling and Self Directed Learning.	7
4	Human Resource Training and Development: Concept and Importance; Assessing Training Needs; Designing and Evaluating T&D Programmes; Role, Responsibilities and challenges to Training Managers.	5
5	Training Methods: Training with in Industry (TWI): On the Job & Off the Job Training; Management Development: Lecture Method; Role Play; In-basket Exercise; Simulation; Vestibule Training; Management Games; Case Study; Programmed Instruction; Team Development; Sensitivity Training; Globalization challenges and Strategies of Training; Program, Review on T&D Programmes in India	7

Text book and Reference books:

1. Nadler, Leonard: Corporate Human Resource Development, Van Nostrand Reinhold, ASTD, New York.
2. Rao, T.V and Pareek, Udai: Designing and Managing Human Resource Systems, Oxford IBH Pub. Pvt.Ltd., New Delhi , 2005.
3. Rao, T.V: Readings in HRD, Oxford IBH Pub. Pvt. Ltd., New Delhi, 2004.
4. Viramani, B.R and Seth, Parmila: Evaluating Management Development, Vision Books, New Delhi.
5. Rao, T.V.(et.al): HRD in the New Economic Environment, Tata McGraw-Hill Pub.Pvt, Ltd., New Delhi, 2003

OEC-AIML-802C: Research Methodology
Lecture per week: 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Discuss different methodologies and techniques used in research work.
2. Explain basic computer skills necessary for the conduct of research.
3. Explain key research concepts and issues.
4. Select and define appropriate research problem and parameters.
5. Develop the required numerical skills necessary to carry out research.
6. Develop an appropriate framework for research studies.

Prerequisites:

- Probability and Statistics

Detailed Content:

Module	*Content*	*Hours/ Module*
1	Research Formulation and Design: Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.	8
2	Data Collection and Analysis: Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically package (Sigma STAT, SPSS for student t-test, ANOVA, etc.), hypothesis testing	8
3	Research Ethics, IPR and Scholarly Publishing: Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.	8
4	Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Project Report, Layout of the Project/Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Project/Research Report, Precautions for Writing Research Reports, Conclusions.	8

Text book and Reference books:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications.2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing.
5. Wadehra, B.L. 2000. Law relating to patents, trade-marks, copyright designs and geographical indications. Universal Law Publishing.

6. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
7. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
9. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
10. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
11. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
12. Satarkar, S.V., 2000. Intellectual property rights and Copy right. EssEss Publications.

OEC-AIML-802D: Soft Skill and Interpersonal Communication
Lecture per week: 3 Credits: 3

Course Outcomes (COs):

At the end of the course, the students will be able to:

1. Develop effective communication skills (spoken and written).
2. Develop effective presentation skills.
3. Develop all-round personalities with a mature outlook to function effectively in different circumstances.
4. Develop broad career plans, evaluate the employment market, identify the organizations to get good placement, match the job requirements and skill sets.
5. Improve self-confidence.
6. Become more effective individual through goal/target setting, self-motivation and practicing creative thinking.

Prerequisites:

- English Grammar

Detailed Content:

Module	*Content*	*Hours/ Module*
1	An Introduction – Definition and Significance of Soft Skills; Process, Importance and Measurement of Soft Skill Development. Inter personal relations; communication models, process and barriers; team communication; developing interpersonal relationships through effective communication; listening skills; essential formal writing skills; corporate communication styles –assertion, persuasion, negotiation	6
2	SWOT & Creative Thinking Discovering the Self; Setting Goals; Beliefs, Values, Attitude, Virtue. Developing Positive Thinking and Attitude; Driving out Negativity; Meaning and Theories of Motivation; Enhancing Motivation Levels.	6
3	Corporate Communication Public Speaking: Skills, Methods, Strategies and Essential tips for effective public speaking. Group Discussion: Importance, Planning, Elements, Skills assessed; Effectively	6

	disagreeing, Initiating, Summarizing and Attaining the Objective. Interview& Presentation Skills: Interviewer and Interviewee– in-depth perspectives. Before, During and After the Interview. Tips for Success: Types, Content, Audience Analysis, Essential Tips – Before, During and After, Overcoming Nervousness	
4	Non-Verbal Communication & Personality Development Importance and Elements; Body Language. Concept, Essentials Meaning, Nature, Features, Stages, Models; Learning Skills; Adaptability Skills.	6
5	Business Etiquette & Team Work Concept of Teams; Building effective teams; Concept of Leadership and honing Leadership skills. Meaning, Nature, Features, Stages, Models; Learning Skills; Adaptability Skills	6

Text book and Reference books:

1. Managing Soft Skills for Personality Development – edited by B.N. Ghosh, McGraw Hill India, 2012.
2. Effective Communication and Soft Skills, Nitin Bhatnagar, Pearson Education India, 2011
3. English and Soft Skills – S.P. Dhanavel, Orient Blackswan India, 2010.
4. Effective Business Communication, Kulbhushan Kumar, Khanna Publishing House, 2021

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