PROGRAM

AMRITA ONLINE

Master of Computer Applications

(MCA-Online)

CURRICULUM AND SYLLABUS
2025

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO1	Graduates with comprehensive knowledge and skills will be technically strong to design and develop innovative software for emerging requirements.
PEO2	Graduates will be lifelong learners with an aptitude for research, focusing on societal issues.
PEO3	Graduates will be proficiently employed as consultants / Entrepreneurs in the IT industry.

PROGRAMME OUTCOMES (PO)

PO1	**Foundation Knowledge**: Apply knowledge of mathematics, programming logic and coding fundamentals for solution architecture and problem solving
PO2	**Problem Analysis:** Identify, review, formulate and analyse problems primarily focusing on customer requirements using critical thinking frameworks.
PO3	**Development of Solutions**: Design, develop and investigate problems with an innovative approach for solutions incorporating ESG/SDG goals.
PO4	**Modern Tool Usage**: Select, adapt and apply modern computational tools, such as the development of algorithms, with an understanding of the limitations, including human biases
PO5	**Individual and Teamwork**: Function and communicate effectively as an individual or a team leader in diverse and multidisciplinary groups. Use methodologies such as agile.
PO6	**Project Management and Finance**: Use the principles of project management, such as scheduling, work breakdown structure and be conversant with the principles of Finance for profitable project management.
PO7	**Ethics**: Commit to professional ethics in managing software projects with financial aspects. Learn to use new technologies for cybersecurity and insulate customers from malware
PO8	**Life-long learning:** Change management skills and the ability to learn, keep up with contemporary technologies and ways of working

PROGRAMME SPECIFIC OUTCOMES (PSO)

Sl No	PSO	Stream
PSO1	Design, develop, and deploy software solutions using modern programming languages, databases, frameworks, and tools to meet real-world user needs in diverse domains	Regular
PSO2	Design, develop, and deploy AI-powered applications, including intelligent agents, decision-making systems, and adaptive software using techniques such as neural networks, natural language processing, and reinforcement learning, with an understanding of ethical, legal, and societal implications.	AI and ML
PSO3	Gain and demonstrate a thorough understanding of the Cyber Security landscape, including its growing threats and vulnerabilities in the computing world across software and hardware. Develop skills to comprehend, apply, and anticipate future challenges, and devise methods to address them effectively. Articulate strategies to convince all stakeholders.	Cyber Security

CURRICULUM

SEMESTER 1

	Course Code	Course Title	L T P	Cr
1	25CSA501A	Foundations of Computer Systems	3 1 0	4
2	25MAT501A	Mathematical Foundations for Computer Applications	3 1 0	4
3	25CSA502A	Object-Oriented Programming using Java	3 0 2	4
4		Stream Core 1	3 0 2	4
5		Stream Core 2	3 0 2	4
		TOTAL		**20**

SEMESTER II

	Course Code	Course Title	L T P	Cr
1	25CSA511A	Data Structures and Algorithms	3 0 2	4
2	25SSK512A	Soft Skills	3 0 0	3
3		Stream Core – Mathematics	2 0 1	3
4		Stream Core 3	3 0 2	4
5		Stream Core 4	3 0 2	4
6		Professional Elective 1	2 0 2	3
		TOTAL		**21**

SEMESTER III

	Course Code	Course Title	L T P	Cr
1	25CSA601A	Software Project Management	2 0 2	3
2	25CSA602A	Research Methodology	2 1 0	3
3		Stream Core 5	2 0 2	3
4		Stream Core 6	2 0 2	3
5		Professional Elective 2	2 0 2	3
6		Professional Elective 3	2 0 2	3
7	25CSA698A	Case Study		3
		TOTAL		**21**

SEMESTER IV

	Course Code	Course Title	L T P	Cr
1	25CSA699A	Capstone Project		12
2		Professional Elective 4	2 0 2	3
3		Professional Elective 5	2 0 2	3
		TOTAL		**18**
TOTAL CREDITS = 20+21+21+18 = 80				

LIST OF STREAM CORE COURSES

	Course Code	Course Title	L T P	Cr
		STREAM CORE MATHEMATICS		
1	25MAT531A	Probability and Statistics - Regular Stream	2 0 1	3
2	25MAT532A	Computational Linear Algebra - AI and ML Stream	2 0 1	3
3	25MAT533A	Mathematical Foundations for Cryptography - Cyber Security Stream	2 0 1	3

	Course Code	Course Title	L T P	Cr
		REGULAR STREAM		
1	25CSA531A	Programming Essentials in Python	3 0 2	4
2	25CSA532A	Advanced Computer Networks	3 0 2	4
3	25CSA533A	Software Engineering and Design Patterns	3 0 2	4
4	25CSA534A	Advanced DBMS	3 0 2	4
5	25CSA535A	Software Testing	2 0 2	3
6	25CSA536A	Full Stack Development	2 0 2	3
		AI AND ML STREAM		

1	25CSA541A	Python Programming for AI	3 0 2	4
2	25CSA542A	Foundations of Machine Learning	3 0 2	4
3	25CSA543A	Deep Learning for AI	3 0 2	4
4	25CSA544A	Natural Language Processing	3 0 2	4
5	25CSA545A	Complex Network Analysis	2 0 2	3
6	25CSA546A	Reinforcement Learning	2 0 2	3
		CYBER SECURITY STREAM		
1	25CSA551A	Python Scripting for Security	3 0 2	4
2	25CSA552A	Fundamentals of Security Operations	3 0 2	4
3	25CSA553A	ML and AI in Cybersecurity	3 0 2	4
4	25CSA554A	Network Security	3 0 2	4
5	25CSA555A	Blockchain and Centralized Applications	2 0 2	3
6	25CSA556A	Cyber Forensics	2 0 2	3

LIST OF PROFESSIONAL ELECTIVE COURSES

	Course Code	Course Title	L T P	Cr
		REGULAR STREAM		
1	25CSA631A	Design and Analysis of Algorithms	2 0 2	3
2	25CSA632A	Cloud Computing	2 0 2	3
3	25CSA633A	Machine Learning	2 0 2	3
4	25CSA634A	Switching, Routing and Wireless Essentials	2 0 2	3
5	25CSA635A	Blockchain Technologies	2 0 2	3
6	25CSA636A	Deep Learning	2 0 2	3
7	25CSA637A	Enterprise Networking, Security and Automation	2 0 2	3
8	25CSA638A	Mobile Application Development	2 0 2	3
		AI and ML STREAM		

1	25CSA641A	Data Engineering for AI	2 0 2	3
2	25CSA642A	No SQL databases	2 0 2	3
3	25CSA643A	Applications of Machine Learning	2 0 2	3
4	25CSA644A	Computational Statistics	2 0 2	3
5	25CSA645A	IOT for AI	2 0 2	3
6	25CSA646A	Computer Vision	2 0 2	3
7	25CSA647A	Business Analytics and Visualisation	2 0 2	3
8	25CSA648A	Generative AI and LLM	2 0 2	3
		CYBER SECURITY STREAM		
1	25CSA651A	Cybersecurity Governance, Risk and Compliance	2 0 2	3
2	25CSA652A	Essentials of Cyber Security	2 0 2	3
3	25CSA653A	Cyber Security Law	2 0 2	3
4	25CSA654A	System Security	2 0 2	3
5	25CSA655A	Web Application Security	2 0 2	3
6	25CSA656A	Cloud and Infrastructure Security	2 0 2	3
7	25CSA657A	Vulnerability Assessment and Penetration Testing	2 0 2	3
8	25CSA658A	Zero Trust Architecture	2 0 2	3
* Students registered to any stream are allowed to take a maximum of 2 electives from courses offered in another stream				

SYLLABUS

SEMESTER 1

	Course Code	Course Title	L T P	Cr
SEMESTER 1				
1	25CSA501A	Foundations of Computer Systems	3 1 0	4
2	25MAT501A	Mathematical Foundations for Computer Applications	3 1 0	4
3	25CSA502A	Object-Oriented Programming using Java	3 0 2	4
4		Stream Core 1	3 0 2	4
5		Stream Core 2	3 0 2	4
		TOTAL		**20**

25CSA501A Foundations of Computer System 3-1-0 - 4

Course Objectives

- Introduce students to the basics of Computer Systems.
- To enable the student to identify the interrelationships between Computer hardware and software.
- To enable the student to identify the interrelationships of further courses in the MCA program.

Course Outcomes

COs	Description
CO1	Explain the basic components of computer systems and their functionality.
CO2	Demonstrate the functions of the operating system and its role as a resource manager to execute any application.
CO3	Explain the need for database storage and apply SQL queries to retrieve, filter, and manipulate data from relational databases using SQL.
CO4	Implement the connection between operating systems, computer networks and database management through a case study

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	-	-	-	-	-	-	2
CO2	3	-	-	-	-	-	-	2
CO3	3	2	-	3	-	-	-	2
CO4	3	2	-	3	-	-	-	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Basics of Computers, Generations, and Classifications of Computers, Computer System hardware, Inside a compute cabinet, Input/ Output units, Computer Memory, Processor, Instruction format, Computer Architecture. Microcomputers: Digital Signal Processor, Microcontrollers, Smart Cards, Radio Frequency Identification.

Unit II

Data Representation, Binary Arithmetic, Binary coding schemes, Logic Circuits, and gates.

Unit III

Types of Softwares, Operating System, Different types and functions, Process management, memory management, File and device management, protection and security, UNIX Operating System, Utilities, Micro kernel based OS.

Unit IV

Data, Information and Knowledge, Introduction to Database Management Systems, Data Models, Introduction to SQL: Datatypes, Classification of SQL-DDL with constraints, DML, DCL, TCL.

Unit V

Computer Networks, Data transmission media, network types and topologies, Network devices, ISO/OSI and TCP/IP models, Protocols, Voice and data communication, Wireless networking, Cellular communication, Bluetooth, Mobile communication.

Textbooks / References

1. Fundamentals Computers, V Rajaraman, Neeharika Adabala, Phi Learning Pvt. Ltd.
2. Computer Fundamentals, Anita Goel, Pearson.
3. J. Glenn Brookshear," Computer Science: An Overview", Addison-Wesley, Twelfth Edition, 2014.

25MAT501A Mathematical Foundations for Computer Applications 3-1-0 4

Course Objectives

- This course provides a mathematical background and sufficient experience on various topics like matrix algebra, logic and proofs, combinatorics, and algebraic structures. This knowledge enhances students' logical and Mathematical thinking, as well as their ability to deal with abstract concepts in computer science and solve practical problems.

Course Outcomes

COs	Description
CO1	Construct valid mathematical arguments using propositional and predicate logic, including connectives, quantifiers, and inference rules, and relevant proofs.
CO2	To Explain the fundamentals of set theory, relations, equivalence relations, and functions, including their properties and operations.
CO3	Analyse the algebraic structure of groups, including subgroups, cyclic groups, cosets, and group isomorphisms, using Lagrange's theorem.
CO4	Apply concepts of matrices and linear algebra to solve systems of linear equations, compute rank, and determine eigenvalues and eigenvectors.
CO5	Solve combinatorial problems using principles of counting, permutations, combinations, the pigeonhole principle, and the principle of inclusion and exclusion.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	2
CO3	3	2	-	-	-	-	-	2
CO4	3	3	-	-	-	-	-	2
CO5	3	3	-	-	-	-	-	2

3-strong, 2-moderate, 1-weak

Syllabus:

Unit I

Mathematical logic: Introduction, Statements and Notation, Connectives, Arguments, Normal Forms, Theory of Inference for the Statement Calculus, The Predicate Calculus, Inference Theory of the Predicate Calculus, Proofs.

Unit II

Sets- Basic definitions - Laws of set theory - Principle of inclusion and exclusion – Partitions - Permutation and combination – Relations - Properties of relations – Equivalence Relation-Matrices of relations - Closure operations on relations -n-array relations- Functions.

Unit III

Groups – Axiom of a group – Examples and basic algebra in groups – Order of an element of a group – Isomorphism of groups – Cyclic groups – Subgroups – Cosets and Lagrange's theorem – Rings-Field

Unit IV

Matrices - Rank of a matrix - Solving system of equations – Echelon form of a matrix and row reduced echelon form of a matrix. - Eigenvalues and Eigenvectors - Cayley-Hamilton theorem.

Unit V

COMBINATORICS -Review of Permutation and Combination - Mathematical Induction - Pigeon hole

principle - Principle of Inclusion and Exclusion - generating function - Recurrence relations, Homogeneous and nonhomogeneous recurrences, and their solutions - solving recurrences using generating functions.

Textbooks/References

1. Rosen K. H., "Discrete Mathematics and its Applications", Seventh Edition, Tata McGraw-Hill, New Delhi, 2007.
2. R. P. Grimaldi, "Discrete and Combinatorial Mathematics", Pearson Education, Fifth Edition, 2007.
3. David Makinson, "Sets, Logic, and Maths for Computing", Springer Indian Reprint, 2011.
4. Trembley, J.P., and Manohar, R, "Discrete Mathematical Structures with Applications to Computer Science", Tata McGraw Hill, New Delhi, 2007.
5. Strang, G. (1976). *Linear algebra and its applications.* Academic Press.
6. Gallian, J. A. (2017). *Contemporary abstract algebra*. (Ninth edition ed.) Cengage Learning.

25CSA502A Object Oriented Programming using Java 3 0 2 - 4

Course Objectives

- The main objective of this course is to understand the basic concepts and techniques that form the object-oriented programming paradigm using the Java Language.

Course Outcomes

COs	Description
CO1	Identify classes, objects, members of a class and relationships among them needed for a specific problem.
CO2	Implement Java application programs using OOP principles and proper program structuring.
CO3	Demonstrate the concepts of polymorphism, inheritance and thread and document a Java Program using Javadoc.
CO4	Use Java AWT and Swing classes to build GUIs and understand how collection interface is implemented.
CO5	Demonstrate the Conceptual model of UML, activity diagram and their modelling techniques.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	-	2	1	-	-	1
CO2	3	3	-	3	1	-	-	1
CO3	3	2	-	2	1	-	-	1
CO4	3	3	-	1	1	-	-	1
CO5	3	3	-	3	-	-	-	1

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to object-oriented software design, Comparison of programming methodologies, Object Basics, Java Environment, Classes and Objects, Data Members, Access Specifiers, Arrays within a Class, Array of Objects, Constructors, Default Constructors, Destructors, Static Members, Constant Members.

Unit II

Overview of Streams, Bytes vs. Characters, File Object, Binary Input and Output, Reading and Writing Objects, Method Overriding, Polymorphism, Super, Interfaces and Abstract Classes, Packages, Exception

Unit III

Introduction to Threads, Creating Threads, Thread States, Runnable Threads, Coordinating Threads, Interrupting Threads, Runnable Interface, Synchronization.

Unit IV

Collection framework, Collection interfaces and classes, AWT, Swing, Event Handling, Javadoc

Unit V

Object Oriented Design with UML, Class, object diagrams and sequence diagrams. Use case diagrams and activity diagrams

Textbooks / References

1. Herbert Scheldt, "Java: The Complete Reference, Eleventh Edition", Oracle, 13th edition, 2024
2. Deitel PJ. Java how to program. Eleventh Edition, Pearson; 12th Edition, 2025.
3. Nino J, Hosch FA. Introduction to Programming and Object-oriented Design using Java. Wiley India Private Limited; 2010.
4. Naughton P. and Schildt H. Java 2: The Complete Reference. Eighth Edition, Tata McGraw- Hill; 2011.
5. Bahrami A. Object Oriented Systems Development. Second Edition, McGraw-Hill; 2008.
6. Booch G, Maksimchuk RA. Object-oriented Analysis and Design with Applications. Third Edition, Pearson Education; 2009.

SEMESTER II

	Course Code	Course Title	L T P	Cr
		SEMESTER II		
1	25CSA511A	Data Structures and Algorithms	3 0 2	4
2	25SSK512A	Soft Skills	3 0 0	3
3		Stream Core - Mathematics	2 0 1	3
4		Stream Core 3	3 0 2	4
5		Stream Core 4	3 0 2	4
6		Professional Elective 1	2 0 2	3
		TOTAL		**21**

25CSA511A	**Data Structures and Algorithms**	**3 0 2 - 4**

Course Objectives

- This course aims to provide the basic knowledge of different data structures and its usage. It also covers techniques used for analysing algorithms and notations for expressing time complexity.

Course Outcomes

COs	Description
CO1	Implement basic data structures such as Linked lists, Stack and Queue.
CO2	Analyze the time and space complexities of algorithms to evaluate their efficiency in various applications.
CO3	Implement different searching and sorting algorithms.
CO4	Use different data structures including tree and graph and solve computational problems using it.
CO5	Evaluate different programming paradigms to choose appropriate techniques for problem-solving.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	-	1	-	-	-	2
CO2	3	1	-	1	-	-	-	3
CO3	3	3	-	1	-	-	-	1

CO4	3	3	-	1	-	-	-	3
CO5	2	3	-	2	-	-	-	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Linear Data Structures: Arrays (single and multi-dimensional), Stack ADT, Multi Stack ADT, Queue ADT, Circular Queue, Priority Queue, Singly Linked List, Doubly Linked List, Circular Linked List.

Unit II

Nonlinear Data Structures: Trees - Array and List Representations: Binary Tree, Binary Search Tree, and Threaded Binary Tree. Balanced Trees: Weight Balanced Trees, Applications of WBTs, Height Balanced Trees -AVL Trees, Red-Black Trees. Binary Heaps: applications

Unit III

Graphs: Matrix and List Representation of Graphs, Breadth-First Search, Depth First Search, Shortest Path Algorithms (with Analysis) – Dijkstra - Bellman Ford- Floyd Warshall's all Pair shortest path Algorithm-Minimum spanning Tree (with Analysis) – Kruskal– Prims - Applications of BFS and DFS.

Unit IV

The efficiency of algorithms - the notion of time and space complexity, Basic Complexity Analysis - Worst case, Average case, and Best cases, Asymptotic Analysis- notations, analyzing iterative programs – Simple examples; Recurrences, Recurrence Relation: Substitution method, Recursion Tree Methods, Master Method.

Unit V

Dynamic Programming: Longest common subsequence problem, Matrix Multiplication Problem- 0/1 Knap-sack Problem. Branch and Bound – backtracking , Analysis of Divide and conquer algorithms – Quick Sort, Merge sort, Bucket Sort, Heap Sort, Greedy Algorithm: Fractional Knapsack Problem- Task Scheduling Problem.

Textbooks / References

1. Ellis Horowitz, Sartaj Sahni, and Susan Anderson-Freed, "Fundamentals of Data Structures in C", Second Edition, Silicon Press, 2008.
2. Jean-Paul Tremblay and G. Sorenson, "An introduction to Data Structures with Applications", Second Edition, Tata McGraw-Hill, 2008.
3. Robert L.Kruse, Bruce P. Leung, Clovis.L. Tondo and Shashi Mogalla, "Data Structure and Program Design in C", Pearson Education, Second Edition, 1997.
4. CormenT.H, Leiserson C.E, Rivest R.L, and Stein C, "Introduction to Algorithms", Third Edition, Prentice-Hall of India, 2009.
5. Baase.S and Gelder A.V., "Computer Algorithms- Introduction to Design and Analysis", Third Edition, Pearson Education Asia, 2003.

25SSK512A	Soft Skills	3 0 0 -3

Course Objective:

- Soft skills are non-technical skills that help individuals succeed in their studies, interactions, social circles and careers. These include communication, teamwork, problem-solving, critical thinking, adaptability, and more. Understanding and developing these skills can lead to improved academic performance, enhanced relationships, and better career prospects.

Course Outcomes

COs	Description
CO1	Able to develop effective communication skills and assertiveness.
CO2	Able to develop group problem solving skills and manifest it in practical situations.
CO3	Able to prepare an impressive and industry relevant resume (written and video format).
CO4	Able to measure and improve self-awareness for creating a social and professional impact.
CO5	Able to develop interview skills and managerial skills for optimum performance in an interview and in the corporate environment.

CO-PO Affinity Map

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	1	-	1	3	1	1	2
CO2	-	3	-	-	2	2	2	1
CO3	-	-	-	-	3	2	2	2
CO4	1	1	-	-	2	3	3	3
CO5	-	-	-	-	2	3	3	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Soft Skills for Life & Corporate Success: To explain the difference between campus life and corporate life, Able to develop effective communication skill and assertiveness. Set realistic personal and professional goals and achieve them by mastering the art of time management and stress management

Unit II

Self-Analysis: Able to measure and improve self-awareness for creating social and professional impact.

Unit III

Assertive Communication: Able to develop interview skills and managerial skills for optimum

performance in an interview and in a corporate environment. To identify the aspects of effective communication and evaluate oneself on the different types of communication. To help develop effective communication skills and assertiveness

Unit IV

Goal Setting: To be able to identify personal goals from personal values. To create and analyse SMART goals

Textbooks/ References

1. Self-Analysis - Johari window – How to understand your personality? - https://thinkinsights.net/leadership/johari-window/
2. Ethics In Profession: To Be Or Not To Be That Is The Question, Raka Bhattacharyya, APR 01, 2021
3. Thinking, Fast and Slow. by Daniel Kahneman & Asking the Right Questions: A Guide to Critical Thinking by M. Neil Brown
4. Creative Confidence: Unleashing the Creative Potential Within Us All, by Tom Kelley
5. How To Win Friends and Influence People by Dale Carnegie
6. The 21 Irrefutable Laws of Leadership, Subtitle: Follow Them and People Will Follow You, by John C. Maxwell
7. 60 Seconds and You're Hired! by Robin Ryan
8. "Unleash the Power of Storytelling" by Rob Biesenbach
9. Organizational Behaviour – Stephen Robbins, Pearson Education.
10. Personality Development & Soft Skills – Barun.K.Mitra , Oxford
11. Effective Presentation Skills, Revised Edition: A Practical Guide for Better Speaking – Steve Mandel, Crisp Publications;
12. The One Minute Manager – Ken Blanchard, Simon & Schuster Audio/Nightingale-Conant;
13. Leadership Development - Highflyers: Developing the Next Generation of Leaders Morgan W. McCall Jr. Harvard Business Press; First edition (January 15, 1998)
14. How to Grow Leaders: The Seven Key Principles of Effective Development (The John Adair Leade) John Adair Kogan Page; Re issue edition (March 1, 2009)

SEMESTER III

	Course Code	Course Title	L T P	Cr
		SEMESTER III		
1	25CSA601A	Software Project Management	2 0 2	3
2	25CSA602A	Research Methodology	2 1 0	3
3		Stream Core 5	2 0 2	3
4		Stream Core 6	2 0 2	3
5		Professional Elective 2	2 0 2	3
6		Professional Elective 3	2 0 2	3
7	25CSA698A	Case Study		3
		TOTAL		**21**

25CSA601A Software Project Management (2 0 2 -3)

Course Objectives

- This course is aimed at introducing the primary important concepts of project management related to managing software development projects. They will also get familiar with the different activities involved in Software Project Management. Further, they will also come to know how to successfully plan and implement a software project management activity, and to complete a specific project in time with the available budget.

Course Outcomes

COs	Description
CO1	To explain the basic concepts, terminologies and issues of software project management
CO2	To apply appropriate methods and models for the development of solutions
CO3	To analyze the cost-benefits of calculations so as to optimize the selection strategy.
CO4	To evaluate methods, models and technologies towards achieving project success
CO5	To design and evaluate network planning models with criticality.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	-	-	-	2	2	1
CO2	3	2	-	-	-	2	2	-
CO3	3	2	-	-	-	3	3	2
CO4	3	2	-	-	-	3	3	-

CO5	2	2	-	-	-	3	3	-

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Software Project Management: Software Projects-Other Types of Projects -Problems with Software Projects. Project Evaluation and Program Management:

Unit II

Evaluation of Individual Projects – Cost Benefit Evaluation Techniques – Risk Evaluation. Step Wise: An Overview of Project Planning. Selection of an Appropriate Project Approach: Build or Buy? - Waterfall Model – Spiral Model – Prototyping – Incremental Delivery–RAD – Agile Methods – XP - Scrum.

Unit III

Software Effort Estimation: Bottom up Estimating – Top-down Estimating – FP Analysis –COCOMO II – Cost Estimation. Activity Planning: Project Schedules - Sequencing and Scheduling Projects - Network Planning Models – AOA – AON - CPM - Shortening Project Duration – Crashing - Identifying Critical Activities.

Unit IV

Risk Management: A Framework for Dealing with Risk – Risk Management – PERT. Resource Allocation: Identifying Resource Requirements – Scheduling Resources –Publishing Resource Schedule – Cost Schedule.

Monitoring and Control: Visualizing Progress - Earned Value Analysis. Managing People in SW Environments: Organizational Behavior – Motivation.

Unit V

Working in Teams: Organizing Teams. Software Quality Management: Defining Software Quality – Metrics – Process Capability Models – Software Reliability. Case Study: PMBOK - MS Project.

Textbooks / References:

1. Mike Cotterell and Bob Hughes, “Software Project Management”, Fifth Edition, Tata McGraw-Hill, 2010.
2. Roger S. Pressman, “Software Engineering a Practitioner’s Approach”, Seventh Edition, Tata McGraw-Hill, 2010.
3. Jalote P, “Software Project Management in Practice”, Addison Wesley, 2002

25CSA602A Research Methodology (2 1 0 -3)

Course Objectives

- To inculcate research interest in students, help them to identify a research area and conduct literature review.

Course Outcomes

COs	Description
CO1	Demonstrate a clear understanding of the research process, its purpose, and various types of research through appropriate frameworks.
CO2	Identify and evaluate credible sources of information for literature review and data collection using digital and academic tools.
CO3	Apply appropriate research methods and analytical tools to design and conduct effective research.
CO4	Develop and document a research study from problem formulation to report writing while addressing ethical considerations and intellectual property rights.
CO5	Critically analyze a case study to formulate a relevant research problem, design a suitable research methodology, and synthesize findings into a structured review report.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	2	1	-	-	-	2
CO2	3	3	2	2	-	1	-	3
CO3	3	3	2	2	-	-	-	2
CO4	3	2	2	2	1	-	-	2
CO5	3	3	2	3	-	-	1	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Research – Definition and Purpose – Types of Research: Basic, Applied, Descriptive, Analytical, Quantitative, Qualitative – Steps in the Research Process – Identification, Selection and Formulation of Research Problem – Formulating Research Questions and Hypotheses – Developing a Research Design – Types of Research Design – Role of Literature Review – Sources of Literature – Using the Internet and Academic Databases – Identifying Research Gaps – Defining Objectives – Structuring a Research Report – Components of a Research Report – Plagiarism and Tools for Detection – Referencing Styles: APA, MLA, Chicago – Use of Reference Management Tools (Zotero, Mendeley)

Unit II

Research Ethics – Ethical Issues in Research Design and Conduct – Informed Consent – Confidentiality and Anonymity – Copyright and Fair Use – Royalty and Licensing – Understanding Intellectual Property Rights (IPR) – Patents, Trademarks, and Copyright Law – Academic Misconduct and Consequences – Role of Ethics Committees and Institutional Review Boards – Acknowledgement of Contributions – Proper Citation Practices – Avoiding Fabrication and Falsification.

Unit III

Case Study – Selecting a Research Topic – Framing Objectives and Scope – Conducting a Systematic Literature Review – Organising Literature using Thematic Mapping or Conceptual Frameworks – Writing a Review Report – Summarising Key Findings – Identifying Future Scope – Preparing for a Research Seminar – Delivering Oral Presentation – Using Visual Aids and Presentation Tools – Addressing Audience Questions – Receiving and Reflecting on Feedback

Textbooks / References

1. C.R. Kothari and Gaurav Garg, *Research Methodology: Methods and Techniques*, 4th Edition, New Age International Publishers, 2019.
2. Jacques Barzun, Henry F. Graff: "The Modern Researcher" Edition 6, Wadsworth Inc Fulfillment, 2003.
3. Creswell, John W. and J. David Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 5th Edition, SAGE Publications, 2018.
4. Robert P. Merges, Peter S. Menell, and Mark A. Lemley, *Intellectual Property in the New Technological Age: 2022 – Vol. I*, Clause 8 Publishing

25CSA698A	Case Study	3

Course Objectives

- This course introduces students to major areas of computer science by practicing acquired knowledge within the chosen area of technology for project development. Students will investigate and analyze real software systems, computing solutions, and technology decisions. The course encourages critical thinking, collaborative learning, and practical application of computing knowledge.

Course Outcomes

COs	Description
CO1	Able to practice acquired knowledge within the chosen area of technology for project development.
CO2	Reproduce, improve, and refine technical aspects for the projects
CO3	Work as an individual or in a team in development of technical reports and present findings from case studies
CO4	Evaluate system architectures, algorithms, and design patterns in existing systems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	2	1	1	1	1
CO2	1	2	2	2	3	-	2	-
CO3	2	2	3	3	3	-	3	-
CO4	1	2	2	2	3	2	2	-

3-strong, 2-moderate, 1-weak

SEMESTER IV

	Course Code	Course Title	L T P	Cr
SEMESTER IV				
1	25CSA699A	Capstone Project		12
2		Professional Elective 4	2 0 2	3
3		Professional Elective 5	2 0 2	3
		TOTAL		**18**
TOTAL CREDITS = 20+21+21+18 = 80				

25CSA699A Capstone Project 12

Course Objectives

- The Capstone Project course is a culminating academic experience where students apply the knowledge and skills acquired throughout the Computer Science program to solve a real-world problem. Working individually or in teams, students will design, implement, test, and present a comprehensive software/hardware project.

Course Outcomes

COs	Description
CO1	Apply the skills a student acquired through the different courses in this program to design software solutions for real world problems
CO2	Design a project architecture using appropriate tools, models, and methodologies and implement functional software/hardware solutions with proper testing strategies.
CO3	To integrate and apply theoretical and practical computer science knowledge, under time and deliverable constraints.
CO4	Demonstrate independence and originality in thought and application.

CO-PO Affinity Map

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	3	2	3	3	1
CO2	3	3	3	3	2	3	3	1
CO3	3	2	2	3	3	3	3	2
CO4	2	2	2	1	1	1	1	3

3-strong, 2-moderate, 1-weak

Scope

- Software development, hardware-software integration, AI/ML models, simulations, data science apps, IoT systems, cybersecurity tools, etc.

LIST OF STREAM CORE COURSES

	Course Code	Course Title	L T P	C r
		STREAM CORE - MATHEMATICS		
1	25MAT531A	Probability and Statistics - Regular Stream	2 0 1	3
2	25MAT532A	Computational Linear Algebra - AI and ML Stream	2 0 1	3
3	25MAT533A	Mathematical Foundations for Cryptography - Cyber Security Stream	2 0 1	3

25MAT531A Probability and Statistics (2 0 1 -3)

Course Objectives

- Introduce students to the basics of probability
- To enable the student to build statistical distribution-based models to perform data analysis tasks.
- To apply statistical concepts in data science problems

Course Outcomes

COs	Description
CO1	Explain the importance of probability distribution and statistical testing in data modeling and data analytics and solve problems.
CO2	Illustrate the basic concepts and techniques of probability and statistical testing.
CO3	Apply the concepts of probability theory for building datasets for computational experiments in data science
CO4	Should be able to wisely choose tools and techniques in probability and statistics for building and evaluating solutions to real life problems

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1
CO1	3	3	-	-	-	-	-	2	2
CO2	3	3	-	-	-	-	-	2	2
CO3	3	3	-	2	-	-	-	2	3
CO4	3	3	-	2	-	-	-	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Probability: Review of probability concepts, conditional probability and independence, Bayes' Theorem, Random Variables and Probability Distributions- mean and variance of a distribution, discrete and continuous distributions, Binomial, Poisson, Geometric, Uniform, Exponential, Normal distribution functions, Two-dimensional Random Variables, and distribution functions - conditional mean, variance, and covariance.

Unit II

Statistics: Linear correlation, correlation coefficient, properties of a correlation coefficient, sampling distributions, Chi-square, t and F distributions, Central Limit Theorem, theory of estimation-point estimation, unbiased estimator, maximum likelihood estimator - interval estimation.

Unit III

Testing of Hypothesis: Critical region, level of significance, errors in the testing of hypothesis, one-tailed and two-tailed tests, procedure for testing hypothesis, a test of significance of large and small samples, Student's t-distribution, Chi-Square Test for Goodness of fit and independence, F-test test for ratio of variances

Textbooks / References

1. Douglas C. Montgomery and George C.Runger, Applied Statistics and Probability for Engineers, (2005) John Wiley and Sons Inc
2. Sheldon M Ross, Introduction to Probability and Statistical Inference, 6th Edition, Pearson.
3. Ravichandran J, Probability and Statistics for Engineers, (2010) First edition, Wiley India

25MAT532A Computational Linear Algebra 2 0 1 -3

Course Objectives

- Introduce students to the basics of linear algebra, and calculus concepts
- To enable the student to build mathematical background to perform data analysis tasks.
- To apply mathematical concepts in AI and data science applications.

Course Outcomes

COs	Description
CO1	Use computational techniques and algebraic skills essential for the study of systems of linear equations, matrix algebra, vector spaces, eigenvalues and Eigenvectors, orthogonality and diagonalization.
CO2	Illustrate the basic concepts and techniques of linear algebra and calculus.
CO3	Integrate the application of these disciplines within the scientific field.

CO4	Should be able to wisely choose tools and techniques in Linear algebra for building and evaluating solutions to real life problems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO2
CO1	3	3	-	-	-	-	-	2	3
CO2	3	3	-	-	-	-	-	2	2
CO3	3	3	-	2	-	-	-	2	3
CO4	3	3	-	2	-	-	-	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Vector Spaces: Vector spaces, subspaces, linear independence, basis, dimension, inner products, orthogonality, orthogonal basis, Gram Schmidt Process, projection on subspace, least-square principle, QR decomposition.

Unit II

Eigen values and Eigen vectors, diagonalization and orthogonal diagonalization, iterative methods for the solution of linear systems, power method for Eigen values, and Eigen vectors.

Unit III

Numerical sets, functions, limits, derivatives: differentiability, chain rule, Mean Value Theorem, convexity, single variate functions extrema, and first derivative, extrema and second derivative, multivariate functions, partial derivatives, differentiability of a multivariate function

Textbooks/References:

1. Elementary Linear Algebra, Howard Anton and Chris Rorres, 11thEdition, Wiley, 2015.
2. Linear algebra: A modern introduction, D Poo, Cengage Learning, 4thEdition 2015.
3. Calculus, Monty J. Strauss, Gerald J. Bradley and Karl J. Smith, 3rdEdition, 2002.
4. Thomas Calculus, Pearson, 14thEdition, 2018

25MAT533A Mathematical Foundations for Cryptography 2-0-1-3

Course Objectives

- Students will be familiarized with the mathematics of cryptography. They will understand the fundamental algorithms behind all modern cryptographic primitives.

Course Outcomes

COs	Description
CO1	Explain Mathematical concept behind Security operations and the differences between symmetric and asymmetric cryptography.
CO2	Analyze, understand and evaluate the basic mathematical concepts used in cryptography
CO3	Learn the mathematical concepts and implement various Symmetric cryptography algorithms.
CO4	Learn the mathematical concepts and implement various Asymmetric cryptography algorithms.
CO5	Understand the use and implement the protocols in cryptography such as Hash functions, digital signatures, and MACs.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3
CO1	3	2	1	1	-	-	-	3	1
CO2	3	2	3	1	-	-	-	3	3
CO3	3	2	2	1	-	-	-	2	2
CO4	3	2	2	1	-	-	-	2	2
CO5	3	2	1	1	-	-	-	3	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Cryptography covering: Overview of cryptography, Symmetric Cryptography, Cryptanalysis logic and some basic attacks, Kercheoff's Principle and cover the discussion topic. Discussion: How many Key bits are enough.

Unit II

The mathematics used in cryptography: Why mathematics is important, Set Theory, Integer Theory, Rings, Division, Congruence, Euclidean algorithm, extended Euclidean algorithm.

Begin with symmetric cryptography and looked at mathematical concepts behind Cease cipher, affine cipher and their corresponding attacks. Moving onto Stream ciphers, LFSR, RNGS, Trivium, DES, DES Weaknesses, AES, Finite Fields, Galois Fields, AES AND DES in software and hardware implementation. Modes of operation

Unit III

Public Key Cryptography: Advantages and Disadvantages, different types of PKC:
RSA: Algorithm, drawbacks, Finding Large Primes, RSA Padding Diffie Hellman Algorithm, Groups, Order

of Groups, Discrete Logarithm Problem, Generalised discrete logarithm Problem, Attacks on DLP El Gamal Protocol, Computational Aspects, Passive Attacks, Active Attacks

Unit IV

Hash Functions:Properties of Hash Functions and security MD4 Family, SHA-1, SHA-2, SHA-3, Merkle Damgard Construction, Birthday Paradox

Digital Signatures and Message Authentication Codes, Digital Signature security services, RSA Digital Signature, DSA, Elgamal Digital Signature, Attacks on Digital Signatures, Message Authentication Codes MAC services, Prefix Mac, Suffix Mac

Unit V

Key Establishment Protocols: Man-in-the-middle attack, Kerberos, Certificates, Public Key Infrastructure, CA, Trusted third party

Textbooks / References

1. Understanding Cryptography: A Textbook for Students and PractitionersTextbook by Christof Paar and Jan Pelzl
2. Handbook of Applied Cryptography1996 EditionPaul C. van Oorschot, Scott A. Vanstone A. J. Menezes
3. History of Cryptography and Cryptanalysis 2019 John F Dooley
4. Everyday Cryptography, Fundamental Principles and Applications, Keith M. Martin
5. Cryptography made simple by Nigel Smart

	Course Code	Course Title	L T P	Cr
		REGULAR STREAM		
1	25CSA531A	Programming Essentials in Python	3 0 2	4
2	25CSA532A	Advanced Computer Networks	3 0 2	4
3	25CSA533A	Software Engineering and Design Patterns	3 0 2	4
4	25CSA534A	Advanced DBMS	3 0 2	4
5	25CSA535A	Software Testing	2 0 2	3
6	25CSA536A	Full Stack Development	2 0 2	3

25CSA531A Programming Essentials in Python 3 0 2 -4

Course Description

- Python is a versatile programming language that can be used to develop a wide range of applications. Python is key for backend web development, data analysis, artificial intelligence and scientific computing, all of which are key for pursuing IT careers. Through this course, students learn to design, write, debug, and run programs encoded in the Python language. No prior programming knowledge is required.

Course Outcomes

COs	Description
CO1	Develop problem-solving skills by applying algorithmic thinking to implement computational solutions in Python.
CO2	Manipulate data using built-in data structures such as lists, tuples, dictionaries, and sets.
CO3	Analyze and model real-life problems in Object-Oriented Programming categories.
CO4	Design, develop, and improve multi-module computer programs – using functions, modules and libraries

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1
CO1	3	3	-	1	-	-	-	-	3
CO2	3	3	-	1	-	-	-	-	3
CO3	3	3	-	2	-	-	-	-	3
CO4	3	3	-	3	3	-	-	-	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Python and Computer Programming- Python as a modern, universal and growing programming language, Python versions and language development, Brief review of tools and environments needed to start programming in Python. Data Types, Variables, Basic Input-Output Operations, Basic Operators- How to write and run the very first Python program, Python literals, Python operators and expressions, Variables – naming and using Basic input/output operations in Python . Boolean Values, Conditional Execution, Loops, Lists and List Processing, Logic and Bitwise Operations- Boolean data type, Relational operators in Python, Decision making in Python: if, if-else, if-elif-else, repeating code execution using loops: while and for Logic and bitwise operations in Python.

Unit II

Lists: constructing, indexing, slicing and content manipulation, how to sort a list using a bubble-sort algorithm, Multidimensional lists and their applications . Characters, strings and coding standards, Strings vs. lists – similarities and differences, List methods, String methods. Sets and Tuples – purpose, constructing and using Dictionaries – purpose, constructing and using

Unit III

Functions and Data Processing- Code structuring and the concept of functions, Function invocation and returning a result from a function, Name scopes and variable shadowing, Python's way of handling runtime

errors, Controlling the flow of errors using try and except, Hierarchy of exceptions. What is a module and why do we need it? , Importing and using modules, Review of some useful Python modules, what is a package and how does it differ from a module? Constructing and using packages, PIP – the Swiss army knife for package maintenance

Unit IV

Object-Oriented Programming- Basic concepts of object programming, From procedural to object approach – motivations and profits, Classes, objects, properties and methods, Inheritance and polymorphism, Exception as an object.

Unit V

Miscellaneous- Generators, iterators and closures, Working with file system, directory trees and files, Selected Python Standard Library modules (os, date, date time, calendar)

TextBooks/References

1. https://www.netacad.com/courses/programming/pcap-programming-essentials-python
2. Python: Essential Reference by David M. Beazley Released July 2009, Publisher(s): Addison-Wesley Professional
3. "Think Python: How to Think Like a Computer Scientist" by Allen B. Downey

25CSA532A Advanced Computer Networks 3 0 2 - 4

Course Objectives

- The primary course objective is to provide the foundation of basics in computer networks in the digital era.
- Enable the student to understand the fundamental networking principles, standards, protocols and technologies.
- The course also provides insights into networking concepts in each layer of the protocol model.
- The course will enrich the students with hands on experience in configuring networking devices using Packet Tracer and analysing the protocols using Wireshark.

Course Outcomes

COs	Description
CO1	To master the network basics and examine the function of the layers in the Internet protocol stack.
CO2	Determine the IP addressing for hosts in subnets and configure the networking devices like routers and switch.
CO3	To design and build simple local area networks using simulator/emulator/real time devices.
CO4	To design or simulate network applications and study its performance
CO5	To examine the foundation of network security

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1
CO1	3	3	-	-	-	-	-	2	2
CO2	2	1	-	-	-	-	-	2	3
CO3	3	3	-	2	-	-	-	2	3
CO4	3	3	-	2	-	-	-	2	3
CO5	3	3	-	1	-	-	-	2	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction: The Network Edge- The Network Core– Delay– Loss and Throughput in Packet Switched Networks. Network Types –LAN, WAN, PAN etc. Common network services in End devices, Wireshark and Packet Tracer Simulation tools, Characteristics of reliable networks.

Protocols: Open and Internet Standards, Network Protocol Interactions, Protocol suite, Layered Models - OSI, TCP/IP, Data Encapsulation, Logical and physical host address, Data Transfer in the network Internetwork Operating Systems(IOS) basics, IOS Access and Navigation, The Command Structure, Basic Device Configurations. **Physical Layer** - Physical Layer purpose and Characteristics, Copper and UTP cabling for wired LAN, Fibre-optic cabling and wireless media.

Unit II

Network Access - Purpose of the Data Link Layer, Topologies, Frame, MAC address, Address Resolution Protocol (ARP), Ethernet switch functionalities, Wireless LANs Basics. Configuring Wired and Wireless LAN. **Network Layer** – Layer Characteristics, IPv4 and IPv6 Packet, Host Routing Table, Functions of a router, Routing principles, Routing algorithm – Interior and Exterior routing, Routing decision process. Configure IP Addressing, Build a network in the Packet Tracer simulator

Unit III

Internet Protocol – Internet Layer-Class full Addressing – Class less addressing – Private Addresses – Subnets – Subnet masks, Classless and Subnet Address Extensions (CIDR), Variable Length Subnet Masking(VLSM), Internet Multicasting. Familiarising with IPv4 and IPv6 addressing, Network Address Translation (NAT), ping and trace route utilities, and ICMP.

Routing & Forwarding - Global Internet– RIP – OSPF – BGP – Broadcast & Multicast routing, Configuring Routing Protocols and application of subnetting in Packet Tracer,

Unit IV

Transport Layer –connection oriented and connection less service using sockets, Traffic Control and reliability strategies.**Application Layer** - Functionality, Web and Email Protocols, IP Addressing and File Sharing services

Unit V

Internet of Things – Components like controllers, services, Fog and cloud computing, Applications. Network Security – Security threats and vulnerabilities, network attacks, network attack mitigation, device security.

Textbooks / References

1. James F. Kurose and Keith W. Ross, "Computer Networking: A Top-Down Approach", 6th Edition, Addison Wesley, 2008.
2. Andrew S.Tanenbaum, "Computer Networks", Fifth Edition, Prentice Hall of India, 2011.
3. Richard Stevens, Bill Fenner and Andrew M. Rudoff, "UNIX Network Programming", Volume 1: "The Sockets Networking API", Third Edition, Addison Wesley, 2004.
4. Cisco Certified Networking Associate Certification (CCNA) Part1 Introduction to Computer Networks, Cisco Networking Academy.
5. Cisco Netacad academy course regarding Introduction to Cybersecurity and Internet of Things Fundamentals

25CSA533A Software Engineering and Design Patterns 3 0 2 -4

Course Objectives

- This course presents a broad perspective on software systems engineering, concentrating on widely used techniques for developing large-scale software systems covering a wide spectrum of software processes from initial requirements elicitation through design and development to system evolution. The course also covers a wide range of software development abilities and skills, from analysing a problem to implementing a solution, by discussing the design patterns in Smalltalk MVC architecture, Express representation invariants, understanding their impact on efficiency and ease of implementation, and implementing them as runtime assertions by differentiating between structural patterns and behavioural patterns involved in a software development process.

Course Outcomes

COs	Description
CO1	Delivering quality software products by possessing the leadership skills as an individual or contributing to the team development and demonstrating effective and modern working strategies by applying both communication and negotiation management skills.
CO2	Explain the concept of software requirements analysis and software design engineering methodologies
CO3	Illustrate the concept of Design patterns and its importance in gaining behavioural knowledge of the problem and its solutions using Creational, Structural design patterns.
CO4	Explain the need for programming by using basic design principles in solving real life problems or case studies.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1
CO1	3	2	-	3	1	-	-	1	2
CO2	3	2	-	3	1	-	-	1	3
CO3	3	2	-	3	1	-	-	1	3
CO4	3	2	-	3	1	-	-	1	3

Syllabus

Unit I

Software Engineering – Introduction - Software Classification - Layered Technology – Software Process –Practice - Generic Process Model, Process Assessment and Improvement – CMMI framework - Perspective Models - Specialized Models - Agile Process Models

Unit II

Requirements Engineering – SRS - Requirement Analysis- Unified Modelling Language –Approaches - Scenario-based Modelling - UML Models that supplement Use Cases- Activity and Swim lane Diagrams

Unit III

Design Engineering - Architectural Design – Modelling Component level design - Performing User Interface Design.

Unit IV

Introduction: What Is a Design Pattern?, Design Patterns in Smalltalk MVC, Describing Design Patterns, The Catalog of Design Patterns, Organizing the Catalog, How Design Patterns Solve Design Problems, How to Select a Design Pattern, How to Use a Design PatternCreational Patterns: Abstract Factory, Builder, Factory Method, Prototype, Singleton, Discussion of Creational Patterns. Structural Pattern Part-I: Adapter, Bridge, Composite. Structural Pattern Part-II: Decorator, *Façade*, Flyweight, Proxy. Behavioral Patterns Part-I: Chain of Responsibility, Command, Interpreter, Iterator. Behavioral Patterns Part-II: Mediator, Memento, Observer, State, Strategy, Template Method, Visitor, Discussion of Behavioral Patterns.

Unit V

A Case Study: Designing a Document Editor: Design Problems, Document Structure, Formatting, Embellishing the User Interface.

Textbooks / References

1. Roger S. Pressman, “Software Engineering-A Practitioner’s Approach”, Seventh Edition, Tata McGraw-Hill, 2020.
2. Ian Sommerville “Software Engineering”, Ninth Edition, 2015
3. Richard Fairley, “Software Engineering concepts”, Tata McGraw-Hill Publishing Company Pvt. Ltd., Ninth Edition
4. Pattern’s in JAVA Vol-I By Mark Grand, Wiley DreamTech.
5. JAVA Enterprise Design Patterns Vol-III By Mark Grand, Wiley DreamTech.
6. Head First Design Patterns By Eric Freeman-Oreilly-spd, 2nd Edition, 2021

25CSA534A	Advanced DBMS	3 0 2 - 4

Course Objectives

- To provide students with theoretical knowledge and practical skills in advanced topics in database systems.
- To Design and implement object-relational database queries using Structured Query Language.
- To Understand and study parallel and distributed database principles.

Course Outcomes

COs	Description
CO1	Explain and assess advanced database architectures, data models, and query processing techniques including relational algebra and indexing methods.
CO2	Evaluate concurrency control mechanisms and analyze recovery strategies to ensure database consistency and reliability.
CO3	Design and implement object-relational database systems using structured types, inheritance, and complex data representations for real-world applications.
CO4	Analyze the principles and performance aspects of parallel databases
CO5	Demonstrate understanding of distributed database concepts

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1
CO1	3	2	-	2	-	-	-	2	3
CO2	2	2	-	-	-	-	-	2	3
CO3	3	3	-	3	-	-	-	2	3
CO4	3	3	-	2	-	-	-	2	2
CO5	3	3	-	1	-	-	-	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction - Data Independence - The Three Levels Of Architecture - The External Level - Conceptual Level - Internal Level- System Structure, Instance and schema, Data Models, Types of DBMS , Keys, Structure Of Relational Databases, Introduction to relational algebra - Database Design using ER modeling.

Indexing and hashing- Basic concepts, B+Tree index files, Hashing

SQL -DDL, DML, Order by, Group by, Join, Subquery

Unit II

Transaction model and properties, Transaction structure, concurrency control -lock-based, timestamp-based, multi-version Schemas. Recovery System

Unit III

Introduction to an object-relational database, Complex Data Types, Structured Types and Inheritance in SQL Table Inheritance, Array. Representing multivalued and composite attributes.

Unit IV

Introduction to Parallel database and I/O Parallelism, Interquery Parallelism, Intraquery Parallelism. Intraoperation Parallelism, Interoperation Parallelism.

Unit V

Distributed Databases- Fragmentation, Replication, Distributed Transactions, Commit protocols

Textbooks / References

1. Database Systems Concepts; Silberschatz, Abraham, Henry F. Korth, and S.Sudarshan, 6th Edition, McGraw-Hill, 2010.
2. RamezElmasri and ShamkantNavathe, "Fundamentals of Database Systems", Sixth Edition, Addison Wesley, 2010.
3. Hector Garcia-Molina, Jeffrey Ullman, and Jennifer Widom, "Database Systems: The Complete Book", Second Edition, Prentice-Hall, 2008.
4. Carlo Zaniolo, Stefano Ceri, Christos Faloutsos, Richard T.Snodgrass, V.S.Subrahmanian, Roberto Zicari, ―Advanced Database Systems, Morgan Kaufmann Publishers,2006.

25CSA535A	Software Testing	2 0 2 -3

Course Objectives

- This course provides fundamental concepts in software testing, including software testing objectives, process, criteria, strategies, and methods.
- To discuss various software testing issues and solutions in software unit test; integration, regression, and system testing.
- This also expose the advanced software testing topics, such as object-oriented software testing methods, and component-based software testing issues, challenges, and solutions.

Course Outcomes

COs	Description

CO1	Explain different software testing techniques, process and errors handled in software projects.
CO2	Distinguish black box and white box testing techniques for functional and structural testing and testcase designing.
CO3	Illustrate the different testing activities and levels of testing which aims to uncover the defects in all the stages of project.
CO4	Discuss non-functional testing and debugging methods.
CO5	Demonstrate various issues for object-oriented testing and tools for testing.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1
CO1	3	2	-	3	1	-	-	-	2
CO2	3	2	-	3	1	-	-	-	2
CO3	3	2	-	3	1	-	-	-	3
CO4	3	2	-	3	1	-	-	-	3
CO5	3	2		3	2			-	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction: Introduction to software testing and analysis, Error, Fault, Failure, Incident, Test Cases, Testing Process, Limitations of Testing, No absolute proof of correctness.

Unit II

Specification-based testing techniques, code-based testing techniques, Model-based testing,

Blackbox box testing- Functional Testing: Boundary Value Analysis, Equivalence Class Testing, Decision Table Based Testing, Cause Effect Graphing Technique.

Whitebox testing- Structural Testing: Path testing, DD-Paths, Cyclomatic Complexity, Graph Metrics, Data Flow Testing, Mutation testing, Static Analysis, Dynamic Analysis

Unit III

Reducing the number of test cases: Prioritization guidelines, Priority category, Scheme, Risk Analysis, Regression Testing, Slice-based testing Testing Activities: Unit Testing, Levels of Testing, Integration Testing, System Testing, Debugging, Domain Testing, Regression Testing, Acceptance testing

Unit IV

Object Oriented Testing: Issues in Object Oriented Testing, Class Testing, GUI Testing, Object

Oriented Integration and System Testing, Methods of test data generation and validation.

Unit V

Program slicing and its application, Reliability analysis, Formal methods; verification methods; oracles. Testing Tools: Static Testing Tools, Dynamic Testing Tools, and Characteristics of Modern Tools

Textbooks / References:

1. William Perry, "Effective Methods for Software Testing", John Wiley & Sons, New York, 2007.
2. CemKaner, Jack Falk, Nguyen Quoc, "Testing Computer Software", Second Edition, Van Nostrand Reinhold, New York, 2000.
3. Boris Beizer, "Software Testing Techniques", Second Volume, Second Edition, Van Nostrand Reinhold, New York, 1990.
4. Louise Tamres, "Software Testing", Pearson Education Asia, 2002
5. "Software Testing: A Craftsman's Approach, Second Edition," by Paul C Jorgensen, CRC Press, June 26, 2002.

25CSA536A Full Stack Development 2 0 2-3

Course Objectives

- Full Stack Development is an indispensable course for computer science students. The course is concerned with end-to-end development of a three-tier web application.
- It deals with the frameworks necessary to implement front-end, back-end and database covering design, development and deployment.
- The course is designed to progress on both front-end and back- end in a synchronized fashion and leverages GitHub for version control and deployment.

Course Outcome

COs	Description
CO1	Utilize markup and scripting languages to create and validate dynamic and interactive web pages.
CO2	Implement responsive web design principles to tailor web pages for various devices and user needs.
CO3	Design and implement database services that meet specific application requirements, including schema creation and data management.
CO4	Design, develop, and deploy a complete end-to-end web application, integrating front-end, back-end, and database components.

CO-PO Mapping

PO/PS									

O / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1
CO1	3	3	-	2	2	-	-	-	3
CO2	3	3	-	2	2	-	-	-	3
CO3	3	3	-	3	2	2	2	-	3
CO4	3	3	-	2	2	2	2	-	3

Syllabus

Unit I

Introduction to web development, Git and GitHub, Taxonomy of frameworks. HTML basics – structuring, positioning, alignment, CSS and JS basics, Browser development tools, Bootstrap basics. Basic Backend App serving text/HTML and HTML from templates. Intro to React (or Vue/Angular), components, props, state, hooks.

Unit II

Jinja template, Semantic tags, HTTP components – parameters, headers, cookies, sessions, Handling forms, Serve-Handle JSON/XML requests, Intro to jQuery, jQuery request handling and Ajax, More jinja templating, Lists and tables, DOM styling, Responsive design.

Unit III

Database creation and connection, SQL (MySQL/PostgreSQL),NoSQL (MongoDB) Creation of DB Schema from model, Adding relation between models, Intro to REST APIs, Basic CRUD app, Form and tables for CRUD services. Authentication, designing error pages, setup default error pages. Simple hosting on a public web host,JWT (security).

Text Book/References

1. Laura Lemay, Rafe Colburn, Jennifer Kyrnin, “Mastering HTML, CSS & JavaScript Web Publishing”, Paperback, 2016.
2. Jon Duckett, “Web Design with HTML, CSS, JavaScript and jQuery”, Paperback, 2014.
3. Miguel Grinberg, “The New And Improved Flask Mega-Tutorial”, Paperback., 2017.
4. Kunal Relan, “Building REST APIs with Flask: Create Python Web Services with MySQL”, Paperback, 2019.

	Course Code	Course Title	L T P	Cr
		AI and ML STREAM		
1	25CSA541A	Python Programming for AI	3 0 2	4

2	25CSA542A	Foundations of Machine Learning	3 0 2	4
3	25CSA543A	Deep Learning for AI	3 0 2	4
4	25CSA544A	Natural Language Processing	3 0 2	4
5	25CSA545A	Complex Network Analysis	2 0 2	3
6	25CSA546A	Reinforcement Learning	2 0 2	3

25CSA541A Python Programming for AI 3 0 2 – 4

Course Objectives

- Explain the foundational concepts of Python programming
- Apply Python tools and libraries to handle data for AI tasks
- Implement basic machine learning techniques using Python
- Develop Python-based AI applications using real-world datasets

Course Outcomes

COs	Description
CO1	Apply Python fundamentals to solve computational problems
CO2	Perform data analysis and preprocessing using standard Python libraries
CO3	Build and evaluate machine learning models using Python
CO4	Develop simple AI applications by integrating Python modules and tools

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO2
CO1	3	2	-	2	-	-		2	3
CO2	2	2	-	3	-	-		2	3
CO3	2	2	-	3	3	-		2	3
CO4	2	3	-	3	2	-	-	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Python Foundations: Introduction to Python and its relevance in AI. Variables, data types, and type conversion. Arithmetic and logical expressions, Control flow: if, elif, else, loops (for, while). Functions, recursion, and lambda functions. Built-in data structures: lists, tuples, sets. Dictionaries and their applications, File I/O and exception handling. Introduction to object-oriented programming in Python

Unit II

Scientific Computing for AI: NumPy: arrays, indexing, slicing, broadcasting, matrix operations. Pandas: DataFrames, series, reading CSV/Excel, filtering, groupby. Exploratory data analysis using pandas. Basic statistics: mean, median, standard deviation. Data cleaning and handling missing values. Feature engineering and transformation

Unit III

Advanced Python Programming: List, dictionary, and set comprehensions. Iterators and generators (yield). Functional tools: map, filter, reduce. Exception handling and debugging (try-except, logging, pdb). File handling: reading/writing structured data. Modularisation: using modules and creating packages. Introduction to virtual environments and pip.

Unit IV

Python for Data Interaction:Web scraping with requests and Beautiful Soup. Consuming REST APIs. JSON serialisation/deserialization. Working with datetime, os, shutil, pathlib. Basic command-line scripting with argparse. Writing testable code using unittest or pytest

Textbooks

1. Python for Data Analysis – Wes McKinney, O'Reilly, 2nd Edition
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow – Aurélien Géron.
3. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2/e, Schroff, 2016
4. Automate the Boring Stuff with Python, 3rd Edition, Al Sweigart

Web References

- https://docs.python.org/3/
- https://numpy.org/doc/
- https://pandas.pydata.org/docs/
- https://scikit-learn.org/stable/

25CSA542A Foundations of Machine Learning 3 0 2 -4

Course Objectives

- Formulate a machine learning problem
- Preprocess and visualize data
- Develop models for classification/prediction using supervised learning algorithms
- Evaluate and fine-tune model performance
- Apply unsupervised learning algorithms for dimensionality reduction, association rules
- Use of Python packages for developing models

Course Outcomes

COs	Description
CO1	Identify and formulate a machine learning problem and select the subset of applicable techniques for model building.
CO2	Explain supervised learning problems, pre-process the data and train multiple models for testing using Python.

CO3	Explain unsupervised learning algorithms for building recommendation systems, clusters using Python.
CO4	Fine-tune and evaluate the performance of different models and select the best model for deployment using Python.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO2
CO1	3	3	-	3	1	-	-	2	3
CO2	3	3	-	3	1	-	-	2	3
CO3	3	3	-	3	1	-	-	2	3
CO4	3	3	-	3	1	-	-	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Machine Learning, Supervised Learning vs Unsupervised Learning, Semi-supervised, self-supervised, reinforcement learning (overview)**,** Data Preparation, Pre-processing, Challenges: Data leakage, Imbalance; Visualising data, Performance metrics for Classification and Prediction.

Unit II

Supervised Learning Algorithms: Linear Regression, Logistic Regression, SVM, Decision Trees, Ensemble models – Bagging and Boosting, Random Forest, Gradient Boosted trees, Model evaluation and improvement, Regularization, Bias Variance, Hyper-parameter Tuning, pipelines and grid search , Model Selection, Feature selection techniques

Unit III

Unsupervised Learning Algorithms: Dimensionality Reduction - Principal Component Analysis (PCA), Nonnegative Matrix Factorization (NMF), Singular Value Decomposition (SVD), t-SNE, UMAP (Overview), Association Rules, Clustering – Hierarchical, Non-hierarchical, eXplainable AI (XAI)

Textbooks / References:

1. Andreas Muller, "Introduction to Machine Learning with Python: A Guide for Data Scientists", Shroff/O'Reilly, 2016
2. Alexey Grigorev, Machine Learning Bookcamp, Manning, 2020
3. Tom Mitchell, Machine Learning, McGraw-Hill, India, 2017
4. Aurolien Geron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow, Shroff/O'Reilly", 2017
5. Ethem Alpaydin, “Introduction to Machine Learning”, PHI Learning Pvt. Ltd.; Third edition, 2015
6. https://developers.google.com/machine-learning/glossary

25CSA543A Deep Learning for AI 3 0 2 -4

Course Objectives

- Gain basic knowledge in Neural Networks, Training, and on Hyperparameter settings

- Learn to apply Neural Network Architectures for Object Detection, Localization Applications in Computer Vision (CNN)
- Learn to apply Neural Network Architectures for Sequence Modeling Applications like NLP, Action Recognition, Tracking (RNN)
- Applying Neural Network Architectures for Semi-Supervised Learning Settings (DBN)
- Applying Neural Network Architectures for Goal-Oriented Decision Making (DQN)

Course Outcomes

COs	Description
CO1	Understand and Explain the main architectures for deep learning algorithms.
CO2	Design and implement deep neural network models
CO3	Be able to design and train neural networks for solving real life practical problems
CO4	Develop knowledge (Conceptual & Mathematical) on different neural network settings to pursue Research in this Field

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO2
CO1	3	2	-	3	-	-	-	1	3
CO2	3	3	-	3	-	-	-	3	3
CO3	3	3	-	3	2	-	-	3	3
CO4	3	2		3	1	-	-	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Single Layer Neural Networks – Multi-Layer Neural Networks – Back Propagation – Train – Development – Test Set – Bias-Variance Trade-off – Hyper Parameter Settings

Unit II

Convolutional Neural Networks – Basics and Evolution of Popular CNN architectures – Transfer Learning–Applications: Object Detection and Localization, Face Recognition, Neural Style Transfer
Recurrent Neural Networks – GRU – LSTM – NLP – Word Embeddings – Transfer Learning – Attention Models – Applications: Sentinel Classification, Speech Recognition, Action Recognition

Unit III

Restricted Boltzmann Machine – Deep Belief Network – Auto Encoders – Applications: Semi-Supervised classification, Noise Reduction, Non-linear Dimensionality Reduction
Goal-Oriented Decision Making – Policy and Target Networks – Deep Quality Network for Reinforcement Learning. Introduction to GAN – Encoder/Decoder, Generator/Discriminator architectures
Challenges in NN training – Data Augmentation – Hyper parameter Settings – Transfer Learning– Deploying

ML Models with Pytorch/Tensor Flow

Textbooks / References

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville (2016) Deep Learning Book, MIT Press, 2016
2. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer, 2018
3. Aston Zhang, Zachary C. Lipton, Dive into Deep Learning, Cambridge University Press
4. Research Papers on Relevant Topics and Internet Resources

25CSA544A Natural Language Processing 3 0 2 - 4

Course Objectives

- Introduce the fundamental concepts and techniques of natural language processing
- To understand the computational properties of natural languages
- Introduce commonly used deep learning algorithms for processing linguistic information.
- Enable students to be capable to describe the application based on natural language processing and to show the points of syntactic, semantic, and pragmatic processing.

Course Outcomes

COs	Description
CO1	Apply foundational Natural Language Processing techniques for text preprocessing
CO2	Analyze and evaluate text representation methods including traditional and word embedding techniques
CO3	Design and implement supervised learning models for text categorization tasks.
CO4	Develop and evaluate NLP applications using machine learning and deep learning models

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO2
CO1	3	2	-	3	-	-	-	-	3
CO2	2	3	-	2	-	-	-	-	3
CO3	-	2	-	3	-	-	-	2	3
CO4	-	3	-	3	-	-	-	-	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

NLP Basics and Text Preprocessing: NLP Introduction, NLP Applications, Computational Linguistics- Introduction, syntax, semantics, morphology, co-location, and other NLP problems. Text Preprocessing - tokenisation, part-of-speech tagging, chunking, stemming, lemmatisation, syntax parsing, and named entity recognition. Error analysis techniques, Introduction of corpora and datasets, Public NLP toolkits – NLTK, spacy.

Unit II

Text Representations and Embeddings: One-hot encoding, Bag-of-Words (BoW) Dictionary: Term Frequency – Inverse Document Frequency (TF-IDF), N-gram. Word Embedding: Word2vec, Glove, and FastText, Static and contextual embeddings, HuggingFace tokeniser.Text categorisation: Basic supervised text categorisation algorithms, including Naive Bayes, k Nearest Neighbor (kNN), and Logistic Regression. Sequences and sequential data. Introduction to contextual embeddings: ELMo, BERT, GPT family, Transformer architecture basics.

Unit III

NLP Applications:Topic classification, Part-of-Speech tagging, Named Entity recognition, Morphological analysis, Sentiment analysis, Dependency parsing, Machine translation, Question answering, Text summarization. Introduction to Machine learning and deep learning for NLP, Topic modeling: Probabilistic Latent Semantic Indexing (pLSI), BERTopic and Latent Dirichlet Allocation (LDA), zero-shot classification. Fine-tuning pre-trained transformer models (e.g., BERT for classification, GPT for text generation). Evaluation metrics for NLP applications.

Textbooks / References

1. Jurafsky and James H. Martin. Speech and Language Processing, 2023 edition.
2. Tunstall, L., von Werra, L., & Wolf, T. (2022). Natural Language Processing with Transformers (O'Reilly).
3. Hobson Lane, Cole Howard, Hannes Hapke Natural Language Processing in Action 2019
4. Jacob Eisenstein Introduction to Natural Language Processing 2019
5. Dipanjan Sarkar , Text Analytics with Python 2016

25CSA545A Complex Network Analysis 2 0 2 -3

Course Objectives

- Describe fundamental tools to study networks, mathematical models of network structure
- Learn computer algorithms for network data analysis and the theories of processes taking place on networks.
- Experience working with complex network data sets and implement computer algorithms to solve network problems, use modern network tools to analyze data
- Design algorithms to solve large real-world network problems, devise models of network structure to predict the behavior of networked systems.

Course Outcomes

COs	Description

CO1	Apply the knowledge of mathematics, graph theory, and computer science fundamentals to analyze and model real-world networks.
CO2	Compute and interpret network measures (degree, centrality, PageRank, clustering, etc.) to analyze the structure and dynamics of networks.
CO3	Implement fundamental network algorithms for graph partitioning, spectral analysis, and community detection using computational tools.
CO4	Visualize and explore complex networks using software such as Gephi and NetworkX to communicate insights effectively.
CO5	Analyze and evaluate large-scale network properties (e.g., modularity, clustering, assortativity) to identify communities and hidden structures.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO2
CO1	3	2	2	-	-	-	-	1	2
CO2	3	3	2	-	-	-	-	1	3
CO3	3	3	3	3	-	-	-	2	3
CO4	2	2	2	2	2	-	-	2	2
CO5	2	3	3	2	-	-	-	3	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Graphs and Networks- Review of basic graph theory, Mathematics of networks- Networks and their representation, Graph spectra, Graph Laplacian, The structure of complex networks, Clustering, Community structures, Social networks - the web graph, the internet graph, citation graphs. Introduction to Gephi/NetworkX

Unit II

Measures and metrics- Degree centrality, Eigenvector centrality, Katz centrality, PageRank, Hubs and authorities, Closeness centrality, Betweenness centrality, Transitivity, Reciprocity, Similarity, assortative mixing.

Unit III

Fundamental network algorithms- Graph partitioning, Spectral graph partitioning, Community detection, Girvan and Newmann Algorithm, Simple modularity maximization, Spectral modularity maximization, Fast methods based on the modularity.

Textbooks / References:

1. M.E.J. Newman, “Networks: An Introduction”, Oxford University Press, 2010.
2. Dougles West, “Introduction to Graph Theory”, Second Edition, PHI Learning Private Limited, 2011.
3. Guido Caldarelli, “Scale-Free Networks”, Oxford University Press, 2007.

4. Alain Barrat, Marc Barthelemy, and Alessandro Vespignani, “Dynamical processes on Complex Networks”, Cambridge University Press, 2008.

25CSA546A Reinforcement Learning 2 0 2 -3

Course Objectives

- Understand the relevance of Reinforcement Learning and how it complements other ML techniques.
- Given a problem, how to formulate it as a Reinforcement Learning problem and solve it.
- Build a Reinforcement Learning system for sequential decision making.
- Understand various RL algorithms.
- Implement RL algorithms using Python.

Course Outcomes

COS	Description
CO1	Explain the relevance of Reinforcement Learning and how does it complement other ML techniques.
CO2	Analyze and Compare various RL algorithms
CO3	Implement RL algorithms using Python
CO4	Formulate a real life problem as a Reinforcement Learning problem and find solution to it.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO2
CO1	3	2	-	-	-	-	-	2	3
CO2	3	2	-	-	-	-	-	2	3
CO3	2	3	-	3	-	-	-	2	3
CO4	2	3	-	3	-	-	-	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Machine Learning and its various types, Motivation and Introduction to Reinforcement Learning, Multi arm Bandits; Markov Decision Process, Value functions; Dynamic programming: Policy evaluation and improvement, Value iteration and Policy iteration algorithms

Unit II

Value prediction problems: Temporal difference learning infinite state spaces Algorithms for large state spaces Control: Closed-loop interactive learning, online and active learning in bandits, Q learning infinite MDPs, Q learning with function approximation

Unit III

On policy approximation of action values: Value Prediction with Function Approximation, Gradient-Descent Methods, Policy approximation: Actor critic methods, Monte Carlo Methods: Monte Carlo prediction, estimation of action values, off policy prediction via importance sampling, Overview of Deep Q-Networks (DQN), Reward Metrics, OpenAI Gym, Stable Baselines3 tools

Textbooks / References

1. Richard S. Sutton, Andrew G. Barto, Reinforcement Learning: An Introduction", Second edition, MIT Press, 2018
2. Csaba Szepesvari, Algorithms for Reinforcement Learning, 2010, Morgan and Claypool

	Course Code	Course Title	L T P	Cr
		CYBER SECURITY STREAM		
1	25CSA551A	Python Scripting for Security	3 0 2	4
2	25CSA552A	Fundamentals of Security Operations	3 0 2	4
3	25CSA553A	ML and AI in Cybersecurity	3 0 2	4
4	25CSA554A	Network Security	3 0 2	4
5	25CSA555A	Blockchain and Decentralized Applications	2 0 2	3
6	25CSA556A	Cyber Forensics	2 0 2	3

25CSA551A Python Scripting For Security 3 0 2-4

Course Objectives

- In this course students will learn to program in python, using an object-oriented approach. Students will learn and write short and long programs to use python to write programs that automate common security tasks.

Course Outcomes

COs	Description
CO1	Explain the fundamentals of computing concepts and Python programming constructs.
CO2	Apply object-oriented programming principles in Python to design and implement reusable scripts for automation.
CO3	Debug and test Python programs to identify and resolve logical and runtime errors.

CO4	Demonstrate familiarity with the Python ecosystem, including its simplicity and versatility for application development.
CO5	Utilize standard Python libraries securely and effectively for problem solving.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3
CO1	2	1	2	3	-	-	-	2	1
CO2	2	2	3	3	-	-	-	2	1
CO3	1	3	3	3	-	-	-	2	1
CO4	2	1	3	3	-	-	-	3	1
CO5	2	2	3	3	-	-	-	3	3

Syllabus

Unit I

Fundamentals of Python, REPL, Variables, Datatypes, Control Flow, Functions, Recursion Containers: List, Tuple, Dictionaries, Sets, Frozensets, Mutable vs Immutable, Generators: list comprehensions, dictionary creation routines.

Unit II

Object-Oriented Programming, Classes and Objects, Data attributes and methods, Serialization and deserialization using JSON, Pickle, Error handling and Debugging, Importing and using modules

Unit III

Scripting Files and folders, Os.path and pathlib, Process management and command execution, Os.system and subprocess module, Os.exec, os. fork, and os. kill

Unit IV

Networking, Socket Module and SSL modules, Socket Creation, Binding, Sending and receiving data, Cryptography, CSPRNG, secrets module, hashlib, fernet, MAC & HMAC

Unit V

Website Automation, Requests, Scraping, Beautiful Soup, Selenium, Data processing and Visualization with pandas, numpy , seaborn

Textbooks / References:

1. Wesley J. Chun, “Core Python Applications Programming”, 3rd Edition, Pearson Education, 2016.
2. https://automatetheboringstuff.com/ (free online version)
3. realpython.com (free articles only)

4. https://jakevdp.github.io/PythonDataScienceHandbook/ (free online version)

25CSA552A Fundamentals of Security Operations 3 0 2-4

Course Objectives

- The course teaches students security concepts, common network and application operations and attacks, and the types of data needed to investigate security incidents. Students will learn how to monitor alerts and breaches and become contributing members of a Cybersecurity Operations Centre (SOC), including understanding the IT infrastructure, operations, and vulnerabilities.

Course Outcomes

COs	Description
CO1	Students should be able to understand and explain the functionalities of various SOC generations.
CO2	Illustrate different data collection, data analysis, and security analysis techniques as part of SOC technologies.
CO3	illustrate the vulnerability management techniques and threat intelligence methodologies.
CO4	Assess the SOC capabilities using different SOC tools and techniques.
CO5	Learn and apply how SOC helps in business continuity and disaster recovery plan.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3
CO1	1	1	2	3	-	-	-	3	2
CO2	2	1	3	3	1	-	-	3	3
CO3	2	2	2	3	-	-	-	2	3
CO4	2	2	3	3	1	-	-	2	3
CO5	1	2	2	3	1	1	1	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Information security incident management (Incident detection, triage and incident categories, Incident severity, resolution, Closure, Post-incident)

Unit II

Security Operations Center (SOC) Generations (First-generation, second, third and fourth generation SOC), SOC Maturity models (Introduction to maturity models, and applying maturity models in SOC)

Unit III

SOC and SIEM – Introduction (Role of SIEM in SOC), SOC and Splunk (Splunk architecture & SOC, Splunk Rules, Splunk log management, Splunk correlation), SOC and Health Care - A Case study (SOC Considerations for a HealthCare situation), SOC and Application security (OWASP, Application security and SOC).

Unit IV

SOC - Business Continuity, Disaster recovery (Importance of BCP and DR processes, and its interface to SOC), Security event generation and collection (Cloud Security, IDPS, Breach Detection)

Unit V

SOC Technologies-1 (Data collection and analysis, syslog protocol), SOC Technologies-2 (Telemetry Data, Security analysis, Data enrichment), Vulnerability Management (Broad introduction), Threat intelligence (Broad introduction), Assessment of SOC capabilities (Business and IT Goals, Assessing capabilities & IT processes)

Textbooks / References:

1. Security Operations Center: Building, Operating, and Maintaining your SOC Authors: Joseph Muniz Gary McIntyre, Nadhem AlFardan Publisher: Cisco Press

2. Computer Security Incident Handling Guide (NIST SP 800-61r2) Publisher: NIST (National Institute of Standards and Technology) Free Download
https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-61r2.pdf

25CSA553A Machine Learning and Artificial Intelligence in Cybersecurity 3 0 2-4

Course Objectives

- The students will be exposed to the fundamentals of machine learning: classification, regression, supervised and unsupervised learning. They will learn which algorithms to use in which context, including model validation and evaluation. They will be exposed to a thorough survey of the fundamental security applications that machine learning provides as well the current security limitations of machine learning.

Course Outcomes

COs	Description
CO1	Explain the basic concepts of machine learning and artificial intelligence.

CO2	Gain proficiency in scikit-learn and demonstrate the use of supervised and unsupervised learning algorithms.
CO3	Explain the fundamentals of regression and classification
CO4	Apply classification and anomaly detection systems in security – fraud and spam detection
CO5	Use threat model for machine learning, understanding adversarial attacks

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3
CO1	2	3	1	2	-	-	-	3	1
CO2	1	2	2	3	-	-	-	3	1
CO3	3	3	2	2	-	-	-	3	1
CO4	2	3	3	3	-	-	-	3	3
CO5	2	2	3	3	-	-	-	3	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Python, Jupyter Notebooks, Pandas, Numpy, Matplotlib, Seaborn, Scikit-Learn. Supervised learning: Linear regression, Decision Trees, Support Vector Machines, K-nearest neighbors, random forests, AdaBoost, gradient boosting, multi-layer perceptrons, logistic regression.

Unit II

Unsupervised learning: k-means clustering, dbscan, GMM, PCA, T-SNE. Bias-variance tradeoff. Learning and validation curves. Cross-validation, shuffle split, k-fold, time-series split. Random seeds. Baseline and benchmarking models. Gradient descent, regularization, feature scaling, one-hot encoding, label encoding. Train-test-split. Metrics: accuracy, f1-score, precision, recall, confusion matrices. Gini impurity, information gain ratio, feature ranking with multivariate and univariate methods. Hyper-parameter tuning with grid search and random search. Natural language processing, ngrams, bag of words, vectorizers. Data wrangling with feature preprocessing and EDA.

Unit III

Artificial Intelligence (AI), Deep Learning (DL), and Machine learning (ML) in security. Understand the role AI plays in making decisions in large-scale settings. Algorithm bias and fraud.

Unit IV

Machine learning for security - anomaly detection, fraud detection, malware detection, spam detection, phishing detection, IDS, and NIDS.

Unit V

Security of machine learning: adversarial attacks on machine learning. Data poisoning, model stealing,

evasion attacks at inference time. Adversarial hardening.

Textbooks / References:

1. Tom M Mitchell, Machine Learning, McGraw Hill, 1997
2. Jake Vanderplas, Python Data Science Handbook, O'Reilly Media, 2016
3. Clarence Chio, David Freeman, Machine Learning and Security, O'Reilly Media, 2018

25CSA554A Network Security 3 0 2-4

Course Objectives

- Students will gain a fundamental understanding of network security. They will protect networks, both physical and wireless. Common protocols and data management techniques. They will be comfortable with all the layers of a network, Wifi, Bluetooth. The student will become comfortable with cryptography over networks, and IPv6 security, email security, and firewalls. Students will be familiar with IDS and IPS, common tools against network attacks

Course Outcomes

COs	Description
CO1	Describe the fundamental concepts of computer networking and network security.
CO2	Demonstrate methods to ensure confidentiality, integrity, and availability of data in networked environments
CO3	Analyze and apply security protocols to safeguard networks against threats and vulnerabilities.
CO4	Evaluate mechanisms for securing data transmission across networks.
CO5	Implement and experiment with Python networking libraries to develop secure network applications.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3
CO									
CO1	2	3	1	2	-	-	-	3	2
CO2	2	3	1	1	-	-	-	3	3
CO3	1	2	2	3	-	-	-	3	3
CO4	1	2	1	2	-	-	-	3	2
CO5	-	3	3	3	-	-	-	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Information Security Awareness: Bad Actors, Data Security Perspectives, Password Perspectives,

Internet Threat Perspectives and Insider Threat Perspectives. Application Layer, Web and HTTP, Electronic mail protocols (SMTP,POP3,IMAP), DNS, Content Distribution Networks, Web Application Firewall Transport Layer, Process to Process delivery, UDP, TCP, Flow Control and Error Control in TCP, Congestion Control in TCP, UDP Socket Programming, TCP Socket Programming, Practical

Unit II

Evolution of Network Security, Secure Access Service Edge, Cloud Security, SD-WAN, Endpoint Security, Data Link Layer, Relationship with other layers, Error detection and correction Techniques, ARP and RARP, Link-layer protocols, Switched Local Area Networks, Practical WIFI Technologies: Introduction 1 (WiFi), WiFi Security, Practical - Traffic analysis, Practical - Demonstration of WIFI Exploitation

Unit III

Bluetooth and Zigbee, Bluetooth -Working, Zigbee – Working, Bluetooth and Zigbee security, Symmetric Key Cryptography, Asymmetric Key Cryptography, Digital Signatures, Cryptographic, Hash Functions, Message Authentication Codes, IPv6 Security, Network Layer Security, Transport Layer Security Email Security, Securing Email, Email Header Analysis, Secure Email Gateway, Firewalls, Threat Intelligence Services IDS and IPS, Types of IDS and IPS, IDS and IPS Designs, Network Risk and Vulnerability Management, Types of Vulnerability Assessment, Tools for Network Vulnerability Assessment, Network Attacks, Information Extraction using NMAP + Port scanning

Unit IV

Access Attacks, DNS Poisoning + ARP Poisoning,Replay attack and privilege Escalation Malware & DDoS Attacks, DOS & DDOS, MAC Spoofing + switch port stealing,Wireless Network Security(WPA2/WPA3).

Textbooks / References:

1. J. F. Kurose and K. W. Ross, Computer Networking: A Top-Down Approach, Pearson Publication, 7th Edition, 2017.
2. L. Peterson and B. Davie, Computer Networks: A Systems Approach, 5th Edition, Elsevier Inc., 2011.
3. S.K.PARMAR, Cst, Computer, Internet, and Network Systems Security.
4. Scott Hogg and Eric Vyncke, IPv6 Security, Cisco, 2009

25CSA555A Blockchain and Decentralized Applications 2 0 2-3

Course Objectives

- Students will be exposed to blockchains and decentralized applications. They will understand the fundamental algorithms supporting this modern technology and its place in the security setting of the modern technology era.

Course Outcomes

COs	Description
CO1	Explain the fundamentals of blockchain technology, its generations and types, enterprise blockchain architectures, core mechanics, common optimizations, and major consensus algorithms.
CO2	Analyze real-world blockchain deployments, common network attacks, scaling

	challenges, and emerging directions for blockchain systems.
CO3	Describe and compare Bitcoin, major alternative cryptocurrencies (altcoins), and the technical/economic causes and consequences of forks.
CO4	Explain and evaluate the Ethereum ecosystem—dApps, smart contracts, programming languages and tools—and related innovations such as stablecoins, NFTs, DeFi, and DAOs.
CO5	Assess security threats to digital assets and cryptocurrencies, explore governance and funding models for crypto development, and evaluate practical enterprise use-cases and socio-economic impacts.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3
CO1	2	3	1	2	2	-	-	3	3
CO2	2	3	1	3	2	-	-	3	3
CO3	3	3	1	3	2	-	-	3	3
CO4	2	3	2	3	1	-	-	3	3
CO5	2	3	2	3	1	-	-	3	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Blockchain History. What is a Blockchain? Do you need a Blockchain? Permission-less vs Permissioned Blockchains, Public vs Private vs Hybrid vs Consortium Blockchains, Enterprise Blockchains (Hyperledger, R3 Corda), Generation of Blockchains – Bitcoin (First), Ethereum (Second with dApps), Cosmos (Third as IOB – Internet of Blockchains)

Unit II

Introduction to Cryptography, Public Key Cryptography, Cryptographic primitives – Cryptographic hash functions and Digital signatures, Elliptic Curve Digital Signature Algorithm (ECDSA)
Blockchain Mechanics and Optimizations – Structure, Architecture, GHOST Protocol, Mining Process, Blockchain Demos Blockchain Consensus Algorithms – Proof-of-Work (POW), Proof-of-Stake (POS), Delegated POS (DPOS), Byzantine Fault Tolerance (BFT), Practical BFT (PBFT), Ripple Protocol Consensus Algorithm (RPCA) and Unique Node Lists (UNL).

Unit III

BlockDAG & Blockless DAG Protocols ,Blockchain IRL – Public & Private Keys, Hot and Cold Storages, Wallets, Lite Clients & Full nodes, Miners, Block & Transaction Incentives, Mining Infrastructure, Mining Pools & Organizations Languages & Tools – Ethereum Smart Contracts using Solidity language with Tools (ethPM / npm, Node.js, EVM, Truffle, Remix IDE, Ganache, MetaMask, web3.js, etc. …) and Hyperledger Fabric Chaincodes in GO language Anonymity, Attacks on Blockchain Networks & Wallets, Scaling of Blockchains, Future of Blockchains

Unit IV

Decentralized Applications: Cryptocurrencies (Internet of Money) – History, Bitcoin, Ethers & Gas (Ethereum) and Atom (Cosmos), Introduction to Altcoins & Stablecoins, DOT (Polkadot), Ripple, Stellar &

IOTA, Forking of Cryptocurrencies, Attacks on Digital Assets, Cryptocurrencies for the Masses, Funding Crypto development (Crowd Funding, ICO & STO), How to destroy Cryptocurrencies?

Unit V

Token Specifications, Non-Fungible Tokens (NFTs – Internet of Assets), Decentralized Finance (DeFi) and Decentralized Autonomous Organizations (DAO) Digital Asset applications (Cryptokitties …) and Enterprise Real-World applications

Textbooks / References:

1. Blockchain Technology by Chandramouli Subramanian, Asha A George, Abhilash K A and Meena Karthikeyan
2. Blockchain Applications – A Hands-on Approach by Arshdeep Bahga and Vijay Madisetti
3. Bitcoin and Cryptocurrency Technologies by Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder
4. Mastering Bitcoin by Andreas Antonopoulos
5. Mastering Ethereum, Building Smart Contracts and dApps by Andreas Antonopoulos and Dr. Gavin Wood

25CSA556A Cyber Forensics 2 0 2-3

Course Objectives

- Students will learn an introduction to cyber forensics with investigation tools. They will be able to perform evidence collection, preservation, and data recovery. All platforms: Windows, Linux, iOS, Android will be covered. Cyber laws in India and case studies to illuminate.

Course Outcomes

COs	Description
CO1	Explain and apply the principles of cyber forensic investigation, including investigation tools, digital evidence collection, preservation, data recovery, and encryption/decryption methods.
CO2	Analyze and perform hardware forensics across storage devices such as disks, SSDs, memory, and mobile platforms.
CO3	Illustrate host and operating system forensics, focusing on MS Windows, Linux, Android, iOS, and their respective file systems.
CO4	Demonstrate knowledge of database, e-mail, browser, and dark web forensics, while recognizing and mitigating anti-forensics techniques.
CO5	Examine and apply forensic techniques in network, wireless, cloud, and IoT environments.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3

CO1	2	3	2	3	2	2	2	3	3
CO2	2	2	2	3	2	1	1	3	3
CO3	1	3	2	3	2	2	2	3	3
CO4	1	3	2	3	2	1	1	3	3
CO5	2	2	3	3	1	2	2	3	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Cyber Forensic Investigation, Investigation Tools, Digital Evidence Collection, Evidence Preservation, Data Recovery, Encryption and Decryption methods, Search and Seizure of Computers and devices, Recovering deleted evidences, Password Cracking, Security Standards, Cyber Laws and Legal Frameworks, Cyber laws in India, Case studies and tools.

Unit II

Hardware/SSD/Device Forensics, File System Forensics, OS Forensics (Windows, Linux, Android and iOS), Memory Forensics, Web/Browser Forensics, Dark Web/Tor Forensics, E-Mail Forensics, Mobile/Wireless Forensics, Network and Communication Forensics, Anti-forensics, Steganography, and Image File Forensics, IOT Forensics, Cloud Forensics, Overwriting/Forging/Wiping/Destruction, Obfuscation, Online Anonymity and Rootkits.

Unit III

Assessing Threat Levels, Operating System Attacks, Malware Analysis, Financial Frauds, Espionage and Investigations, Investigating copiers, IVR, Video surveillance, RFID and Sim cards, Lab on Forensic Tools.

Textbooks / References:

1. File System Forensic Analysis by Brain Carrier ISBN: 978-0-32-126817-2
2. Incident Response and Computer Forensics, Third Edition by Jason T Luttgens, Mathew Pepe ISBN: 978-0-07-179869-3
3. Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software by Michael Sikorski, Andrew Honig ISBN: 978-1-59327-290-6
4. Android Forensics: Investigation, Analysis and Mobile Security for Google Android by Andrew Hoog, ISBN: 978-1-59749-651-3
5. iPhone and iOS Forensics: Investigation, Analysis and Mobile Security for Apple iPhone, iPad, and iOS Devices by Andrew Hoog, Katie Strzempka ISBN: 978-1-59749-659-9

LIST OF PROFESSIONAL ELECTIVE COURSES

	Course Code	Course Title	L T P	Cr
		REGULAR STREAM		
1	25CSA631A	Design and Analysis of Algorithms	2 0 2	3
2	25CSA632A	Cloud Computing	2 0 2	3
3	25CSA633A	Machine Learning	2 0 2	3
4	25CSA634A	Switching, Routing and Wireless Essentials	2 0 2	3
5	25CSA635A	Blockchain Technologies	2 0 2	3
6	25CSA636A	Deep Learning	2 0 2	3
7	25CSA637A	Enterprise Networking, Security and Automation	2 0 2	3
8	25CSA638A	Mobile Application Development	2 0 2	3
* Students registered to any stream are allowed to take maximum 2 electives from courses offered in another stream				

25CSA631A Design and Analysis of Algorithms 2 0 2 –3

Course Objectives

- To learn fundamental techniques for designing and analyzing algorithms.
- To understand various asymptotic analyses.
- To understand divide-and-conquer, greedy strategy, dynamic programming, using data structures

Course Outcomes

COs	Description
CO1	To develop an understanding of algorithm design techniques and apply them to real-life problems.
CO2	Map problems to the known classes of tractable or intractable problems.
CO3	To be able to analyze algorithms and compare their efficiency using empirical frameworks.
CO4	To be able to implement programs fluently using constructs of a programming language.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1
CO1	3	1	-	-	-	-	-	2	3
CO2	2	3	-	-	-	-	-	1	2
CO3	2	3	-	-	-	-	-	1	3
CO4	2	3	-	2	-	-	-	1	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Programming fundamentals – Input, Output, Variables, Data types, Operators, Branching, Iterators, Functions, Lists, Strings, Recursion.Notion of an Algorithm – Fundamentals of Algorithmic Problem Solving – Important Problem Types – Fundamentals of the Analysis of Algorithmic Efficiency – Asymptotic Notations and growth rate- Empirical analysis – Recursive and non-Recursive Templates.

Unit II

Divide and Conquer Methodology: Binary Search – Merge sort – Quick sort – Master's method. Principle of optimality: Optimal substructure – Greedy choice property – Overlapping subproblems. Dynamic programming: 0/1 Knapsack – Longest Increasing Subsequence - Longest Common Subsequence - Chain Matrix Multiplication.

Unit III

Greedy Technique: Currency exchange problem – Task Scheduling – Huffman Trees. Measuring Limitations: Lower – Bound Arguments – P, NP NP-Complete and NP-Hard Problems. Backtracking: N Queens problem -Branch and Bound: Travelling Salesman Problem

Textbooks / References:

1. 'Analysis of Algorithms', Jeffrey J McConnel, Jones and Bartlett Publishers, Inc; 2nd Revised edition, 2 November 2007
2. 'Introduction to the Design and Analysis of Algorithms, Anany Levitin, Third Edition, Pearson Education, 2012
3. 'Algorithms Design and Analysis', Harsh Bhasin, Oxford university press, 2016
4. CormenT.H, Leiserson C.E, Rivest R.L, and Stein C, "Introduction to Algorithms", Third Edition, Prentice-Hall of India, 2009.
5. Baase.S and Gelder A.V., "Computer Algorithms- Introduction to Design and Analysis", Third Edition, Pearson Education Asia, 2003.

25CSA632A	Cloud Computing	2 0 2 -3

Course Objectives

- The course is designed as an introductory guide to cloud computing and helps students to under-stand why it is a technological and business game-changer.
- This course provides an overview of compute options, structured and unstructured cloud storage models.
- This course also introduces a variety of managed services in the cloud.

Course Outcomes

COs	Description
CO1	Explain cloud computing models, including compute options and structured/unstructured storage services.
CO2	Apply cloud APIs and security services to ensure data protection and compliance.
CO3	Illustrate cloud automation strategies, management tools, and AI-enabled services for optimized operations.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1
CO1	3	1	-	3	-	-	-	3	3
CO2	3	1	-	2	-	-	-	3	3
CO3	3	1	-	3	-	-	-	3	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Cloud - Google Cloud Architecture - The cloud Console - Understanding projects - Billing - Install and configure Cloud SDK - Use Cloud Shell – APIs . Compute Services - Compute options in the cloud - Google Compute Engine virtual machine - zones, regions, and machine types- Exploring IaaS with Compute Engine - Exploring PaaS with App Engine. Structured and unstruc-tured storage - Storage options in the cloud.

Unit II

Cloud API - The purpose of APIs - Cloud Endpoints - Exploring Cloud SQL - Cloud Pub/Sub. Cloud Security - Introduction to security in the cloud, Cloud Identity and Access Management (IAM), Authentication and Authorization with Cloud. Networking - Introduction to networking in the cloud - Routes and firewall rules in the cloud.

Unit III

Cloud automation and management tools - Introduction to Infrastructure as Code - Cloud Deploy-ment

Manager - Big data services - Introduction to big data managed services in the cloud - Machine learning - Introduction to Machine Learning Models with AI Platform in the cloud - Pre-trained Machine Learning APIs - Natural Language and Google Cloud Speech APIs.

Textbooks / References

1. Bahga, Arshdeep., Madisetti, Vijay. Cloud Computing: A Hands-on Approach. United Kingdom: Arsheep Bahga & Vijay Madisetti, 2014.
2. Google Cloud Computing Foundations, https://cloud.google.com/edu/curriculum

25CSA633A Machine Learning 2 0 2-3

Course Objectives

- Formulate a machine learning problem
- Preprocess and visualize data
- Develop models for classification/prediction using supervised learning algorithms
- Evaluate and fine-tune model performance
- Apply unsupervised learning algorithms for dimensionality reduction, association rules
- Use of Python packages for developing models

Course Outcomes

COs	Description
CO1	Identify and formulate a machine learning problem and select the subset of applicable techniques for model building.
CO2	Understand and explain supervised learning problems, pre-process the data and train multiple models for testing using Python.
CO3	Apply unsupervised learning algorithms in Python to build recommendation systems and perform clustering.
CO4	Fine-tune and evaluate the performance of different models and select the best model for deployment using Python.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1
CO1	3	3	-	3	1	1	1	2	1
CO2	3	3	-	3	1	1	1	2	2
CO3	3	3	-	3	1	1	1	2	2
CO4	3	3	-	3	1	1	1	2	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Machine Learning, Supervised Learning vs Unsupervised Learning, Semi-supervised, self-supervised, reinforcement learning (overview)**,** Data Preparation, Pre-processing, Challenges: Data leakage, Imbalance; Visualising data, Performance metrics for Classification and Prediction.

Unit II

Supervised Learning Algorithms: Linear Regression, Logistic Regression, SVM, Decision Trees, Ensemble models – Bagging and Boosting, Random Forest, Gradient Boosted trees, Model evaluation and improvement, Regularisation, Bias Variance, Hyper-parameter Tuning, pipelines and grid search, Model Selection, Feature selection techniques

Unit III

Unsupervised Learning Algorithms: Dimensionality Reduction - Principal Component Analysis (PCA), Nonnegative Matrix Factorization (NMF), Singular Value Decomposition (SVD), t-SNE, UMAP (Overview), Association Rules, Clustering – Hierarchical, Non-hierarchical, eXplainable AI (XAI)

Textbooks / References:

1. Andreas Muller, "Introduction to Machine Learning with Python: A Guide for Data Scientists", Shroff/O'Reilly, 2016
2. Alexey Grigorev, Machine Learning Bookcamp, Manning, 2020
3. Tom Mitchell, Machine Learning, McGraw-Hill, India, 1990
4. Aurolien Geron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow, Shroff/O'Reilly", 2017
5. Ethem Alpaydin, “Introduction to Machine Learning”, PHI Learning Pvt. Ltd.; Third edition, 2015
6. https://developers.google.com/machine-learning/glossary

25CSA634A Switching, Routing and Wireless Essentials 2 0 2 -3

Course Objectives

- The course curriculum focuses on switching technologies and router operations that support small-to-medium business networks and includes wireless local area networks (WLANs) and security concepts.
- Students learn key switching and routing concepts.
- They can perform basic network configuration and troubleshooting, identify and mitigate LAN security threats, and configure and secure a basic WLAN.

Course Outcomes

COs	Description
CO1	Configure initial settings on a switch. Configure basic settings on a router, using CLI, to route between two directly connected networks.
CO2	Explain how STP enables redundancy in a Layer 2 network. Describe Ether Channel technology. Explain how STP operates in a simple, switched network.
CO3	Explain the purpose and operation of First Hop Redundancy protocols, Explain how vulnerabilities compromise LAN security.
CO4	Implement a WLAN using a wireless router and WLC, Explain how routers use information in packets to make forwarding decisions. Configure IPv4 and IPv6 static routes. Explain how a router processes packets when a static route is configured.

CO-PO Mapping

PO/CO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1
CO1	3	3	-	1	1	1	1	-	3
CO2	3	3	-	1	3	1	1	-	2
CO3	3	3	-	2	3	2	2	-	3
CO4	3	3	-	1	3	1	1	-	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Configure a Switch with Initial Settings- Configure Switch Ports- Secure Remote Access- Basic Router Configuration- Verify Directly Connected Networks-Frame Forwarding- Switching Domains-Overview of VLANs- VLANs in a Multi-Switched Environment- VLAN Configuration- VLAN Trunks-Dynamic Trunking Protocol-Inter-VLAN Routing Operation- Router-on-a-Stick Inter-VLAN Routing- Inter-VLAN Routing using Layer 3 Switches- Troubleshoot Inter-VLAN Routing

Unit II

STP: Purpose of STP- STP Operations- Evolution of STP-EtherChannel: EtherChannel Operation-Configure Ether Channel- Verify and Troubleshoot EtherChannel-DHCPv4: DHCPv4 Concepts- Configure DHCPv4 Server- Configure DHCPv4 Client-SLAAC and DHCPv6 Concepts- IPv6 Global Unicast Address Assignment- SLAAC- DHCPv6- Configure DHCPv6 Server

Unit III

FHRP Concepts: First Hop Redundancy Protocol- HSRP-LAN Security Concepts: Endpoint Security- Access Control- Layer 2 Security Threats- MAC Address Table Attack- LAN Attacks-Switch Security Configuration: Implement Port Security- Mitigate VLAN Attacks- Mitigate DHCP Attacks- Mitigate ARP Attacks- Mitigate STP Attacks-WLAN Concepts: Introduction to Wireless- Components of WLANs-WLAN Operation- CAPWAP Operation- Channel Management- WLAN Threats- Secure WLANs

Unit IV

WLAN Configuration: Remote Site WLAN Configuration- Configure a Basic WLC on the WLC-Configure a WPA2 Enterprise WLAN on the WLC- Troubleshoot WLAN Issues-Routing Concepts: Path determination- Packet Forwarding- Basic Router Configuration review- IP Routing Table- Static and Dynamic Routing-IP Static Routing: Static Routes- Configure IP Static Routes- Configure IP Default Static Routes-Configure Floating Static Routes- Configure Static Host Routes-Troubleshoot Static and Default Routes: Packet Processing with Static Routes- Troubleshoot IPv4 ,Static and Default Route Configuration**.**

TextBooks / References:

1. Cisco Certified Networking Associate Certification (CCNA) Part2 Switching, Routing and Wireless Essentials, Cisco Networking Academy.

https://www.netacad.com/courses/networking/ccna-switching-routing-wireless-essentials

2. https://learningnetwork.cisco.com/s/ccna-training-videos
3. Switching, Routing, and Wireless Essentials Companion Guide (CCNAv7), By Cisco Networking Academy Published Aug 18, 2020 by Cisco Press. Part of the Companion Guide series.

25CSA635A	Blockchain Technologies	2 0 2 -3

Course Objectives

- Students will be exposed to blockchains and decentralized applications. They will understand the fundamental algorithms supporting this modern technology and its place in the security setting of the modern technology era.

Course Outcomes

COs	Description
CO1	Exploring the fundamentals of Blockchain, Types & Generations of Blockchains, Enterprise Blockchains, Blockchain Mechanics & Optimizations and Blockchain Consensus Algorithms
CO2	Familiarizing with Blockchain IRL, Network Attacks, Scaling and Future of Blockchains
CO3	Understanding Bitcoin, Altcoins and Forking
CO4	Exploring Ethereum, dApps – Smart Contracts and related Languages & Tools, Forking, Stablecoins, NFTs, DeFi and DAO
CO5	Exploring Attack on Digital assets, Cryptocurrencies for the Masses, Funding Crypto development, How to destroy Cryptocurrencies? Digital Asset applications and Enterprise Real-World applications

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1
CO1	2	3	-	2	2	-	-	3	3
CO2	2	3	-	3	2	-	-	3	3
CO3	3	3	-	3	2	-	-	3	2
CO4	2	3	-	3	1	-	-	3	3
CO5	2	3	-	3	1	-	-	3	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Blockchain History. What is a Blockchain? Do you need a Blockchain? Permission-less vs Permissioned Blockchains, Public vs Private vs Hybrid vs Consortium Blockchains, Enterprise Blockchains (Hyperledger, R3 Corda), Generation of Blockchains – Bitcoin (First), Ethereum (Second with dApps), Cosmos (Third as IOB – Internet of Blockchains)

Unit II

Introduction to Cryptography, Public Key Cryptography, Cryptographic primitives – Cryptographic hash functions and Digital signatures, Elliptic Curve Digital Signature Algorithm (ECDSA).Blockchain Mechanics and Optimizations – Structure, Architecture, GHOST Protocol, Mining Process, Blockchain Demos Blockchain Consensus Algorithms – Proof-of-Work (POW), Proof-of-Stake (POS), Delegated POS (DPOS), Byzantine Fault Tolerance (BFT), Practical BFT (PBFT), Ripple Protocol Consensus Algorithm (RPCA) and Unique Node Lists (UNL).

Unit III

BlockDAG & Blockless DAG Protocols ,Blockchain IRL – Public & Private Keys, Hot and Cold Storages, Wallets, Lite Clients & Full nodes, Miners, Block & Transaction Incentives, Mining Infrastructure, Mining Pools & Organizations Languages & Tools – Ethereum Smart Contracts using Solidity language with Tools (ethPM / npm, Node.js, EVM, Truffle, Remix IDE, Ganache, MetaMask, web3.js, etc. …) and Hyperledger Fabric Chaincodes in GO language Anonymity, Attacks on Blockchain Networks & Wallets, Scaling of Blockchains, Future of Blockchains

Unit IV

Decentralized Applications: Cryptocurrencies (Internet of Money) – History, Bitcoin, Ethers & Gas (Ethereum) and Atom (Cosmos), Introduction to Altcoins & Stablecoins, DOT (Polkadot), Ripple, Stellar & IOTA, Forking of Cryptocurrencies, Attacks on Digital Assets, Cryptocurrencies for the Masses, Funding Crypto development (Crowd Funding, ICO & STO), How to destroy Cryptocurrencies?

Unit V

Token Specifications, Non-Fungible Tokens (NFTs – Internet of Assets), Decentralized Finance (DeFi) and Decentralized Autonomous Organizations (DAO) Digital Asset applications (Cryptokitties …) and Enterprise Real-World applications

Textbooks / References:

1. Blockchain Technology by Chandramouli Subramanian, Asha A George, Abhilash K A and Meena Karthikeyan

25CSA636A	Deep Learning	2 0 2 -3

Course Objectives

- This course gives an exposure to neural networks and deep learning architectures.

- This course focuses on implementing, training, and debugging deep feed-forward neural networks.
- This course enables the application of Convolutional neural networks and RNN for Images and image sequences.

Course Outcomes

COs	Description
CO1	Explain the main architectures for deep learning algorithms
CO2	Design and evaluate convolutional neural network architectures for image and structured data tasks.
CO3	Apply sequence models including RNNs and LSTMs to temporal and language-based applications.
CO4	Select and deploy appropriate deep learning techniques for solving large-scale real-world problems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1
CO1	3	2	-	2	-	-	-	1	3
CO2	3	2	-	2	-	-	-	1	3
CO3	2	2	-	2	-	-	-	1	2
CO4	2	2	-	2	-	-	-	2	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Deep Feedforward Neural Networks, Gradient-Based Learning and Backpropagation, Hidden Units and Activation Functions (ReLU, sigmoid, tanh), Loss Functions (MSE, Cross Entropy), Regularization: L1/L2, Dropout, Early Stopping, Ensemble Methods: Bagging, Boosting, Techniques for Generalization: Data Augmentation, Parameter Tying and Sharing, Sparse Representations, Adversarial Training, Multi-task and Semi-supervised Learning

Unit II

Convolution Operation and Pooling, CNN Architectures: LeNet, AlexNet, VGG, Variants of Convolutions: Dilated, Depthwise, Separable, Structured Outputs and Multi-label Classification ,Data Handling for Images, Efficient CNN Training Strategies, Introduction to Transfer Learning and Pre-trained Models, Regularization in CNNs (BatchNorm, Dropout)

Unit III

Sequence Modeling: Concepts and Applications, Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM), Gated Recurrent Units (GRUs), Bidirectional RNNs, Encoder-Decoder and Sequence-to-Sequence Models, Deep RNN Architectures, Time Series and NLP Use Cases, Conceptual Overview: Transformers and Attention

Textbooks/References:

1. Goodfellow I, Bengio Y, Courville A. Deep learning. MIT press; 2016.
2. Patterson J, Gibson A, Deep learning: A practitioner's approach, O'Reilly Media, Inc., 2017.
3. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer, 2018
4. Aston Zhang, Zachary C. Lipton, Dive into Deep Learning, Cambridge University Press
5. Chollet, F., *Deep Learning with Python,* MIT Press. 2018**.**

25CSA637A Enterprise Networking, Security and Automation 2 0 2 -3

Course Description

- The course describes the architectures and considerations related to designing, securing, operating, and troubleshooting enterprise networks.
- This course covers wide area network (WAN) technologies and quality of service (QoS) mechanisms used for secure remote access.
- ENSA also introduces software-defined networking, virtualization, and automation concepts that support the digitalization of networks.
- Students can gain skills to configure and troubleshoot enterprise networks, and learn to identify and protect against cybersecurity threats.

Course Outcomes

COs	Description
CO1	Describe basic OSPF features and characteristics. Configure single-area OSPFv2 in a point-to-point network. Verify a single-area OSPFv2 implementation. Describe tools used by threat actors to exploit networks. Compare standard and extended IPv4 ACLs.
CO2	Implement IPv4 ACLs to filter traffic and secure administrative access. Describe the advantages and disadvantages of NAT. Compare internet-based WAN connectivity options. Explain how the IPsec framework is used to secure network traffic.
CO3	Describe the different QoS models. Use commands to back up and restore an IOS configuration file. Explain considerations for designing a scalable network.
CO4	Describe different networking troubleshooting tools. Describe the virtualization of network devices and services. Explain how APIs enable computer to computer communications.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1
CO1	3	3	-	1	1	1	1	-	3
CO2	3	3	-	1	3	1	1	-	3
CO3	3	3	-	2	3	2	2	-	3
CO4	3	3	-	1	3	1	1	-	3

3-strong, 2-moderate, 1-weak

Syllabus:

Unit I

Single-Area OSPFv2 Concept, OSPF Features and Characteristics, OSPF Packets, OSPF Operation. Single-Area OSPFv2 Configuration-OSPF Router ID-Point-to-Point OSPF Networks-Multi access OSPF Network-Modify Single-Area OSPFv2-Default Route Propagation-Verify Single-Area OSPFv2-Network Security Concepts-Current State of Cybersecurity-Threat Actors-Threat Actor Tools-Malware-Common Network Attacks-IP Vulnerabilities and Threats-TCP and UDP Vulnerabilities-IP Services-Network Security Best Practice-Cryptography-ACL Concepts-Purpose of ACLs-Wildcard Masks in ACLs-Guidelines for ACL Creation-Types of IPv4 ACLs

Unit II

ACLs for IPv4 Configuration-Configure Standard IPv4 ACLs-Modify IPv4 ACLs-Secure VTY Ports with a Standard IPv4 ACL-Configure Extended IPv4 ACLs-NAT for IPv4-NAT Characteristics-Types of NAT-NAT Advantages-Configure Static NAT-Configure Dynamic NAT-Configure PAT-NAT64-WAN Concepts-Purpose of WANs-WAN Operations-Traditional WAN Connectivity-Modern WAN Connectivity-Internet-Based Connectivity-VPN and IPsec Concepts-VPN Technology-Types of VPNs-IPsec

Unit III

QoS Concepts-Network Transmission Quality-Traffic Characteristics-Queuing Algorithms-QoS Models-QoS Implementation Techniques-Network Management -Device Discovery with CDP-Device Discovery with LLDP-NTP-SNMP-Syslog-Router and Switch File Maintenance-IOS Image Management-Network Design-Hierarchical Networks-Scalable Networks-Switch Hardware-Router Hardware

Unit IV

Router Hardware-Network Documentation-Troubleshooting Process-Troubleshooting Tools-Symptoms and Causes of Network Problems-Troubleshooting IP Connectivity-Network Virtualization-Cloud Computing-Virtualization-Virtual Network Infrastructure-Software-Defined Networking-Controllers-Network Automation-Automation Overview-Data Formats-APIs-REST-Configuration Management-IBN and Cisco DNA Center.

References:

1. Cisco Certified Networking Associate Certification (CCNA) Part3 Enterprise Networking, Security and Automation, Cisco Networking Academy.

   https://www.netacad.com/courses/networking/ccna-enterprise-networking-security-automation
2. https://learningnetwork.cisco.com/s/ccna-training-videos
3. Enterprise Networking, Security, and Automation Companion Guide (CCNAv7) ,By Cisco Networking Academy,Published Jul 16, 2020 by Cisco Press. Part of the Companion Guide

25CSA638A Mobile Application Development 2 0 2 –3

Course Objectives

This course is suitable for postgraduate Computer Science or IT programs. The main objectives are to

- Understand the fundamentals of mobile application development, including architecture, design principles, and platform differences (iOS & Android).
- Learn the Dart programming language, which serves as the foundation for Flutter app development.
- Build interactive and responsive user interfaces using Flutter widgets and layouts.

Course outcomes

COs	Description
CO1	To design flutter applications using basic UI components.
CO2	To design flutter application using Advanced UI components
CO3	To develop mobile application to fetch data from remote server and advanced operations.
CO4	To develop mobile application with DB connections.

CO-PO Mapping

CO/PO CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PSO1
CO1	2	1		3	3	-		-	3
CO2	2	1		3	3	-		-	3
CO3	2	2		3	3	3	3	-	3
CO4	2	2		3	3	3	3	-	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to dart & flutter- Widgest and their role-material app –scaffold-appbar-Floating action button.Text-centere-padding-Hot reload and hot-restart-Containers-Images from asset and network-Icon-row& column-list view-list tile-geusture detection-ink well-stateless vs satefull widgets-state management-navigator and routs-text field-terms-custom fonts-grid view-stack-alert dialog.

Unit II

Advanced widgets,chips ,play video,music,date picker-time picker-future-async-await-Http-REST API-Model class-Json parsing-Displying remot data-BLoC-GetX-dyanamic dashboareds with charts and plots-put notifications-Animations.

Unit III

Firebase-Flutter-SQFLite-inflex dB mongo DB-Map-GPS-Sensors-Test and deploy the applications

Textbook (s)

Miola,A.(2020).Flutter complete reference:create beautiful,fast and native apps for any device.

Reference(S)

Windmil,E.,&Rischapter,R,(2020).Flutter in action.Manning publication Co.

Payne, R.(2019).Beginning app development with flutter:Create cross-platform mobile apps.Apress.

Napoli,M.L (2020). Biginning Flutter:A hands on guide to app development.Jhon Wiley & Sons.

	Course Code	Course Title	L T P	Cr
		AI and ML STREAM		
1	25CSA641A	Data Engineering for AI	2 0 2	3
2	25CSA642A	No SQL databases	2 0 2	3
3	25CSA643A	Applications of Machine Learning	2 0 2	3
4	25CSA644A	Computational Statistics	2 0 2	3
5	25CSA645A	IOT for AI	2 0 2	3
6	25CSA646A	Computer Vision	2 0 2	3
7	25CSA647A	Business Analytics and Visualization	2 0 2	3
8	25CSA648A	Generative AI and LLM	2 0 2	3

25CSA641A Data Engineering for AI 2 0 2 -3

Course Objectives

- Familiarity with the concepts of data architecture, different data models, languages, and data storage for data manipulation
- Understand the different data retrieval methods by querying and combining big data sources
- Able to build a pipeline or interface for the flow and access of information
- Hands-on learning of SPARKSQL

Course Outcomes

COs	Description
CO1	Explain various architectures available for data modeling
CO2	Design and implement data engineering workflows using tools such as Apache Spark or Apache Airflow
CO3	Analyze and evaluate the performance of data-driven applications
CO4	Select appropriate data engineering tools and techniques to solve real-world data processing problems

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO2

CO									
CO1	3	2	-	1	-	-	-	2	2
CO2	2	2	-	3	-	-	-	2	3
CO3	2	2	-	3	-	-	-	2	3
CO4	3	3	-	3	-	-	-	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Data modeling, relational data models, ER models – Graph models - Normalization and de-normalization, OLTP and OLAP - Big data – Data Science – Processing big data – Languages – SQL, Cypher, Embedded SQL, Constraints – Data Consistency – Query optimization – Object-oriented databases - NoSQL data models – XML databases –schema migrations - PostgreSQL, Apache Cassandra, Presto, Cloud-native databases: AWS Redshift, Google BigQuery, or Azure Synapse, Data Governance: metadata management, versioning, and cataloging (e.g., Apache Hive Metastore, Amundsen).

Unit II

Spark and data lakes: Python programming in Spark; Data wrangling – Sparkql, spark data frames - SparkSQL, ETL in Spark, SparkMlLib, Comparison of Pyspark with H2O, Dask, and Vaex

Unit III

Data Pipeline – Apache Airflow - Set up task dependencies- Create data connections using hooks - Track data lineage - Set up data pipeline schedules - Partition data to optimize pipelines - Write tests to ensure data quality - Backfill data - Build reusable and maintainable pipelines -Implement subDAGs - Set up task boundaries - Monitor data pipelines

Textbooks / References:

1. Database System Concepts, Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill Education, 2011
2. NoSQL Distilled: Pramod J. Sadalage, Martin Fowler, Addison-Wesley, 2012
3. Learning Spark: Lightning-Fast Big Data Analysis, Holden Karau, Andy Konwinski, Patrick Wendell, MateiZaharia, O'Reilly Media, Inc., 2015
4. Practical Machine Learning with H2O: Powerful, Scalable Techniques for Deep Learning and AI, Darren Cook, O'Reilly Media, Inc., 2016
5. Data Engineering with Python by Paul Crickard (2020, Packt)
6. Designing Data-Intensive Applications by Martin Kleppmann (2017, O'Reilly)
7. Apache project docs (Airflow, Kafka, Spark)

25CSA642A No SQL Databases 2 0 2 - 3

Course Objectives

- To understand the difference between SQL and NoSQL databases.
- To understand the advanced concepts and terminology related to NoSQL database.
- To develop advanced web application using MongoDB and python.

Course Outcomes

COs	Description
CO1	Analyze and evaluate the role of NoSQL databases in solving modern data challenges across applications
CO2	Perform CRUD operations using MongoDB and other NoSQL query languages
CO3	Integrate NoSQL databases with high-level languages like Python using libraries and frameworks
CO4	Compare and select appropriate NoSQL databases (MongoDB, Cassandra, Neo4j, Riak) based on specific application requirements

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO2
CO1	3	3	-	3	-	-	-	2	3
CO2	3	3	-	3	-	-	-	-	2
CO3	3	1	-	3	-	-	-	-	3
CO4	3	3	-	3	-	-	-	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to NoSQL and its need – CAP theorem, BASE vs ACID. Overview of traditional RDBMS concepts (brief recap) – normalization, indexing. Classification of NoSQL databases – Key-Value, Document, Columnar, Graph. Case studies: MongoDB (Document), Cassandra (Columnar), Neo4j (Graph), HBase (Columnar).

Unit II

Key-Value Store Design Patterns: Redis as a case study – transactions, consistency, data structures, performance. Use cases: session storage, caching, shopping carts.
Graph Databases using Neo4j – Cypher query language, traversal, and indexing. Applications: recommendation systems, geolocation services, social networks.
Trade-offs in consistency, availability, partitioning, query limitations in NoSQL.

Unit III

CRUD operations and schema design in MongoDB – aggregation pipelines, indexing strategies, upserts, geospatial queries. Python–MongoDB integration with pymongo. Web frameworks: integrating MongoDB with Flask and Django for full-stack development. Case studies: product catalog, user profiling, logging systems.

Textbooks / References:

1. NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, Author: Sadalage, P. and Fowler, Publication: Pearson Education, August 2012
2. Seven Databases in Seven Weeks: A Guide to Modern Databases and the NoSQL Movement, 2nd edition, Luc Perkins, Jim Wilson, Eric Redmond, 2018
3. *MongoDB: The Definitive Guide,* Shannon Bradshaw, Eoin Brazil & Kristina Chodorow, O'Reilly, 2020.
4. Practical MongoDB: Architecting, Developing, and Administering MongoDB, Shakuntala Gupta Edward, APress, 2015
5. Christof Strauch, "NoSQL Databases"

25CSA643A Applications of Machine Learning 2 0 2 -3

Course Objectives

- Understand how Machine learning is applied to solve problems in various applications like game playing, recommendation systems, social graph mining, and targeted web advertising.
- Present and Implement ML algorithms to solve real-world problems

Course Outcomes

COs	Description
CO1	Explain how machine learning techniques are applied in real-world applications such as recommendation systems, high-dimensional data analysis, and targeted web advertising
CO2	Implement suitable machine learning algorithms to solve real-world problems and present results effectively
CO3	Analyze and compare different machine learning approaches for application-specific problems in terms of implementation and performance
CO4	Design and evaluate machine learning systems by integrating appropriate components and assessing their performance

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO2
CO1	2	2	-	1	-	-	-	2	3
CO2	3	3	-	3	-	-	-	2	3
CO3	3	3	-	3	-	-	-	2	3
CO4	3	3	-	3	-	-	-	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Review of machine learning Concepts, Design of ML system – Model selection, bias, variance, learning curves, and error analysis.

Recommendation Systems – Model for Recommendation Systems, Utility Matrix, Feature extraction from documents, Content-Based Recommendations, Collaborative Filtering, Usage of UV decomposition and SVD in Recommendation systems, Overview of Neural Collaborative filtering, Cold start problem and hybrid recommenders.

Unit II

Customer segmentation – Subspace Clustering, Types of Subspace clustering, Top-down and bottom-up approach: PROCLUS and CLIQUE.

Advertising on the Web: Issues in Online Advertising, Online and offline algorithms, The matching Problem, The AdWords Problem, The Balance Algorithm, A Lower Bound on Competitive Ratio for Balance, Reinforcement learning applications.

Application of dimensionality reduction- PCA, t-SNE, UMAP for compression, visualization, and preprocessing in image analytics.

Unit III

Independent component Analysis(ICA) for speech processing, comparison with PCA.

Social Network Mining – Clustering and partitioning of large-scale graphs, Overlapping communities, Centrality measures, Embedding techniques (node2vec, DeepWalk), Introduction to Graph Neural Networks

Textbooks / References:

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

25CSA644A Computational Statistics 2 0 2 -3

Course Objectives

- Introduce students to the importance of computation in data analysis
- To familiarize students with computational methods and simulation techniques used in statistics.
- To enable the student to explore the features of high dimensional data sets
- To apply suitable computational methods to analyze real world data
- To apply computer algorithms and use Monte Carlo methods to solve statistical problems

Course Outcomes

COs	Description
CO1	Explain computational methods in data analysis
CO2	Choose suitable computational methods to analyze real world high dimensional data sets

CO3	Identify statistical patterns in data using suitable algorithms
CO4	Use existing methods to develop new statistical tools

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO2
CO1	3	3	-	2	-	-	-	2	2
CO2	3	3	-	2	-	-	-	2	3
CO3	3	3	-	2	-	-	-	2	3
CO4	3	3	-	2	-	-	-	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Probability concepts, Probability simulations, Sampling concepts - random sampling, sampling distribution-, Parameter estimation methods – Maximum Likelihood Estimation, Method of Moments

Unit II

Random number generation - General techniques for generating Random Variables, Monte Carlo Algorithms-Buffon's needle experiment, Monte Carlo integration,Monte Carlo Methods for Inferential Statistics - Monte Carlo Hypothesis Testing, Bootstrap Methods

Unit III

Exploratory data analysis – Traditional statistics methods and computational statistics methods, Data Partitioning, Cross-Validation, Probability Density Estimation

Unit IV

Linear models and regression analysis, Linear Regression, Polynomial Regression, Stepwise Regression, Ridge Regression, Lasso, ElasticNet

Unit V

Statistical Pattern Recognition- Bayes Decision Theory Estimating Class-Conditional Probabilities Bayes Decision Rule Classification and Regression Trees, Clustering

Textbooks / References:

1. Wendy L. Martinez and Angel R, "Martinez Computational Statistics," Chapman & Hall/CRC, 2002.
2. Ian H. Witten, "Data Mining: Practical Machine Learning Tools and Techniques with Java Implementations", Morgan Kaufmann, 2000.
3. Murphy, Kevin P. Machine learning: a probabilistic perspective. MIT Press, 2012.

4. Friedman, Jerome, Trevor Hastie, and Robert Tibshirani. The elements of statistical learning. Vol. 1. No. 10. New York: Springer series in statistics, 2001.

25CSA645A IOT for AI 2 0 2 -3

Course Objectives

- Understand the general concepts in IoT and get familiar with the various hardware and software components of it
- Develop the basic skill set required to build real-life IoT based projects for different application domains
- Gain the necessary skills needed to evaluate the security issues associated with the IoT system designs

Course Outcomes

Cos	Description
CO1	Explain the architecture, the design principles and elements of IoT.
CO2	Gain the necessary skills needed to build Machine learning models for edge devices and Implement it.
CO3	Be able to design, deploy and evaluate scalable real-life IoT systems for different application domains
CO4	Understand and build scalable ML pipeline using Flask, Python, uWSGI, TensorFlow

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO2
CO1	3	2	-	3	-	-	-	2	2
CO2	3	2	-	3	-	-	-	2	3
CO3	3	3	-	3	-	-	-	2	3
CO4	3	3	-	3	-	-	-	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to IoT, Architectural Overview and Design Principles, Elements of IoT (Arduino, Raspberry Pi, NodeMCU, Sensors & Actuators), IoT Applications, Sensing, Actuation, Networking Basics, Embedded OS, IoT and Cloud, Security aspects in IoT.

Unit II

IoT Application Development, Introduction to Raspberry Pi, Integrating Sensors and Actuators with Raspberry Pi, Pushing and Managing Data in IoT Clouds, Programming APIs (Python/Node.js/Arduino) for communication protocols (MQTT, ZigBee, Bluetooth, UDP, TCP), Implementation of IoT with Raspberry Pi (lab - sensor, MQTT, visualization)

Unit III

Introduction to ML and Deep learning models for IoT (challenges, opportunities, solutions), Sensor data classification using ML in Raspberry Pi (lab), Introduction to TensorFlowLite, Image classification on Raspberry Pi (lab), object detection on Raspberry Pi (optional lab), building scalable ML pipeline using Flask, Python, uWSGI, TensorFlow (project)

Textbooks / References:

1. Vijay Madisetti, Arshdeep Bahga, İnternet of Things, "A Hands-on Approach", University Press
2. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill
3. Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill
4. https://www.tensorflow.org/lite/tutorials

25CSA646A Computer Vision 2 0 2 -3

Course Objectives

- To introduce students to the state of the art algorithms in the area of image analysis and object recognition
- Give exposure to video analysis techniques for object tracking and motion estimation
- To build a good understanding of the computer vision concepts and techniques to be applied for robotic vision applications
- Enable students to apply the vision algorithms and develop applications in the domain of image analysis, robotic navigation

Course Outcomes

COs	Description
CO1	To build an understanding of detailed models of image formation and explain it.
CO2	To apply image analysis techniques through image feature extraction and object recognition.
CO3	To understand and model fundamental algorithms for video analysis such as object tracking and motion segmentation.
CO4	Illustrate the major technical approaches involved in image registration, camera calibration, pose estimation, stereo vision, etc. to be applied to develop vision algorithms for robotic applications.
CO5	Apply the algorithms and develop applications in the domain of image analysis and robotic vision.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO2
CO1	3	2	-	1	-	-	-	2	2

CO2	3	2	-	2	-	-	-	2	3
CO3	3	2	-	2	-	-	-	2	3
CO4	3	3	-	2	-	-	-	2	3
CO5	3	3	-	3	-	-	-	2	3

Syllabus

Unit I

Introduction to Image Processing-Basic mathematical concepts: Image enhancement: Grey level transforms, Spatial filtering. Extraction of special features: edge and corner detection. Morphological processing, Image transforms, Discrete Fourier Transform, Fast Fourier Transform. Frequency domain enhancement.

Unit II

Image Segmentation Algorithms: contextual, non-contextual segmentation, texture segmentation. Feature Detectors and Descriptors, Feature Matching-Object Recognition, Face detection (Viola-Jones), Face Recognition, Modern computer vision architectures based on deep convolutional neural networks, The Use of Motion in Segmentation Optical Flow & Tracking Algorithms, YOLO, DeepSORT: Deep Learning to Track Custom Objects in a Video, Action classification with convolutional neural networks, RNN, LSTM

Unit III

Image registration, 2D and 3D feature-based alignment Pose estimation, Geometric intrinsic calibration, -Camera Models and Calibration: Camera Projection Models – orthographic, affine, perspective, projective models. Projective Geometry, transformation of 2-d and 3-d, Internal Parameters, Lens Distortion Models, Calibration Methods – linear, direct, indirect, and multiplane methods. Geometry of Multiple views-Stereopsis, Camera and Epipolar Geometry, Fundamental matrix; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration., Introduction to SLAM (Simultaneous Localization and Mapping).

Textbooks / References:

1. Deep Learning (Adaptive Computation and Machine Learning series) Ian Goodfellow, Yoshua Bengio, Aaron Courville, Francis Bach, January 2017, MIT Press
2. Introduction to Computer Vision and its Application, Richard Szelinski,2010
3. E. Trucco and A. Verri, Prentice Hall, 1998.Introductory techniques for 3D Computer Vision.
4. Marco Treiber, “An Introduction to Object Recognition Selected Algorithms for a Wide Variety of Applications”, Springer, 2010.
5. Forsyth and Ponce, “Computer Vision – A Modern Approach”, Second Edition, Prentice-Hall, 2011.
6. R. C. Gonzalez, R. E. Woods, ‘Digital Image Processing, 4th edition Addison-Wesley,2016

25CSA647A Business Analytics and Visualization 2 0 2 -3

Course Objectives

- To promote the ability to critically analyze and solve data-oriented real-world decision problems.
- To utilize the theories of statistics and probabilities in business analytics.
- Familiarise the modeling techniques and best practices in visualization.

Course Outcomes

COs	Description
CO1	Apply best practices of data visualization in different stages of the data mining process.
CO2	Analyze and explore data to get useful insights for business.
CO3	Ability to choose an appropriate data analysis methodology suitable for a given business problem.
CO4	Achieve familiarity with data analysis tools.
CO5	Apply time series analysis to real world problems.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO2
CO1	2	1	-	2	-	-	-	1	2
CO2	2	3	-	1	-	-	-	-	3
CO3	2	3	-	1	-	-	-	-	3
CO4	1	2	-	3	-	-	-	1	2
CO5	2	3	-	1	-	-	-	-	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Business Analytics , Descriptive Statistics - Types of Data and its Measures, Data cleansing. Data Visualization-Design Techniques, Tables, Charts, Advanced data Visualization, Dashboards, Case Studies.

Unit II

Inferential Analysis - Statistical Inference, Descriptive Data Mining - Clustering and Association Rules. Performance Evaluation, Overview of key Classification and prediction techniques, Case studies.

Unit III

Introduction to Forecasting, Time Series – Level, Trend, and Seasonality, Smoothing Techniques – Moving Average and Exponential Smoothing, Determining the best forecasting model to use. Case Study.

Textbooks / References:

1. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, Dennis J. Sweeney, Thomas A. Williams 'Business Analytics',3/e, Cengage Learning,2019.

2. GalitShmueli, Kenneth C. Lichtendahl Jr., 'Practical Time Series Forecasting with R: A Hands-On Guide', 2/e, Axelrod Schnall Publishers, 2016.
3. Joel Grus, 'Data Science from Scratch: First Principles with Python', 2/e, O'Reilly Media, 2019.
4. Cole Nussbaumer Knaflic, 'Storytelling with Data: A Data Visualization Guide for Business Professionals', John Wiley& Sons, 2015.
5. Claus O. Wilke, "Fundamentals of Data Visualization: A primer for making informative and compelling figures", O'Reilly, 2019.

25CSA648A Generative AI and LLM 2 0 2 –3

Prerequisites

- Basic knowledge of machine learning and natural language processing
- Familiarity with Python programming.

Course Objectives:

- Understand the architecture of large language models and their underlying principles.
- Explore the training and fine-tuning processes used to develop language models.
- Investigate various applications and practical use cases of large language models.
- Gain hands-on experience using language model tools and libraries.
- Develop the ability to apply large language models to real-world problems effectively.

Course Outcomes

COs	Description
CO1	Illustrate fundamental principles of Large Language Model (LLM) architectures
CO2	Evaluate strengths and weaknesses of various LLM methodologies for critical/insightful analysis.
CO3	Apply and analyze techniques for training and fine-tuning LLMs for specific tasks
CO4	Develop LLM Applications to address real world challenges effectively.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO 2
CO1	3	1	-	2	-	-	-	1	1
CO2	2	2	-	3	-	-	-	1	1
CO3	2	2	-	2	-	-	-	1	2
CO4	2	3	-	3	1	2	2	1	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Popular Generative AI Models

Generative Adversarial Networks (GANs) and Latent Diffusion Models (e.g., Stable Diffusion) for image generation and synthesis, brief overview of Variational Autoencoders (VAEs). Computational linguistics: Introduction , Word representation: One-hot encoding, Bag-of-Words (BoW), Dictionary: TF-IDF, Embedding: Word2vec, Glove, Fasttext, contextual embeddings (ELMo, BERT embeddings), Language Model: n-gram, Sequences and sequential data, Transformer Architecture – Positional Encoding, Self-attention mechanism

Unit II

Introduction to Large Language Models – Decoder-only LLMs: A deep dive into GPT and pretraining objective, Encoder Only LLMs-BERT, Prompting – different prompting strategies – Instruction tuning – fine tuning – parameter efficient fine-tuning – quantized fine tuning. Small Language models. Training LLMs using reinforcement Learning.

Unit III

Connecting LLMs and Knowledge Graphs, Retrieval-Augmented Generation (RAG), Evaluating LLMs: Benchmarks, evaluation frameworks and popular leaderboards. Applications/Case study of Large Language Models - Text Generation, Translation, and Summarization - Question Answering, Sentiment Analysis, Chatbots, Application of LLMs in healthcare and Code generation, latest advancements in LLMs.

Textbooks

1. Hands-On Large Language Models by Jay Alammar, Maarten Grootendorst, December 2024 Publisher(s): O'Reilly Media.
2. Deep Learning for Natural Language Processing: Develop Deep Learning Models for your Natural Language Problems (Ebook)
3. Deep Learning with PyTorch, Eli Stevens, Luca Antiga, Thomas Viehmann, Manning Publications, 2020
4. Getting Started with Google BERT: Build and train state-of-the-art natural language processing models using BERT by Sudharsan Ravichandiran, Packt Publishing Limited January 2021
5. Transformers for Natural Language Processing by Denis Rothman, Packt Publishing, 2021.
6. Latest research papers on LLM

References

- Comprehensive Overview of LLMs- A survey paper: https://arxiv.org/pdf/2307.06435
- 'Foundations of Statistical Natural Language Processing', Christopher Manning and Hinrich Schütze, MIT press, 1999
- 'Natural Language Processing with Python', Steven Bird, Ewan Klein and Edward Loper, O'Reilly Media, Inc.", 2009.
- Speech & language processing' , Daniel Jurafsky, James H Martin, preparation [cited 2020 June 1]Available from: https://web.stanford.edu/~jurafsky/slp3/ed3book.pdf

	Course Code	Course Title	L T P	Cr
		CYBER SECURITY STREAM		

1	25CSA651A	Cybersecurity Governance, Risk and Compliance	2 0 2	3
2	25CSA652A	Essentials of Cyber Security	2 0 2	3
3	25CSA653A	Cyber Security Law	2 1 0	3
4	25CSA654A	System Security	2 0 2	3
5	25CSA655A	Web Application Security	2 0 2	3
6	25CSA656A	Cloud and Infrastructure Security	2 0 2	3
7	25CSA657A	Vulnerability Assessment and Penetration Testing	2 0 2	3
8	25CSA658A	Zero Trust Architecture	2 0 2	3

25CSA651A Cybersecurity Governance, Risk And Compliance 2-0-2-3

Course Objectives

The students will learn the principles of cybersecurity governance, risk, and compliance. They will understand the tools methods, including vulnerability management, threat detection, metrics, and evaluations of organizations. Students will study the NIST framework and learn organizational roles within a company.

Course Outcomes

COs	Description
CO1	Explain different methods to assess cybersecurity maturity.
CO2	Illustrate the vulnerability management techniques and threat management methodologies.
CO3	Illustrate the governance metrics (Application security, vulnerability, and network security).
CO4	Explain the relationship between security analytics and security governance.
CO5	Interpret NIST compliance requirements and their role in enforcing security mandates.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3
CO1	-	3	1	-	1	2	2	3	2
CO2	1	3	1	-	-	2	2	3	2
CO3	1	2	1	-	-	2	2	3	2
CO4	-	2	1	-	-	-	-	3	2
CO5	-	2	2	-	-	-	-	3	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Basics of Cyber security governance, Principles of cyber-security governance, Assessment of cyber security maturity, Theories of governance – introduction, Governance – definitions and typologies

Unit II

Governance of security operations, Tools, methods, and processes, Vulnerability management, Threat management, Endpoint management, Intrusion detection and prevention (IDPS), Security incident management

Unit III

Security metrics and governance, Measurement of governance: Metrics – concepts, Application security metrics, Network security metrics, Security incident metrics, Vulnerability metrics, Service level objectives/agreement (SLO / SLA), NIST metrics

Unit IV

Security analytics and governance, Basics of security analytics, Threat intelligence and governance, Data-driven security governance, Impact of cognitive security on security governance

Unit V

Compliance and governance, Industry-specific security compliance, Cyber security governance – Republic of India, NIST mandates for compliance, Security reporting basics, CISO – role and organization structure, HIPAA, COBITZ compliance

Unit VI

Cyber Security Risk:, Information security risk management framework and methodologies, Risk Management Process, Framework, and Life Cycle, Identifying and modeling information security risks, Qualitative and quantitative risk assessment methods, Articulating information security risks as business consequences

Textbooks / References:

1. Information Security Governance: A Practical Development and Implementation Approach, Wiley publications 2009.
2. Information Security Governance, S.H. Solms, Rossouw Solms, Springer Science & Business Media.
3. Internet governance in an age of cyber insecurity,2010, Council on Foreign Relations Press.
4. Cyber justice: human rights and good governance for the internet, 2017, Springer.
5. Cyber Risk Management: Prioritize Threats, Identify Vulnerabilities and Apply Controls 1st Edition, Kogan Publishers, 2019.

25CSA652A Essentials of Cybersecurity 2-0-2-3

Course Objectives

The student will learn to navigate a Linux CLI and run basic bash commands. Comfort in understanding the common architecture and platforms. Students will practice basic cryptography with code, as well as analyzing malicious binaries.

Course Outcomes

COs	Description
CO1	Explain and apply the fundamental principles and usage of the GNU/Linux operating system.
CO2	Describe and analyze the core principles of widely used cryptographic algorithms.
CO3	Demonstrate reverse engineering techniques on the x86/x86-64 platform
CO4	Perform static and dynamic analysis of malicious binaries.
CO5	Examine and exploit stack and heap vulnerabilities related to system calls.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3
CO1	3	1	2	3	-	-	-	3	2
CO2	2	2	2	3	-	-	-	3	2
CO3	1	3	3	3	-	-	-	3	3
CO4	2	3	2	3	-	-	-	3	2
CO5	2	3	2	3	-	-	-	3	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Linux, Shell essential concepts, Shell I/O, Linux Paths and File Manipulation, Linux permissions,

Unit II

Cryptography, Kerkhoff's principle, Symmetric key encryption, MAC, Public key cryptography, Asymmetric key encryption, Digital signatures, TLS cryptography, Password hashing

Unit III

System security, System calls, Context switches, Malware Analysis, Static and dynamic analysis, Windows API, Malware identification, Malware disassembly

Textbooks / References:

1. Arpaci-Dusseau, R. H., & Arpaci-Dusseau, A. C. (2018). Operating systems: Three easy pieces. Arpaci-Dusseau Books LLC.
2. David Wong. (2021). Real-World Cryptography. Manning Publishing

25CSA653A Cyber Security Law 2 1 0-3

Course Objectives

- Students will learn the cybersecurity laws in India and abroad. A clear introduction to the laws behind data security, breaches, cybercriminal combat, and much more.

Course Outcomes

COs	Description
CO1	Explain the history of cybercrime and the laws created.
CO2	Explain and demonstrate the different classes of cyber-crime.
CO3	Explain the key provisions of the Information Technology (IT) Act.
CO4	Describe the procedures and authorities governing cyber laws in India and abroad.
CO5	Interpret legal frameworks related to privacy and data protection.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3
CO1	1	2	1	-	-	-	-	3	2
CO2	1	2	2	-	-	-	-	3	2
CO3	1	2	2	-	-	-	-	3	2
CO4	1	2	2	-	-	-	-	3	2
CO5	1	2	2	-	-	-	-	3	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Jurisprudence of cyber law, Iinformation Technology Act, 2008, Cybercrimes, history and evolution of cybercrime, unauthorized access crimes, BEC, ATM frauds, online banking frauds, SIM swap frauds, email frauds, lottery frauds, Web defacement, Web Jacking, crimes relating to digital signature

Unit II

Penalties under the IT Act, Relevant Offences under the IT Act

Unit III

Exemption of liability of intermediaries, Information Technology (Intermediary Guidelines and Digital Media Ethics Code) Rules, 2021, due diligence, Procedures & Authorities

Unit IV

Authorities and their duties; The National Cyber Coordination Centre (NCCC), Cyber and Information Security (C&IS) Division, National Critical Information Infrastructure Protection Centre (NCIIPC), National Technical Research Organisation (NTRO) ,Law of Privacy. GDPR and the EU,DPDPA 2023.

Textbooks / References:

1. Satish Chandra, “Cyberlaw in India”.
2. Nilakshi Jain, Ramesh Menon “Cybersecurity and Cyber laws” Wiley media

25CSA654A	System Security	2-0-2-3

Course Objectives

Students will learn the fundamentals of securing a computer system. They will understand and implement defenses against all common system attacks.

Course Outcomes

COs	Description
CO1	Describe security goals and principles which is used in designing a secure system
CO2	Demonstrate the exploitation of Access control vulnerabilities and develop its mitigation
CO3	Explain the basics of system organization, assembly language and Linux system calls.
CO4	Demonstrate buffer overflow attack, Format string attack and Return to libc attack withexamples
CO5	Illustrate preventive mechanisms for different exploits

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3
CO1	1	2	2	2	2	-	-	3	2
CO2	1	2	2	3	2	-	-	3	2
CO3	2	2	1	3	2	-	-	3	2
CO4	3	2	2	3	1	-	-	3	2
CO5	2	2	3	2	1	-	-	3	3

Syllabus

Unit I

Security Goals, Secure Design Principles, Authentication, Linux Password scheme, Password Security, Authorization - Access control, MAC, DAC, ACL, Capabilities, Information flow control, Privilege Escalation Attacks, constraining and sandboxing users and applications.

Unit II

Assembly Primer, Shell coding, ELF File Format. Memory Exploits – Buffer Overflow, Off byone overflow, Format String Attacks, Integer Overflow, Return to Libc, Heap Overflow, Exploit prevention mechanisms: stack canaries, Data Execution Prevention, Address Space Layout Randomization, bypassing DEP & ASLR. Trusted Execution Environment - Case Study on IntelSGX.

Unit III

Fuzzing - Types of fuzzers, Bug detection, Case study - AFL fuzzer. Vulnerability and exploit analysis: spectre, meltdown, foreshadow, dirty COW.

Textbooks / References:

1. Neil Daswani, Christopher Kern, Anita Kesavan, "Foundations of Security, What Every Programmer Needs to Know", Apress, 2007
2. Jon Ericson, "Hacking: The Art of Exploitation", Second Edition, No Starch Press, 2008
3. Gary McGraw, John Viega, "Building Secure Software", Addison-Wesley Professional, 2001.
4. Michael Sutton, Adam Greene, Pedram Amini, "Fuzzing Brute Force Vulnerability Discovery"

25CSA655A Web Application Security 2 0 2-3

Course Objectives

Students will learn an overview of web application architectures and the associated security vulnerabilities and defenses. By the end of the course, students will be confident to understand how to secure web applications.

Course Outcomes

COs	Description
CO1	Ability to find and exploit vulnerabilities in web applications
CO2	Ability to find CVEs in open source web application frameworks
CO3	Ability to participate and win in bug bounty programs
CO4	Ability to implement secure coding practices
CO5	Demonstrate knowledge and practice of responsible vulnerability disclosure processes.

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3
CO1	2	3	2	3	-	1	1	3	2
CO2	1	3	2	3	-	1	1	3	2
CO3	1	1	2	3	-	1	1	3	2
CO4	2	3	3	3	-	1	1	3	3
CO5	1	2	3	3	-	1	1	3	3

Syllabus

Unit I

Introduction - Overview of web architecture, Protocols, Client-server architecture, P2P architecture, DNS, etc.Understanding the browser: Same origin policy, Cookies, Cache, authentication.

Unit II

Website development basics, understanding server-side languages like HTML, PHP and Database languages such as SQL. Understanding the frontend, backend, database paradigm of web application

development.

Unit III

Injection attacks: SQL injection, OS command injection.File upload vulnerability: LFI, RFI, how to properly secure a file inclusion vulnerability.Request forgery vulnerability: Server-side request forgery, Client-side request forgery. Cross-site scripting attacks: Reflected XSS, Stored XSS, how to properly secure against XSS attacks. DOS & DDOS attacks, Phishing attacks.Automating vulnerabilities: SQLmap, Burp Suite.

Unit IV

OWASP Top 10: Broken Authentication, Sensitive Data Exposure, XML External Entities, Broken Access Control, Security Misconfiguration, Insecure Deserialization, Using Components with Known Vulnerabilities, Insufficient Logging & Monitoring. Responsible vulnerability disclosure: CVE's, CVEmitre, Exploit-db, SearchSploit, bug bounty. Secure coding practices: blacklisting, whitelisting, user input validation, automated testing, sanitizing HTML.

Textbooks / References:

1. Peter Yaworski, "Real-World Bug Hunting: A Field Guide to Web Hacking"
2. Michal Zalewski, "The Tangled Web: A Guide to Securing Modern Web Applications"
3. Dafydd Stuttard and Marcus Pinto, "The Web Application Hacker's Handbook" Second edition, 2011
4. OWASP, "Web Security Testing Guide", Fourth edition

25CSA656A Cloud And Infrastructure Security 2 0 2-3

Course Objectives

- Familiarization of popular cloud platforms, VM creation, Container management, and Kubernetes, Storage management, Database creation, Network management, Access control mechanism in a computing environment, Virtual private cloud, Design and deployment of secure microservice applications, load balancing, Identity management, Homomorphic encryption, VPC Networking, and security.

Course Outcomes

COs	Description
CO1	Explain the architecture and infrastructure of cloud computing along with hands-on experience in various cloud computing platforms.
CO2	Identify the known threats, risks, vulnerabilities, and privacy issues in the various layers of cloud computing.
CO3	Compare modern security concepts as they are applied to cloud computing
CO4	Explain the concepts and various methods of secure data management in the cloud.
CO5	Demonstrate practical skills in deploying and managing modern cloud technologies.

CO-PO Mapping

PO/PS									

O / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3
CO1	2	1	2	3	-	-	-	3	2
CO2	1	1	2	2	-	-	-	3	3
CO3	2	1	3	3	-	-	-	3	3
CO4	2	1	3	3	-	-	-	3	3
CO5	2	1	3	3	-	-	-	3	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Cloud computing essentials: - Characteristics, service models, deployment models, NIST reference architecture, virtualization, containers, Kubernetes, design of microservices, high availability, Load Balancing in the cloud, cloud storage, and databases, cloud networking and vpc, popular cloud platforms, open-source architectures.

Unit II

Threats classification and countermeasures: - Infrastructure and host threats, service provider threats, generic threats, threats assessment, CSA Top threats, Virtualization system vulnerabilities, Authentication and authorization techniques for cloud solutions, Protection of application infrastructure, Protecting Data in the Cloud:- Tokenization, Cryptographic key management for data protection.

Unit III

Encryption techniques and applications for cloud computing, homomorphic encryption, Intrusion Detection and Prevention for cloud workloads, security breaches management for cloud computing, Cloud-centric regulatory compliance issues, and mechanisms.

Textbooks / References:

1. John R. Vacca(Editor), “Cloud Computing Security - Foundations and Challenges” CRC Press, 2017
2. Ronald L. Krutz and Russell Dean Vines, “Cloud Security- A Comprehensive Guide to Secure Cloud Computing”, Wiley, 2010
3. Chris Dotson “Practical Cloud Security “, O'Reilly,2019
4. Tim Mather, S. Kumaraswamy, and S. Latif, “Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance”, O’Reilly Media, 2009

25CSA657A Vulnerability and Penetration Testing 2 0 2-3

Course Objectives

- The student will be confident to perform vulnerability and penetration testing for any organization of product team, generate a report and communicate remediation steps.

Course Outcomes

COs	Description
CO1	Perform vulnerability assessment independently
CO2	Perform penetration testing against a target and generate a report
CO3	Demonstrate ability to find CVEs in open source CMS
CO4	Perform bug bounties
CO5	Explain the difference between private vs public research

CO-PO Mapping

PO/PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3
CO1	1	2	2	3	-	1	1	2	3
CO2	2	3	3	3	-	3	3	3	3
CO3	2	3	2	3	-	3	3	3	3
CO4	1	3	3	3	-	3	3	3	3
CO5	1	2	2	2	-	2	2	2	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Active information gathering , General vulnerability scanners, Port-based, Service-based, Banner grabbing, Web application scanners, General application flaw scanners, Directory listing/Brute forcing, Web server version/Vulnerability identification, Technology stacks and packages version detection, Network vulnerability scanners/Specific protocols, VPN, Manual direct connections

Unit II

Passive information gathering, Metadata analysis, Traffic monitoring, ARP/MAC cache overflow, Etherleak, Misconfigured clusters or load balancers

Public Research:, Vulnerability databases, Vendor advisories, Exploit databases and framework modules, Common/default passwords, Hardening guides/common misconfigurations, Private Research, Fuzzing

Unit III

WiFi password hacking, aircrack-ng, DNS Cache poisoning/Spoofing, Recon tools : NS enumeration tools, Nmap, Netcat, Tcpdump, Wireshark, Directory enumeration tools, Google hacking, Shodan

Unit IV

SQL injection Case study: SQLi , File upload vulnerabilities, Case study: SSRF , Reverse shell, Password brute-forcing using shadow file, Hashcat, John the ripper, Hydra, Medusa, Ncrack, Cross site scripting , XSS, Client-side request forgery, IDOR, Metasploit

Unit V

XML attacks , Case study: XXE, Vulnerability Exploitation and Generating PoC, Vulnerability assessment, Pen Test Report Generation

Textbooks / References:

1. OWASP Web Security Testing Guide V4
2. Bugcrowd, “The Ultimate Guide to Penetration Testing”, 2020 edition
3. HackerOne, “Web hacking 101”

25CSA658A	Zero Trust Architecture	2 0 2-3

Course Objectives

- To introduce students to the Zero Trust security model and its evolution from traditional perimeter-based approaches and provide a deep understanding of Zero Trust components, architecture, and operational integration.This equips students with the knowledge to assess, design, and implement Zero Trust strategies in real-world IT infrastructures and helps explore compliance, auditing, and incident response within a Zero Trust context.

Course Outcomes

COs	Description
CO1	Explain the core concepts and principles of Zero Trust Architecture (ZTA).
CO2	Develop incident response strategies aligned with Zero Trust models.
CO3	Analyze and audit ZTA environments for compliance with cybersecurity regulations.
CO4	Apply access control, identity management, and continuous monitoring techniques in ZTA.
CO5	Evaluate and compare different ZTA implementation strategies and tools.
CO6	Design secure architectures based on ZTA principles for both on-prem and cloud-based systems.

CO-PO Mapping

PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO3
CO1	3	2	1	1	1	1	1	1	2
CO2	1	2	1	2	1	2	2	2	2
CO3	2	3	2	3	3	3	3	2	3
CO4	2	2	2	2	2	1	1	3	3
CO5	1	2	3	1	2	3	3	2	3

CO6	1	2	2	1	3	3	3	3	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Zero Trust: Evolution of network security models, Traditional perimeter-based vs. Zero Trust models, Core principles of Zero Trust,NIST SP 800-207 overview

Unit II

Core Components of Zero Trust: Identity and Access Management (IAM),Device security posture,Network segmentation and micro-segmentation,Continuous monitoring and analytics,Policy engines and enforcement points

Unit III

Zero Trust Network Architecture: Software-defined perimeter,Zero Trust in cloud environments,Role of firewalls, proxies, and SDN,Integration with hybrid and multi-cloud

Unit IV

Authentication and Authorization in ZTA: Multi-Factor Authentication (MFA), Role-Based Access Control (RBAC) vs. Attribute-Based Access Control (ABAC), Identity federation and Single Sign-On (SSO), Risk-based access decisions

Unit V

Implementation Strategies: TA maturity model and roadmap, Vendor solutions (Okta, Zscaler, Palo Alto, Cisco, etc.)Migration challenges from perimeter-based models, Case studies (Google BeyondCorp, Microsoft Zero Trust)

Unit VI

Zero Trust and Compliance: Mapping ZTA to compliance frameworks (e.g., NIST, ISO 27001, GDPR), Auditing in ZTA environments, Logging and telemetry

Unit VII

Security Operations and Incident Response in ZTA: Role of SIEM and SOAR, Threat detection and response under ZTA, Forensics and response strategy.

Textbooks/References

1. "Zero Trust Networks: Building Secure Systems in Untrusted Networks" by Evan Gilman & Doug Barth (O'Reilly Media)
2. "Zero Trust Security: An Enterprise Guide" by Jason Garbis & Jerry W. Chapman (Manning Publications)
3. NIST Special Publication 800-207 – Zero Trust Architecture (Free PDF at

https://csrc.nist.gov/publications/detail/sp/800-207/final)

Supplementary Reading

1. "Practical Cybersecurity Architecture" by Ed Moyle & Diana Kelley
2. "Designing Secure Software" by Loren Kohnfelder
