

HALDIA INSTITUTE OF TECHNOLOGY (AUTONOMOUS)
B. Tech in Computer Science & Engineering (Cyber Security)
PROGRAM OUTCOMES (ALIGNED WITH GRADUATE ATTRIBUTES) (PO)

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 modelling 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 teamwork:** 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-CS-301	Digital Electronics & Computer Architecture	4	0	0	4
2		Professional Core Course	PCC-CS-301	Data Structure and Algorithms	3	1	0	4
3		Professional Core Course	PCC-CS-302	Object Oriented Programming using Java	3	1	0	4
4		Basic Science Course	BSC-CS-301	Linear Algebra	2	0	0	2
5		Humanities Social Science including Management Course	HSMC-CS-301	Economics for Engineers	2	0	0	2
6	Practical	Engineering Science Course	ESC-CS-391	Digital Electronics Lab	0	0	4	2
7		Professional Core Course	PCC-CS-391	Data Structure and Algorithms Lab	0	0	3	1.5
8		Professional Core Course	PCC-CS-392	Object Oriented Programming Lab using Java	0	0	3	1.5
Total Credits								21

Semester IV (Second year)

Sl. No.		Type of Course	Code	Course Title	Hours per week			Credits
					L	T	P	
1	Theory	Basic Science Course	BSC-CS-401	Discrete Mathematics	3	0	0	3
2		Engineering Science Course	ESC-CS-401	Formal Language and Automata Theory	3	1	0	4
3		Professional Core Course	PCC-CS-401	Data Communication and Networks	3	1	0	4
4		Professional Core Course	PCC-CS-402	Operating System	3	0	0	3
5		Professional Core Course	PCC-CS-403	Malware Analysis	2	0	0	2
6		Humanities and Social Sciences including Management	HSMC-CS-401	Cyber Law and Professional Ethics	2	0	0	2
7	Practical	Professional Core Course	PCC-CS-491	Data Communication and Networks Lab	0	0	3	1.5
8		Professional Core Course	PCC-CS-492	Operating System Lab	0	0	3	1.5
9		Professional Core Course	PCC-CS-493	IT Workshop (Python)	0	0	3	1.5
10		Mandatory Course	MC-CS-401	Environmental Sciences	2	0	0	0
Total Credits								22.5

Semester V (Third Year)								
Sl. No.		Type of Course	Code	Course Title	Hours per week			Credits
					L	T	P	
1	Theory	Engineering Science Course	ESC-CS-501	Probability and Statistics	3	0	0	3
2		Professional Core Course	PCC-CS-501	Database Management System	3	1	0	4
3		Professional Core Course	PCC-CS-502	Internet Technology	3	0	0	3
4		Professional Core Course	PCC-CS-503	Cryptography & Network Security	3	1	0	4
5		Professional Elective Course I	PEC-CS-501 (A/B/C/D)	Cloud Computing and Security	3	0	0	3
				Compiler Design				
				Digital Image Processing				
				Mobile Computing				
6		Open Elective Course I	OEC-CS-501 (A/B/C/D)	Ethical Hacking	2	0	0	2
				Graph Theory				
	Numerical Methods							
	Qualitative Skills Practice I							
7	Practical	Professional Core Course	PCC-CS-591	Database Management System Lab	0	0	3	1.5
8		Professional Core Course	PCC-CS-592	Internet Technology Lab	0	0	3	1.5
9		Professional Core Course	PCC-CS-593	Cryptography & Network Security Lab	0	0	3	1.5
Total Credits								23.5

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-CS-601	Digital Forensics	3	0	0	3
2		Professional Core Course	PCC-CS-602	Artificial Intelligence and Machine Learning in Security	3	0	0	3
3		Humanities and Social Sciences Including Management	HSMC-CS-601	Project Management and Entrepreneurship	3	0	0	3
4		Professional Elective Course II	PEC-CS-601 (A/B/C/D)	Introduction to IoT Application	3	0	0	3
				Design and Analysis of Algorithm				
				Principles of Generative AI & LLM Architectures				
				Natural Language Processing				
5		Open Elective Course II	OEC-CS-601 (A/B/C/D)	Security Assessment and Audit	3	0	0	3
				Web Application Security				
	Human Resource Management							
	Economic Policies in India							
6	Open Elective Course III	OEC-CS-602 (A/B/C/D)	Software Engineering	3	0	0	3	
			Operation Research					
			Social Network Analysis					
			Qualitative Skills Practice II					
7	Practical	Professional Core Course	PCC-CS-691	Digital Forensics Lab	0	0	3	1.5
8		Professional Core Course	PCC-CS-692	Artificial Intelligence and Machine Learning Lab	0	0	3	1.5
9		Professional Core Course	PCC-CS-693	Oracle Application Development Lab	0	0	3	1.5
Total Credits								22.5

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-CS-701 (A/B/C/D)	Deep Learning	3	1	0	4
				Big Data Analytics				
				Steganography and Watermarking				
				Bio Informatics				
2	Theory	Professional Elective Course IV	PEC-CS-702 (A/B/C/D)	Block chain and Crypto Currency	3	1	0	4
				Information Theory and Coding				
				Soft skill and Interpersonal Communication				
				Qualitative Skills Practice III				
3	Sessional	Project	PROJ-CS-781	Project I	0	0	10	5
4		Summer Internship	SI-CS-782	Internship I				3
Total Credits								16

Semester VIII (Fourth Year)

<u>Semester VIII (Fourth Year)</u>								
Sl. No.		Type of Course	Code	Course Title	Hours per week			Credits
					L	T	P	
1		Professional Elective Course V	PEC-CS-801 (A/B/C/D)	Introduction to Quantum Algorithm	3	1	0	4
				Data Analytics in Fraud Detection				
				Deep Learning in Cyber Security				
				Web and Database Security				
2		Open Elective Course IV	OEC-CS-801 (A/B/C/D)	E-commerce and ERP	3	1	0	4
				Multimedia Security				
				Introduction to Arts and Aesthetics				
				Research Methodology				
3	Sessional	Project	PROJ-CS-881	Project II	0	0	10	5
4		Winter Internship	WI-CS-882	Internship II				3
Total Credits								16

Semester-III

ESC-CS-301: DIGITAL ELECTRONICS & COMPUTER ARCHITECTURE

CONTACTS: 4(L) PER WEEK

CREDITS: 4

Course Outcomes (COs):

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

ESC-CS-301	CO1	Recall number system, Boolean algebra, working of logic families and logic gates.
	CO2	Understand data representation, and experiment with basic arithmetic operations.
	CO3	Apply various modes of I/O operations and summarize working principles of I/O interface circuits.
	CO4	Analyze and model various functional units of CPU such as ALU, control unit and register file.
	CO5	Evaluate the memory hierarchy concept for further memory implementation.
	CO6	Design and implement many Sequential and Combinational circuits

Prerequisites:

1. Number Systems
2. Basic programming skills
3. Basics of Digital Electronics

Detailed Content:

Module	Content	Hours/ Module
Part A: Digital Electronics		
1.	Introduction: 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.	2
2.	Boolean Algebra: 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, Demultiplexer and Parity Generator. Error detecting and correcting codes. Adders, Subtractors, BCD arithmetic, carry look ahead adder, serial adder	6
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	7
Part B: Computer Architecture		

1.	Introduction: Role of operating systems and compiler/assembler. Fetch, decode and execute cycle, Concept of operator, operand, registers and storage. Fixed and floating point representation of numbers. Overflow and underflow.	2
2.	Fixed point multiplication - Booth's algorithm. Fixed point division - Restoring and non-restoring algorithms. Design of ALU.	5
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.	6
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.	7
	Total	40

Text book and Reference books:

1. Digital Electronics – Kharate – Oxford
2. Digital Electronics – Logic & Systems by J.Bigmeil & R.Donovan; Cambridge Learning.
3. Digital Logic and State Machine Design (3rd Edition) – D. J. Comer, OUP
4. P. Raja- Digital Electronics- Scitech Publications
5. Morris Mano- Digital Logic Design- PHI
6. R. P. Jain—Modern Digital Electronics, 2/e , McGraw Hill
7. H. Taub & D. Shilling, Digital Integrated Electronics- McGraw Hill.
8. D. Ray Chaudhuri- Digital Circuits-Vol-I & II, 2/e- Platinum Publishers
9. Tocci, Widmer, Moss- Digital Systems,9/e- Pearson
10. J. Bignell & R. Donovan-Digital Electronics-5/e- Cenage Learning.
11. Leach & Malvino—Digital Principles & Application, 5/e, McGraw Hill
12. Floyd & Jain- Digital Fundamentals-Pearson.
13. Mano, M. M., —Computer System Architecture, PHI.
14. Behrooz Parhami –Computer Architecture, Oxford University Press
15. Hayes J. P., –Computer Architecture & Organisation, McGraw Hill,
16. Hamacher, –Computer Organisation, McGraw Hill,
17. T. K. Ghosh, –Computer Organization 2nd Ed., TMH
18. Chaudhuri P. Pal, —Computer Organisation & Design, PHI,
19. P. N. Basu- –Computer Organization & Architecture, Vikas Pub
20. Rajaraman – –Computer Organization & Architecture, PHI
21. B. Ram – –Computer Organization & Architecture, New Age Publications

PCC-CS-301: DATA STRUCTURE AND ALGORITHMS
CONTACTS: 3(L) + 1(T) PER WEEK
CREDITS: 4

Course Outcomes (COs):

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

PCC-CS-301	CO1	Understand and remember introductory concepts of data structure, time and space analysis of algorithms using different asymptotic notations.
	CO2	Understand the concept of operations of linear data structures like stack, queue, array, linked list and apply in real life problem solving
	CO3	Understand the concept of operations non-linear data structure such as trees, its traversal, insertion, deletion, height-balanced and B-tree and apply in real life problem solving.
	CO4	Analyze the time and space complexities various algorithms.
	CO5	Analyze and evaluate various searching and sorting algorithms along with the problem analysis and representation of graph traversal methods, including Breadth-First Search (BFS) and Depth-First Search (DFS).
	CO6	Analyze and evaluate the importance of data structure and be able to correlate future programming structure, and its market issues specific to complex engineering 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 trade off. 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– Corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each type of Queues: Algorithms and their analysis.	8
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	Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis. 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. B Tree, B+ Tree: definitions, algorithms and analysis.	9
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	Introduction to NP and Approximation algorithm.	2

	Total	40
--	--------------	----

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.B Patel, Khanna Publishing House.

PCC-CS-302: OBJECT ORIENTED PROGRAMMING USING JAVA
CONTACTS: 3(L) + 1(T) PER WEEK
CREDITS: 4

Course Outcomes (COs):

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

PCC-CS-302	CO1	Remember key concepts and terminologies related to Object-Oriented Programming (OOP), such as class, object, encapsulation, inheritance, polymorphism,
	CO2	Understand the basic architecture of Java (byte-code, JVM) along with the advantages of using Java.
	CO3	Implement and apply basic Java programs and I/O operations that utilize OOP principles.
	CO4	Analyze Java code for error handling mechanisms, and the use of multithreading approach.
	CO5	Evaluate different Java data structures and classes within the Java Collection Framework (e.g., ArrayList, HashSet) for optimal performance in various programming scenarios.
	CO6	Design and develop a complete Java application that incorporates OOP concepts, handles exceptions, implements multithreading, and utilizes Event Handling and GUI components from AWT/Swing.

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.	7
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 Basic String handling in Java: (All relevant methods from String class and StringBuffer class) Concept of mutable and immutable string, command line arguments, Wrapper class ,Basic I/O operations using BufferedReader and Scanner class. 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.	13
3	Exception handling & Multithreading: Exception handling basics, different types of exception classes, use of try & catch with throw, throws & finally, creation of user defined exception classes. 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.	9
4	AWT/Swing and Event Handling: AWT classes, Frame Windows, Graphics, Working with color and font labels, Buttons, boxes, List, Text field, Understanding Layout managers, Border layout, Grid Layout. Event Handling: Event Delegation Model, Window Event, Mouse Event, Key Event etc. Introduction to Swing components.	8
5	Introduction to Java Collection Framework Overview to Interfaces SET, LIST etc., Classes ArrayList, Vector, LinkedList, HashSet, LinkedHastSet etc.The software development process, Model-view-controller pattern.	3
	Total	40

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, Mc Graw Hill.
3. The complete reference-Java2, Patrick Naughton, Herbert Schildt, TMH.
4. Core Java For Beginners, R.K Das, VIKAS PUBLISHING.

5. Java How to Program, Deitel and Deitel, 6th Ed. – Pearson.
6. Beginning Java 2 SDK, Ivor Horton's, Wrox.
7. Programming With Java: A Primer, E. Balagurusamy, 3rd Ed., TMH.

BSC-CS-301: LINEAR ALGEBRA
CONTACTS: 2(L) PER WEEK
CREDITS: 2

Course Outcomes (COs):

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

BSC-CS-301	CO1	Remember key concepts and terminology related to linear algebra.
	CO2	Understand the concepts of matrix, vector spaces, significance of linear transformations and their matrix representations.
	CO3	Apply elementary row operations to solve systems of linear equations.
	CO4	Analyze linear transformations using the rank-nullity theorem, diagonalizability of transformations.
	CO5	Evaluate implications of the Cayley-Hamilton theorem on minimization and primary decomposition theorem.
	CO6	Understand concepts like Gram-Schmidt process for orthonormalization, cyclic decompositions, Jordan forms.

Prerequisites:

- Mathematics-I
- Mathematics-II

DETAILED CONTENT:

<i>Module</i>	<i>Content</i>	<i>Hours/Module</i>
1	Vector spaces, Subspaces, Linearly dependent and independent vectors, Bases and dimension, Ordered bases and coordinates.	5
2	Linear transformations, Rank-nullity theorem, Algebra of linear transformations, Isomorphism, Matrix representation, Change of basis, Linear functional, Transpose of a linear transformation.	7
3	Characteristic values and characteristic vectors of linear transformations, Diagonalizability, Minimal polynomial of a linear transformation, Invariant subspaces, Direct-sum decompositions, Invariant direct sums, Jordan forms, Generalized eigenvectors.	7
4	Inner product spaces, Orthonormal bases, Projections, Orthogonal projections, Gram-Schmidt process.	5
	Total	24

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-CS-301: ECONOMICS FOR ENGINEERS

CONTACTS: 2(L) PER WEEK

CREDITS: 2

Course Outcomes (COs):

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

HSMC-CS-301	CO1	Students will recall and explain fundamental concepts of engineering economics.
	CO2	Students will apply economic principles and techniques to analyze engineering projects and make informed decisions based on economic criteria.
	CO3	Students will analyze project cost structures, estimate costs using appropriate methods, and evaluate cost-effectiveness of the engineering projects using NPV, IRR, BCR etc.
	CO4	Students will integrate economic sustainability considerations into engineering design and decision-making processes by assessing project risk through sensitivity analysis.
	CO5	Students will engage in critical analysis of economic challenges, synthesizing information to devise innovative solutions for engineering problems.
	CO6	Students will be able to take decisions which will be grounded in ethical considerations, addressing both economic constraints and societal needs.

Pre-requisites: Analytical and mathematical

DETAILED CONTENT:

Module	Content	Hours/ Module
1	Introduction to Engineering Economy: Origin of Engineering Economy, Principles of Engineering Economy, Role of Engineers in Decision Making	2
2	Time Value of Money : Introduction to Time Value of Money, Simple Interest, Compound Interest, Nominal Interest rate, Effective Interest rate, Continuous Compounding, Economic Equivalence, Development of Interest Formulas, The Five Types of Cash flows, Single Cash flow Formulas, Uneven Payment Series, Equal Payment Series	4

3	Methods of comparison of alternatives: NPV, Profitability Index or Benefit Cost Ratio, Payback Period Method, Equivalent Worth Methods, Present Worth Method, Future Worth Method, Annual Worth Method, Rate of Return Methods (IRR and ARR)	4
4	Engineering Costs & Estimation: Elements of cost (Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs) and cost estimation models (Per-Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve), Concept of Revenue, Break even analysis, Cost sheet.	6
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.	4
Total		20

Text books and Reference books:

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

ESC-CS-391: DIGITAL ELECTRONICS LAB
CONTACTS: 4(P) PER WEEK
CREDITS: 2

Course Outcomes:

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

ESC-CS-391	CO1	Recall knowledge about basics of digital electronics logic gates and number system.
	CO2	Explain about how to solve problems related to number systems and Boolean algebra.
	CO3	Apply digital electronics logic gates knowledge for implement sequential digital circuits like flip-flops, registers, counters and verify outputs
	CO4	Compare and analyze various synchronous and asynchronous sequential circuits.
	CO5	Identify, evaluate working logic of combinational circuits like adder, subtractor, multiplexer etc.
	CO6	Design and construct combinational and sequential circuits and using logic gates and flip flop verify outputs

Laboratory Experiments:	
1	Design Half Adder, Full Adder, Half Subtractor and Full Subtractor using basic gates and verify outputs.
2	Design other combinational circuits using 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-CS-391: DATA STRUCTURE AND ALGORITHMS LAB
CONTACTS: 3(P) PER WEEK
CREDITS: 1.5

Course Outcomes (COs):

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

PCC-CS-391	CO1	Remember introductory concepts of data structure, and implement basic searching and sorting algorithms
	CO2	Apply the concept of operations of linear data structures like stack, queue, array, linked list in real life problem solving
	CO3	Evaluate recursive and non-recursive traversal of trees and implementation of recursive binary tree traversal and AVL tree.
	CO4	Evaluate expressions operations using multiple stacks & queues..
	CO5	Analyze and evaluate various searching and sorting algorithms along with the problem analysis and representation of graph traversal methods, including Breadth-First Search (BFS) and Depth-First Search (DFS).
	CO6	Analyze and evaluate the importance of data structure and be able to correlate future programming structure, and its market issues specific to complex engineering problems.

Prerequisites:

- Programming for Problem Solving
- Data Structure and Algorithms

Laboratory Experiments:	
Linear Data Structure	
1	Implementation of array operations.
2	Stacks and Queues: adding, deleting elements

	Circular Queue: Adding & deleting Elements.
3	Application of Stack: Evaluation of expressions operations on Multiple stacks & queues:
4	Implementation of linked lists: inserting, deleting and inverting a linked list. Implementation of stacks & queues using linked lists.
5	Polynomial addition, Polynomial multiplication.
Non Linear Data Structure	
6	Recursive and Non-recursive traversal of Trees.
7	Threaded binary tree traversal. AVL tree implementation.
8	Application of Trees. Application of sorting and searching algorithms.
9	Hash tables implementation: searching, inserting and deleting, searching & Sorting techniques.
Total lab sessions	
	10

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.B Patel, Khanna Publishing House

PCC-CS-392: OBJECT ORIENTED PROGRAMMING USING JAVA LAB
CONTACTS: 3(P) PER WEEK
CREDITS: 1.5

Course Outcomes (COs):

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

PCC-CS-392	CO1	Remember key concepts and terminologies related to Object-Oriented Programming (OOP), such as class, object, encapsulation, inheritance, polymorphism,
	CO2	Understand the basic architecture of Java (byte-code, JVM) along with the advantages of using Java.
	CO3	Implement and apply basic Java programs and I/O operations that utilize OOP principles.
	CO4	Analyze Java code for error handling mechanisms, and the use of multithreading approach.
	CO5	Evaluate different Java data structures and classes within the Java Collection Framework (e.g., ArrayList, HashSet) for optimal performance in various programming scenarios.
	CO6	Design and develop a complete Java application that incorporates OOP concepts, handles exceptions, implements multithreading, and utilizes Event Handling and GUI components from AWT/Swing.

Prerequisites:

- Programming for Problem Solving
- Object Oriented Programming & Java

Detailed Content:

Laboratory Experiments:	
1.	Assignments on basic programming. Decision control, Loop Control, Array.
2.	Assignments on class, constructor, overloading, inheritance, overriding.
3.	Assignments on Strings.
4.	Assignments on developing abstract class interfaces- multiple inheritance, extending interfaces
5.	Assignments on creating and accessing packages
6.	Assignments on multithreaded programming, Exception handling programming.
7.	Assignments on AWT/Swings and Event handling programming
	Note: Use Java for programming
Total Lab sessions	10

- 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 book and Reference books:

1. Object Oriented Modelling and Design, Rumbaugh, James Michael, Blaha, Prentice Hall, India.
2. Object Oriented System Development Ali Bahrami, Mc Graw Hill.
3. The complete reference-Java2, Patrick Naughton, Herbert Schildt, TMH.
4. Core Java for Beginners, R.K Das, VIKAS PUBLISHING.
5. Java How to Program, Deitel and Deitel, 6th Ed. – Pearson.
6. Beginning Java 2 SDK, Ivor Horton's, Wrox.
7. Programming with Java: A Primer, E. Balagurusamy, 3rd Ed., TMH.

FOURTH SEMESTER

BSC-CS-401: DISCRETE MATHEMATICS

Contacts: 3(L) per week

Credits: 3

Course Outcomes (COs):

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

BSC-CS-401	CO1	Recall and list mathematical logic for identify problems to solve them.
	CO2	Describe and summarize the concepts related to the basics of set theory and binary operations.
	CO3	Apply logical notations to define and reason-about fundamental mathematical concepts such as sets relations and functions.
	CO4	Discover and distinguish different operations on algebraic structure.
	CO5	Choose and justify appropriate algebraic structure for cryptographic operation.
	CO6	Create 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	<p>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.</p> <p>Function: Definition, type of functions, one to one, into and onto function, inverse function, composition of functions, recursively defined functions, pigeonhole principle. Composition of Functions.</p>	7
2	<p>Monoalphabetic Substitution Ciphers: Mathematical induction, Some number theory Modular arithmetic, Simple ciphers. Polyalphabetic Substitution Ciphers: The multiplication principle, Permutations and combinations, Probability theory. Bayesian methods of estimation. Random Processes: general concepts, power spectrum, discrete-time processes, random walks and other applications, Markov chains, transition probabilities.</p>	6

3	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.	8
4	Rings and fields: Definition and basic concepts in rings, examples and basic properties, zero divisors, integral domains, fields, characteristic of a ring, quotient field of an integral domain, subrings, ideals, maximal ideal, prime ideal, quotient rings. Advanced Number Theory: Primality Testing algorithms, Chinese Remainder Theorem, Quadratic Congruence, Discrete Logarithm, Factorization Methods, Side Channel Attacks, Shannon Theory, Perfect Secrecy, and Semantic Security.	9
5	Graph Theory: Introduction to Eulerian paths and circuits, Hamiltonian paths and circuits, Graph colouring, chromatic number, Isomorphism and Homomorphism of graphs, matching, vertex/edge covering.	5
Total		35

Text/Reference Books:

1. Discrete Mathematics with Applications, Koshy, Elsevier
2. Discrete Mathematical Structures By Lipshutz & Lipson, TMH
3. Discrete Mathematical Structures, Kolman et. al, Pearson
4. Fundamentals of Discrete Mathematical Structures, K R Chowdhary, 3ed, PHI
5. D.S. Dummit and R.M. Foote, "Abstract Algebra", John Wiley.
6. Michael Artin, "Algebra", Pearson Education.
7. J.A. Gallian, "Contemporary Abstract Algebra", Narosa Publishing House.
8. I. N. Herstein, "Topics in Algebra", Wiley.
9. N. Jacobson, "Basic Algebra I", Hindustan Publishing Company.
10. William Stallings, "Cryptography and Network Security Principles and Practice", Pearson Education.

ESC-CS-401: FORMAL LANGUAGE AND AUTOMATA THEORY CONTACTS: 3(L) +1(T) PER WEEK CREDITS: 4

Course Outcomes (COs):

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

ESC-CS-401	CO1	Identify finite automata to accept a set of strings of a language.
	CO2	Understanding whether the given language is regular or not.
	CO3	Use context free grammars to generate strings of context free language.
	CO4	Determine and design of computability and non-computability, decidability and un-decidability of language.
	CO5	Implement the hierarchy of formal languages, grammars, and machines.

	CO6	Analyze the equivalence of languages accepted by Push down Automata and languages generated by context free grammars.
--	------------	--

Pre-Requisite: NIL

Detailed Content:

Unit	Content	Hrs/ Unit
1	Introduction: Alphabet, languages and grammars, productions and derivation, Chomsky hierarchy of languages.	3
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)	11
3	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.	10
4	Context-sensitive languages: Context-sensitive grammars (CSG) and languages, linear bounded automata and equivalence with CSG.	6
5	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	8
6	Undecidability: Church-Turingthesis, universal Turing machine, the universal and diagonalization languages, reduction between languages and Rice s theorem, undecidable problems about languages	6
	Total	44

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.

PCC-CS-401: DATA COMMUNICATION AND NETWORKS
CONTACTS: 3(L) +1(T) PER WEEK
CREDITS: 4

Course Outcomes (COs):

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

PCC-CS-401	CO1	Identify and list 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.
	CO2	Understand the performance of the different routing protocol (RIP, OSPF) based on routing cost, convergence rate and complexity to find the shortest path.
	CO3	Implement the flow control and error control techniques.
	CO4	Examine and demonstrate different LLC protocols, Internet Protocol, and usage of the IP address and subnet mask to setup a network.
	CO5	Evaluate the importance of existing protocols (DNS, DHCP, FTP, WWW, HTTP) running in application layer.
	CO6	Investigates various techniques (open loop and close loop) to Develop congestion control and quality of service (traffic scheduling and shaping).

Prerequisites:

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

Detailed Content:

<i>Module</i>	<i>Content</i>	<i>Hours/Module</i>
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.	07
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	07
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.	09
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	08

	Protocols - RIP, OSPF, BGP.	
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.	06
6	Application Layer Protocols: DNS, SMTP, FTP & DHCP. Modern Topic: Introduction to wireless LAN and Bluetooth, Mobile IP, Mobile TCP.	05
Total		42

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-CS-402: OPERATING SYSTEM

CONTACTS: 3(L) PER WEEK

CREDITS: 3

Course Outcomes:

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

PCC-CS-402	CO1	Understand the mechanisms of OS to handle processes and threads and their communication
	CO2	Apply various CPU scheduling algorithms for any given problem and outline the needs and applications of process synchronization.
	CO3	Analyze the different schemes used in memory management including paging and segmentation.
	CO4	Understand the components and management aspects of concurrency management.
	CO5	Evaluate the effectiveness of various disk scheduling algorithms in optimizing I/O performance.
	CO6	Explain the structure of file systems and directory implementations. 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, Dining 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
	Total	35

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-CS-403: MALWARE ANALYSIS**CONTACTS: 2(L) PER WEEK****CREDITS: 2****Course Outcomes (COs):**

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

PCC-CS-403	CO1	Identify and analyze various malware types by static, dynamic analysis, and reverse engineering.
	CO2	Have an intimate understanding of executable formats, Windows internals and APIs, and malware analysis is techniques.
	CO3	Possess and implement the skills necessary to carry out independent analysis of modern malware samples using both static and dynamic analysis is techniques.
	CO4	Examine and extract investigative leads from host and network-based indicators associated with a malicious program.
	CO5	Evaluate and apply techniques and concepts to unpack, extract, decrypt, or bypass new anti-analysis techniques in future malware samples.
	CO6	Develop proficiency with industry standard tools including ProcMon, CFF Explorer, Proc Explore, Bin Text, File Analyzer, Olly Dbg etc.

Prerequisite: NIL**Detailed Content:**

Module	Content	Hours/Module
1	Malware taxonomy - Malware threats - Malware analysis methodologies – Legal considerations - Identifying and protecting against malware - Malware hiding places - Collecting malware from live system - Identifying malware in dead system Malware Analysis Environment : Virtual machine - Real systems - Malware analysis tools ProcMon, CFF Explorer, ProcExplore, BinText, FileAlyzer, OllyDbg	03
2	Static Analysis: Detailed file analysis -Database of file hashes. Identifying file compile date Identifying packing/ obfuscation methods - Strings analysis - File signature analysis - Local and online malware scanning -Identifying file dependencies.	03

3	Dynamic Analysis: System baselining - Host integrity - Monitor - Installation monitor - Process monitor - File monitor - Registry analysis/ monitoring - Network traffic monitoring/ ana lysis - Port monitor – DNS monitoring/ resolution -Simulating internet services	03
4	Code Analysis: Reverse engineering malicious code - Identifying malware passwords - Bypassing authentication - Assembly level computing Standard x86 instructions, Introduction to IDA, Olly Dbg, Advanced malware analysis Virus, Trojan. Parsing Basic analysis of an APK	03
5	Malicious Document Analysis: PDF and Microsoft Office document structures - PDF and office document vulnerabilities - Malware extraction and analysis tools – Analysis of malicious documents	03
6	Malware Challenges: Virtual environment – Live internet connection – Real, fake, and virtual services –Anti-debug and anti-forensic malware	03
7	Mobile Malware Analysis: Need for mobile application penetration testing methodology Android and iOS Vulnerabilities - Exploit Prevention - Handheld Exploitation- Android Root Spreading and Distribution Android Debugging	04
	Total	22

Text book and Reference books:

1. M. Sikorski and A. Honig, Practical Malware Analysis: The Hands-on Guide to Dissecting Malicious Software. San Francisco: No Starch Press San Francisco, CA, 2012.
2. M. H. Ligh, S. Adair, and B. Hartstein, Cookbook and DVD: Tools and Techniques for Fighting Malicious Code. Indianapolis, IN: Wiley, John Sons, 2010.
3. K. Dunham and S. Abu-Nimeh, Mobile Malware Attacks and Defense. Washington, DC, United States: Syngress Media,U.S., 2008.
4. C. H. Malin, J. M. Aquilina, and E. Casey, Malware Forensics Field Guide for Windows Systems: Digital Forensics Field Guides, R. Maxwell, Ed. Waltham, MA: Syngress Media,U.S., 2012.
5. B. Dang, A. Gazet, E. Bachaalany, and S. Josse, Practical Reverse Engineering: X86, X64, arm, Windows Kernel, Reversing Tools, and Obfuscation. United States: Wiley, 2014.
6. C. Eagle, The IDAPro Book: The Unofficial Guide to the world’s most popular Disassembler, 2nd Ed. San Francisco: No Starch Press San Francisco, CA, 2011.

HSMC-CS-401: CYBER LAW AND PROFESSIONAL ETHICS
CONTACTS: 2(L) PER WEEK
CREDITS: 2

Course Outcomes (COs):

After studying this course, student will be able to:

HSMC-CS-401	CO1	Remember the computer network and cyber-attacks on real time crimes.
	CO2	Understand in depth knowledge of information technology act and legal frame work of right to privacy, data security and data protection.
	CO3	Apply learner conversant with the social and intellectual property issues emerging from cyberspace.

	CO4	Analyze the legal and policy developments in various countries to regulate cyberspace.
	CO5	Evaluate the legal implication of cybercrime.
	CO6	Develop the understanding of relationship between commerce and cyberspace.

Prerequisites:

1. Computer Network Fundamentals
2. Cyber Security and Cyber attacks

Unit	Content	Hrs./ Unit
1.	<p>Introduction of Cybercrime: What is cybercrime? Forgery, Hacking, Computer Network intrusion [2L].</p> <p>Category Cybercrime: of how criminals plan attacks, passive attack, Active attacks, cyberstalking. [3L]</p> <p>Phishing & Identity Theft: Phishing methods, ID Theft; Online identity method. [3L]</p>	8
2.	<p>Cybercrime Mobile & Wireless devices: Security challenges posted by mobile devices, cryptographic security for mobile devices, Attacks on mobile/cellphones, Theft, Virus, Hacking. Bluetooth; Different viruses on laptop [4L]</p> <p>Tools and Methods used in Cybercrime: Proxy servers, pan word checking, Random checking, Trojan Horses and Backdoors; DOS & DDOS attacks; SQL injection: buffer over flow. [4L]</p>	8
3.	<p>Cyber Law: Basics of Law, Defining Cyber Laws, Scope and Jurisprudence, Concept of Jurisdiction, Cyber Jurisdiction, Overview of Indian Legal System, Introduction to IT Act 2000, Amendments in IT Act [3L]</p> <p>Indian IT Act and Standards: Indian IT ACT, Adjudication under Indian IT ACT, IT Service Management Concept, IT Audit standards, ISO/IEC 27000 Series, COBIT, HIPPA, SOX, System audit, Information security audit, ISMS, SoA (Statement of Applicability), BCP (Business Continuity Plan), DR (Disaster Recovery), RA (Risk Analysis/Assessment), Public key certificate. [5L]</p>	8
4.	<p>Intellectual Property Rights Issues: Copyrights, Jurisdiction Issues and Copyright Infringement, Multimedia and Copyright issues, WIPO, Intellectual Property Rights, Trademarks in Internet, Software Piracy, Legal Issues in Cyber Contracts, Authorship, Document Forgery [5L]</p> <p>International Laws governing Cyber Space: Introduction to International Cyber Law, UNCITRAL, Cyber Laws: Legal Issues and Challenges in India, Net neutrality, Role of INTERPOL. Cyber Laws of EU – USA – Australia - Britain, other specific Cyber laws [3L]</p>	8
	Total	32

Text book and Reference books:

1. Cyber security by Nina Gobole & Sunit Belapune; Wiley India.

2. Information Security & Cyber laws, Gupta & Gupta, Khanna Publishing House
3. Cyber Law Simplified, Vivel Sood , McGraw Hill Education
- 4 Cyber frauds, cybercrimes & law in India Pavan Duggal, Saakshar Law Publications
- 5 The Internet Law of India: Indian Law Series Shubham Sinha Create Space Independent Publishing Platform

PCC-CS-491: DATA COMMUNICATION AND NETWORKS LAB
LABS PER WEEK: 3
CREDITS: 1.5

Course Outcomes (COs):

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

PCC-CS-491	CO1	Identify an application to execute command remotely using socket programming.
	CO2	Understand file transfer application using socket programming.
	CO3	Use 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.
	CO4	Analyze error-control mechanism for data transmission.
	CO5	Evaluate and understand the concepts of NIC installation and configuration.
	CO6	Design a proper network environment to gather network information using socket programming.

Prerequisites:

- Programming for Problem Solving
- Data Structure and Algorithms
- Object Oriented Programming & Java
- Data Communication and 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 –

PCC-CS-492: OPERATING SYSTEM LAB
CONTACTS: 3P PER WEEK
CREDITS: 1.5

Course Outcomes:

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

PCC-CS-492	CO1	Remember shell syntax and perform the basic operations related to process and system using shell programming
	CO2	Understand and execute programs like, creating a new process, creating orphan process and zombie process, synchronizing parent and child process.
	CO3	Analyze process synchronization, applying the knowledge of semaphore and thread.
	CO4	Adapt the concept of signals and their uses in process executions.
	CO5	Apply POSIX threads using pthread_create, pthread_join and pthread_exit.
	CO6	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
	Total	16

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-CS-493: IT WORKSHOP (PYTHON)**CONTACTS: 3(P) PER WEEK****CREDITS: 1.5****Course Outcomes (COs):**

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

PCC-CS-493	CO1	Remember basic syntax, data types, operators to write simple Python statements and expressions.
	CO2	Understand control flow and decision making concept in Python for solving problems.
	CO3	Use/Apply Python data structures – lists, tuples & dictionaries for representing compound data
	CO4	Analyse/Examine Exception handling and file operations
	CO5	Use functions, modules and packages in Python for solving problems.
	CO6	Design and implement solutions to numeric data handling problems using NumPy arrays.

PREREQUISITES:

- Programming for Problem Solving

Syllabus

1. Introduction to Python
 - Overview of Python
 - History and Features of Python
 - Setting Up the Python Environment
 - Basic Syntax
 - Variables and Data Types
 - Operators
2. Control Flow
 - Conditional Statements
 - If Statements
 - If-Else Statements
 - Nested If-Else Statements
 - Looping Constructs
 - For Loops
 - While Loops
 - Nested Loops
 - Control Statements
 - Break Statement

- Continue Statement
 - Pass Statement
3. String Manipulation
- Accessing Strings
 - Basic String Operations
 - String Slicing
 - String Functions and Methods
4. Data Structures
- Lists
 - Introduction to Lists
 - Accessing Lists
 - List Operations
 - Functions and Methods for Lists
 - Tuples
 - Introduction to Tuples
 - Accessing Tuples
 - Tuple Operations
 - Functions and Methods for Tuples
 - Dictionaries
 - Introduction to Dictionaries
 - Accessing Values in Dictionaries
 - Working with Dictionaries
 - Properties of Dictionaries
5. Functions in Python
- Defining Functions
 - Calling Functions
 - Types of Functions
 - Function Arguments
 - Anonymous Functions (Lambda)
 - Global and Local Variables
6. Overview to modules and packages
- Importing Modules
 - Using the Math Module
 - Using the Random Module
 - Understanding Packages
 - Composition of Programs
7. Input and Output
- Printing Output on Screen
 - Reading Data from Keyboard
 - File Handling
 - Opening and Closing Files
 - Reading and Writing Files
 - Functions Related to Input and Output

- 8. Exception Handling
 - Understanding Exceptions
 - Exception Handling Mechanisms
 - The Except Clause
 - Try/Finally Clause
 - Creating User-Defined Exceptions

- 9. Introduction to NumPy
 - Introduction 95 6.2
 - Array
 - NumPy Array
 - Indexing and Slicing
 - Operations on Arrays
 - Concatenating Arrays , Reshaping Arrays, Splitting Arrays
 - Statistical Operations on Arrays
 - Loading Arrays from Files
 - Saving NumPy Arrays in Files on Disk

Total 10 lab sessions

Text book and Reference books:

1. Martin C. Brown — Python : The Complete Referencel, McGraw Hill Education
2. Reema Thareja — Python Programming: Using Problem Solving Approachll, Oxford University Press.
3. Ashok Namdev Kamthane and Amit Ashok Kamthane, —Programming and Problem Solving with Pythonll, McGraw Hill,
4. Vishwajit K. Barbudhe, llIntroduction of Pythonll, Notion Press
5. Taneja Sheetal and Kumar Naveen — Python Programming-A modular approachll, Pearson Education.

MC-CS-401: ENVIRONMENTAL SCIENCES
CONTACTS: 2(L) PER WEEK
CREDITS: 0

MC-CS-401	CO1	Understand the fundamental knowledge of different aspects of environment and local, regional and global environmental problems.
	CO2	Get the information about ecosystem and also about its functions like Food chain, Ecological pyramids etc.
	CO3	Reproduce 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.
	CO4	Explain the knowledge about the ecosystem diversity, its values and also about the importance of the endemic species and different techniques involved in its conservation.
	CO5	Apply the knowledge about the different types of pollutions and their control technologies, Waste water treatment, Bio medical waste management etc. into real life situations.

	CO6	Understand 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:

- Basic biological knowledge.

Detailed Content:

Module	Content	Hours/ Module
1	Environment: Basic concepts of Environment; Biosphere; Society, Environment & their interrelationship; Nature and scope of Environmental Science and Engineering; Overview of ecosystems and biodiversity; Biogeochemical Cycle: Oxygen, Carbon, Nitrogen, Phosphate, Sulphur etc.)	4
2	Air Pollution and Control: Atmospheric composition; Climate, Weather; Definition of pollutants and contaminants, Primary and secondary pollutants, sources and effects of pollutants; Greenhouse effect, Depletion of ozone layer, Acid rain, Sources and effects of water pollutants; Water Treatment System: Physical; Chemical; Biological.	4
3	Land Pollution: Lithosphere; Pollutants (Municipal, Industrial, Commercial, Agricultural, and Hazardous Solid Wastes); Origin and effects; Collection and disposal of solid waste, Recovery and conversion methods Noise Pollution: Sources, Effects, Standards and Control.	4
4	Environmental ethics and impact assessment : Environmental Impact Assessment, Environmental Audit, Environmental laws and protection act of India, Different international environmental treaty / Agreement / Protocol Awareness Activities: Small group meetings about waste management, Promotion of recycle use, Cleanliness drive, Avoiding electricity waste, Plantation, Slogan making event, Poster making event.	4
	Total	16

Reference Book:

1. Environmental Engineering, Davis & Cornwel, McGraw Hill.
2. Principles of Environmental Engineering, Gilbert Masters
3. Introduction to Environmental Biotechnology, Milton Wainwright
4. Environmental Biotechnology, Pradipta Kumar Mohapatra
5. A.K.De, Environmental Chemistry], New Age International

Semester-V

ESC-CS-501: PROBABILITY AND STATISTICS
CONTACTS: 3(L) PER WEEK
CREDITS: 3

Course Outcomes (COs):

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

ESC-CS-501	CO1	Students should be proficient in the application of the laws of logic to mathematical statements.
	CO2	Students should be competent enough to analyze the data based on statistics and probability. This also enables students to make use of data through curve filling and different equations.
	CO3	Prepare students for realization of journal papers outcomes, and expose them to the world of research. Illustrate the current research works and publications of the subjects in different fields adopted by the students as per course curriculum in various journals and literature.
	CO4	Lighten on the latest and modern developments in the research fields. Explain how the ideas those are adopted can be implemented through projects and demonstrate various models, recent project proposals executing the knowledge adopted from the course.
	CO5	An ability to function on multi-disciplinary teams and ability to analyze the local and global impact of computing on individuals, organizations, and society.
	CO6	An understanding of professional, ethical, legal, security and social issues and responsibilities.

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): 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. Special Distributions: Binomial and Poisson distributions, Normal distribution, Exponential distribution, Weibull distribution, Chebycheff's inequality and related examples.	10
3	Correlation and regression: Two dimensional random variables, Joint distribution and Joint density functions - Marginal, Conditional	10

	Distribution and Density functions. Regression and Correlation, Partial and Multiple Correlation- Multiple Regression, Curve fitting by least square method: straight lines, second degree parabolas and more general curves.	
4	Test of Significance: Random Sampling, Parameter, Statistic and its Sampling distribution, Standard error of statistic, Sampling distribution of sample mean and variance in random sampling from a normal distribution. Testing of hypothesis – Introduction - Types of errors, critical region, and 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
Total		35

Text book 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-CS-501: DATABASE MANAGEMENT SYSTEM
CONTACTS: 3(L) +1(T) PER WEEK
CREDITS: 4

Course Outcomes (COs):

On completion of the course students will be able to:

PCC-CS-501	CO1	Remember the fundamental elements of data structure; file system and memory management systems.
	CO2	Understand conversion rule to convert the ER-model to relational model, populate relational database and formulate SQL queries on data.
	CO3	Apply normalization techniques and functional dependency for robust database design.
	CO4	Analyze the transaction processing, concurrency control and recovery techniques, basic database storage structures and access techniques: file and page organizations, indexing methods including B tree, and hashing.
	CO5	Evaluate and optimize queries and improve the database design by Normalization, transaction processing, concurrency control and recovery techniques.
	CO6	Design database schema and implement it in real world application.

Prerequisites:

1. Basic programming skills
2. Data structure
3. Computer organization

Detailed Content:

Unit	Content	Hrs/ Unit
1.	Database system architecture: Introduction to DBMS, File based system versus Database System, 3 schema architecture, Data Abstraction, Data Independence, Administration roles, types of users.	4
2.	Data models: Relational model- definition and Properties, Key concepts, integrity constraints. Codd’s Rules. ER Model to Relational model. (ER Diagram –Strong entity, weak entity, binary, ternary relationship, cardinality, participation, extended ER feature)	6
3.	Query languages: Relational algebra (operations, Codd’s algebraic rules), Evaluation of relational algebra expressions, Querying by non-procedural language (SQL)	5
4.	Relational database design: Single valued functional dependency, Armstrong’s axioms, Normal forms (up to BCNF), Properties of decomposition. Multivalued Functional dependency, 4NF. (Overview), Join dependency and 5NF.	9
5.	Storage strategies: Storage structures (Sequential, indexed sequential) Types of single level index (Primary, secondary, clustering), multi-level index, Dynamic multilevel indices using B-trees and B+ tree (Creation, insertion, deletion)	6
6.	Transaction processing: Concurrency control, ACID property, Serializability of scheduling (conflict and view), Locking (2PL) and timestamp-based schedulers, Database recovery techniques.	6
7	Database Security: Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection, SQL injection.	4
	Total	40

Text book and Reference books:

1. “Database System Concepts”, 6th Edition by Abraham Silberschatz, Henry F. 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, New Delhi (AICTE Recommended Textbook – 2018)
4. “Fundamentals of Database Systems”, 5th Edition by R. Elmasri and S. Navathe,
5. Pearson Education “Foundations of Databases”, Reprint by Serge Abiteboul, Richard Hull, Victor Vianu, Addison-Wesley

PCC-CS-502: INTERNET TECHNOLOGY
CONTACTS: 3(L) PER WEEK
CREDITS: 3

Course Outcomes (COs):

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

PCC-CS-502	CO1	Remember the concepts of networking and internet.
	CO2	Understanding the concepts of Web design languages like HTML, Perl, Java Script and java applet and create cookies.
	CO3	Illustrate the concepts of Web design languages like HTML, Perl, Java Script and java applet and create cookies.
	CO4	Analyze a web page and identify its elements and attributes.
	CO5	Evaluate the concept of Multimedia Applications, Search Engine and Web Crawler.
	CO6	Design a dynamic web page using the concept of Languages and Create XML documents and Schemas.

Prerequisites:

- Knowledge of Programming Language
- Computer Networks

Detailed Content:

Module	Content	Hours/ Module
1	Introduction to World Wide Web: Domain and Sub domain, Address Resolution, DNS, Telnet, FTP, HTTP.	1
2	HTML: Introduction, Introduction to HTML, Editors, Elements, Attributes, Heading, Paragraph. Formatting, Link, Head, Table, List, Block, Layout, CSS.Form, Iframe, Colors, Colorname, Colorvalue. Image Maps: Map, area, attributes of image area. Extensible Markup Language (XML): Introduction to XML, Introduction, Tree, Syntax, Elements, Attributes, Validation, Viewing. XHTML in brief. CGI Scripts : Introduction, Environment Variable, GET and POST Methods	4
3	JavaScript: Basics, Statements, comments, variable, comparison, condition, switch, loop, break. Object – string, array, Boolean, reg-ex. Function, Errors, Validation. Cookies: Definition of cookies, Create and Store a cookie with example.	6

	Introduction to AWS services, Azure, GCD, Github, Git Lab, Bitbucket, React Native Flutter	6
4	Client-Server programming In Java: Java Socket, Java RMI. Network security techniques: Password and Authentication; VPN, IP Security, security in electronic transaction, Secure Socket Layer (SSL), SecureShell (SSH). Firewall: Introduction, Packet filtering, Stateful, Application layer, Proxy.	6
5	Search Engine and Web Crawler : Definition, Meta data, Web Crawler, Indexing, Page rank, overview of SEO	3
	Backend: NodeJS/ Spring Boot/ Spark/ Golang/ PHP (Introduction to PHP, Decisions and loop, Function, Array, Handling Html Form with PHP, Working with file and Directories, Session and Cookie, Database Connectivity with MySql, Exception Handling)	4
Total		30

Text book and Reference books:

1. Web Technology: A Developer's Perspective, N.P. Gopalan and J. Akilandeswari, PHI Learning, Delhi, 2013.
2. Internetworking Technologies, An Engineering Perspective, Rahul Banerjee, PHI Learning, Delhi, 2011.
3. Computational Thinking on The Internet: Foundations, Web Design & Cyber Security (3rd ed.), 2023.
4. Introduction to Security Reduction by Fuchun Guo, Willy Susilo, et al.

PCC-CS-503: CRYPTOGRAPHY AND NETWORK SECURITY
CONTACTS: 3(L) + 1(T) PER WEEK
CREDITS: 4

Course Outcomes (COs):

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

PCC-CS-503	CO1	Recall the concepts of computer networks, linear algebra and some of the factors driving the need for network security.
	CO2	Understand the terms vulnerability, threat and attack.
	CO3	Apply and classify particular examples of attacks.
	CO4	Analyze physical points of vulnerability in simple networks.
	CO5	Evaluate and contrast symmetric and asymmetric encryption systems and their vulnerability to attack, and explain the characteristics of hybrid systems.
	CO6	Develop new security enhancement mechanisms.

Prerequisites:

- Linear Algebra
- Mathematics I
- Discrete Mathematics

Detailed Content:

Module	Content	Hours/ Module
1	Introduction to Security: Introduction to security attacks, Confidentiality, Integrity & Availability – Authentication, Authorization & Non-Repudiation – Introduction to Plain Text, Cipher Text, Encryption and Decryption Techniques, Secure Key, symmetric cipher model, substitution techniques. Types of attacks- Caesar cipher, mono-alphabetic cipher, poly-alphabetic cipher, transposition techniques, etc.	5
3	Symmetric Encryption: Block cipher, Stream cipher - Data Encryption Standard (DES) - Cipher Block Chaining (CBC) – Multiple Encryption DES – International Data Encryption Algorithm (IDEA) - Advanced Encryption Standard (AES).	8
4	Asymmetric Encryption: symmetric key generation techniques – Applications of asymmetric encryption methods – RSA, Elliptic Curve Cryptography – Homomorphic encryption.	8
5	Digital Signature: Digital signature standards - Secure One-time Signatures - Application of Digital Signatures – Diffie-Hellman Key Exchange - Elliptic Curve Digital Signature algorithm.	5
6	Hashing and Message Digests: Cryptographic Hash Functions- Applications- Simple hash functions and features for ensuring security – Hash functions based on Cipher Block Chaining- Secure Hash Algorithm (SHA) - Message Digest - MD5.	5
7	Message Authentication: Authentication Systems – Password and Address – Security Handshake Drawbacks - Authentication Standards – Kerberos- PKI Trust Models -Message Authentication Codes (MAC) – Security features- MAC based on Hash Functions - MAC based on Block Ciphers.	5
8	Electronic mail security: PGP, S/MIME, Firewall, DMZ Network.	4
	Total	40

Text book and Reference books:

1. D. R. Stinson, Cryptography: Theory and Practice, 3rd Ed. Boca Raton, FL: Chapman & Hall/CRC, 2005.
2. W. Stallings, Cryptography and Network Security: Principles and Practice, 7th Ed. Pearson Publishers, 2017.
3. J. H. Silverman, A Friendly Introduction to Number Theory, 4th Ed. Boston: Pearson, 2012.
4. C. Kaufman, R. Perlman, and M. Speciner, Network Security: Private Communication in a

Public World, 2nd Ed. United States: Prentice Hall PTR, 2002.

5. Atul Kahate, "Cryptography and Network Security", 2nd Edition, 2009, McGraw Hill Education India Pvt Ltd.

PEC-CS-501A: CLOUD COMPUTING AND SECURITY

CONTACTS: 3(L) PER WEEK

CREDITS: 3

Course Outcomes (COs):

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

PEC-CS-501A	CO1	Describe cloud computing concepts, service models, and deployment models.
	CO2	Explain cloud computing architecture and virtualization.
	CO3	Apply IaaS concepts to provision and manage cloud resources.
	CO4	Analyze PaaS and SaaS service models and architectures.
	CO5	Evaluate cloud service management, including SLAs and billing models.
	CO6	Explain cloud security concepts, including IAM and data protection.

Prerequisites:

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

Detailed Content:

Module	Content	Hours/Module
1	Introduction to Cloud Computing: Definition, benefits, and limitations of cloud computing. Overview of Cloud service models (IaaS, PaaS, SaaS) and deployment models (Public, Private, Hybrid). Overview of major cloud providers (AWS, OCI, Azure, GCP, etc.).	3
2	Fundamentals Cloud Computing - Cloud Computing (NIST Model), Introduction to Cloud Computing, History of Cloud Computing, Role of cloud providers in delivering infrastructure, platform, and software services. Properties, Characteristics & Benefits and limitations of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing, Role of Open Standards.	4

3	Cloud Computing Architecture – Components of Cloud Computing Architecture, Cloud computing stack, Comparison with traditional computing architecture (client/server), Services provided at various levels, How Cloud Computing Works, Role of Networks in Cloud computing, protocols used, Virtualization and its Role in Cloud Architecture, Role of Cloud Service Models in architecture , Cloud Deployment Models , Cloud Resource Management and Load Balancing, Basic Cloud Security Architecture.	5
4	Infrastructure as a Service (IaaS) - Introduction to IaaS: IaaS definition, Introduction to virtualization, Different approaches to virtualization, Hypervisors, Machine Image, Virtual Machine (VM), Resource Virtualization: server, storage, Network-Virtual Machine (resource) provisioning and manageability, storage as a service, Data storage in cloud computing . Hands-on Activity Oracle Cloud – Compute – Hands-On Labs[Oracle Academy]/ Amazon EC2, Amazon S3. Platform as a Service (PaaS) - Definition and Fundamental Concepts of PaaS , PaaS Architecture and Service Model, Role of Service-Oriented Architecture (SOA) in PaaS, Cloud Platform and Management- Computation, Storage, Hands-on Activity: Deploy Application using Oracle APEX (PaaS) [Oracle Academy]/ overview of AWS Elastic Beanstalk, Software as a Service (SaaS) - Definition and Fundamental Concepts of SaaS, SaaS Architecture and Service Delivery Model, Role of Web Services in SaaS , SaaS Application Access and Delivery through Web Browsers, Multi-Tenancy and Resource Sharing in SaaS, Advantages and Limitations of SaaS, Case Study of Software as a Service Applications.	12
5	Service Management in Cloud Computing – Introduction to Service Management in Cloud Computing, Service Level Agreements (SLAs) in Cloud Computing, Billing and Accounting Models in Cloud Services, Comparison of Hardware Scaling: Traditional Infrastructure vs. Cloud Infrastructure, Economics of Cloud Scaling and Cost Benefits.	3
	Cloud Security - Cloud Security Fundamentals and Shared Responsibility Model, Identity and Access Management (IAM) and Authentication, overview on Cloud Data Security and Encryption, Cloud Network and Infrastructure Security, Cloud Security Threats and Best Practices.	5
	Total	32

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, Elsevier, 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
7. Cloud Security: A Comprehensive Guide to Secure Cloud Computing ,Ronald L. Krutz,RussellDeanVines, Wiley-India, 2010

PEC-CS-501B: COMPILER DESIGN

CONTACTS: 3(L) PER WEEK

CREDITS: 3

Prerequisites: Basic knowledge of Formal Language and Automata

Course Outcomes (COs):

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

PEC-CS-501B	CO1	Recall the basics of formal language and automata
	CO2	Understand the mean of token and distinguish between the NFA and DFA. Recommend a DFA to recognize partial keywords of programming language.
	CO3	Apply the knowledge of code optimization and code generation. Make DAG representation of basic blocks and flow graphs.
	CO4	Analyze the different phases of compiler and identify different possible errors detected by different phases, the role of semantic analysis phase to syntax analysis phase.
	CO5	Evaluate the role of a parser, the top-down and bottom-up parsing techniques and its design issues.
	CO6	Constructs the significance of intermediate code generation phase. Revise the different ways of intermediate code generation techniques and run-time environment issues in compilation.

Detailed Content:

Unit	Content	Hrs. / Unit
1	Introduction to Compiling: Compilers, Analysis of the source program, The phases of the compiler, Cousins of the compiler.	3
2	Lexical Analysis: 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).	5
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.	3
5	Type checking: Type systems, Specification of a simple type checker, Equivalence of type expressions, Type conversions	3
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.	4
7	Intermediate code generation: Intermediate languages, Graphical representation, Three-address code, Implementation of three address statements (Quadruples, Triples, Indirect triples).	3
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
Total		35

Text books:

1. Aho, Sethi, Ullman - "Compiler Principles, Techniques and Tools" - Pearson Education.
2. Holub - "Compiler Design in C" - PHI.

PEC-CS-501C: DIGITAL IMAGE PROCESSING
CONTACTS: 3(L) PER WEEK
CREDITS: 3

Course Outcomes (COs):

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

PEC-CS-501C	CO1	Review the fundamental concepts of a digital image processing system.
	CO2	Understand various compression techniques.
	CO3	Execute Interpret Image compression standards.

	CO4	Analyze images in the frequency domain using various transforms.
	CO5	Evaluate the techniques for image enhancement and image restoration.
	CO6	Interpret and design image segmentation and representation techniques.

Prerequisites:

- Digital Signal Processing
- Linear Algebra
- 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.	7
4	Image Compression: coding redundancy, Image compression model, Compression Methods – Huffman coding, Arithmetic coding, LZW coding, Run-length coding, and Predictive 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
Total		33

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-CS-501D: MOBILE COMPUTING
CONTACTS: 3(L) PER WEEK
CREDITS: 3

Course Outcomes (COs):

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

PEC-CS-501D	CO1	Remember TCP, MAC protocols and their technical feasibility.
	CO2	Understand the necessary knowledge of cellular communication, infrastructure-less networks.
	CO3	Execute device independent applications.
	CO4	Acquire and Analyze knowledge about the basic concepts and principles in mobile computing.
	CO5	Evaluate and Implement techniques involved, in networks.
	CO6	Design the mobile computing systems and find implementation issues.

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.	5
2	General Packet Radio Services (GPRS): GPRS Architecture, GPRS Network Nodes. Mobile Data Communication: WLANs (Wireless LANs) IEEE 802.11 standard, Mobile IP	5
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.	7
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.	7
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	3
Total		33

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-CS-501A: ETHICAL HACKING
CONTACTS: 2(L) PER WEEK
CREDITS: 2

Course Outcomes (COs):

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

OEC-CS-501A	CO1	Remember cryptography and basics of web application attacks.
	CO2	Understand fundamentals of ethical hacking and penetration testing.
	CO3	Apply tools and techniques to face the domain of ethical hacking and ethical responsibilities.
	CO4	Analyze various types of attacks, attackers and security threats and vulnerabilities present in computer system.
	CO5	Evaluate how social engineering can be done by attacker to gain access of useful and sensitive information about confidential data.
	CO6	Formulate reverse engineering process.

Prerequisites:

- Operating System
- Data Communication and Networks
- Cryptography

Module	Content	Hours/Module
1	Ethical Hacking: Introduction, Networking & Basics, Foot Printing, Google Hacking, Scanning, Windows Hacking, Linux Hacking, Trojans & Backdoors, Virus & Worms.	4
2	Proxy & Packet Filtering, Denial of Service, Sniffer, Social Engineering System and Network Vulnerability and Threats to Security, Various types of attack and the various types of attackers in the context of the vulnerabilities associated with computer and information systems and networks Physical Security, Steganography.	6

3	Wireless Hacking, Firewall & Honeypots, IDS & IPS, Vulnerability, Penetration Testing, Session Hijacking, Hacking Web Servers, SQL Injection, Cross Site Scripting, Exploit Writing, Buffer Overflow.	5
4	Reverse Engineering, Email Hacking, Incident Handling & Response, Bluetooth Hacking, Mobile Phone Hacking Basic ethical hacking tools and usage of these tools in a professional environment. Legal, professional and ethical issues likely to face the domain of ethical hacking. Ethical responsibilities, professional integrity and making appropriate use of the tools and techniques associated with ethical hacking. Knock SubDomain Tool, DIRB Tool, OWASP, Bug Bounty Methodology, Burpsuite tool, BruteForce Vulnerability, CSRF.	7
5	Tools for Ethical hacking: Nuclei Tool, Subfinder Tool, HTTPX Tool, Clickjacking Scanner Tool, Gobuster Tool, SecLists.	3
	Total	25

Text book and Reference books:

1. Georgia Weidman, Penetration Testing: A Hands on Introduction to Hacking, No Starch Press, First Edition 2014.
2. Rafay Baloch, Ethical Hacking and Penetration Testing Guide, CRC Press, 2015.
3. Dr. Patrick Engebretson, The Basics of Hacking and Penetration Testing, Syngress Publications Elseveir, 2013.
4. Michael T. Simpson, Kent Backman, James Corley, Hands-On Ethical Hacking and Network Defense, 2016
5. Steven DeFino, Barry Kaufman, Nick Valenteen, Official Certified Ethical Hacker Review Guide, 2015
6. Abhinav Ojha, Beginners Guide to Ethical Hacking and Cyber Security, Notion Press; 1st edition.

OEC-CS-501B: GRAPH THEORY
CONTACTS: 3(L) PER WEEK
CREDITS: 3

Course Outcomes (COs):

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

OEC-CS-501B	CO1	Remember basic concepts of Mathematical proof technique and linear algebra.
	CO2	Understand the linear programming principles and its conversion.
	CO3	Apply the various types of graph Algorithms and graph theory properties.
	CO4	Analyze the NP – complete problems.
	CO5	Evaluate the features of the various tree and matching algorithms
	CO6	Create suitable graph model and algorithm for solving applications.

Prerequisites:

1. Mathematical proof technique (induction, proof by contradiction)

- Linear algebra (determinants, eigenvalues).

Detailed Content:

Unit	Content	Hours/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.	6
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.	6
3	Network Flows - Planar Graph - Representation - Detection - Dual Graph - Geometric and Combinatorial Dual - Related Theorems - Digraph - Properties - Euler Digraph.	6
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.	6
5	Graph Algorithms- Connectedness and Components- Spanning Tree- Fundamental Circuits- Cut Vertices- Directed Circuits- Shortest Path - Applications overview.	6
	Total	30

Text and reference books:

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

OEC-CS-501C: NUMERICAL METHODS

CONTACTS: 3(L) +1(T) PER WEEK

CREDITS: 4

Course Outcomes (COs):

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

OEC- CS- 501C	CO1	Define and List basic concepts and methods in probability, statistics, and numerical analysis, including probability spaces, random variables, probability distributions.
------------------------------	------------	--

CO2	Explain key concepts such as expectation, variance, correlation, and regression in the context of probability theory and statistics, and Describe how these concepts are applied in numerical methods and statistical analysis.
CO3	Apply various probability distributions (e.g., binomial, Poisson, normal) and statistical tests (e.g., t-tests, chi-square test) to real-world problems, and Use numerical methods to solve systems of linear equations, algebraic equations, and ordinary differential equations.
CO4	Analyze the error propagation in numerical computations, including truncation and rounding errors, and Evaluate the efficiency and accuracy of different interpolation methods and numerical techniques for solving equations.
CO5	Evaluate the performance of various numerical methods based on accuracy, stability, and computational cost.
CO6	Synthesize various numerical methods to Develop integrated solutions for complex mathematical problems.

Prerequisites:

- Basic Mathematics on Probability, Integration, Differentiation.

Detailed Content:

Module	Content	Hours/ Module
1	Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality, Bayes' rule.	8
2	Basic Statistics, Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation. Curve fitting by the method of least squares-fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, Tests for single mean, difference of means, and difference of standard deviations. Test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.	9
3	Approximation in numerical computation: Truncation and rounding errors, Fixed and floating-point arithmetic, Propagation of errors. Interpolation: Newton forward/backward interpolation, Lagrange's and Newton's divided difference Interpolation. Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Expression for corresponding error terms.	8

4	Numerical solution of a system of linear equations: Gauss elimination method, Matrix inversion, LU Factorization method, Gauss-Seidel iterative method. Numerical solution of Algebraic equation: Bisection method, Regula-Falsi method, Newton- Raphson method.	8
5	Numerical solution of ordinary differential equation: Euler's method, Runge-Kutta methods, Predictor Corrector methods and Finite Difference method.	7
Total		40

Text book and Reference books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Chandrika Prasad & Reena Garg, Advanced Engineering Mathematics, Khanna Publishing House, 2019.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
4. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003
5. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
6. Ramana, Higher Engineering Mathematics, TMH
7. Sashtry, Advanced Engineering Mathematics, PHI
8. C. Xavier: C Language and Numerical Methods.
9. R.S. Salaria, Computer Oriented Numerical Methods, Khanna Publishing House.
10. Dutta & Jana: Introductory Numerical Analysis.
11. J.B. Scarborough: Numerical Mathematical Analysis.

OEC-CS-501D: QUALITATIVE SKILLS PRACTICE I

CONTACTS: 2(L) PER WEEK

CREDITS: 2

Bachelor of Technology (B. Tech) courses, incorporating qualitative skills can enhance technical education by developing students' problem-solving, critical thinking, and communication abilities.

PCC-CS-591: DATABASE MANAGEMENT SYSTEM LAB

CONTACTS: 3(L) PER WEEK

CREDITS: 1.5

Course Outcomes (COs):

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

PCC- CS-591	CO1	Use various software to design and build ER Diagrams, UML, Flow chart for related database systems.
	CO2	Create a database schema, relation and implement referential integrity constraint.

	CO3	Implement and control the database using simple SQL queries for a given specification in ORACLE platform
	CO4	Compare and contrast (analyses) views with tables, discussing the performance implications.
	CO5	Apply administrative activities like working with views, creating users and granting or revoking privileges on database objects.
	CO6	Create database objects by using Procedural extension of SQL to develop a better control on database.

Prerequisites:

1. Oracle-SQL
2. Visual Basic 6.0

Detailed Content:

Laboratory Experiments:		
Structured Query Language		No. of sessions
1.	Creating Database, Creating a Database, Creating a Table, Specifying Relational Data Types, Creating Constraints	1
2.	Table and Record Handling: INSERT, DELETE, UPDATE, TRUNCATE commands, DROP, ALTER commands, COMMIT, ROLLBACK commands	1
3.	Retrieving Data from a Database : The SELECT statement Using the WHERE clause ORDER BY, GROUP BY and HAVING Clause Using Logical Operators, Using IN, BETWEEN, LIKE, IS operators Using ANY, ALL, EXISTS operator Using Aggregate Functions Combining Tables Using JOINS Subqueries(independent and correlated)	4
4.	Database Management: Creating Views, Creating Column Aliases Creating Database Users, Using GRANT and REVOKE	2
5.	Introduction to PL/SQL: Basic programming constructs (decision making, iteration), Practical implementation of Stored Procedure and function, Overview to Cursor and Trigger	4

Resources

1. Sql, pl/sql the programming language of oracle by Bayross, Ivan
2. <https://livesql.oracle.com/>

PCC-CS-592: INTERNET TECHNOLOGY LAB
CONTACTS: 3(L) PER WEEK
CREDITS: 1.5

Course Outcomes (COs):

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

PCC-CS-592	CO1	Illustrate the concepts of Web design languages like HTML, PHP, Java Script and java applet and create cookies.
	CO2	Differentiate the concept of Java socket and Java RMI (Client Server Programming).
	CO3	Apply web applications using PHP.
	CO4	Analyze a dynamic web page using the concept of Languages
	CO5	Evaluate a Website that can be created in many ways by using front end and back end tools.
	CO6	Create web pages using HTML and Cascading Styles sheets.

Prerequisites:

- Demonstrate the role of languages like HTML, CSS, Javascript, PHP and protocols in the workings of the web and web applications.

Lab Experiments List:

1. HTML

- Creating a webpage with HTML
- Insert an image and create a link
- Creating a table
- Specifying frames
- Specifying Embed Audio and Video

2. CSS

- Implementation of in-line CSS
- Creating a form with CSS
- Implementation of radio buttons, check boxes and password field

3. JavaScript

- Create a form with JavaScript
- Learn how to display information box
- Implementation of page load

4. JSP

- Creating a JSP page
- Analysing the separation of JSP and HTML coding
- Retrieving the contents of request object
- Implementation of AJAX

5. PHP

- Introduction to XAMPP

- Implementation of SQL server
- Creating a web page with PHP
- Creating login page with PHP
- Implementation of cookies
- Introduction to session

6. Client-Server programming In Java

- Implement a multi-threaded server
- Design a client-server application
- Introduction to Java sockets
- Creating a chat application
- Implementation of Java RMI application
- Implementation of RPC
- Implementation of TCP sockets & UDP sockets

7. Search Engine and Web Crawler

Text book and Reference books:

- [1] Web Technology: A Developer's Perspective, N.P. Gopalan and J. Akilandeswari, PHI Learning, Delhi, 2013.
- [2] Internetworking Technologies, An Engineering Perspective, Rahul Banerjee, PHI Learning, Delhi, 2011.
- [3] Computational Thinking on The Internet: Foundations, Web Design & Cyber Security (3rd Ed.), 2023.
- [4] Introduction to Security Reduction by Fuchun Guo, Willy Susilo, et al.

PCC-CS-593: CRYPTOGRAPHY & NETWORK SECURITY LAB
CONTACTS: 3(L) PER WEEK
CREDITS: 1.5

Course Outcomes (COs):

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

OEC-CS-701D	CO1	Remember the concept and application of public key cryptography.
	CO2	Understand the application of firewall, SSH for network security.
	CO3	Apply symmetric and asymmetric key algorithms for cryptography.
	CO4	Analyze the vulnerabilities in any computing system and hence be able to design a security solution.
	CO5	Evaluate security mechanisms using rigorous approaches by key ciphers and hash functions.
	CO6	Design various networking protocols.

Prerequisites:

- Programming for Problem Solving

- Object Oriented Programming
- Operating System
- Data Communication and Networks
- Cryptography
- Network Security

Detailed Content:

- 1) Implementation of Caesar Cipher, Substitution cipher and Hill Cipher technique.
- 2) Implementation of the Play fair Cipher.
- 3) Implementation of the Pure Transposition Cipher.
- 4) Implementation of Euclid Algorithm.
- 5) Implementation of DES Encryption and Decryption.
- 6) Implementation of the AES Encryption and decryption.
- 7) Implementation of RSA Encryption Algorithm.
- 8) Calculation of message digest of text using SHA-1, MD5 algorithms.
- 9) Implementation of Diffie-Hellman Key Exchange mechanism.
- 10) Configure SSH (Secure Shell) and send/receive a file on this connection to verify the correctness of this system using the configured parameters.
- 11) Configure a firewall to block the following for 5 minutes and verify the correctness of this system using the configured parameters.
 - (a) Two neighborhood IP addresses on your LAN
 - (b) All ICMP requests.
- 12) Configure a mail agent to support Digital Certificates, send a mail and verify the correctness of this system using the configured parameters.

Text book and Reference books:

1. William Stallings, Cryptography and Network security Principles and Practices, Pearson/PHI.
2. Wade Trappe, Lawrence C Washington, Introduction to Cryptography with coding theory, Pearson.
3. W. Mao, Modern Cryptography – Theory and Practice, Pearson Education.
4. Charles P. Pfleeger, Shari Lawrence Pfleeger – Security in computing – Prentice Hall of India.
5. Cryptography and Network Security – by Atul Kahate – TMH.
6. Data Communications and Networking- by Behourz A Forouzan.

SIXTH SEMESTER

PCC-CS-601: DIGITAL FORENSICS
CONTACTS: 3(L) PER WEEK
CREDITS: 3

Course Outcomes (COs):

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

PCC-CS-601	CO1	Define or remember the concept of Forensics and its associates.
	CO2	Understand the need of digital forensic and role of digital evidences.
	CO3	Apply the method to generate legal evidence and supporting investigation reports and will also be able to use various digital forensic tools.
	CO4	Analyze the methodology of incident response and various security issues in ICT world, and identify digital forensic tools for data collection.
	CO5	Evaluate the importance of various digital forensic tools for analysis to achieve adequate perspectives of digital forensic investigation in various applications/devices like Windows/Unix system.
	CO6	Formulate and Judges a crime from a given case study.

Prerequisites:

- Malware Analysis
- Operating System

Detailed Content:

Module	Content	Hours/ Module
1	Introduction to Cyber forensics: Information Security Investigations, Corporate Cyber Forensics, Scientific method in forensic analysis, investigating large scale Data breach cases. Analyzing malicious software. Types of Computer Forensics Technology, Types of Military Computer Forensic Technology, Types of Law Enforcement: Computer Forensic Technology, Types of Business Computer Forensic Technology, Specialized Forensics Techniques, Hidden Data and How to Find It, Spyware and Adware, Encryption Methods and Vulnerabilities, Protecting Data from Being Compromised Internet Tracing Methods, Security and Wireless Technologies, Avoiding Pitfalls with Firewalls Biometric Security Systems.	8
2	Types of Computer Forensics Systems: Internet Security Systems, Intrusion Detection Systems, Firewall Security Systems, Storage Area Network Security Systems, Network Disaster Recovery Systems, Public Key Infrastructure Systems, Wireless Network Security Systems, Satellite Encryption Security Systems, Instant Messaging (IM) Security Systems, Net Privacy Systems, Identity Management Security Systems, Identity Theft, Biometric Security Systems, Router Forensics. Cyber forensics tools and case studies.	8

3	Evidence Collection and Data Seizure: Why Collect Evidence, Collection Options Obstacles, Types of Evidence, The Rules of Evidence, Volatile Evidence, General Procedure, Collection and Archiving, Methods of Collection, Controlling Contamination: The Chain of Custody, Reconstructing the Attack, The digital crime scene, Investigating Cybercrime, Investigating Web attacks, Investigating network Traffic ,Identification of Data: Timekeeping, Forensic Identification and Analysis of Technical Surveillance Devices, Reconstructing Past Events.	8
5 4	Current Computer Forensics Tools: Software, hardware tools, validating and testing forensic software, addressing data-hiding techniques, performing remote acquisitions, E-Mail investigations- investigating email crime and violations, understanding E-Mail servers, specialized E-Mail forensics tool. Mobile Forensics: mobile forensics techniques, mobile forensics tools. E-contracting- Salient features of E-contracts, formation of E-contracts and types, E-governance, E-governance models.	8
	Total	32

Text book and Reference books:

1. John Sammons, —The Basics of Digital Forensics, Elsevier.
2. John Vacca, —Computer Forensics: Computer Crime Scene Investigation, Laxmi Publications.
3. Warren G. Kruse II and Jay G. Heiser, —Computer Forensics: Incident Response Essentials, Addison Wesley.
4. Nelson, B, Phillips, A, Enfinger, F, Stuart, C., —Guide to Computer Forensics and Investigations, 2nd ed., Thomson Course Technology.
5. Ali Jahangiri, Live Hacking: The Ultimate Guide to Hacking Techniques & Countermeasures for Ethical Hackers & IT Security Experts, First edition, 2009

PCC-CS-602: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN SECURITY
LECTURE PER WEEK (L): 3
CREDITS: 3

Course Outcomes (COs):

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

PCC-CS-602	CO1	Demonstrate a comprehensive understanding of fundamental AI concepts, including machine learning, knowledge representation, and reasoning techniques.
	CO2	Apply AI techniques to solve real-world cyber security problems.
	CO3	Implement machine learning algorithms to analyze network traffic and detect anomalies.
	CO4	Critically analyze the strengths and limitations of various AI algorithms and their suitability for different cyber security tasks.
	CO5	Evaluate the ethical implications of AI in cyber security, including the potential for misuse and the need for responsible development.

	CO6	Design and develop novel AI-powered cyber security solutions, integrating multiple techniques and considering the evolving threat landscape.
--	------------	---

Prerequisites:

1. Data Structure & Algorithm
2. Probability

Detailed Content:

MODULE NO	CONTENT	HOURS/MODULE
1	<p>Introduction to AI: Applying AI in cyber security, The evolution from expert systems to data mining and AI, The different forms of automated learning, The characteristics of algorithm training and optimization.(2L)</p> <p>Introduction to ML: Definitions of machine learning and use cases, Delving into machine learning in the cyber security world, Different types of machine learning systems, Different data preparation techniques.(2L)</p>	4
2	<p>Characteristics of production systems: Breadth first search and depth first search techniques. Heuristic search Techniques: Hill Climbing, Iterative deepening DFS, Bidirectional search. A* algorithm, and their analysis. Introduction to Genetic Algorithms. Physical Symbol System Hypothesis in AI, production systems. (5L).</p> <p>Knowledge Representation: Problems in representing knowledge, knowledge representation using propositional and predicate logic. Forward and backward reasoning. Monotonic and non-monotonic reasoning.(2L)</p>	7
3	<p>Network-based representation and reasoning: Semantic networks, Conceptual Graphs, frames. Description logic (DL), reasoning using DL. Conceptual dependencies (CD). Introduction to natural language processing.(3L)</p> <p>Adversarial search and Game theory: classification of games, game playing strategies, prisoner's Dilemma. Game playing techniques, minimax procedure, alpha-beta cut-offs.(3L)</p>	6
4	<p>Reasoning in uncertain environments: Fuzzy logic, Fuzzy composition relation, operations on fuzzy sets. Probabilistic reasoning, Bayes theorem, Bayesian networks, belief propagation. Markov processes and Hidden Markov models.(6L)</p> <p>Detecting Cyber security Threats with AI: How to detect spam with perceptron, Image spam detection with support vector machines (SVMs), Phishing detection with logistic regression and decision trees, Spam detection with Naive Bayes, Spam detection adopting NLP.(4L)</p>	10

5	<p>Artificial Intelligence in Cyber Security: Model Stealing & Watermarking, Network Traffic Analysis, Malware Analysis. Role of AI in Cyber Security and Security Framework: Artificial Intelligence in Cyber Security, Challenges and Promises, Security Threats of Artificial Intelligence (4L)</p> <p>Machine Learning in Cyber Security: Introduction to Machine Learning, Applications of Machine Learning in Cyber Security Domain, Machine Learning tasks and Approaches, Anomaly Detection, Privacy Preserving Nearest Neighbor Search, Machine Learning Applied to Intrusion Detection, Online Learning Methods for Detecting Malicious Executables.(4L)</p>	8
Total		35

Text/ Reference Books:

1. Artificial Intelligence: Elaine Rich, Kevin Knight, Mc-Graw Hill.
2. Introduction to AI & Expert System: Dan W. Patterson, PHI.
3. Artificial Intelligence by Luger (Pearson Education)
4. Dr. Nilakshi Jain (2019). Artificial Intelligence, As per AICTE: Making a System Intelligent, Wiley Publication.
5. Alessandro Parisi .(2019). Hands-On Artificial Intelligence for Cybersecurity: Implement smart AI systems for preventing cyber-attacks and detecting threats and network anomalies, Packt Publication.
6. Russel & Norvig, Artificial Intelligence: A Modern Approach, Pearson Education.
7. Artificial Intelligence and Data Mining Approaches in Security Frameworks Editor(s): Neeraj Bhargava, Ritu Bhargava, Pramod Singh Rathore, Rashmi Agrawal, 2021.
8. Machine learning in cyber trust: security, privacy, and reliability. Springer Science & Business Media, 2009. Tsai, Jeffrey JP, and S. Yu Philip, eds.
9. Machine Learning: A Probabilistic Perspective, Kevin P Murphy, MIT Press. 6. Christopher M. Bishop. Pattern Recognition and Machine Learning. Springer 2006.

**HSMC-CS-601: PROJECT MANAGEMENT AND ENTREPRENEURSHIP
CONTACTS: 3(L) PER WEEK
CREDITS: 3**

Course Outcomes (COs):

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

HSMC-CS-601	CO1	Remember project management principles, methodologies, and tools with entrepreneurial practices to effectively plan, execute, and manage projects within start-up ventures.
	CO2	Understand business opportunities by applying project management techniques such as feasibility analysis, market research, and risk assessment, enabling them to make informed decisions regarding new venture creation.
	CO3	Apply an entrepreneurial mindset characterized by creativity, innovation, and adaptability, as well as leadership skills necessary to drive entrepreneurial initiatives, lead project teams and navigate uncertainties inherent in startup environments.

CO4	Analyze the knowledge and skills needed to effectively execute and manage entrepreneurial projects, including project planning, resource allocation, time management and stakeholder communication, ensuring successful project delivery within budget and schedule constraints.
CO5	Evaluate comprehensive business plans and project proposals that articulate the value proposition, market opportunity, competitive advantage, and implementation strategy of entrepreneurial ventures, as well as effectively present these plans to stakeholders, investors, and potential partners.
CO6	Implement the overall knowledge while dealing with or undertaking live projects subject to socio-economic and environmental considerations.

Pre-requisites: Mathematical and analytical skill

Detailed Content:

Unit	Contents	Hrs/ Unit
1.	Basic Concepts of Project Management: Definition and types of project, Project life cycle, Project constraints, Organizational structures for projects, Responsibilities of project manager, Project risk analysis, Project appraisal.	4
2.	Environmental and social aspects of project: Environmental considerations in project evaluation, Primary issues and secondary issues in Feasibility study, Social cost benefit analysis, Managing Project Risks, Contingency Planning, Project Audit Process and Closure.	4
3.	Network analysis: Network modeling of a project, Activity on Arrow (AOA), Forward and backward pass computation, Critical paths, floats and slack, Project Scheduling Techniques, PERT, CPM Models, Time-Cost Trade-off in a project, Project Monitoring Techniques, Gantt chart, Line of Balance (LoB).	10
4.	Foundation of Entrepreneurship: Entrepreneurship and Intrapreneurship (comparisons), India's Start up Revolution, Rural and Social Entrepreneurship, Key attributes of an entrepreneur, women entrepreneurship, Myths and realities of entrepreneurship, Transition from college/ regular job to the world startups.	6
5.	Project Financing for entrepreneurs: Venture Capitalist, Role of Incubators and Angel Investors, Private Equity, Crowd sourcing, Overview of debt financing, Examples of project management software.	6
	Total	30

Text Books and Reference Books:

1. Project Management by Prasanna and Chandra, Tata McGraw Hill.
2. Elements of Project Management by Pete Spinner, Prentice Hall, USA.
3. A course in PERT and CPM by R. C. Gupta, Dhanpat Rai Publications (P) Ltd, Delhi.

4. Project Management for Engineering, Business and Technology: Nicholas, J.M., and Steyn, H.; PHI
5. Innovation and Entrepreneurship by Drucker, P.F.; Harper and Row
6. Business, Entrepreneurship and Management: Rao, V. S. P Vikas

PEC-CS-601A: INTRODUCTION TO IOT APPLICATION
CONTACTS: 3(L) PER WEEK
CREDITS: 3

Course Outcomes (COs):

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

PEC-CS-601A	CO1	Recall basic protocols in wireless sensor network.
	CO2	Understand the application areas of IOT.
	CO3	Apply IoT in Industrial and Commercial Building Automation and Real World Design Constraints.
	CO4	Analyze building blocks of Internet of Things and characteristics.
	CO5	Evaluate IoT applications in different domain and be able to analyze their performance.
	CO6	Create basic IoT applications on embedded platform.

Prerequisites:

Data communication and Network

Detailed Content:

MODULE NO	CONTENT	HOURS/MODULE
1	FUNDAMENTALS OF IoT ECOSYSTEM: IoT security issues, Fundamental blocks of IoT, How to design an IoT system, Hardware, software and network security related to IoT systems - Basics of cryptographic solutions to IoT systems.[5L]	5
2	OVERVIEW OF CLOUD COMPUTING AND ITS SERVICES: Cloud Computing Fundamental: Cloud computing definition, private, public and hybrid cloud. Cloud types; IaaS, PaaS, SaaS.[3L] CHALLENGES IN CLOUD COMPUTING: Benefits and challenges of cloud computing - Public vs. Private clouds, Role of virtualization in enabling the cloud.[2L]	5
3	DEVELOPING IoT's: Introduction to Python, Introduction to different IoT tools, developing applications through IoT tools, developing sensor-based application through embedded system platform, Implementing IoT concepts with python.[4L] CHALLENGES IN IoT: Design challenges, Development challenges, Security challenges, Other Challenges.[2L]	6
4	CRYPTOGRAPHIC FUNDAMENTALS FOR IOT: Cryptographic primitives and its role in IoT, Encryption and Decryption, Hashes, Digital Signatures, Random number generation, Cipher suites,	6

	Key management fundamentals, Cryptographic controls built into IoT messaging and communication protocols, IoT Node Authentication.[6L]	
5	CLOUD SECURITY FOR IOT: Cloud services and IoT, Offerings related to IoT from cloud service providers, Cloud IoT security controls, An enterprise IoT cloud security architecture, New directions in cloud enabled IoT computing.[4L] SECURITY CONCEPTS IN CONTEXT TO IoT DEVICES: Security Concepts: Confidentiality, privacy, integrity, authentication, Non-repudiation, Virtualization.[3L]	7
6	IoT SECURITY THREATS AND COUNTERMEASURES: System-Specific Attacks: Guest hopping, attacks on the VM (delete the VM, attack on the control of the VM, code or file injection into the virtualized file structure), VM migration attack, hyper jacking.[4L]	4
	Total	33
	<u>Practical Tools:</u> 1. IoTFy tool2. 2. ForeScout CounterACT3. 3. LogRhythm Netmon4. 4. Trustwave5. 5. Zingbox. etc.	
1	FUNDAMENTALS OF IoT ECOSYSTEM: IoT security issues, Fundamental blocks of IoT, How to design an IoT system, Hardware, software and network security related to IoT systems - Basics of cryptographic solutions to IoT systems.[5L]	5
2	OVERVIEW OF CLOUD COMPUTING AND ITS SERVICES: Cloud Computing Fundamental: Cloud computing definition, private, public and hybrid cloud. Cloud types; IaaS, PaaS, SaaS.[3L] CHALLENGES IN CLOUD COMPUTING: Benefits and challenges of cloud computing - Public vs. Private clouds, Role of virtualization in enabling the cloud.[2L]	5
3	DEVOLPOING IoT's: Introduction to Python, Introduction to different IoT tools, developing applications through IoT tools, developing sensor-based application through embedded system platform, Implementing IoT concepts with python.[4L] CHALLENGES IN IoT: Design challenges, Development challenges, Security challenges, Other Challenges.[2L]	6

Text book and Reference books:

1. Vijay Madiseti, Arshdeep Bahga, —Internet of Things: A Hands-On Approach
2. Walteneus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice".
3. Matt Richardson & Shawn Wallace, Getting Started with Raspberry Pi . O'Reilly (SPD), 2014.
4. Adrian McEwen, Hakim Cassimally, —Designing the Internet of Things, Wileypublication, 1st Edition, November 2013.
5. Jeeva Jose, Internet of Things, Khanna Publishing House, New Delhi (AICTE

- Recommended – 2018)
6. Michale Miller, —The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the Worldll, PearsonEducation
 7. Hanes David ,Salgueiro Gonzalo, Grossetete Patrick, Barton Rob ,—IoT Fundamentals: Networking Technologies, Protocols and Use Cases for the Internet of Thingsl , PearsonEducation
 8. RMD SundaramShriram, K Vasudevan, Abhishek S Nagarajan,—Internet of Thingsl ,Wiley publication

PCC-CS-601B: DESIGN AND ANALYSIS OF ALGORITHM
CONTACTS: 3(L) PER WEEK
CREDITS: 3

Course Outcomes (COs):

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

PCC-CS-601B	CO1	Recall the running time of the basic algorithms for those classic problems in various domains.
	CO2	Understand the algorithms and design techniques to solve problems.
	CO3	Apply design and development principles in the construction of software systems of varying complexity.
	CO4	Analyze the complexities of various problems in different domains.
	CO5	Evaluate current techniques, skills, and tools necessary for computing practice.
	CO6	Design and develop principles in the construction of software systems of varying complexity.

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	6
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	6

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	6
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 approximation schemes: 0/1 knapsack Problem	5
Total		35

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.Horowitz and Shani —Fundamentals of Computer algorithms
8. E. M. Reingold, J. Nievergelt and N. Deo- —Combinational algorithms- Theory and Practicel, Prentice Hall, 1997
9. A. Borodin and I. Munro, —The computational complexity of Algebraic and Numeric problems.

PEC-CS-601C: PRINCIPLES OF GENERATIVE AI & LLM ARCHITECTURES
CONTACTS: 3L PER WEEK
CREDITS: 3

Course Outcomes (COs):

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

PEC-CS-601C	CO1	Understand the evolutionary architecture of Large Language Models (LLMs), distinguishing between Generative and Discriminative AI, and explaining key training phases like RLHF and Scaling Laws.
--------------------	------------	--

	CO2	Apply advanced Prompt Engineering techniques (Chain of Thought, ReAct) and Lang Chain orchestration components (Chains, Memory) to design robust LLM interactions.
	CO3	Analyze data ingestion and splitting strategies to optimize the preprocessing of unstructured data (PDFs, Web) for Limited Context Windows.
	CO4	Examine the mathematical principles of Vector Spaces and Embeddings to select appropriate Vector Databases and retrieval algorithms (Cosine Similarity, HNSW).
	CO5	Design autonomous AI Agents that utilize Tool Calling and Reasoning Loops (ReAct) to solve complex, multi-step problems.
	CO6	Evaluate GenAI systems using RAGAS metrics and assess critical ethical risks including Hallucinations, Bias, and Copyright infringement.

Prerequisites:

- Artificial Intelligence
- Programming in any high-level language, preferably Python

Unit	Content	Hrs/Unit
1	Foundations & Evolution of LLMs: Concepts: AI vs. ML vs. DL vs. GenAI; Generative vs. Discriminative Models. The Transformer: Attention Mechanisms ("Attention is All You Need"), Encoder-Decoder Architectures. Training: Pre-training (Next Token Prediction), SFT (Supervised Fine-Tuning), and RLHF (Reinforcement Learning from Human Feedback). LLM Landscape: Evolution (GPT-1 to GPT-4, Llama, Gemini, Mistral), Closed vs. Open Source, Parameters, Scaling Laws & Compute requirements.	6
2	Prompt Engineering & Orchestration (Lang Chain): Prompt Engineering: Zero-shot, Few-shot, Chain of Thought (CoT) , Tree of Thoughts, and the ReAct (Reason + Act) Framework. Prompt Safety: Jailbreaking, Prompt Injection, and Hacking strategies. Lang Chain Core: Why Orchestration? Lang Chain Components: Models (LLM vs. Chat), Prompts (Templates, Output Parsers), Chains (Sequential, Router), and Memory (Buffer, Summary, Knowledge Graph).	6
3	Data Engineering for LLMs (ETL Pipelines): Ingestion: Document Loaders (PDF, Web Base Loader, CSV Loader, Directory Loader). Splitting Strategies: The Context Window problem. Recursive Character Text Splitter vs. Token Splitter. Advanced Splitting: Structural Splitting (Markdown/HTML) and Semantic Splitting (chunking by meaning).	5
4	Embeddings & Vector Database Architecture: Embeddings: Converting text to vectors; OpenAI vs. Hugging Face vs. Ollama models. Vector Stores: Theory of High-Dimensional Vector Spaces; Vector DBs (Chroma DB, FAISS, Pinecone). Retrieval Algorithms: Cosine Similarity, Euclidean Distance, and HNSW (Hierarchical Navigable Small World) indexing for fast search.	5
5	AI Agents & Advanced Tooling: Agent Theory: LLM as a Reasoning Engine; The ReAct Loop (Observation to Thought to Action). Tools: Built-in Lang Chain Tools (Search, Calculator), Creating Custom Tools, Toolkit Integration (SQL, Gmail). Tool Calling: How LLMs "bind" to API tools and execute actions. Architecture: Designing Single-Agent vs. Multi-Agent systems.	5
6	Advanced RAG, Evaluation & Ethics: Advanced RAG: Hybrid Search (Keyword + Vector), Re-ranking, and Query Translation. Evaluation: Testing GenAI with RAGAS metrics (Faithfulness, Answer Relevance, Context Recall). Ethics & Safety: Hallucinations (Causes & Mitigation), Bias and Fairness in Training Data, Copyright issues, and Data Privacy in Enterprise GenAI.	5
	Total	32

Text Books and References:

1. Learn Python Generative AI: by Zonunfeli Ralte and Indrajit Kar
2. Learn AI with Python: by Gaurav Leekha
3. Generative AI with LangChain : by Ben Auffarth and Leonid Kuligin

PEC-CS-601D: NATURAL LANGUAGE PROCESSING**CONTACTS: 3L PER WEEK****CREDITS: 3****Course Outcomes (COs):**

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

PEC-CS-601D	CO1	Recall the various steps necessary for processing natural language.
	CO2	Understand appropriate lexical and parsing techniques for a given natural language.
	CO3	Apply appropriate statistical models for a given natural language application.
	CO4	Modify existing algorithms to suit any natural language for processing.
	CO5	Evaluate appropriate pre-processing steps essential for the various applications involving natural language processing.
	CO6	Design applications involving natural language.

Prerequisites:

- Linear algebra
- Probability and Statistics
- Artificial Intelligence
- Programming in any high-level language, preferably Python

Unit	Content	Hrs/Unit
1	Regular Expressions and Automata (Recap) [1L]: Introduction to NLP, Regular Expression, Finite State Automata Tokenization [4L] : 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 Lexicon and Morphotactics, Morphological Parsing with Finite State Transducers, Orthographic Rules and Finite State Transducers, Porter Stemmer	9
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	7

	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	
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	8
	Total	32

Text Books and References:

1. Natural Language Processing, Computational Linguistics and Speech, Pearson Publication, 2014.
2. Steven Bird, Ewan Klein and Edward Loper, —Natural Language Processing with Python, First Edition, OReilly Media, 2009.
3. Lawrence Rabiner And Biing-Hwang Juang, “Fundamentals Of Speech Recognition”, Pearson Education, 2003.
4. Frederick Jelinek, “Statistical Methods Of Speech Recognition”, MIT Press, 1997.
5. Nitin Indurkha and Fred J. Damerau, —Handbook of Natural Language Processing, Second Edition, Chapman and Hall/CRC Press, 2010.
6. Tanveer Siddiqui, U.S. Tiwary, —Natural Language Processing and Information Retrieval, Oxford University Press, 2008.

OEC-CS-601A: SECURITY ASSESSMENT & AUDIT
CONTACTS: 3(L) PER WEEK
CREDITS: 3

Course Outcomes (COs):

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

OEC-CS-601A	CO1	Design information security risk management framework and methodologies.
	CO2	Identify and modeling information security risks.
	CO3	Understand the difference between Security Metrics and Audits
	CO4	Knowledge on Vulnerability Management.
	CO5	Acknowledge various trends in data analysis, data architecture, and data governance and their implications on investigations.
	CO6	Judge the difference between qualitative and quantitative risk assessment methods.

Prerequisites:

- Cyber security fundamentals

Detailed Content:

Module	Content	Hours/ Module
1	Introduction: What is risk and risk management, risk assessment, monitoring and review, cyberspace, cyber system. Information Security Performance Metrics and Audit: Security Metrics and Reporting, Common Issues and Variances of Performance Metrics, Introduction to Security Audit, Servers and Storage devices, Infrastructure and Networks, Communication Routes, Information Security Methodologies (Black-box, White-box, Greybox), Phases of Information Security Audit and Strategies, Ethics of an Information Security Auditor etc.	8
2	Information Security Audit Tasks, Reports and Post Auditing Actions: Pre-audit checklist, Information Gathering, Vulnerability Analysis, External Security Audit, Internal Network Security Audit, Firewall Security Audit, IDS Security Auditing, Social Engineering Security Auditing, Web Application Security Auditing, Information Security Audit Deliverables & Writing Report, Result Analysis, Post Auditing Actions, Report Retention etc.	8
3	Vulnerability Management: Information Security Vulnerabilities – Threats and Vulnerabilities, Human-based Social Engineering, Computer-based Social Engineering, Social Media Countermeasures, Vulnerability Management – Vulnerability Scanning, Testing, Threat management, Remediation etc.	8
4	Information Security Assessments: Vulnerability Assessment, Classification, Types of Vulnerability Assessment, Vulnerability Assessment Phases, Vulnerability Analysis Stages, Characteristics of a Good Vulnerability Assessment Solutions & Considerations, Vulnerability Assessment Reports – Tools and choosing a right Tool, Information Security Risk Assessment, Risk Treatment, Residual Risk, Risk Acceptance, Risk Management Feedback Loops etc.	8
5	Configuration Reviews: Introduction to Configuration Management, Configuration Management Requirements-PlanControl, Development of configuration Control Policies, Testing Configuration Management etc.	8
Total		40

Text Books:

1. Assessing Information Security (Strategies, Tactics, Logic and Framework) By A Vladimirov, K. Gavrilenko, And A. Michajlowski
2. W. Stallings, Cryptography and network security: Principles and practice, 5 th Edition, Upper Saddle River, NJ: Prentice Hall., 2011
3. C. Kaufman, r. Perlman, & M. Speciner, Network security: Private communication in a public world, 2 nd Edition, Upper Saddle River, NJ:Prentice Hall, 2002
4. C. P. Pfleeger, S. L. Pfleeger, Security in Computing, 4 th Edition, Upper Saddle River,

- NJ:Prentice Hall, 2007 4. T
- M. Merkow, & J. Breithaupt, Information security: Principles and practices. Upper Saddle River, NJ:Prentice Hall, 2005

Reference Books:

- The Art of Computer Virus Research and Defense by Peter Szor.

OEC-CS-601B: WEB APPLICATION SECURITY
LECTURE PER WEEK: 3
CREDITS: 3

Course Outcomes (COs):

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

OEC-CS-601B	CO1	Recall the skill to think like a hacker and to use hacker’s tool sets.
	CO2	Understand the basic concepts of web application security and the need for it.
	CO3	Apply the Integrity standards for information systems.
	CO4	Analyze the Cryptanalysis techniques.
	CO5	Evaluate the authentication schemes for membership authorization.
	CO6	Develop and deploy of web applications.

Prerequisites:

- Interactive Web Development
- Ethical Hacking & Systems Defense

Detailed Content:

Module	Content	Hours/Module
1	Introduction: Introduction to web application, fundamentals of web application security, The history of Software Security-Recognizing Web Application Security Threats, Web Application Security, Authentication and Authorization, Secure Socket layer, Transport layer Security, Session Management-Input Validation.	4
2	Wireless Sensor Networks: Introduction, Applications of Wireless Sensor Networks, WSN Standards, IEEE 802.15.4, Zigbee. Network Architectures and Protocol Stack – Network architectures for WSN, classification of WSN, protocol stack for WSN.	4
3	Wireless Transmission Technology and Systems: Wireless Transmission Technology and Systems – Radio Technology, Available Wireless Technologies. Wireless Sensor Technology - Sensor Node Technology, Hardware and Software, Sensor Taxonomy, WN Operating Environment.	5

4	Secure API Development: API Security- Session Cookies, Token Based Authentication, Securing Natter APIs: Addressing threats with Security Controls, Rate Limiting for Availability, Encryption, Audit logging, Securing service-to-service APIs: API Keys , OAuth2, Securing Microservice APIs: Service Mesh, Locking Down Network Connections, Securing Incoming Requests.	6
5	Hacking Techniques and Tools: Social Engineering, Injection, Cross-Site Scripting(XSS), Broken Authentication and Session Management, Cross-Site Request Forgery, Security Misconfiguration, Insecure Cryptographic Storage, Failure to Restrict URL Access, Tools: Comodo, OpenVAS, Nexpose, Nikto, Burp Suite, etc.	6
6	Web Application Vulnerabilities: What Makes Web Application Vulnerable – Web Application Vulnerabilities – Broken Access Control – Broken Authentication and Session Management – Buffer Overflows – Cross Site Scripting Flaws – Denial of Service – Improper Error Handling – Insecure Configuration Management – Insecure Storage – SQL Injection Flaws – Unvalidated Input – Defensive Measures.	8
Total		33

Text Books:

1. Andrew Hoffman, Web Application Security: Exploitation and Countermeasures for Modern Web Applications, First Edition, 2020, OReilly Media, Inc.
2. Bryan Sullivan, Vincent Liu, Web Application Security: A Beginners Guide, 2012, The McGraw-Hill Companies.
3. Neil Madden, API Security in Action, 2020, Manning Publications Co., NY, USA.

REFERENCE BOOKS:

1. Kazem Sohraby, Daniel Minoli, Taieb Znati, “Wireless Sensor Networks, Technology, Protocols and Applications”, Wiley, 2007.
2. Holger Karl, Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John Wiley, 2005.
3. Jun Zheng, Abbas Jamalipour, “Wireless Sensor Networks: A Networking Perspective”, Wiley, 2009.

OEC-CS-601C: HUMAN RESOURCE MANAGEMENT

CONTACTS: 3(L) PER WEEK

CREDITS: 3

Course Outcomes (COs):

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

○ E	CO1	Demonstrate an understanding of key terms, theories/concepts and practices within the field of HRM
-----	------------	---

	CO2	Design competence in development and problem-solving in the area of HRM.
	CO3	Formulate innovative solutions to problems in the fields of HRM.
	CO4	Identify and appreciate the significance of the ethical issues in HR.
	CO5	Analyze the problem and issues related to human resources in an organization.
	CO6	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 urriculum; 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
	Total	31

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-CS-601D: ECONOMIC POLICIES IN INDIA
CONTACTS: 3(L) PER WEEK
CREDITS: 3

Course Outcomes (COs):

After studying this course, student will be able to:

OEC-CS-601D	CO1	Understand comprehensive of Indian Economy.
	CO2	Analyze govt policies and programs.
	CO3	Formulate the links between household behaviour and the economic models of demand.
	CO4	Understand govt policies and programs.
	CO5	Remember how planning and infrastructure support can develop an economy.
	CO6	Apply their knowledge in policy formulation.

Prerequisites:

- Fundamental of Economics

Detailed Content:

Unit	Content	Hrs. / Unit
1.	Basic Structure of the Indian Economy Concepts of Development, Underdevelopment – Basic Features of Indian Economy: Growth and Structural Changes in Indian Economy – Demographic Features – Population: Size, Growth, Composition and their Implications on Indian Economy – Concept of Demographic Dividend – Occupational Distribution of Population in India – Population Policy of India.	8
2.	National Income, Poverty and Unemployment Estimation of National Income – Trends and Composition of National Income in India – Income Inequalities in India: Magnitude, Causes, Consequences and Remedial Measures – Poverty in India: Concept, Types, Causes and Consequences – Unemployment in India: Concept, Types, Trends, Causes and Consequences – Poverty Alleviation and Employment Generation Programmes in India.	8
3.	Planning and Public Policy Five Year Plans: Concept and Objectives – Review of Five Year Plans – NITI Aayog – Economic Reforms: Liberalization, Privatization and Globalization – Impact of WTO on Indian Economy.	8
4.	Agricultural and Industrial Sectors Importance and Role of Agriculture in Indian Economy – Trends in Agricultural Production and Productivity – Land Reforms – Green Revolution – Agricultural Finance – Agricultural Marketing – Agricultural Pricing – Food Security in India. Structure, Growth, Importance and Problems of Indian Industry – Large, Medium and Small Scale Industries: Role and Problems – Industrial Policies of 1948, 1956 and 1991– FEMA and Competition Commission of India –Disinvestment Policy – Foreign	8

	Direct Investment.	
	Total	32

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.
2. Dantwala, M. L. (1996), Dilemmas of Growth: The Indian Experience, Sage Publications, New Delhi.
3. Datt, R. (Ed.) (2001), Second Generation Economic Reforms in India, Deep Publications, New Delhi.
4. Government of India, Economic Survey (Annual), Ministry of Finance, New Delhi.
5. Jain, a. K. (1986), Economic Planning in India, Ashish Publishing House, New Delhi.
6. Jalan, B. (1992), The Indian Economy – Problems and Prospects, Viking, New Delhi.

**OEC-CS-602A: SOFTWARE ENGINEERING
CONTACTS: 3(L) PER WEEK
CREDITS: 3**

Prerequisites:

- Basic knowledge of programming

Course Outcomes (COs):

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

OEC-CS-602A	CO1	Recall and Describe the various software process models (Waterfall, Prototype, RAD, Spiral, Incremental, and Evolutionary).
	CO2	Demonstrate understanding of the software project planning process, including feasibility analysis, technical feasibility, and cost-benefit analysis.
	CO3	Apply structured analysis techniques, such as creating context diagrams, data flow diagrams (DFDs), and ER diagrams, to model software requirements.
	CO4	Analyze the advantages and disadvantages of different software design approaches (Top-Down vs. Bottom-Up) and select the appropriate methodology for a given scenario.
	CO5	Evaluate the effectiveness of various software testing techniques and methods (unit testing, integration testing, system testing) to ensure software quality.
	CO6	Design and Implement software systems using object-oriented programming

	principles, demonstrating proficiency in modular design, coupling, and cohesion.
--	--

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, and 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, Quality Assurance, Software Maintenance, Software Configuration Management, Software Architecture.	7
	Total	34

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)

OEC-CS-602B: OPERATIONS RESEARCH

CONTACTS: 3(L) PER WEEK

CREDITS: 3

Course Outcomes (COs):

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

OEC-CS-602B	CO1	Remember and Define PERT/CPM technique for project scheduling and resource allocation in an optimal way.
	CO2	Understand the basic elements of a Queuing model.
	CO3	Apply forecasting methods for predicting demands.
	CO4	Analyze decision making under certainty, uncertainty and conflicting situations.
	CO5	Evaluate transportation problems to minimize cost and understand the principles of assignment of jobs and recruitment polices.

	CO6	Design linear programming tools for optimal utilization of resources in various types of industries.
--	------------	--

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	6

	associated to Inventory, Inventory models with deterministic demands (EOQ, EPQ and price discount models), inventory classification systems.	
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
Total		32

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-CS-602C: SOCIAL NETWORK ANALYSIS
CONTACTS: 2(L) PER WEEK
CREDITS: 2

Course Outcomes (COs):

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

OEC-CS-602C	CO1	Learn knowledge representation using ontology.
	CO2	Understand the concept of semantic web and related applications.
	CO3	Represent knowledge using ontology.
	CO4	Analyze visualization of social networks.
	CO5	Evaluate user data management inference and distribution for enabling new human experiences.
	CO6	Develop semantic web related applications.

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.	5
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.	5
5	Understanding and predicting human behavior 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.	5
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.	4
	Total	25

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. Max Chevalier, Christine Julien and Chantal Soule-Dupuy, —Collaborative and Social Information Retrieval and Access: Techniques for Improved user Modelling, IGI Global Snippet, 2009.
5. John G. Breslin, Alexander Passant and Stefan Decker, —The Social Semantic Web, Springer, 2009.

OEC-CS-602D: QUALITATIVE SKILLS PRACTICE II

CONTACTS: 3(L) PER WEEK

CREDITS: 3

Bachelor of Technology (B. Tech) courses, incorporating qualitative skills can enhance technical education by developing students’ problem-solving, critical thinking, and communication abilities.

PCC-CS-691: DIGITAL FORENSICS LAB

CONTACTS: 3(P) PER WEEK

CREDITS: 1.5

Course Outcomes (COs):

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

PCC-CS-691	CO1	Recall the problem solving and analytical skills of digital forensics fundamentals, proficiency in using forensic tools.
	CO2	Understand live response techniques, and analyze system logs and memory dumps to effectively evaluate and respond to cyber-attacks.
	CO3	Apply network forensics tools to analyze network traffic, identify malicious activity, and evaluate network security protocols.
	CO4	Analyze file systems, interpret metadata, and apply advanced techniques for data recovery and carving, demonstrating a deep understanding of file system structure and data recovery principles.
	CO5	Evaluate digital evidence from mobile devices, identify data hiding techniques, and interpret extracted data to support investigations.
	CO6	Dissect a deep understanding of advanced digital forensics techniques, including data hiding, encryption analysis, and specialized tool.

Prerequisites:

1. Digital Forensics Tools and Techniques
2. Understanding of Legal and Ethical Implications
3. Problem-Solving and Analytical Skills with C++, Python, Java.
4. Strong Foundation in Computer Science

Detailed Content:

Sl. No.	Content
1	Introduction to Digital Forensics and Tools <ul style="list-style-type: none"> • Objectives:

	<ul style="list-style-type: none"> ○ Understand the fundamentals of digital forensics. ○ Learn to use basic forensic tools like FTK Imager and WinHex. ○ Practice creating forensic disk images. • Exercises: <ul style="list-style-type: none"> ○ Create a forensic image of a hard drive. ○ Analyze a simple file system using WinHex. ○ Identify common file signatures.
2	<p>File System Analysis</p> <ul style="list-style-type: none"> • Objectives: <ul style="list-style-type: none"> ○ Understand different file systems (FAT, NTFS, ext2/3/4). ○ Learn to analyze file system metadata. ○ Practice recovering deleted files. • Exercises: <ul style="list-style-type: none"> ○ Analyze the MFT record of a deleted file. ○ Recover deleted files using tools like Recuva and PhotoRec. ○ Identify file carving techniques.
3	<p>NETWORK FORENSICS</p> <ul style="list-style-type: none"> • Objectives: <ul style="list-style-type: none"> ○ Understand network protocols and traffic analysis. ○ Learn to use network forensics tools like Wireshark and tcpdump. ○ Practice packet capture and analysis. • Exercises: <ul style="list-style-type: none"> ○ Capture network traffic using Wireshark. ○ Analyze HTTP, FTP, and other protocols. ○ Identify malicious network activity.
4	<p>MOBILE DEVICE FORENSICS</p> <ul style="list-style-type: none"> • Objectives: <ul style="list-style-type: none"> • Understand the architecture of mobile devices. • Learn to use mobile forensics tools like Cellebrite and Oxygen Forensic. • Practice extracting data from mobile devices. • Exercises: <ul style="list-style-type: none"> • Extract data from an Android or iOS device. • Analyze call logs, text messages, and browsing history. • Identify data hiding techniques on mobile devices.
5	<p>EMAIL FORENSICS</p> <ul style="list-style-type: none"> • Objectives: <ul style="list-style-type: none"> ○ Understand email protocols (SMTP, POP3, IMAP). ○ Learn to analyze email headers and body content. ○ Practice recovering deleted emails. • Exercises: <ul style="list-style-type: none"> ○ Analyze email headers to identify sender and recipient information. ○ Recover deleted emails using tools like Outlook PST Recovery. ○ Identify phishing emails and spam.
6	<p>Incident Response and Live Response</p> <ul style="list-style-type: none"> • Objectives: <ul style="list-style-type: none"> ○ Understand incident response methodologies. ○ Practice live response techniques. ○ Learn to use tools like Responder and Helix.

	<ul style="list-style-type: none"> • Exercises: <ul style="list-style-type: none"> ○ Respond to a simulated cyber-attack. ○ Collect volatile data from a live system. ○ Analyse system logs and memory dumps.
7	<p>Advanced Forensics Topics</p> <ul style="list-style-type: none"> • Objectives: <ul style="list-style-type: none"> ○ Understand data hiding techniques (steganography, encryption). ○ Learn to analyse encrypted data. ○ Practice using specialized forensic tools. • Exercises: <ul style="list-style-type: none"> ○ Identify hidden data in images and audio files. ○ Analyze encrypted files using tools like TrueCrypt and BitLocker. ○ Use specialized tools for analyzing specific types of digital evidence.
8	<p>Legal and Ethical Considerations</p> <ul style="list-style-type: none"> •Objectives: <ul style="list-style-type: none"> ○ Understand legal frameworks for digital forensics. ○ Learn about ethical guidelines for digital forensics. ○ Practice writing forensic reports. •Exercises: <ul style="list-style-type: none"> ○ Analyze a real-world case study involving digital evidence. ○ Write a forensic report summarizing findings and conclusions. ○ Discuss ethical implications of digital forensics.

Text/Reference Books:

1. Mobile Device Forensics by Andrew Hoog.
2. Network Forensics by Chris Sanders and Michael Dickens
3. Hacking Exposed: Computer Security Secrets & Solutions by Ed Skoudis and Mike Schiffman
4. The Hacker's Playbook 3: Practical Guide to Penetration Testing by Peter Kim
5. Digital Investigation and Response by Andrew G. West
6. Malware Analysis by Michael Sikorski and Andrew Honig

PCC-CS-692: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING LAB

CONTACTS: 3P PER WEEK

CREDITS: 1.5

Course Outcomes (COs):

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

PCC-CS-692	CO1	Understanding to install and configure Anaconda, Jupyter Notebook, NumPy, Pandas, SciPy, and Matplotlib.
	CO2	Applying anaconda environments to manage Python environments and packages effectively.
	CO3	Analyze and interpret data using NumPy, Pandas, SciPy, and Matplotlib.
	CO4	Create and customize data visualizations using Matplotlib.
	CO5	Evaluate the effectiveness of different data analysis techniques and tools.
	CO6	Develop and implement data-driven solutions to real-world problems using

	Python and its libraries.
--	---------------------------

Prerequisites:

- Data Structures
- Probability and Statistics
- Python Programming Language

Detailed Content:

Sl. No.	Content
1	<p>Anaconda: Learn how to use Anaconda to manage packages and environments for use with Python.</p> <p>Jupyter Notebooks: Learn how to use Jupyter Notebooks to create documents combining code, text, images, and more.</p>
2	<p>Numpy: NumPy Creating Arrays, Array Indexing, Array Slicing, Data Types, Copy vs View , Array Shape, Array Reshape, Array Iterating, Array Join, Array Split, Array Search, Array Sort, Array Filter.</p> <ul style="list-style-type: none"> • Learn the value of NumPy and how to use it to manipulate data for AI problems. • Mini-Project: Use Numpy to mean normalize an ndarray and separate it into several smaller nd arrays.
3	<p>Pandas: Pandas Series, Pandas DataFrames, Pandas Read CSV, Pandas Read JSON, Pandas Analyzing Datam.</p> <p>Learn to use Pandas to load and process data for machine learning problems.</p> <ul style="list-style-type: none"> • Mini-Project: Use Pandas to plot and get statistics from stock data
4	<p>SciPy: SciPy Constants, SciPy Optimizers, SciPy Sparse Data, SciPy Graphs, SciPy Spatial Data, SciPy Matlab Arrays, SciPy Interpolation, SciPy Significance Tests.</p> <ul style="list-style-type: none"> • Learn the value of NumPy and how to use it to manipulate data for AI problems. • Mini-Project: Use SciPy to build a Hybrid Recommender System in Python using LightFM
5	<p>Matplotlib: Learn how to use Matplotlib to Matplotlib Pyplot, Matplotlib Plotting, Matplotlib Markers, Matplotlib Line, Matplotlib Labels, Matplotlib Grid, Matplotlib Subplot, Matplotlib Scatter, Matplotlib Bars, Matplotlib Histograms, Matplotlib Pie Charts</p> <p>Mini-Project: Use Matplotlib to Analyzing Climate.</p>
6	<p>Unsupervised Machine Learning</p> <ul style="list-style-type: none"> • Lab 1: Data Exploration and Preprocessing <ul style="list-style-type: none"> ○ Load and visualize datasets. ○ Handle missing values and outliers. ○ Feature scaling and normalization. • Lab 2: Clustering Techniques <ul style="list-style-type: none"> ○ Implement K-Means clustering. ○ Apply hierarchical clustering. ○ Perform DBSCAN clustering. • Lab 3: Dimensionality Reduction <ul style="list-style-type: none"> ○ Apply Principal Component Analysis (PCA). ○ Use t-SNE for visualization.

7	<p>Supervised Machine Learning</p> <ul style="list-style-type: none"> • Lab 1: Linear Regression <ul style="list-style-type: none"> ○ Implement simple and multiple linear regression. ○ Evaluate model performance using metrics. • Logistic Regression <ul style="list-style-type: none"> ○ Build logistic regression models for binary classification. ○ Use regularization techniques (L1, L2). • Lab 2: Decision Trees and Random Forests <ul style="list-style-type: none"> ○ Implement decision trees and random forests. ○ Tune hyperparameters for optimal performance. • Support Vector Machines (SVM) <ul style="list-style-type: none"> ○ Train SVM models for classification and regression. ○ Explore kernel tricks.
8	<p>Application of AI in Cybersecurity and Datasets</p> <ul style="list-style-type: none"> • Lab 1: Intrusion Detection Systems (IDS) <ul style="list-style-type: none"> ○ Use machine learning techniques to build IDS. ○ Evaluate IDS performance using metrics. • Malware Analysis <ul style="list-style-type: none"> ○ Extract features from malware samples. ○ Build machine learning models for malware classification. • Lab 2: Dataset Exploration and Preparation <ul style="list-style-type: none"> ○ Explore popular cybersecurity datasets (e.g., KDD Cup 99, CIC-IDS2017). ○ Preprocess and clean datasets for machine learning.

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.
5. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow
6. Python Machine Learning: Machine Learning in Python
7. Pattern Recognition and Machine Learning

PCC-CS-693: ORACLE APPLICATION DEVELOPMENT LAB
CONTACTS: 3(L) PER WEEK
CREDITS: 1.5

Course Outcomes (COs):

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

PCC-CS-693	CO1	Construct advanced SQL queries for enterprise databases.
	CO2	Develop PL/SQL programs for business logic implementation.
	CO3	Implement database automation using cursors and triggers.
	CO4	Explain ERP technical architecture and tools.
	CO5	Demonstrate basic configuration in Fusion Cloud FSM.
	CO6	Apply REST API concepts for cloud integration.

Prerequisites:

1. Oracle- Database, SQL
2. Cloud Concept

Detailed Content:

Laboratory Experiments:		
Topics to be covered		No. of sessions
1.	Advanced SQL Complex queries, Views, Indexes, Sequences	2
2.	Advanced PL-SQL -I Function, Procedures , Exception Handling	2
3.	Advanced PL-SQL -II Implicit/Explicit Cursor ,Database Triggers, Packages	2
4.	Web-based Oracle application development Overview of Oracle Forms and reports, Practice in Oracle APEX (Cloud-based alternative) Basic conception of ERP, Net Suite (ERP functional understanding)	4
5.	Fusion Cloud- Introduction Oracle Fusion Overview, Navigation, FSM setup	1
6	Oracle Integration Cloud (OIC) – Fundamentals Components, Integration lifecycle, REST API basics	1

Resources

Note :- Designed as per WIPRO COE Curriculum

1. Sql, pl/sql the programming language of oracle by Bayross, Ivan
2. <https://livesql.oracle.com/>
3. <https://academy.oracle.com/>

SEVENTH SEMESTER

PEC-CS-701A: DEEP LEARNING
CONTACTS: 3(L) +1(T) PER WEEK
CREDITS: 4

Course Outcomes (COs):

On completion of the course students will be able to

PEC-CS-701A	CO1	Recall fundamental concepts of deep learning, including linear classifiers, neural networks, and optimization techniques.
	CO2	Explain the underlying principles of back propagation and gradient descent algorithms.
	CO3	Apply deep learning techniques to solve real-world problems, such as image classification, object detection, and natural language processing.
	CO4	Analyze the impact of hyper parameter tuning on model performance.
	CO5	Evaluate the effectiveness of different optimization techniques and regularization methods.
	CO6	Develop innovative solutions to challenging problems using deep learning mechanisms.

Prerequisites: Basic knowledge of AI & ML

Detailed Content:

Unit	Content	Hours/ Unit
1	Machine Learning Basics Learning Algorithms, Capacity, Over fitting and Under fitting, Hyper parameters and Validation Sets, Estimators, Bias and Variance, Maximum Likelihood Estimation, Bayesian Statistics, Supervised Learning Algorithms, Unsupervised Learning Algorithms, Stochastic Gradient Descent, Building a Machine Learning Algorithm, Challenges Motivating Deep Learning Deep Feed forward Networks Learning XOR, Gradient-Based Learning, Hidden Units, Architecture Design, Back-Propagation and Other Differentiation Algorithms	10
2	Introduction to Deep Learning, Bayesian Learning, Decision Surfaces. Linear Classifiers, Linear Machines with Hinge Loss. Optimization Techniques, Gradient Descent, Batch Optimization. Introduction to Neural Network, Multilayer Perceptron, Back Propagation Learning.	7
3	Unsupervised Learning with Deep Network, Auto encoder. Convolutional Neural Network, Building blocks of CNN, Transfer Learning.	5
4	Revisiting Gradient Descent, Momentum Optimizer, RMSProp, Adam Effective training in Deep Net- early stopping, Dropout, Batch Normalization, Instance Normalization, Group Normalization.	5
5	Recent Trends in Deep Learning Architectures, Residual Network, Skip Connection Network, Fully Connected CNN etc. Classical Supervised Tasks with Deep Learning, Image Denoising, Semanticd Segmentation, Object Detection etc.	7

6	LSTM Networks. Generative Modeling with DL, Variational Autoencoder, Generative Adversarial Network Revisiting Gradient Descent, Momentum Optimizer, RMSProp, Adam.	6
Total		40

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.
7. Pattern Classification- Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons Inc.

PEC CS-701B: BIG DATA ANALYTICS
CONTACTS: 3(L) +1(T) PER WEEK
CREDITS: 4

Course Outcomes (COs):

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

PEC-CS-701B	CO1	Understand the concept of data management and evolution of Big Data.
	CO2	Understand and implement various big data technology foundations.
	CO3	Apply the fundamentals of Hadoop ecosystem and its components for data analysis.
	CO4	Analyze the optimization techniques in data bases.
	CO5	Analyze the storage techniques in data bases.
	CO6	Explore the understanding of text, sentiment analytics.

Prerequisites:

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

Detailed Content:

<i>Module</i>	<i>Content</i>	<i>Hours/Module</i>
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 BigInsights and Big Sheets	8

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.	8
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.	8
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	8
5	Data Analytics with R: Machine Learning: Introduction, Supervised Learning, Unsupervised Learning, Collaborative Filtering. Big Data Analytics with BigR	8
Total		40

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 analytics, John Wiley & sons, 2012.
4. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007
5. Pete Warden, Big Data Glossary, O'Reilly, 2011.
6. Big Data for Dummies, Judith Hurwitz, Alan Nugent, Fern Halper, Marcia Kaufman, Wiley 2013

PEC-CS-701C: STEGANOGRAPHY AND WATERMARKING
CONTACTS: 3(L) +1(T) PER WEEK
CREDITS: 4

Course Outcomes (COs):

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

PCC-CS-701C	CO1	Understand the History and importance of watermarking and steganography.
	CO2	Describe Steganography and Watermarking fundamental concepts principles.
	CO3	Analyze Applications and properties of watermarking and steganography.
	CO4	Demonstrate Models and algorithms of watermarking.

	CO5	Design and implement efficient data hiding methods.
	CO6	Identify theoretic foundations of steganography and steganalysis.

Prerequisites: Cryptography

Detailed Content:

Module	Content	Hours/ Module
1	Introduction: Information Hiding, Steganography and Watermarking – History of watermarking – Importance of digital watermarking – Applications – Properties – Evaluating watermarking systems. Watermarking Models & Message Coding: Notation – Communications – Communication based models – Geometric models – Mapping messages into message vectors – Error correction coding – Detecting multi-symbol watermarks.	8
2	Watermarking With Side Information & Analyzing Errors: Informed Embedding – Informed Coding – Structured dirty-paper codes – Message errors – False positive errors – False negative errors – ROC curves – Effect of whitening on error rates	8
3	Perceptual Models: Evaluating perceptual impact – General form of a perceptual model – Examples of perceptual models – Robust watermarking approaches – Redundant Embedding, Spread Spectrum Coding, Embedding in Perceptually significant coefficients	8
4	Watermark Security & Authentication: Security requirements – Watermark security and cryptography – Attacks – Exact authentication – Selective authentication – Localization – Restoration	8
5	Steganography: Steganography communication – Notation and terminology – Information theoretic foundations of steganography – Practical steganographic methods – Minimizing the embedding impact – Steganalysis	8
	Total	40

Text book and Reference books:

1. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Jessica Fridrich, Ton Kalker, Digital Watermarking and Steganography, Morgan Kaufmann Publishers, New York.
2. Ingemar J. Cox, Matthew L. Miller, Jeffrey A. Bloom, Digital Watermarking, Morgan Kaufmann Publishers, New York.
3. Michael Arnold, Martin Schmucker, Stephen D. Wolthusen, Techniques and Applications of Digital Watermarking and Content Protection, Artech House, London.
4. Shih Frank Y, Digital Watermarking and Steganography, Taylor & Francis Inc.

PEC-CS-701D: BIO INFORMATICS
CONTACTS: 3(L) +1(T) PER WEEK
CREDITS: 4

Course Outcomes (COs):

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

PEC-CS-701D	CO1	Design basic algorithms used in Pairwise and Multiple alignments.
	CO2	Understand the methodologies used for database searching, and determining the accuracies of database search.
	CO3	Application of probabilistic model to determine important patterns.
	CO4	Prediction of structure from sequence and subsequently testing the accuracy of predicted structures
	CO5	Determine the protein function from sequence through analyzing data.
	CO6	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.	10
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	8

	prediction, Combination of two methods, Why is gene prediction difficult.	
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.	8
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 refinement, Evaluation of the model.	9
	Total	40

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.

PEC-CS-702A: BLOCK CHAIN AND CRYPTOCURRENCY

LECT CONTACTS: 3(L) +1(T) PER WEEK

CREDITS: 4

Course Outcomes (COs):

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

PEC-CS-702A	CO1	Remember cryptography and consensus algorithms.
	CO2	Understand the history, types and applications of block chain.
	CO3	Analyze functionality of cryptocurrency system.
	CO4	Apply block chain in various domains.
	CO5	Design, build and deploy a distributed application.
	CO6	Evaluate security, privacy and efficiency of a given block chain system.

Prerequisites:

- Operating System

- Data Communication and Networks
- Cryptography
- Network Security

Detailed Content:

Module	Content	Hours/ Module
1	Basics: Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. Cryptography: Hash function, Digital Signature - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof.	8
2	Blockchain: Introduction, Advantage over conventional distributed database, Block chain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Block chain application, Soft & Hard Fork, Private and Public block chain.	8
3	Distributed Consensus: Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level, Sybil Attack, Energy utilization and alternate.	8
4	Cryptocurrency: History, Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin.	8
5	Cryptocurrency Regulation: Stakeholders, Roots of Bit coin, Legal Aspects-Crypto currency Exchange, Black Market and Global Economy. Applications: Internet of Things, Medical Record Management System, Domain Name Service and future of Block chain.	8
	Total	40

Text book and Reference books:

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press.
2. Imran Bashir, Mastering Blockchain: Distributed Ledger Technology, decentralization, and smart contracts explained, 2nd Edition, Packt Publishing Ltd.
3. Wattenhofer, the Science of the Block chain.
4. Andreas M. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies, O'Reilly Media Inc.
5. Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System.
6. Dr. Gavin Wood, ETHEREUM: A Secure Decentralized Transaction Ledger, Yellow paper.2014.
7. Nicola Atzei, Massimo Bartoletti, and Tiziana Cimoli, A survey of attacks on Ethereum smart contracts.

PEC-CS-702B: INFORMATION THEORY AND CODING
CONTACTS: 3(L) +1(T) PER WEEK
CREDITS: 4

Course Outcomes (COs):

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

PEC-CS-702B	CO1	Derive equations for entropy, mutual information and channel capacity for all kinds of channels.
	CO2	Implement the various types of source coding algorithms and analyse their performance.
	CO3	Understand the fundamentals of Field Theory and polynomial arithmetic
	CO4	Design linear block codes and cyclic codes (encoding and decoding).
	CO5	Implement and decode a sequence at the receiver using Trellis decoder and Viterbi decoder.
	CO6	Perform mathematical analysis of problems in Information Theory and Coding, Implementation and verification using MATLAB simulation

Prerequisites:

1. Basic Mathematics
2. Probability and Statistics

Detailed Content:

Sl No	Content	Hours/Module
1	Introduction: Objective, scope and outcome of the course.	3
2	Source Coding: Uncertainty and information, average mutual information and entropy, information measures for continuous random variables, source coding theorem, Huffman codes.	8
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.	8
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.	6

	Total	40
--	--------------	-----------

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.
6. Ranjan Bose, “Information Theory, Coding and Cryptography”, Tata McGraw Hill, 2nd edition.
7. P.S. Satyanarayana, “Concepts of Information Theory and Coding”, Dynaram Publication, 2005
8. Richard B. Wells, “Applied Coding and Information Theory for Engineers” Pearson Education, LPE 2004.

PEC-CS-702C: SOFT SKILL AND INTERPERSONAL COMMUNICATION CONTACTS: 3(L) +1(T) PER WEEK CREDITS: 4

Course Outcomes (COs):

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

PEC-CS-702C	CO1	Develop effective communication skills (spoken and written).
	CO2	Develop effective presentation skills.
	CO3	Develop all-round personalities with a mature outlook to function effectively in different circumstances.
	CO4	Develop broad career plans, evaluate the employment market, identify the organizations to get good placement, match the job requirements and skill sets.
	CO5	Improve self-confidence.
	CO6	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	8

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.	8
3	Corporate Communication: Public Speaking: Skills, Methods, Strategies and Essential tips for effective public speaking. Group Discussion: Importance, Planning, Elements, Skills assessed; Effectively 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	8
4	Non-Verbal Communication & Personality Development Importance and Elements; Body Language. Concept, Essentials Meaning, Nature, Features, Stages, Models; Learning Skills; Adaptability Skills.	8
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	8
Total		40

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

PEC-CS-702D: QUALITATIVE SKILLS PRACTICE II
CONTACTS: 3(L) PER WEEK
CREDITS: 3

Bachelor of Technology (B. Tech) courses, incorporating qualitative skills can enhance technical education by developing students’ problem-solving, critical thinking, and communication abilities.

PROJ-CS-781: PROJECT I
CREDITS: 5

SI-CS-782: INTERNSHIP I
CREDITS: 3

SEMESTER-VIII

PEC-CS-801A: INTRODUCTION TO QUANTUM ALGORITHM CONTACTS: 3(L) +1(T) PER WEEK CREDITS: 4

Course Outcomes (COs):

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

PEC-CS-801A	CO1	Define and Describe fundamental quantum algorithm concepts, such as qubits, quantum states, inner products, and key postulates.
	CO2	Explain the principles of quantum measurement theory, including projective and generalized measurements, and how these concepts are applied to cryptographic protocols.
	CO3	Apply the concepts of quantum mechanics and cryptography to design and implement basic quantum cryptographic protocols.
	CO4	Analyze the role of quantum entanglement in cryptographic protocols, and compare how different quantum algorithms and protocols
	CO5	Evaluate the security of quantum cryptographic systems in the presence of untrusted devices by critically assessing experimental results.
	CO6	Design various quantum cryptographic methods and propose innovative solutions to enhance the security of quantum communication systems.

Prerequisites:

- Understanding classical algorithms lays the groundwork for comparing the performance of quantum and classical algorithms.
- Learn about techniques like lattice-, hash-, and code-based cryptography that are immune to quantum attacks.

Detailed Content:

Module	Content	Hours/ Module
1	Introduction: Qubit & Quantum States: The Qubit, Vector Spaces. Linear Combination Of Vectors, Uniqueness of a spanning set, basis & dimensions, inner Products, orthonormality, gram-schmidt orthogonalization, bra-ket formalism, the Cauchy-Schwarz and triangle Inequalities, Commutator Algebra, Heisenberg uncertainty principle, polar decomposition & singular values, Postulates of Quantum Mechanics.	8
2	Matrices & Operators: Observables, The Pauli Operators, Outer Products, The Closure Relation, Representation of operators using matrices, outer products & matrix representation, matrix representation of operators in two dimensional spaces, Pauli Matrix, Hermitian unitary and normal operator, Eigen values & Eigen Vectors, Spectral Decomposition, Trace of an operator, important properties of Trace, Expectation Value of Operator, Projection Operator, Positive Operators.	9

3	Quantum Measurement Theory: Distinguishing Quantum states & Measures, Projective Measurements, Measurement on Composite systems, Generalized Measurements, Positive Operator- Valued Measures.	5
4	Quantum tools and a first cryptographic protocol: Qubits, Density matrices, Measurements, Partial trace, Secure message transmission, Classical and quantum one-time pad.	5
5	Distributing keys and quantum key distribution protocols: Secure key distribution, Information reconciliation, The BB84 quantum key distribution protocol, Purifying protocols using entanglement, Security from tripartite uncertainty relations. The power of entanglement: Introduction to entanglement, Purifications, Secret sharing, Bell nonlocality, The monogamy of entanglement.	8
6	Quantum cryptography using untrusted devices: Testing devices using a Bell experiment, Device independent quantum key distribution.	5
Total		40

Text Books:

1. Quantum Computer Science by Marco Lanzagorta, Jeffrey Uhlmann.
2. W. Stallings, Cryptography and Network Security: Principles and Practice, 7th Ed. Pearson Publishers, 2017

Reference Books:

1. An Introduction To Quantum Computing Phillip Kaye, Raymond Laflamme, Michele Mosca.
2. D. R. Stinson, Cryptography: Theory And Practice, 3rd Ed. Boca Raton, Fl: Chapman & Hall/Crc, 2005.

PEC-CS-801B: DATA ANALYTICS IN FRAUD DETECTION

CONTACTS: 3(L) +1(T) PER WEEK

CREDITS: 4

Course Outcomes (COs):

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

PEC-CS-801B	CO1	Explain the importance of data analytics in support of investigations and fraud detection.
	CO2	Identify patterns and outliers quickly to assess possible improper activities.
	CO3	Describe the difference between structured and unstructured data.
	CO4	Use the Data Analysis Maturity Model to identify or search for specific red flags of fraud.

	CO5	Justify various trends in data analysis, data architecture, and data governance and their implications on investigations.
	CO6	Exercise on multiple case studies doing analysis with specific forensic data analysis tools.

Prerequisites:

- Basic probability concepts, including conditional probability, Bayes' theorem, and probability distributions, are foundational to understanding risk and uncertainty in fraud detection.
- Understanding key metrics and visualizations to spot trends and outliers is essential in assessing potential fraudulent activities.
- Anomaly detection techniques, including Z-score, k-means clustering, isolation forest, and auto encoders, are particularly useful for identifying outliers indicative of fraud.
- Knowledge of ethical considerations and data privacy laws (such as GDPR) is important, as fraud detection often involves sensitive personal and financial data.

Detailed Content:

Module	Content	Hours/ Module
1	Introduction: Foundations of Data Analytics, Data analytics terms of reference, Challenges of using data analysis, Using a framework for planning and conducting data analysis, Using a data analysis plan to think through audit objectives.	8
2	Fraud: Defining fraud concepts and terms, How auditors may encounter fraud, Identifying fraud indicators, Cataloguing and mapping fraud indicators, Characteristics of fraud schemes affecting the federal government.	8
3	Fraud Controls (Data-Related): Knowing internal control authorities, Understanding control activities and concepts, Awareness of control limitations, Using identity proofing as a key fraud control, Using data validation or edit checks.	8
4	Data: Knowing the hierarchy of data, Using the Department of the Treasury's Do Not Pay function, Examples of data matching, Extracting data for mining and matching, Cleaning dirty data Position and role.	8
5	Fraud Analytics: Data mining examples, rules-based testing, reasonableness testing outlier detection, Data matching examples, links and patterns analysis cross matching and fuzzy matching.	8
Total		40

Text Books:

1. Data Analytics for Accounting, 2 nd Edition: Richardson, Teeter, and Terrell | ISBN: 9781260837834.
2. Fraud data Analytics Methodology, by Leonard W. Vona, Released January 2017, Publisher(s): Wiley

3. Fraud and Fraud Detection: A Data Analytics Approach, **Sunder Gee**, Wiley

Reference Books:

1. Forensic Analytics: Methods and Techniques for Forensic Accounting Investigations, 2nd Edition: Mark J. Nigrini | ISBN 9781119585763.

PEC-CS-801C: DEEP LEARNING IN CYBER SECURITY
CONTACTS: 3(L) +1(T) PER WEEK
CREDITS: 4

Course Outcomes (COs):

On completion of the course students will be able to

PEC-CS-801C	CO1	Define key terms like machine learning, supervised learning, unsupervised learning, and basics deep learning.
	CO2	Explain the intuition behind regularization techniques like L1 and L2 regularization, dropout, and early stopping.
	CO3	Apply regularization techniques to prevent over fitting.
	CO4	Analyze the strengths and weaknesses of different deep learning algorithms.
	CO5	Evaluate the suitability of different deep learning algorithms for a real life problem.
	CO6	Design and implement novel deep learning model with their own architecture.

Prerequisites: Basic knowledge of deep leaning.

Detailed Content:

Unit	Content	Hours / Unit
1	Regularization for Deep Learning Parameter Norm Penalties, Norm Penalties as Constrained Optimization, Regularization and Under Constrained Problems, Dataset Augmentation, Noise Robustness	8
2	Semi-Supervised Learning, Multitask Learning, Early Stopping, Parameter Tying and Parameter Sharing, Sparse Representations, Bagging and Other Ensemble Methods, Dropout, Adversarial Training, Tangent Distance, Tangent Prop, and Manifold Tangent Classifier, Optimization for Training Deep Models, Learning vs. Pure Optimization, Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies, Algorithms with Adaptive Learning Rates	8
3	Convolutional Networks The Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms, Random or Unsupervised Features Storage strategies: Indices, B-trees, hashing.	8
4.	Recurrent and Recursive Nets Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Challenge of Long-Term Dependencies, Echo State Networks,	8

	Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and Other Gated RNNs, Optimization for Long Term Dependencies, Explicit Memory	
5	Practical Methodology: Performance Metrics, Default Baseline Models, Determining Whether to Gather More Data, Selecting Hyper parameters, Debugging Strategies, Example: Multi-Digit Number Recognition	8
	Total	40

Text book and Reference books:

1. The Elements of Statistical Learning. Hastie, R. Tibshirani, and J. Friedman, Springer.
2. Probabilistic Graphical Models. Koller, and N. Friedman, MIT Press.
3. Bishop. C.M., Pattern Recognition and Machine Learning, Springer, 2006.
4. Yegnanarayana, B., Artificial Neural Networks PHI Learning Pvt. Ltd, 2009.
5. Golub, G.,H., and Van Loan, C.,F., Matrix Computations, JHU Press, 2013.
6. Satish Kumar, Neural Networks: A Classroom Approach, Tata McGraw-Hill Education, 2004

PEC-CS-801D: WEB AND DATABASE SECURITY
CONTACTS: 3(L) +1(T) PER WEEK
CREDITS: 4

Course Outcomes (COs):

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

PEC-CS-801D	CO1	Define and Describe key concepts related to web and database security, including HTTP protocols, authentication mechanisms, injection attacks, and the fundamental requirements for database security.
	CO2	Understanding of different web security vulnerabilities (e.g., Cross-Site Scripting, SQL Injection, Path Traversal) and how these vulnerabilities can be exploited by attackers to compromise web applications and databases.
	CO3	Apply secure coding techniques to protect web applications from common vulnerabilities, such as SQL injection, XSS, and other client-side injection attacks, and implement secure authentication systems.
	CO4	Analyze web application and database security risks by evaluating source code for vulnerabilities and performing vulnerability analysis for both web applications and databases
	CO5	Evaluate the effectiveness of various web and database security strategies, including authentication mechanisms, encryption protocols, and vulnerability mitigation techniques.
	CO6	Creating various security measures to design and develop secure web applications and databases by integrating techniques such as encryption, access control, and secure password management into a cohesive security strategy.

Prerequisites:

- Interactive Web Development
- Advanced security threats

Detailed Content:

Module	Content	Hours/ Module
1	Web Application Basics: Introduction, HTTP Protocol, Web Functionality, Encoding Schemes, Enumerating Content and Functionality, Analyzing the Application. Authentication Security: Authentication Techniques, Design Flaws in Authentication, Implementation Flaws in Authentication, Securing Authentication, Path Traversal Attacks.	6
2	Injection Attacks: Injecting into Interpreted Contexts, SQL Injection, NoSQL Injection, XPath Injection, LDAP Injection, XML Injection, Http Injection, Mail Service Injection User Attacks: Inducing User Actions, Capturing Cross-Domain Data, Client-Side Injection Attacks, Local Privacy Attacks, ActiveX Control attacks, Browser Attacks	6
3	Cross Site Scripting (XSS): Types of XSS, XSS in Real World, Finding and Exploiting XSS Vulnerabilities, Preventing XSS Attacks. Vulnerability Analysis of Source Code: Approaches to Code Review, Signatures of Common Vulnerabilities, Analysis of Java platform, Analysis of ASP.NET platform, Analysis of PHP, Analysis of Perl, Analysis of Javascript, Analysis of SQL.	8
4	Introduction To Database Security: Fundamental Data Security Requirements, Data Security Concerns, Compliance Mandates, Security Risks, Developing Enterprise Security Policy, Defining a Security Policy, Implementing a Security Policy, Techniques to Enforce Security.	4
5	Database Access Control: User Authentication, Protecting Passwords, Creating Fixed Database Links, Encrypting Database Link Passwords, Using Database Links. Database Security Issues: Database Security Basics, Security Checklist, Reducing Administrative Effort, Applying Security Patches, Default Security Settings, Secure Password Support, Enforcing Password Management, Protecting	8
6	Framework For Database Security: Security for Workflow Systems, Secure Semantic Web Services, Spatial Database Security, Security Reengineering, Strong Authentication, Single Sign-On, Public Key Infrastructure (PKI) Tools, Configuring SSL on the Server, Certificates, Using Kerberos for Authentication	8
Total		40

Text Books:

1. “The Web Application Hacker’s Handbook”, Dafydd Stuttard, Wiley India Pvt. Ltd.
2. Database Security” , S.Castano, M. Fugini, G. Martella,P. Samarati, Addison-Wesley.

3. Web Security, Privacy and Commerce Simson GArfinkel, Gene Spafford, O'Reilly.

Reference Books:

1. Database Security “ Alfred Basta, Melissa Zgola, Cengage Publication, 2012.
2. Michael Gertz and Sushil Jajodia (Editors), Handbook of Database Security: Applications and Trends, ISBN-10: 0387485325. Springer, 2007.
3. Bhavani Thuraisingham, Database and Applications Security: Integrating Information Security and Data Management, CRC Press, Taylor & Francis Group, 2005.

OEC-CS-801A: E-COMMERCE AND ERP

CONTACTS: 3(P) +1(T) PER WEEK

CREDITS: 4

Course Outcomes (COs):

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

OEC-CS-501C	CO1	Understand fundamental concepts and technologies related to ERP.
	CO2	Explain the different phases of ERP implementation life cycle.
	CO3	Examine the modules, benefits and various tools of ERP.
	CO4	Analyze the impact of E-commerce on business model and strategies.
	CO5	Assess the electronic payment systems and software.
	CO6	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 Telecommunication.	5
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.	5

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.	5
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.	5
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.	5
Total		25

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

OEC-CS-801B: MULTIMEDIA SECURITY

CONTACTS: 3(L) +1(T) PER WEEK

CREDITS: 4

Course Outcomes (COs):

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

OEC-CS-801B	CO1	Create a well-designed, interactive Web site with respect to current standards and practices.
	CO2	Analyze the basic characteristics of digital watermarking to perform the theoretical analysis and performance measures.
	CO3	Acquire the concepts of steganography to access the sensitive information concealing of file, message, image, or video within another file.
	CO4	Obtain a suitable least significant bits construction and dynamic embedding with one-dimensional cellular automata to resist differential attack and support parallel computing.
	CO5	Examine the multimedia encryption techniques to address the open issues related to confidentiality of the media content.
	CO6	Develop a multimedia system including include multimedia compression techniques and standards, multimedia interfaces, video indexing and retrieval techniques.

Prerequisites:

- Multimedia system
- Need for Security

Detailed Content:

Module	Content	Hours/ Module
1	<p>Introduction: Introduction to multimedia, Components, Uses of multimedia</p> <p>Text: Fonts & Faces, Using Text in Multimedia, Font Editing & Design Tools, Hypermedia & Hypertext,</p> <p>Audio: Digital Audio, MIDI Audio, MIDI vs Digital Audio, Audio File Formats,</p> <p>Image: – Bitmaps, Vector Drawing, 3D Drawing & rendering, Natural Light & Colours, Computerized Colours, Color Pallets, Image File Formats.</p> <p>Video: How Video Works, Analog Video, Digital Video, Video File Formats, Video Shooting and Editing.</p> <p>Animation: Principle of Animations. Animation Techniques, Animation File Formats.</p>	12
2	<p>Digital Watermarking: Digital Watermarking Basics: Models of Watermarking, Basic Message Coding, Error Coding, Digital Watermarking Theoretic Aspects: Mutual information and Channel Capacity, Designing a good digital mark, Theoretical analysis of Digital watermarking.</p>	6
3	<p>Watermarking Schemes: Spread Spectrum Watermarking, Transform Domain Watermarking, Quantization Watermarking.</p>	5
4	<p>Media-Specific Digital Watermarking: Video Watermarking, Audio Watermarking, Binary Image Watermarking, Robustness to Temporal and Geometric Distortions, Affine resistant transformation.</p>	5
5	<p>Steganography: Introduction to Digital Image formats-Modern Steganography, Steganography Channels Steganography Goals.</p>	4
6	<p>Steganography Schemes: Image : Substitution, Bit Plane Coding, Transform Domain, Audio: Data Echo Hiding, Phase Coding, Video: Temporal technique, Spatial technique.</p>	6
7	<p>Multimedia Encryption: Introduction, Goals, Desired Characteristics, Performance metrics.</p>	2
Total		40

Text/ Reference Books:

1. Principles of Multimedia by Parekh, Mc Graw Hill.
2. Shih, F. Y. (2017). Digital watermarking and steganography: fundamentals and techniques.
3. Singh, Amit Kumar, Mohan, Anand (2019). Handbook of Multimedia Information Security: Techniques and Applications, Springer, Security and Cryptology.

Reference Books:

1. Cox, I., Miller, M., Bloom, J., Fridrich, J., Kalker, T. (2007). Digital watermarking and steganography. Morgan kaufmann.
2. Yi, Xun, Paulet, Russell, Bertino, Elisa (2014). Homomorphic Encryption and Applications, Springer, Security and Cryptology.

OEC-CS-801C: INTRODUCTION TO ARTS AND AESTHETICS
CONTACTS: 3(L)+1(T) PER WEEK
CREDITS: 4

Course Outcomes:

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

OEC-CS-801C	CO1	Analyze and implement the concept of Aesthetics.
	CO2	Describe a historical understanding on Western and Indian Aesthetics.
	CO3	Understand the aesthetic concepts from various Western and Indian philosophers.
	CO4	Analyze the contextual relevance of aesthetic theories.
	CO5	Develop a culture of critical and analytical thinking.
	CO6	Implement the aesthetical and philosophical concepts.

Prerequisite: NIL

Detailed Content:

Module	Content	Hours/Module
1	Literary Art Kavya, Fine Arts: Painting (Chitra), Music (Sangita), Sculpture (Bhaskarya). Kavya-Laksana (Definition of Poetry), Kavya-hetu: Pratibha, Vyutpatti and Abhyasa, Their distinctive roles in Poetic Creation, Kavya Prayojana. Varieties of Kavya: Drsyā and Sravya, Structural Varieties of Drsyakavya.	9
2	Different Schools of Literary Criticism (Kavyavicara): Rasa School (Bharata), Vakrokti School or the School of Alankara (Bhamaha and Kuntaka), Riti School or the School of 6 Gunas (Dandin and Vamana), Dhvani School (Anandavardhana) and Rasadvani School (Abhinavagupta).	9
3	Aesthetics and Philosophical Aesthetics: Second order Aesthetics, The World of Human Experience and Art and Experience. Art and its Definition: Art as Representation, Art as Expression and Art as Significant Form. Kantian Aesthetics (Critique of Judgment)	9
4	Art and Emotion: The Concept of Emotion, The Concept of Fiction and Fiction and Emotion. Literary Aesthetics: The Concept of Literature, Metaphor, Truth, Meaning and Interpretation.	7
5	Art, Society and Morality: Views of Tolstoy and Post-modernism.	6
Total		40

Text book and Reference books:

1. K. C. Pandey. Comparative Aesthetics Vol. 1. Chowkhamba: Chowkhamba Sanskrit Series Office, 1950. English.
2. R. Gnoli. The Aesthetic Experience According to Abhinavagupta. Chowkhamba: Chowkhamba Sanskrit Series Office, 1968. English.
3. Panchapagesha Sastri. The Philosophy of Aesthetic Pleasure. Annamalai, 1940. English.

4. S. Kunjunni Raja. Indian Theories of Meaning. Madras: Adyar Library and Research Centre, 1963. English.
5. K. Krishna Murthy. Dhvanyaloka and its Critics. Mysore: Kavyalaya Publishers, 1963. English.
6. S. P Bhattacharyya. Studies in Indian Poetics. Calcutta, 1964. English.
7. Anne Sheppard. Aesthetics: An Introduction to the Philosophy of Art. UK: Oxford University Press, 1987. English.
8. Peter Lamarque. Philosophy and Fiction: Essays in Literary Aesthetics. Aberdeen University Press, 1983. English.
9. Bernard Bosque. History of Western Aesthetics.

OEC-CS-801D: RESEARCH METHODOLOGY

CONTACTS: 3(L) +1(T) PER WEEK

CREDITS: 4

Course Outcomes (COs):

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

OEC-CS-801D	CO1	Discuss different methodologies and techniques used in research work.
	CO2	Explain basic computer skills necessary for the conduct of research.
	CO3	Explain key research concepts and issues.
	CO4	Select and define appropriate research problem and parameters.
	CO5	Develop the required numerical skills necessary to carry out research.
	CO6	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	10
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	10

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.	10
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.	10
	Total	40

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, Ess Ess 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. Ess Ess Publications.

PROJ-CS-881: PROJECT II
CREDITS: 5

WI-CS-882: INTERNSHIP II
CREDITS: 3