PROGRAM

AMRITA ONLINE

Bachelor of Computer Applications

(BCA -Online)

CURRICULUM AND SYLLABUS

2025

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO1	Graduates will strive on a global platform to pursue their career / pursue higher studies in Computer Science and Applications related disciplines.
PEO2	Graduates will contribute as entrepreneurs in interdisciplinary areas.
PEO3	Graduates will demonstrate high regard for professionalism, integrity and respect for values in diverse cultures, and have a concern for society and the environment.

PROGRAM OUTCOMES (PO)

PO1	**Engineering Knowledge**: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialisation as specified in WK1 to WK4, respectively, to develop solutions to the solution of complex engineering problems.
PO2	**Problem Analysis**: Identify, formulate, review research literature and analyse complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4) Problem Analysis: Identify, formulate, review research literature and analyse complex engineering problems, reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO3	**Design/Development of Solutions**: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO4	**Conduct Investigations of Complex Problems**: Conduct investigations of complex engineering problems using research-based knowledge, including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions (WK8).
PO5	**Engineering Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and

	modelling, recognising their limitations to solve complex engineering problems. (WK2 and WK6)
PO6	**The Engineer and The World**: Analyse and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment (WK1, WK5, and WK7).
PO7	**Ethics**: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO8	**Individual and Collaborative Team work**: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams
PO9	**Communication**: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences
PO10	**Project Management and Finance**: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.
PO11	**Life-Long Learning**: Recognise the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1	Demonstrate problem-solving and logical thinking skills with a strong foundation in computer science, applications, and networking; apply practical knowledge from advanced domains such as distributed systems, cloud computing, IoT, AI and VR to design professional engineering solutions that address complex computing challenges, while considering societal, environmental, and ethical contexts.
PSO2	Demonstrate a strong foundation in artificial intelligence and data science by applying modern tools and technologies (such as Python, Power BI, Tableau, Hadoop, SQL, and Excel) to acquire, manage, and analyse large datasets, extract meaningful insights for informed decision-making and prepare for in-demand industry roles.

CURRICULUM

SI No.	Course Code	Course Title	L T P	Cr
		SEMESTER 1		
1	25ENG101A	Communicative English	2 0 2	3
2	25MAT102A	Foundations of Applied Mathematics - I	3 0 0	3
3	25CSA101A	Principles of Management	3 1 0	4
4	25CSA102A	Computer Essentials	3 0 2	4
5	25CSA103A	Problem Solving and Algorithmic Thinking	3 0 2	4
		TOTAL		**18**

SI No.	Course Code	Course Title	L T P	Cr
		SEMESTER 2		
1	25ENG111A	Professional Communication	1 0 2	2
2	25MAT112A	Foundations of Applied Mathematics - II	3 0 0	3
3	25CSA111A	Operating System and Computer Architecture	3 1 0	4
4	25CSA112A	Object Oriented Programming using Java	3 1 0	4
5	25CSA113A	Database Management System	3 1 0	4
6	25CSA181A	Database Management System Lab	0 0 2	1
7	25CSA182A	Object Oriented Programming using Java Lab	0 0 2	1
		TOTAL		**19**

SI No.	Course Code	Course Title	L T P	Cr
		SEMESTER 3		
1	25CSA201A	Data Structures and Algorithms	3 1 0	4
2	25CSA202A	Computer Networks	3 0 2	4
3	25ENV200A	Environmental Science and Sustainability	3 0 0	3
4		Stream Core - Mathematics	3 1 0	4
5		Professional Elective I	2 0 2	3
6		Professional Elective II	2 0 2	3
7	25CSA281A	Data Structures and Algorithms Lab	0 0 2	1
		TOTAL		**22**

SI No.	Course Code	Course Title	L T P	Cr
		SEMESTER 4		
1	25SSK211A	Soft Skills	2 0 0	2
2	25CSA211A	Web Application Development	3 1 0	4
3	25CSA212A	Data Mining	3 0 2	4
4	25CSA213A	Software Engineering	3 1 0	4
5		Professional Elective III	2 0 2	3
6		Professional Elective IV	2 0 2	3
7	25CSA282A	Web Application Development -Lab	0 0 2	1
		TOTAL		**21**

SI No	Course Code	Course Title	L T P	Cr
		SEMESTER 5		
1	25CSA301A	C# and .NET Framework	3 0 2	4
2	25CSA302A	Foundations of Machine Learning	3 0 2	4
3	25CSA303A	Essentials of Cyber Security	3 0 0	3
4		Professional Elective V	2 0 2	3
5		Professional Elective VI	2 0 2	3
6	25CSA398A	Case Study		3
		TOTAL		**20**

Sl No	Course Code	Course Title	L T P	Cr
		SEMESTER 6		
1	25CSA399A	Capstone Project		10
2	25CSA311A	Mobile Application Development	3 0 2	4
3		Professional Elective VII	2 0 2	3
4		Professional Elective VIII	2 0 2	3
		TOTAL		**20**
		Total Credits 18+19+22+21+20+20= 120		

STREAM CORE - MATHEMATICS

Sl No	Course Code	Course Title	L T P	Cr
Stream Core - Mathematics				
1	25MAT231A	Discrete Mathematics	3 1 0	4
2	25MAT232A	Linear Algebra for Data Science	3 1 0	4

PROFESSIONAL ELECTIVES - REGULAR STREAM

SI No.	Course Code	Subject	L_T_P	Cr
1	25CSA331A	Advanced Programming in Python	2 0 2	3
2	25CSA332A	Digital Image Processing	2 0 2	3
3	25CSA333A	Cloud Computing Foundation	2 0 2	3
4	25CSA334A	Switching, Routing and Wireless Essentials	2 0 2	3
5	25CSA335A	Computational Biology	2 0 2	3
6	25CSA336A	Business Analytics	2 0 2	3
7	25CSA337A	Advanced Java and J2EE	2 0 2	3
8	25CSA338A	Enterprise Networking, Security and Automation	2 0 2	3
9	25CSA339A	Block chain Technologies	2 0 2	3
10	25CSA340A	Introduction to VR Programming	2 0 2	3
11	25CSA341A	Distributed Systems	2 0 2	3
12	25CSA342A	Introduction to IOT	2 0 2	3

PROFESSIONAL ELECTIVES - AI AND DS STREAM

SI No.	Course Code	Subject	L_T_P	Cr
1	25CSA351A	Cloud Computing Foundation	2 0 2	3
2	25CSA352A	Exploratory Data Analysis using Python	2 0 2	3
3	25CSA353A	Big Data Analytics and Visualization	2 0 2	3
4	25CSA354A	Business Analytics	2 0 2	3
5	25CSA355A	Data Analysis using Microsoft Excel	2 0 2	3
6	25CSA356A	Data Governance	2 02	3
7	25CSA357A	Natural Language Processing	2 0 2	3
8	25CSA358A	Data Visualization using Power BI	2 0 2	3
9	25CSA359A	Text Mining and Analytics	2 0 2	3
10	25CSA360A	Applications of Machine Learning	2 0 2	3
11	25CSA361A	Tableau for Business Intelligence	2 0 2	3
12	25CSA362A	Artificial Neural Networks and Applications	2 0 2	3

* Any student completing 6 out of 8 of their electives from any particular stream will be given a certificate with the name of that specialisation.

SYLLABUS

SEMESTER 1

SI No.	Course Code	Course Title	L T P	Cr
		SEMESTER 1		
1	25ENG101A	Communicative English	2 0 2	3
2	25MAT102A	Foundations of Applied Mathematics - I	3 0 0	3
3	25CSA101A	Principles of Management	3 1 0	4
4	25CSA102A	Computer Essentials	3 0 2	4
5	25CSA103A	Problem Solving and Algorithmic Thinking	3 0 2	4
		TOTAL		**18**

25ENG101A	Communicative English	2 0 2-3

Course Description

- English is now the international official language; it is necessary to master the language to stay connected with the world. This course is a speaking course designed to guide the students to use the language with confidence and without committing errors. To facilitate their overall ability to interact in English, we have incorporated Soft Skills to develop their self-confidence, thereby helping them acclimate to the requirements and expectations of life, both professional and personal.

Course Outcomes

COs	Description
CO1	Gain awareness and demonstrate the same on the importance of rules of netiquette in presenting oneself in the virtual class, in chat rooms or on discussion boards. Reinforce protecting one's private information and respecting the online privacy of others when on social media.
CO2	Communicate effectively and professionally via email or telephone.
CO3	Develop self-confidence and a positive attitude necessary to compete and challenge themselves. Know oneself well, discover their competencies to achieve their goals, enable them to identify their communication style and to adapt to different communication styles. They would be able to introduce themselves professionally.

CO4	Hone presentation skills by understanding the nuances of content creation, effective delivery, use of appropriate body language and the art of overcoming nervousness to create an impact in the minds of a target audience.
CO5	Develop public speaking skills, and story- telling skills, learn to create a digital image of oneself.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	1	-	-	1	2	3	2	2	3	2
CO2	-	-	-	-	1	–	–	2	3	3	2
CO3	-	-	-	-	1	-	2	3	3	2	3
CO4	-	1	2	-	1	-	2	3	3	3	2
CO5	-	-	-	-	1	–	2	3	3	3	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

   Netiquette: Etiquette to be followed in online classes – code of conduct, usage of audio, video, lighting, dress code and other physical settings. Email Etiquette: Understand the rules of drafting a professional email, Telephone Etiquette: How to make a call, and how to answer a call.

Unit II

   Know thyself: Series of activities undertaken to identify one's hidden potential. Students identify their core values, strengths, skills, and weaknesses. Activities that help students consciously tap into their inner potential and use these to set and accomplish goals. Knowing your style of communication.

Unit III

   Elevator Pitch: Elevator Pitch – Create a script- Practice to deliver it confidently – create self-introduction videos.

Unit IV

   Presentation skills, Public Speaking and Story Telling Content creation and delivery.

Unit V

   Resume Making- To help students understand the difference between a CV, Bio Data, Resume. How to create a resume, and things to be taken care of while creating a resume.

Unit VI

Personal Branding through LinkedIn: Purpose of LinkedIn – Creating an impressive profile – how to network. To create an impressive brand for oneself for better reach.

Textbooks

1. Netiquette: Internet Etiquette in the Age of the Blog, M. Strawbridge, Software Reference Ltd
2. Unleash the Power of Storytelling: Win Hearts, Change Minds, Get Results, Rob Biesenbach, East Lawn Media, 2018
3. Five Stars: The Communication Secrets to Get from Good to Great by Carmine Gallo, Macmillan, 2018
4. Presenting to Win: The Art of Telling Your Story, Jerry Weiss, FT Press; 1st edition, 2008
5. The Professional by Subroto Bagchi, Portfolio

References

1. Organisational Behaviour – Stephen Robbins, Pearson Education.
2. Personality Development & Soft Skills – Barun.K.Mitra, Oxford
3. Effective Presentation Skills, Revised Edition: A Practical Guide for Better Speaking – Steve Mandel, Crisp Publications.
4. The One Minute Manager – Ken Blanchard, Simon & Schuster Audio/Nightingale-Conant;

25MAT102A   Foundations of Applied Mathematics - I   3 0 0-3

Course Description

- Foundations of Applied Mathematics –Part 1 is the first of the two-part course on Foundations of Applied Mathematics. The two courses offer basic mathematical foundations necessary to become computer science professionals. They also form the pre-requisite courses for various other mathematical courses and electives offered throughout the program.

- Unlike conventional methods, these courses are designed to teach mathematics through programming. The curriculum, combined with pedagogy and online learning tools, will help students easily engage with and express mathematical concepts through programming. More emphasis is placed on mathematical understandings and interpretations, while less emphasis is placed on manipulations and memorisation. At the same time, mathematical concepts taught throughout the course will be motivated and connected to various real-life applications. Thus, the students will be able to learn mathematics in new, meaningful, and generalizable ways. We do not learn abstract mathematics in this course, nor focus on mathematical rigour through theorems and proofs.

Course Outcomes

COs	Description
CO1	To develop the ability to model and analyse real-life problems mathematically
CO2	Familiarise yourself with various computational tools to learn and apply mathematics
CO3	Build foundations to learn advanced mathematical concepts necessary to become a computational engineer/scientist, a machine learning or data science practitioner
CO4	Be able to communicate mathematical ideas orally and in writing with precision, clarity and organisation.

CO PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	1	1	1	1	1	-	-	-
CO2	1	2	-	-	3	-	-	2	-	2	3
CO3	3	3	2	-	2	-	-	-	2	1	3
CO4	1	2		-	1	-	-	3	3	2	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I
Mathematical Modelling Roadmap of the mathematics curriculum - Problem solving -Real life applications- Mathematical modelling.

Unit II
Description of data, Learning Computational Tools, Data observation, recording, representation and visualisation (single variable and multi variable) - Introduction to Excel, Python and Jupyter -Simple datastructures-Learning mathematical libraries (Matplotlib, Sympy, Numpy).

Unit III
Algebra and Trigonometry Order of operations - Variables and expressions - Bases and exponents - Evaluation of algebraic expressions - Linear equations and inequalities - System of linear equations - Trigonometry - Degrees and radians.

Unit IV

Functions Definition of functions - Independent and dependent variables - Function visualisation- Algebraic functions- Polynomial functions- Exponential functions- Logarithmic functions-Trigonometric functions - Inverse functions - Arithmetic operation on functions - Composition of functions - Functional transformations.

Unit V

Probability & Statistics Description of data with statistics - Measures of central tendency - Basics of probability - Random numbers - Probability density functions - Normal distributions - Central limit theorem

Textbooks

1. T. Veerarajan, Probability, statistics and Random processes- Third Edition
2. George B Thomas, Revised by Maurice D.Weir, 13th Edition, Thomas' calculus: Early Transcendentals

References

1. Bird, Basic Engineering Mathematics, 7th Edition, Newnes, India
2. Stewart 2015, CALCULUS: Early Transcendentals, 8th Edition, Cengage learning, India
3. Amit Saha 2015, Doing Math with Python, 1st edition, No Starch Press
4. Morley 2020, Applying Math with Python, Packet Publishing
5. Gowers 2002, Mathematics: A Very Short Introduction, 1st edition, Oxford University Press

25CSA101A	Principles of Management	(3 1 0-4)

Course Description

This course is designed to

- acquaint the students with the challenges and opportunities they will face when managing their lives, the time and skills of other people, and the resources of an organisation;
- help the students understand management theory from functional perspectives.
- provide students with opportunities to develop the basic managerial skills of planning, organising, leading & controlling.
- gain experience in working as part of a team and develop skills necessary for effective work team performance.

Course Outcomes

COs	Description
CO1	To understand and explain the basic concepts and theories in management, their application in real life and to know about the functions and roles of managers in the organisation.
CO2	To appreciate the importance and know-how of planning before action.
CO3	To be familiar with the different organization structures and departmentalisation and their importance, and illustrate the same.
CO4	Upon completing this course, participants will be able to effectively hire, lead, and direct teams while applying key motivational techniques to enhance employee engagement and performance in the workplace.
CO5	To understand and explain the necessity of a good control system and to effectively manage the resistance to control.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	2	2	2	2	3	2	3	3	3	3
CO2	2	1	3	2	2	2	2	-	1	1	3
CO3	1	-	3	-	-	2	-	-	3	3	3
CO4	-	-	2	-	-	1	-	1	3	3	3
CO5	-	2	3	1	1	2	-	1	3	3	3

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Management Concepts Management: Meaning – Process - Science or Art - a Profession - Administration vs Management – Significance - Functions of Management - Levels of Management - Managerial Skills - Roles of Managers. Classical Theory - Scientific Management - Administrative Management - Bureaucracy Modern Theory - System approach - Contingency Theory - Z quality management, Behavioural Theory - Hawthorne Studies - Maslow's need theory - Theory X, Y and Z.

Unit II

Planning Definition – Need – Benefits – Steps - Nature and Importance – Objectives - Concepts of Management by Objective – Steps - Difficulties in MBO.

Unit III

Organising Nature – Purpose – Steps - Types of Organisation: Formal & Informal – Power - Authority and Responsibility - Centralisation vs Decentralisation - Span of control – Departmentalisation - Project organisation - matrix organisation.

Unit IV

Staffing and Directing Nature – Significance - Recruitment & Selection Meaning - Training and Placement – Meaning - Difference between Recruitment and Selection - Difference between Training and Development.

Directing - Meaning – Definition - Key elements.

Unit V

Managerial Control Definition, Characteristics - Significance – Limitations – Process - Requirement of an effective control system - Feedback mechanisms Resistance to control - Overcoming resistance to control.

Textbooks

1. Management: Stephen P. Robins and Marry Coulter, Pearson
2. Samuel C Creto And S. Trevis Certo, Modern Management-Concepts and skills, Prentice Hall

References

1. L. M Prasad, Principles and Practices of Management, Sultan Chand & Sons
2. Koontz, Essentials of Management, Tata McGraw-Hill Education
3. Daft, R. L., Management.
4. T. N Chhabra, Principles of Management

25CSA102A	Computer Essentials	3 0 2 – 4

Course Description

- The course gives students an overview of computer science: A foundation from which they can appreciate the relevance and interrelationships of further courses in the field. This course provides an insight into the general structures of computers, operating systems, computer networks and essentials of computer security.

Course Outcomes

COs	Description
CO1	Describe the basic components of computer systems and demonstrate their functionality.
CO2	Perform number system conversions and solve simple problems using binary arithmetic and representations.
CO3	Apply fundamental Linux commands to manage files, processes, and system utilities.
CO4	Illustrate how different components interact to form computer networks and perform basic network troubleshooting.
CO5	Identify security threats and apply basic techniques to secure data and systems.

CO-PO Mapping

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	1	-	-	-	-	-	1
CO2	3	3	-	-	2	-	-	-	-	-	2
CO3	2	2	-	-	3	-	-	-	1	-	2
CO4	2	2	1	-	3	2	-	-	2	-	2
CO5	2	3	-	-	2	3	2	-	2	-	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Computer Fundamentals: Brief history of Computer, Classification of Computers, Functions & Components of a Computer, Central Processing Unit, Storage units, Bus, Input and output Devices. Types of memory, RAM, ROM, Variants of ROM, Secondary storage devices-hard disk-disk components and geometry. Other Secondary Storage devices: CD/DVD Family, Blue ray Disc, Flash Drive, Memory stick, smart cards. Computer Languages-Machine, Assembly Language and Higher-Level languages. Operating systems, Bootstrapping. Program execution with illustrative examples. Cloud storage vs Local storage and emerging I/O devices.

Unit II

Number systems: Decimal, Binary, Octal, Hexadecimal conversion from one to another-Binary arithmetic, representation of signed numbers, Unicode/ASCII representation, 1's and 2's Complement Arithmetic.

Operating System Fundamentals: Operating Systems: Introduction, Functions of an operating System, Classification of Operating Systems, System programs, Application programs, Utilities, Booting, virtualization basics

Basic Linux commands - Searching the file system using find and grep with simple regular expressions. Basic process control using signals: pausing and resuming a process from a Linux terminal, terminating a process. Adding/removing from the search path using the PATH variable. Compressing/uncompressing using tar/gzip and zip tools. Using man pages to understand tool documentation, File permissions (chmod, chown), Package management basics (apt, yum)

Unit III

Computer Networks: Data transmission media, Network types and Topologies, Network devices, Network architecture, Application layer protocols, obtaining essential system network information using system tools: network interfaces and their addresses, active processes using network communication. Basic network debugging: using traceroute to discover the route to a remote computer, ping to check network connectivity, and nslookup for DNS lookup. Understanding basic HTTP client and server using netcat, Wi-Fi vs Ethernet, Intro to IPv4 vs IPv6 addressing, Firewalls, VPNs

Unit IV

Computer Security: Viruses, Worms, Trojans, Adware, Spyware, Grayware, Denial of Service, Spam and Pop-up Windows, Network security, Phishing, Malware, End-point security, MITM attacks, Social Engineering, SQL injection, Ways to protect data, Password hygiene, two-factor authentication, Basics of cryptography (symmetric vs asymmetric encryption)

Textbooks

1. Brookshear, G. (with Brylow, D.). Computer Science: An Overview, 13th Edition, Pearson (2021).
2. Silberschatz, A., Gagne, G., Galvin, P. B. Operating System Concepts, 10th Edition, Wiley (2018).
3. Blum, R., Bresnahan, C. Linux Command Line and Shell Scripting Bible, 4th Edition, Wiley (2021) .

References

1. Cobbaut P. Linux Fundamentals. Samurai Media Limited; 2016.
2. Malvino, A. P., Leach, D. P. *Digital Principles and Applications*, 8th Edition, McGraw-Hill.
3. Sinha, P. K., Sinha, Priti. *Computer Fundamentals*, (4th Edition, 2004) Kurose, J. F., Ross, K. W. *Computer Networking: A Top-Down Approach*, 8th Edition (or latest in some markets).
4. Tanenbaum, A. S., Wetherall, D. J. *Computer Networks*, 6th Edition (or latest accordingly).
5. Stallings, W. *Cryptography and Network Security: Principles and Practice*, 8th Edition, Pearson (2023/2024).

25CSA103A Problem Solving and Algorithmic Thinking (3 0 2 – 4)

Course Description

- Algorithmic Thinking is a fundamental skill in this 21st Century. This course provides the foundations of Computational Problem Solving. It focuses on principles and methods rather than on systems and tools thus providing transferable skills to any other domain. It also provides foundation for developing computational perspectives of one's own discipline. This course imparts the ability to read and understand the problem, analyse and interpret the problem, take out the relevant aspects of it and represent the problem technically, give proper representation to the input data, know what constitutes a solution, design an appropriate solution methodology and implement the solution.

Course Outcomes

COs	Description
CO1	Demonstrate algorithmic thinking to analyze, define, and structure solutions for computational problems
CO2	Design and implement algorithms to address real-world problems using systematic approaches
CO3	Employ fundamental programming constructs such as sequence, selection, iteration, and modularisation in problem-solving
CO4	Analyse and debug algorithms/programs by tracing computational states, detecting errors, and applying corrections effectively.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO

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

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Problem-Solving - understand problem definition, constraints on input/output, sample input and expected output; Algorithmic thinking - reading input/writing output, data representation, choice of data types, formulating solutions to basic problems by applying sequence, selection, and repetition constructs, modularity, Problem solving with basic Python constructs. Familiarity with Google Colab, code forces.

Unit II

Representing and manipulating composite data - lists, strings, tuples, and dictionaries, problem-solving on lists- performing a search, aggregation, range and ordering operations on lists; Manipulating string data - concatenation, splitting, reversal, comparison, pattern matching on strings.

Unit III

Using recursion for problem-solving, practical examples of recursion, iteration vs. recursion, simple and binary recursion; Evaluating algorithms, error handling, writing test cases, and the importance of documentation/ comments.

Textbooks

1. Riley, D., Hunt, K. A. *Computational Thinking for the Modern Problem Solver*, 1st Edition, CRC Press (2014).
2. Dierbach, C. *Introduction to Computer Science Using Python: A Computational Problem-Solving Focus*, 1st Edition, Wiley (2012))

References

- Ferragina, P., Luccio, F. *Computational Thinking: First Algorithms, Then Code*, (2018) Springer
- Beecher, K. *Computational Thinking: A Beginner's Guide to Problem-Solving and Programming*, (2017) BCS Learning & Development
- Curzon, P., McOwan, P. W. *The Power of Computational Thinking: Games, Magic and Puzzles to Help You Become a Computational Thinker*, (2017) World Scientific Publishing

SEMESTER 2

SI NO	Course Code	Course Title	L T P	Cr
		SEMESTER 2		
1	25ENG111A	Professional Communication	1 0 2	2
2	25MAT112A	Foundations of Applied Mathematics - II	3 0 0	3
3	25CSA111A	Operating System and Computer Architecture	3 1 0	4
4	25CSA112A	Object-Oriented Programming using Java	3 1 0	4
5	25CSA113A	Database Management System	3 1 0	4
6	25CSA181A	Database Management System Lab	0 0 2	1
7	25CSA182A	Object-Oriented Programming using Java Lab	0 0 2	1
		TOTAL		**19**

25ENG111A   Professional Communication   1 0 2 – 2

Course Description

- This course is designed to o convey and document information in a formal environment; to acquire the skill of self-projection in professional circles; and to inculcate critical and analytical thinking.

Course Outcomes

COs	Description
CO1	To stimulate critical thinking by identifying the barriers in communication and rectifying them.
CO2	To use English with a high degree of fluency for spoken communication by participating in discussions and delivering presentations.
CO3	To enhance soft skills and non-verbal communication through discussions, conversations, and presentations.
CO4	To draft effective business correspondence with brevity, clarity, and accuracy.
CO5	To develop competency in new media communication skills required for the careers of today.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	-	-	-	-	-	-	3	-	-	2
CO2	-	-	-	-	-	-	-	3	-	-	3
CO3	-	-	-	-	-	-	-	3	-	-	3
CO4	-	-	-	-	-	-	-	3	-	-	1
CO5	-	-	-	-	-	-	-	3	-	-	1

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Professional English: Business English as Language of Business Communication, Verbal and Non-Verbal Communication, Effective Communication – Strategies and Barriers. Importance of English in Professional Communication

Unit II

Listening and Speaking: Principles of Effective Listening, Problems in Effective Listening, Characteristics of Effective and Ineffective Listeners, Guidelines for Effective Oral Communication, Communications to Lead, Persuade & Negotiate, Sounds of English: Stress, Intonation, Situational Dialogues, Group Discussion, Presentations, Interview

Unit III

Reading: Business Reading: Significance and Purpose, The SQ3R Method of Reading: Survey, Question, Read, Recite, and Review

Unit IV

Writing: Skills required in written communication (7 Cs of communication), Elements of effective writing- (Use familiar, concrete and specific words; Avoid jargon, redundancy, discriminatory writing etc.) Modal auxiliaries, Error Analysis, Planning, Writing, and Revising: Business Messages, Instruction, Recommendation, Business Proposals and reports, Circulars, Memos and Business Letters

Unit V

New Media Communication, Cross-cultural communication, Cambridge Business English

References

1. Raman, Meenakshi & Sangeeta Sharma. Technical Communication: Principles and Practice. Third Edition. New Delhi: Oxford University Press, 2015.
2. Thill, John V. & Courtland L. Bovee, Excellence in Business Communication, 12th edition. Boston: Pearson, 2016.
3. Bonet, Diana. The Business of Listening: Fourth Edition. Axzo Press, 2009.
4. Neuliep, James W. Intercultural Communication: A Contextual Approach. Boston: Houghton Mifflin Co., 2017.
5. Thorpe, Edgar & Showick Thorpe. Winning at Interviews. Fifth Edition. Delhi: Dorling Kindersley, 2013.
6. http://www.albion.com/netiquette/corerules.html
7. https://brians.wsu.edu/common-errors/
8. https://networketiquette.net/en-gb/

25MAT112A Foundations of Applied Mathematics - II   3 0 0-3

Course Description

- Foundations of Applied Mathematics –II is the second part of the two-part course on Foundations of Applied Mathematics-I. The two courses offer basic mathematical foundations necessary to become computer science professionals. They also form the pre-requisite courses for various other mathematical courses and electives offered throughout the program.

- Unlike conventional methods, these courses are designed to teach mathematics through programming. The curriculum, with the combination of pedagogy and online learning tools, will help students to engage with and express mathematical concepts easily through programming. More emphasis is laid on mathematical understandings and interpretations, while less emphasis is laid on manipulations and memorisation. At the same time, mathematical concepts taught throughout the course will be motivated and connected to various real-life applications. Thus, the students will be able to learn mathematics in new, meaningful, and generalizable ways. We do not learn abstract mathematics in this course, nor focus on mathematical rigour through theorems and proofs.

Course Outcomes

COs	Description
CO1	To comprehend calculus's basic ideas
CO2	To obtain a basic comprehension of the ideas of linear algebra, and apply differential equations to solve problems in practice

CO3	Build foundations to learn advanced mathematical concepts necessary to become a computational engineer/scientist, machine learning or data science practitioner.
CO4	Be able to communicate mathematical ideas orally and in writing with precision, clarity and organization

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	1	1	1	-	-	-	1	1
CO2	3	3	2	2	2	1	1	-	-	1	-
CO3	3	3	2	1	3	-	-	2	1	1	2
CO4	1	2	2	-	1	2	2	3	3	-	-

3-strong, 2-moderate, 1-weak

Syllabus

Unit-I

Introduction to Calculus, Limits: History of calculus – Overview of calculus – Single variable and multivariable calculus - Calculus and mathematics modelling – Limits of functions – Continuity of functions.

Unit-II

Differential Calculus: Differentiating a function – Slopes and derivatives - Algebra of derivatives - The chain rule of differentiation - Extreme values of functions – The mean value theorem - First and second derivative tests.

Unit-III

Integral Calculus : Area under the curve – Indefinite integral - Integration by substitution – Definite integral –
Fundamental theorem of calculus – Integration by parts – Numerical Integration - Applications of the definite integral in geometry, science and engineering

Unit-IV

Differential equations: Introduction to differential equations – Mathematical modelling with differential equations – Separation of variables – First Order Differential Equations – Second Order Constant Coefficient Linear Equations – Fourier transforms - Laplace transforms – First Order Systems – Convolution.

Unit-V

Elementary Linear Algebra: Systems of linear equations – Gauss elimination – Matrix operations, including inverses – Least square problem – Determinants and their properties – Eigenvalues and eigenvectors – Matrix decompositions

Textbooks

1. Thomas calculus-13th edition - George B. Thomas
2. Advanced Engineering Mathematics- 10th edition- Erwin Kreyszig

References

1. Stewart, 2015, CALCULUS: Early Transcendentals, 8th Edition, Cengage learning, India.
2. Strang, 2005, Linear Algebra and Its Applications, 4th Edition, Cengage Learning (RS).

25CSA111A Operating System and Computer Architecture   3 1 0 -4

Course Description

- This course is intended to introduce basic concepts of digital systems, processor architecture and operating systems.

Course Outcomes

COs	Description
CO1	To illustrate basic concepts of digital systems and their design using both sequential and combinational circuits
CO2	To illustrate the internal units of a CPU and instruction-level execution
CO3	To analyse different process scheduling algorithms and their empirical comparison using numerical examples.
CO4	To study and explain process synchronisation concepts and deadlock handling methods.
CO5	To study and demonstrate memory allocation strategies and page replacement algorithms

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	1	1	-	-	-	-	-	-	-

CO2	3	2	1	-	-	-	-	-	-	-	-
CO3	2	1	1	2	-	-	-	-	-	-	-
CO4	2	2	3	1	1	-	-	-	-	-	-
CO5	2	3	2	3	3	-	-	-	-	-	-

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Digital System Design: SOP and POS Expressions, Karnaugh Map Simplification - Universal gates, Sequential circuits and combinational circuits, Flip Flops, Registers, Counters, Decoder, Encoder. Arithmetic circuits,

Unit II

Computer Organisation and Design - Instruction Codes- Computer Registers- Computer Instructions - Instruction Cycle - Memory Reference Instructions, Central Processing Unit: Address bus, data bus, control lines. Instruction Formats - Addressing Modes - Data Transfer and Manipulation - Conditional Branch Instructions - Program Interrupts

Unit III

Introduction to Operating Systems, Operating System Structures, System components-Operating System services-System calls-System Programs, Process Management, Process Scheduling, CPU Scheduling Algorithms. Process synchronisation and critical section problem (Introductory concepts).

Unit IV

Deadlocks: System Model-Deadlock Characterisation-Methods for handling Deadlocks-Deadlock Prevention-Deadlock Avoidance-Deadlock Detection-Recovery from deadlock.

Unit V

Memory Management: Background-Swapping-Contiguous Memory allocation-Paging-Segmentation-Segmentation with Paging. Virtual Memory: Background-Demand paging-Process creation-Page Replacement-Allocation of Frames-Thrashing.

Textbooks

1. M Morris Mano - Computer System Architecture - PHI - Third Edition
2. Abraham Silber Schartz- peter B Galvin-Greg Gagne, Operating system Concepts. Ninth Edition, Addison-Wesley(2015)
3. M. Morris Mano & Michael D. Ciletti, Digital Design: With an Introduction to the Verilog HDL, VHDL, and System Verilog, 6th Edition, Pearson, 2022.

4. Stephen Brown & Zvonko Vranesic, Fundamentals of Digital Logic with Verilog Design, 4th Edition, McGraw-Hill, 2023.

References

1. P. Pal Chaudhuri — Computer Organisation and Design, 3rd Edition, PHI Learning Pvt. Ltd. (2008)
2. Carl V. Hamacher — Computer Organisation and Embedded Systems, 6th Edition, McGraw-Hill Education (2012)
3. Achyut S. Godbole — Operating Systems, 3rd Edition, Tata McGraw-Hill Education (2012)
4. Computer Organisation and Design: The Hardware/Software Interface (MIPS Edition) David A. Patterson & John L. Hennessy 6th Edition (2020)

25CSA112A   Object Oriented Programming using Java   3 1 0 – 4

Course Description

- 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	Understand object-oriented concepts and represent the problem using objects and classes
CO2	Apply the Object-Oriented concepts to design and develop effective models using UML
CO3	Master core Java programming concepts and Java Libraries and effectively use them in programs.
CO4	Understand and demonstrate parallelisation of tasks and synchronisation using threads
CO5	Develop graphical user interfaces (GUIs) and database connectivity applications in Java

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	2	1	-	2	-	-	-	-	-	-
CO2	3	3	2	1	2	-	-	-	-	-	-
CO3	1	2	3	-	3	-	-	-	2	2	-

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

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to object-oriented software design, Comparison of programming paradigms, Object Basics, Java Environment, Classes and Objects, Data Members, Access Specifiers, Arrays, Array of Objects, Constructors, Default Constructors, Static Members, Constant Members, Object-Oriented Design with UML, Class, object diagrams and sequence diagrams.

Unit II

Polymorphism, Inheritance, Interfaces and Abstract Classes, Packages, Exception Handling, Libraries: Numbers, Math, Strings, StringBuilder, Regex, File object, Accessing and Modifying Files, Generics and Collections.

Unit III

Introduction to Threads, Creating Threads, Thread States, Thread Synchronisation, Serialisation, Basics of GUI Programming, Java Sockets and JDBC, SOLID principles.

Textbooks

1. Herbert Schildt, " Java The Complete Reference", 13 Edition, Tata McGraw-Hill, 2024.
2. Ali Bahrami, "Object-Oriented Systems Development", McGraw-Hill, 2017.

References

1. Grady Booch and Robert A. Maksimchuk, "Object-oriented Analysis and Design with Applications", Third Edition, Pearson Education, 2009.
2. Jaime Nino, Fredrick A Hosch, "An Introduction to Programming and Object-Oriented Design using Java", Wiley India Private Limited, 2010.

25CSA113A   Database Management System   3 1 0 – 4

Course Description

- This course is designed to cover the fundamental aspects of Database Management Systems, including design and implementation of a relational database for a specific domain or application.

Course Outcomes

COs	Description
CO1	Have a broad understanding of database concepts and database management system software, including a high-level understanding of major DBMS components and their functions. The student should be able to illustrate these concepts effectively
CO2	Able to model an application's data requirements using conceptual modelling tools like ER diagrams and design database schemas based on the conceptual model to successfully design a complete application.
CO3	Understand Data normalisation and its usage in database design to successfully design a complete application.
CO4	Understanding and explaining Query processing in DBMSs, and also illustrating transaction properties, their types in a DBMS, including concurrency control and recovery.
CO5	Able to write SQL statements to create tables and indexes, set constraints, insert/update/delete data, query data and PL/SQL programs in a relational DBMS, thereby building a successful application.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	1	2	1	-	-	-	1	-	1
CO2	2	2	2	2	-	-	-	-	1	-	1
CO3	3	2	1	2	-	-	-	-	1	-	1
CO4	2	1	1	2	-	-	-	-	2	-	1
CO5	3	2	2	2	3	-	-	1	2	-	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction - Data Independence - The Three Levels Of Architecture - The External Level - Conceptual Level - Internal Level - Client/Server Architecture- System Structure, Instance and schema, Data Models, Types of DBMS

Unit II

Keys - CODD's Rules, Design Issues -ER – Model –Attribute types- Weak Entity Sets - Extended ER Features –ER to Relational Mapping, Structure of Relational Databases

Unit III

Normalisation –Anomalies- Functional Dependency: Armstrong's axioms- closure of a relation and closure of attribute– Lossless decomposition-1NF, 2NF, 3NF, Boyce - Codd Normal Form

Unit IV

The Relational Algebra -- Query Processing and Optimisation
Transaction Processing: ACID properties, states of a transaction-Introduction to concurrency control

Unit V

DDL, Constraints, LIKE, BETWEEN, Conjunction and disjunction, Order by, Group by, Built-in SQL functions- Set operations, Sub Queries-Joins-DCL, TCL- Views – Sequences – Index
PL/SQL Basics – Exceptions – Cursors - Stored Functions – Triggers

Textbooks

1. Database System Concepts - Silberschatz.Korth. Sudarshan, 7th Edition, McGraw-Hill International Edition (2021)
2. PostgreSQL Documentation https://www.postgresql.org/docs
3. Head First SQL: Lynn Beighley, O'Reilly Media, Inc., Second Edition (2021)

References
1. Date, C. J. — An Introduction to Database Systems, 9th Edition, Pearson Education Asia, 2018.
2. Elmasri, R., & Navathe, S. B. — Fundamentals of Database Systems, 7th Edition, Pearson Education, 2016.

25CSA181A   Database Management System- Lab   0 0 2-1

Course Description

- In this lab course, students will gain hands-on experience with core SQL commands (DML, DDL, DCL, TCL) and advanced techniques such as joins, subqueries, set operations, and built-in functions, alongside the use of operators like LIKE and BETWEEN for efficient data manipulation and retrieval. They will also learn to create and manage database objects such as views, sequences, and indexes, optimising database performance. Additionally, students will develop PL/SQL skills by working with exceptions, cursors, stored functions, and triggers to automate and enhance database functionality, ensuring they can effectively design and manage robust database systems.

Syllabus

Basic SQL Commands DML, DDL - Constraints, LIKE, BETWEEN, Conjunction and disjunction, Order by, Group by, Built-in SQL functions- Set operations, Sub Queries-Joins-DCL, TCL- Views – Sequences – Index, PL/SQL – Exceptions – Cursors - Stored Functions – Triggers

25CSA182A Object Oriented Programming using Java-Lab 0 0 2 –1

Course Description

- The Java Practical Lab Session provides a foundation for developing programming skills in Java. This course is to apply the object-oriented concepts in various software development applications. The course also provides a platform for students to solve interdisciplinary applications through the Java Programming Language.

Syllabus

Introduction to Java Programming Using Eclipse IDE, first program, Java Basics, Implementing Classes and Objects, Constructors, Getters & Setters, implementing Inheritance, Method Overriding, and Polymorphism, Handling Exceptions (try, catch, finally, throw, throws), Creating & Implementing Interfaces, String Manipulation, Wrapper Classes, and StringBuilder, File I/O, Reading and Writing to Files, BufferedReader, PrintWriter, Creating Threads, Runnable Interface, Implementing Swing Components, Event Handling, Layout Managers

SEMESTER 3

SI No	Course Code	Course Title	L T P	Cr
		SEMESTER 3		
1	25CSA201A	Data Structures and Algorithms	3 1 0	4
2	25CSA202A	Computer Networks	3 0 2	4
3	25ENV200A	Environmental Science and Sustainability	3 0 0	3
4		Stream Core - Mathematics	3 1 0	4
5		Professional Elective I	2 0 2	3
6		Professional Elective II	2 0 2	3
7	25CSA281A	Data Structures and Algorithms Lab	0 0 2	1
		Total		**22**

25CSA201A   Data Structures and Algorithms   3 1 0 -4

Course Description

- Data Structure and Algorithms is the course offered to the 3rd semester Online MCA program. This course aims to provide the students with an in-depth understanding of the structure and implementation of the common data structures used in computer science. It imparts the ability to solve problems by choosing and applying the right data structure. It also introduces the concept of analysing algorithms in terms of asymptotic notation

Course Outcomes

COs	Description
CO1	Analyse the efficiency of algorithms using asymptotic notation (Big-O, Big-Ω, Big-Θ) and compare their time and space complexities.
CO2	Implement fundamental data structures such as linked lists, stacks, queues, trees, and graphs using a programming language
CO3	Define and perform standard operations (insertion, deletion, traversal, searching, etc.) on basic data structures.
CO4	Apply appropriate data structures to solve real-world application problems and justify their selection based on problem requirements.

CO5	Evaluate the correctness of algorithms through dry runs, assertions, and test cases

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	2	3	1	3	-	-	-	-	-	-	-	3
CO2	2	1	3	-	-	-	-	-	-	-	-	2
CO3	3	3	3	2	-	-	-	-	-	-	-	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2
CO5	3	2	1	3	-	-	-	-	-	-	-	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Basic complexity analysis – Analysing Programs – Best, Worst, and Average Cases - Asymptotic Analysis. Overview of Data Structures – Abstract Data Types and Data Structures. Linked List: Implementation - Analysis = Variations – LL ADT – LL Applications. Stack: Implementation - Recursion - Expression Evaluation and other applications. Queues - Implementation - Variations - Applications.

Unit II

Trees: Tree Definition and Properties – Binary tree - Representation - Traversals. Priority queues: ADT – Implementing Priority Queue using List – Heaps - Heap sort. Search trees: Binary search tree - AVL tree - Implementation - Analysis. Maps and Dictionaries: Hash Tables - Collisions - Dynamic Resizing.

Unit III

Sorting and Selection: Divide and Conquer Strategy – Merge Sort - Quick Sort - Quick Select. Graphs: ADT- Data structure for graphs - Graph traversals - Reachability, Cycles and Connectedness - Shortest Paths - Minimum spanning tree – Greedy Methods for MST.

Textbooks

1. Michael T Goodrich and Roberto Tamassia, and Michael H Goldwasser, "Data Structures and Algorithms in Java", John Wiley publication, 6th Edition, 2014.
2. Clifford A. Shaffer, "Data Structures and Algorithm Analysis", Third Edition, Dover Publications, 2012.

References

1. Adam Drozdek, "Data Structures and Algorithms in Java", Cengage Learning Asia, Paperback, 2013.
2. Tremblay J P and Sorenson P G, "An Introduction to Data Structures with Applications", Second Edition, Tata McGraw-Hill, 2002.

25CSA202A	Computer Networks	3 0 2 -4

Course Description

- This course presents an in-depth discussion of the most important networking protocols comprising the TCP/IP protocol suite. Students will be able to understand state of the art in network protocols, architectures, and applications.

Course Outcomes

COs	Description
CO1	Understand and explain the core concepts of Computer networks and become familiar with various components
CO2	Learn how to configure different Cisco switches, end devices and routers and also build a small network at the end of the course
CO3	Analyse protocols and algorithms applicable at various layers, such as Data Link layer, Routing, Transport layers and Application layer services.
CO4	Use various tools to analyse network operations in practice.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	-	-	-	-	-	-	-	-	-
CO2	2	3	2	-	-	-	-	-	-	-	-
CO3	2	2	3	-	-	-	-	-	-	-	-
CO4	2	1	2	3	2	-	-	-	-	-	-

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Role of Networks in our lives - Network Components - Network representations - Evolution of Computer Networking-Types of Network- Networks topologies-Network Representations and Topologies – Common types of Networks- Internet Connections – Reliable Network requirements - Network Security. End Device Configuration - on a network switch and end devices. Protocols and Models: The Rules- Protocol Suites, Standard Organisation, Reference Model, data encapsulation allows data to be transported across the network, and data access to local and remote network resources.

Unit II

Physical Layer **-** Purpose- Characteristic and cabling-Wireless media. Number System **-** Hexadecimal and binary formats for addressing in MAC & IP. Data Link Layer- Functioning of the DLL -media access method, both in WAN and LAN Technologies. Ethernet Switching -Ethernet Frame - Building MAC Address Table- switch forwarding methods and port settings.

Unit III

Network Layer - Network layer characteristics-IPv4 and IPv6 Packets- Introduction to Routing - Static vs Dynamic Routing -IPv4 Routing table-Address Resolution Router Configuration**-**Configure initial settings and the default gateway. IPv4 Addressing **-** IPv4 address structure-Network Segmentation - Subnet an IPv4 Network - IPv4 Address Conservation-VLSM topology address assignment. IPv6 Addressing **-** IPv4 Issues, IPv6 Address Representation, GUA and LLA static and Dynamic addressing – Subnet an IPv6 Network. ICMP

Unit IV

Transport Layer **-** TCP and UDP overview – Port Numbers – TCP Communication Process – Reliability and Flow Control- UDP Communication**.** Application Layer **-** Application, Presentation and Session - Peer-to-peer, web and Email Protocols - File sharing services**.** Network Security
Security Threats and Vulnerabilities – Network Attacks and Mitigation- Device Security. Build a Small Network - Put applications and Protocols – Scale to larger Networks

Textbooks

1. Computer Networking: A Top-Down Approach (Seventh Edition)-James F. Kurose-Keith W. Ross (Pearson) 2017
2. Computer Networks (Sixth Edition) – Andrew S. Tanenbaum (Prentice Hall of India) 2021

References

1. Data communication and Networking (Sixth Edition)- Behrouz A Forouzan (Tata McGraw-Hill)
2. Computer Networks and Internets (6th Edition) – Douglas E. Comer (Pearson, 2015, ISBN: 9780133587937)
3. Internetworking with TCP/IP Volume I: Principles, Protocols, and Architecture (6th Edition) – Douglas E. Comer (Pearson, 2013, ISBN: 9780136085300)

25ENV200A   Environmental Science and Sustainability   3 0 0 - 3

Course Description

- This course explores the relationship between humans and the environment, focusing on sustainable development and conservation. It covers ecological principles, biodiversity, environmental challenges like pollution and climate change, and the legal and social frameworks addressing them. Students learn about resource management, circular economy, and green technologies, alongside the social impacts of environmental issues. Emphasising ethical values and traditional knowledge, the course promotes holistic education and active participation for a sustainable future.

Course Outcomes

COs	Description
CO1	Integrate facts and concepts from ecological, physical and social sciences to characterise some common socio-environmental problems.
CO2	Analyse and evaluate the interrelationship between personal values, goals, and consumption patterns to develop sustainable attitudes and responsible consumption practices.
CO3	Develop simple integrated systems and frameworks for solving common interconnected socio-environmental problems
CO4	Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
CO5	Make students change their attitudes, values ethics in issues related to environmental issues.

CO – PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	-	-	-	-	2	3	1	2	1	2
CO2	-	-	-	1	1	-	3	3	2	1	2
CO3	-	-	-	1	-	-	3	1	1	2	2
CO4	-	-	-	1	-	-	3	1	2	2	3
CO5	-	-	-	1	-	-	3	2	3	1	3

Syllabus

Unit I

State of Environment and Unsustainability, Need for Sustainable Development, Traditional conservation systems in India, People in Environment, need for an attitudinal change and ethics, Need for Environmental Education, Overview of International Treaties and Conventions, Overview of Legal and Regulatory Frameworks. Environment: Abiotic and biotic factors, Segments of the Environment, Biogeochemical Cycles, Ecosystems (associations, community adaptations, ecological succession, Food webs, Food chain, ecological pyramids), Types of Ecosystems – Terrestrial ecosystems, Ecosystem Services, Economic value of ecosystem services, Threats to ecosystems and conservation strategies. Biodiversity: Species, Genetic & Ecosystem Diversity, Origin of life and significance of biodiversity, Value of Biodiversity, Biodiversity at Global, National and Local Levels, India as a Mega-Diversity Nation (Hotspots) & Protected Area Network, Community Biodiversity Registers. Threats to Biodiversity, Red Data Book, Rare, Endangered and Endemic Species of India. Conservation of Biodiversity. People's action. Impacts, causes, effects, control measures, international, legal and regulatory frameworks of: Climate Change, Ozone depletion, Air pollution, Water pollution, Noise pollution, Soil/ land degradation/ pollution

Unit II

Linear vs. cyclical resource management systems, need for systems thinking and design of cyclical systems, circular economy, industrial ecology, green technology. Specifically apply these concepts to: Water Resources, Energy Resources, Food Resources, Land & Forests, Waste Management. Discuss the interrelation of environmental issues with social issues such as: Population, Illiteracy, Poverty, Gender equality, Class discrimination, social impacts of development on the poor and tribal communities, Conservation movements: people's movements and activism, Indigenous knowledge systems and traditions of conservation.

Unit III

Common goods and public goods, natural capital/ tragedy of commons, Cost-benefit analysis of development projects, Environment Impact Assessment (EIA), Environment Management Plan (EMP), Green business, Eco-labelling, Problems and solutions with case studies. Global and national state of housing and shelter, Urbanisation, Effects of unplanned development case studies, Impacts of the building and road construction industry on the environment, Eco-homes/ Green buildings, Sustainable communities, Sustainable Cities. Ethical issues related to resource consumption, Intergenerational ethics, Need for investigation and resolution of the root cause of unsustainability, Traditional value systems of India, Significance of holistic value-based education for true sustainability.

Textbooks / References

1. Environmental Studies: From Crisis to Cure (3rd Edition) – R. Rajagopalan (Oxford University Press, 2016
2. Environmental Science (10th Edition) – Daniel D. Chiras (Jones & Bartlett Learning, 2014)
3. Andy Jones, Michel Pimbert and Janice Jiggins, 2011. Virtuous Circles: Values, Systems, Sustainability. IIED and IUCN CEESP, London.URL:http://pubs.iied.org/pdfs/G03177.pdf

4. Annenberg Learner, The Habitable Planet, Annenberg Foundation 2015.
   URL: http:// www.learner.org/courses/envsci/unit/pdfs/textbook.pdf.

25CSA281A   Data Structures and Algorithms- Lab   0 0 2-1

Course Description

- This lab course complements the theory of data structures and algorithms by providing hands-on experience in implementing and analysing core data structures such as linked lists, stacks, queues, trees, heaps, and graphs. Students will practice key algorithms like sorting, searching, graph traversals, and problem-solving techniques to build practical programming skills and understand algorithmic efficiency.

Syllabus

Linked List implementation, Problems based on linked lists, Stack implementation, Binary Search, Merge and Quick sort, Problems based on Stacks , Circular queue implementation , Binary Heap implementation , Tree implementation , Problems based on Binary Search Tree , AVL Tree implementation , Graph representation and traversals , Connectivity problems on Graphs, Shortest path and MST implementation , Disjoint-Set / Union-Find overview , Graph representation and traversals , Connectivity problems on Graphs, Shortest path and MST implementation , Disjoint-Set / Union-Find overvie , Graph representation and traversals , Connectivity problems on Graphs, Shortest path and MST implementation , Disjoint-Set / Union-Find overview , Graph representation and traversals , Connectivity problems on Graphs, Shortest path and MST implementation , Disjoint-Set / Union-Find overview , Hashing overview .

SEMESTER 4

SI No.	Course Code	Course Title	L T P	Cr
		SEMESTER 4		
1	25SSK211A	Soft Skills	2 0 0	2
2	25CSA211A	Web Application Development	3 1 0	4
3	25CSA212A	Data Mining	3 0 2	4
4	25CSA213A	Software Engineering	3 1 0	4
5		Professional Elective III	2 0 2	3
6		Professional Elective IV	2 0 2	3
7	25CSA282A	Web Application Development -Lab	0 0 2	1
		TOTAL		**21**

25SSK211A	**Soft Skills**	**2 0 0 - 2**

Course Description

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	Analyze the differences between campus and corporate environments to understand workplace expectations and professional behavior and assess personal strengths, weaknesses, values, and attitudes through structured self-analysis techniques.
CO2	Demonstrate effective communication skills by identifying communication types and practising assertive expression in professional scenarios.
CO3	Apply appropriate listening styles in varied practical situations to improve comprehension and professional interaction.

CO4	Formulate and evaluate personal and professional goals based on individual values using the SMART goal-setting framework.
CO5	Design and deliver impactful presentations by applying adult learning principles and using suitable audio-visual aids effectively.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	2	2	2	-	2	2	3	2	1	2
CO2	1	1	1	1	-	1	1	2	3	1	2
CO3	1	1	1	1	-	1	1	2	3	1	2
CO4	1	1	1	3	-	1	1	3	2	2	3
CO5	1	1	1	1	1	1	1	3	3	1	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Campus to Corporate : explain the difference between campus life and corporate life, **Self Analysis**: help analyse and appraise self

Unit II

Assertive Communication: identify the aspects of effective communication and evaluate oneself on the different types of communication. Help develop effective communication skills and assertiveness

Unit III

Listening Skills: create an understanding of how to choose the appropriate listening style in a practical situation

Unit IV

Self-Introduction - Deliver a self-introduction. Presenting oneself professionally.

Goal Setting: Identify personal goals from personal values. To create and analyze SMART goals

Unit V

Presentation Skills - Apply the adult learning principles in presentation and the do's and don'ts of effective presentation.

Content Creation: Create impactful content and identify suitable audio-visual aids for presentation.

Textbooks/References

1. **Communication and Listening Skills**
   o Andrew J Durbin, Applied Psychology: Individual and organization effectiveness. Pearson – Merril Prentice Hall, 2004
   o Effective Presentation Skills, Revised Edition: A Practical Guide for Better Speaking – Steve Mandel, Crisp Publications;

2. **Personal Values and attitudes its impact on behaviour**

   o Organizational Behaviour: Foundations, Theories and Analyses, John B Mines, 2002 Oxford University
   o Drive: The Surprising Truth About What Motivates Us, 2011, Daniel H Pink, Canongate Books
   o Personality Development & Soft Skills – Barun.K.Mitra , Oxford

3. **Self- perception and Self- Confidence**

   o Attribution Theory: Social and Functional Extensions (Paperback) Miles Hewstone, Blackwell Publishers, an attributional theory of motivation and emotion, Bernard Weiner, Springer-Verlag, 1987.

4. **Time Management**

   o The habits of highly effective people, Stephen Covey, Free press Revised edition 2004
   o The 25 Best Time Management Tools and Techniques: How to Get More Done Without Driving Yourself Crazy, Kenneth H Blanchard, 2005,
   o Peak Performance Press, First edition
   o The One Minute Manager Kenneth H. Blanchard and Spencer Johnson, Publisher: William Morrow 1984

5. **Stress Management**

   a. Stress Management for Life, Michael Olpin, Margie Hesson, Cengage Learning, 2009
   b. Organizational Behaviour, Stephen P Robbins, Timothy A Judge, Seema Sanghi, Pearson Prentice Hall, 2009

6. **Leadership Development**

   a. Highflyers: Developing the Next Generation of Leaders Morgan W. McCall Jr. Harvard Business Press; First edition (January 15, 1998)
   b. 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)

25CSA211A   Web Application Development   3 1 0-4

Course Description

- This course focuses on the design and development of web-based applications using different languages like HTML, CSS, JavaScript and PHP. This course also gives an introduction to developing web applications using MVC architecture, usage of web framework AngularJS and XML.

Course Outcomes

COs	Description
CO1	Design and develop responsive web pages using HTML5 and CSS3.
CO2	Explain concepts of Document Object Model and AJAX and develop client- side scripts using Java Script.
CO3	Develop simple applications using Angular JS.
CO4	Develop web-based applications with PHP and MySQL using a web application framework.
CO5	Create XML files and explain its applications.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	-	3	2	3	-	-	-	-	-	-
CO2	1	1	3	1	3	-	-	-	-	-	-
CO3	1	1	3	1	3	-	-	2	1	-	1
CO4	1	1	3	1	3	-	-	-	-	-	-
CO5	2	1	3	1	3	-	1	-	1	-	1

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

HTML5 and CSS3: HTML5- Basic Tags, Tables, Forms.HTML5 Tags, HTML Graphics, HTML media, HTML Graphics, HTML APIs. CSS - Background, Borders, margin, Box model. Styling text, fonts, lists, link tables, CSS overflow, float, Inline blocks, pseudoclasses,pseudoelements.CSS border images, and rounded corners

Unit II

JavaScript -Client-side scripting using JavaScript, Introduction to JavaScript, internal and external JavaScript files, variables, control statements, loops, Arrays, string handling, How to write functions in JavaScript, inputting and outputting from form elements to JavaScript. DOM

concept, creating HTML elements using JavaScript. Drawing 2D shapes, handling events. Introduction to AJAX, JQUERY

Unit III

Building single-page applications with AngularJS, Single-page application – introduction, two-way data binding, MVC in AngularJS, controllers, getting user inputs, loops, Client-side routing – accessing URL data, various ways to provide data in AngularJS.

Unit IV

Server-Side Programming -Server-side scripting, Difference between client-side and server-side scripting languages. Introduction to PHP, variables, control statements, loops, Arrays, string handling, PHP forms, Global variables in PHP, Regular expressions and pattern matching, Database programming: inputting and outputting data from MySQL using PHP, insertion, deletion and updating data.
State management in web applications, cookies, Application and session state.

Unit V

Introduction to XML, usage of XML, XML tags, elements and attributes, attribute type, XML validation: DTD and XSD, XML DOM

Textbooks/References
1. Learning PHP, MySQL & JavaScript,2025, 7th Edition by Robin Nixon, O'Reilly Media, Inc.
2. HTML & CSS: The Complete Reference, Fifth Edition – Thomas A. Powell (McGraw-Hill Education, 2010
3. AngularJS: Up and Running - Enhanced Productivity with Structured Web Apps, Shyam Seshadri and Brad Green, Shroff/O'Reilly; First edition
4. XML Bible by Horold, Ellotte Rusty ; Third edition

25CSA212A	Data Mining	3 0 2 - 4

Course Description

- This course provides a structured approach to understanding the processes and techniques involved in valuable insights from large datasets. It covers essential topics such as data preprocessing, mining frequent patterns, classification and prediction, and clustering. These concepts are fundamental for analysing and interpreting complex data, enabling students to apply data mining techniques effectively in various real-world scenarios. The course emphasises practical applications, preparing students to tackle data-related challenges in diverse fields.

Course Outcomes

COs	Description

CO1	Understand and explain the data mining process, types of data, attributes, and the knowledge discovery process.
CO2	Apply data preprocessing techniques such as cleaning, integration, reduction, and transformation before mining.
CO3	Discover frequent patterns and association rules using algorithms such as Apriori and FP-Growth.
CO4	Apply prediction and classification algorithms such as Decision Trees, Bayesian classifiers, and k-NN, and evaluate their performance using accuracy and related measures.
CO5	Apply clustering algorithms such as K-Means, K-Medoids, and Hierarchical methods, and differentiate between situations for applying different data mining techniques.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	2	2	-	-	-	-	-	2
CO2	3	2	2	3	3	-	-	-	-	--	2
CO3	3	3	2	2	3	-	-	-	-	-	2
CO4	3	3	3	2	3		-	-	-	-	2
CO5	3	3	3	2	3	2	-	2	2	2	3

Syllabus

Unit I

Introduction: Introduction to Data Mining-Types of Data and Patterns Mined-Technologies- Applications-Major Issues in Data Mining. Introduction to Data Warehousing: Basic Concepts and Techniques

Unit II

Knowing about Data-Data Preprocessing: Cleaning– Integration–Reduction–Data Transformation and Discretization

Unit III

Mining Frequent Patterns: Basic Concept – Frequent Item Set Mining Methods -Apriori and FP Growth algorithms -Mining Association Rules

Unit IV

Classification and Predication: Issues – Algorithms- Decision Tree Induction - Bayesian Classification –k Nearest Neighbor- Prediction - Accuracy- Precision and Recall

Unit V

Clustering: Overview of Clustering – Types of Data in Cluster Analysis – K Means and K-Medoids, Hierarchical Clustering Algorithms

Textbooks/References

1. Jiawei Han, Micheline Kamber and Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Elsevier Publisher, 2006.

2. K.P. Soman, Shyam Diwakar and V. Ajay, "Insight into Data Mining Theory and Practice", Prentice Hall of India, 2006.

3. William H Inmon, "Building the Data Warehouse", Wiley, Fourth Edition, 2005.

4. Tan, Steinbach, and Kumar – *Introduction to Data Mining* (Pearson, 2018, 2nd Edition).

25CSA213A	Software Engineering	3 1 0-4

Course Description

- Software Engineering presents a broad perspective on software systems engineering, concentrating on widely used techniques for developing large-scale software systems. This course covers a wide spectrum of software processes from initial requirements elicitation through design and development to system evolution.

Course Outcomes

COs	Description
CO1	Understand and apply the principles of software engineering techniques.
CO2	Understand and illustrate various software process models
CO3	Apply the right software design methodology for a given scenario
CO4	Evaluate a system developed for real-world applications
CO5	Understand and implement various industry standards in software development and maintenance.

CO –PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	3	2		-	-	-	-	-	-
CO2	3	3	3	3	2	-	-	-	-	-	-
CO3	2	3	3	3	3	-	2	-	-	2	-
CO4	2	2	3	3	2	2	2	-	-	2	1
CO5	1	1	1	2	1	1	2	-	-	2	1

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction: Software - Software characteristics -- Software life-cycle models: Basics of Life cycle and Waterfall Model, Prototyping and Spiral life cycle models - Agile Manifesto, Principles of agile manifesto, Various Agile methodologies: Scrum, Extreme programming.

Unit II

Requirements Engineering: Tasks Initiation, Elicitation-Developing Use Cases, Building the analysis Mode, Negotiation, Validation - Requirements Modelling: building Analysis model, Scenario-based methods, UML (Unified Modelling Language) Models, Data Models. Design. Software requirements specification, formal requirements specification and verification.

Unit III

Software Design: Design Concepts - Function-oriented software design: Data Flow Diagram - Architectural design styles - Object-oriented design: Class and Interaction Diagram, Activity and State Chart Diagram, Design Patterns.

Unit IV

User interface design: Concepts of User Design, Types of User Interfaces. - Coding and testing: Black-box testing, White Box Testing, Unit, Integration and Systems testing -Debugging techniques.

Unit V

Software Quality: SEI CMM and ISO-900 - Software maintenance – Computer-Aided Software Engineering (CASE) - Reverse Engineering and Reengineering

Textbooks

1. Roger S. Pressman, "Software Engineering", Tata McGraw-Hill Publishing Company Pvt. Ltd, Sixth Edition.

References

1. Ian Sommerville, Software Engineering, 10th Edition, Pearson (2016)
2. Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India. Fourth Edition   2014
3. Pankaj Jalote, An integrated approach to Software Engineering, Springer/Narosa. Third Edition

25CSA282A	Web Application Development Lab	0 0 2-1

Course Description
- This lab course focuses on various technologies, frameworks and languages for developing web-based applications.

Syllabus

Web application development using HTML5, CSS, JavaScript, PHP and XML.
Single-page applications with AngularJS.
Case study: -Application Development using the Laravel framework

SEMESTER 5

SI No	Course Code	Title	L T P	Cr
		SEMESTER 5		
1	25CSA301A	C# and .NET Framework	3 0 2	4
2	25CSA302A	Foundations of Machine Learning	3 0 2	4
3	25CSA303A	Essentials of Cyber Security	3 0 0	3
4		Professional Elective V	2 0 2	3
5		Professional Elective VI	2 0 2	3
6	25CSA398A	Case Study		3
7		**TOTAL**		**20**

25CSA301A	C# and .NET Framework	3 0 2-4

Course Description

- This course is designed to introduce the student to a new object-oriented programming language, C#, within the Microsoft .NET Framework. This course covers the essentials of using managed programming to create Windows and Web applications using C#. NET.

Course Outcomes

COs	Description
CO1	Understand and explain the .NET Framework and its architecture.
CO2	Create console applications in C# language.
CO3	Able to build Windows applications with event handling and MDI.
CO4	Design and implement a database application using ADO.NET.
CO5	Build Web applications using ASP.NET

CO-PO Affinity Map:

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	1	-	2	-	-	-	-	-	-

CO2	2	1	1	3	2	-	-	-	-	-	-
CO3	2	2	3	1	2	1	-	1	-	-	1
CO4	1	2	3	1	2	1	-	1	-	-	1
CO5	2	2	3	1	2	1	-	1	-	-	1

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Net Framework Overview- Architecture-.Net Framework class Libraries-CLR-Metadata-Interoperability-Assemblies-the .net Packaging system-CLR-MSIL,

Introduction to Visual Studio.Net-C# Programming Concepts-Predefined Types- Value types and reference type, Classes and Objects, Constructors and methods, Conditional statements, loops, arrays, Collection classes: Array List, Hash Table, Stack, Queue, indexers and properties.

Unit II

String class: methods and properties of string class, enumerations, boxing and unboxing,

OOPS concepts: Encapsulation, data hiding, inheritance, interfaces, polymorphism, operator overloading, overriding Methods, Static Class members, Delegates and events. Exception Handling, garbage collector, generics and collection, Using I/O, Streams and Files

Unit III

Basics of Windows Programming- Event Driven Programming, Windows Forms, using common controls-Labels, textboxes, buttons, check boxes, radio button, progress bar, combo box, list box. Components-timer, image list, Menus, Modal and Modeless Dialog Boxes, MDI, Mouse and keyboard event handling.

Unit IV

Introduction to ADO.Net-Object Model- System, LINQ, Data Namespace- Data Bound controls- Connected Mechanism-Disconnected mechanism-.Net Data Providers.

Unit V

Introduction to ASP.NET, programming model, Web Forms and Web controls, server controls, data binding, Master Pages, ASP.NET state management.

Textbooks

1. C# Programming Yellow Book, Rob Miles, "Cheese" Edition 8.1 December 2019

2. Mastering C# and .NET Framework, Marino Posadas, O'Reilly, 2016

References

1. C# 4.0 the Complete Reference by Herbert Schildt, McGraw-Hill, 2012
2. C#.NET Code Wizard: A Tour to C#|.NET Framework: A Complete Book Kindle Edition by Dr. Richa Handa
3. Beginning ASP.Net 4.5 in C#, Matthew MacDonald, Apress

25CSA302A   Foundations of Machine Learning   3 0 2 - 4

Course Description

- To understand the fundamentals of machine learning and its applications.
- To familiarize with the popular ML algorithms used to solve real world problems.

Course Outcomes

COs	Description
CO1	Able to categorize the problems as supervised or unsupervised and be able to apply regression algorithm for prediction problems.
CO2	Build ML models like Logistic regression, SVM classifiers, Simple Neural Networks, Bayesian Learning, Ensembles and analyze the models using different evaluation parameters.
CO3	Select supervised algorithms to perform feature engineering, PCA and LDA.
CO4	Apply different clustering algorithms to the unlabeled data and interpret the results.
CO5	Understand and explain the fundamental concepts of deep learning.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	2	-	-	-	-	-	2

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

Syllabus

Unit I

Introduction to ML, Goals and applications of machine learning. Aspects of developing a learning system: training and testing data. Types of learning: Supervised, Unsupervised, and Reinforcement. Linear regression, variance, bias, gradient descent, R^2, Ridge and Lasso regression.

Unit II

Logistic regression, decision boundary, Bayesian learning - Perceptron and backpropagation neural network - Support vector machine: multicategory generalizations, Kernels for learning non-linear functions, classification parameters: Accuracy, precision, recall, F-measure, RoC curve.

Unit III

Model Selection: KFold, Grid Search, Bootstrap, Bagging, Regression tree – random forest, AdaBoost classifier. Feature engineering and feature selection. PCA and LDA

Unit IV

Unsupervised learning. Clustering: Learning from unclassified data. Clustering. Hierarchical Agglomerative Clustering. k-means partitional clustering. Expectation maximization (EM) for soft clustering. Semi-supervised learning with EM using labeled and unlabled data.

Unit V

Deep learning: Deep Neural network, Activation functions, Cost function, CNN, Sequential Models.

Textbooks/References

1. Kevin P. Murphey, "Machine Learning, a probabilistic perspective", The MIT Press, 2012.
2. EthemAlpaydin,"Introduction to Machine learning", PHI learning, MIT Press, 2010, 2nd edition
3. John D. Killeher, Brian Mac, Namee, AoiFE D'Arcy, Fundamental of Machine Learning for Predictive Data Analytics, 2015 MITpress.
4. Alex Smola and SVN. Viswanathan, "Introduction to Machine Learning", Cambridge University Press, 2008.
5. ShaiShalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press,2014.
6. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016.

25CSA303A   Essentials of Cyber Security   3 0 0 - 3

Course Description

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	Understand and explain the usage and fundamental principles behind the GNU/Linux operating system
CO2	Illustrate the essential principles behind currently used cryptographic algorithms
CO3	Demonstrate reverse engineering skills associated with the x86/x86-64 platform
CO4	Perform analysis of malicious binaries
CO5	Understand and explain how stack and heap exploits work on system calls

CO PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	1	3	-	-	3					
CO2	2	2	3	-	-	3					
CO3	1	3	3	-	-	3					
CO4	2	3	3	-	-	3					
CO5	2	3	3	-	-	3					

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

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

References
1. William Stallings, Cryptography and Network Security: Principles and Practice, 8th Ed., Pearson, 2023.
2. Michael Sikorski and Andrew Honig, Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software, No Starch Press, 2012.
3. Brian Ward, How Linux Works: What Every Superuser Should Know, 3rd Ed., No Starch Press, 2021.

25CSA398A	Case Study	3

Course Description

This course introduces students to major areas of computer science through practising 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 of the projects
CO3	Work as an individual or in a team in the 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 CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	3	2	-	-	1	2	2	3	1	2
CO2	2	3	3	-	3	3	3	2	3	1	2
CO3	2	2	3	-	-	1	3	3	3	2	3
CO4	1	2	2	2	3	3	2	3	3	2	2

3-strong, 2-moderate, 1-weak

SEMESTER 6

SI NO	Course Code	Title	L T P	Cr
		SEMESTER 6		
1	25CSA399A	Capstone Project		10
2	25CSA311A	Mobile Application Development	3 0 2	4
3		Professional Elective VII	2 0 2	3
4		Professional Elective VIII	2 0 2	3
		TOTAL		**20**

25CSA399A	Capstone Project	10

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	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 Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	Po7	PO8	PO9	PO10	PO11
CO1	3	3	3	3	2	2	1	1	2	3	2
CO2	3	3	3	3	2	3	1	3	2	2	2
CO3	3	2	3	3	3	2	2	2	2	2	3
CO4	2	2	1	1	1	3	3	1	3	2	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.
- Project must demonstrate originality, scalability, and feasibility.

25CSA311A	Mobile Application Development	3 0 2-4

Course Description

- This course introduces mobile app development using Flutter and Dart. Students learn to design user interfaces, manage data, and deploy cross-platform apps through hands-on projects integrating APIs, databases, and Firebase.

Course Outcome

COs	Description
CO1	Understand the fundamentals of the Dart programming language and the Flutter framework for mobile app development.
CO2	Design and build user interfaces using common Flutter widgets and layout structures.
CO3	Implement data handling and networking features using REST APIs, JSON, and asynchronous programming.
CO4	Integrate local and cloud databases (SQLite and Firebase) for data storage and user authentication.
CO5	Develop, test, and deploy complete cross-platform mobile applications using Flutter.

CO PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	–	1	–	–	–	–	–	–	–
CO2	2	3	2	–	1	–	–	–	–	–	–
CO3	3	2	3	2	–	1	–	–	–	–	–
CO4	2	1	3	3	2	–	1	–	–	–	–
CO5	1	–	2	2	3	–	–	1	–	–	–

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Getting Started with Dart & Flutter: Introduction to Mobile App Development, Overview of Flutter and its advantages, Introduction to Dart programming (variables, data types, functions, control structures), Setting up Flutter and Android Studio, Understanding Widgets and their purpose, Using basic Widgets: Text, Image, Icon, Row, Column, and Container, Hot Reload and Hot Restart

Unit II

Building User Interfaces: Common Widgets: ListView, GridView, Card, and Button Widgets, User Input: TextField and Forms, Gesture Detection and InkWell, Using Navigator for screen navigation, Simple Dialogs and Alerts, Introduction to Animations

Unit III

Networking and Data Handling: Working with Async, Await, and Future, Fetching Data using HTTP and REST API, JSON Basics and Parsing Data, Displaying Remote Data in the App, Simple State Management using Provider or setState

Unit IV

Databases and App Deployment: Local Database: Introduction to SQFLite, Basics of Firebase Integration (Authentication and Firestore), Accessing Device Features (Camera, Maps, and Sensors), Testing Flutter Apps, Building and Deploying Flutter Applications

Textbooks/References

1. Thompson Carter: Learning Dart for Flutter Development: Create Mobile Apps Fast, Kindle Edition:

2. Ryan Edge & Alberto Miola, Cross-Platform UIs with Flutter, Packt Publishing:

3. Richard Rose, Flutter and Dart Cookbook: Developing Full-Stack Applications for the Cloud, O'Reilly Media, Inc.,1st Edition (2023),

STREAM CORE - MATHEMATICS

25MAT231A	Discrete Mathematics	3 1 0 -4

Course Description

- Discrete Mathematics is regarded as the language of computer science. Anyone who aspires to excel in fields like data science, machine learning & software engineering should be fluent in this. Through a blended learning approach, students are taught in detail about Combinations, graph theory, logical statements, algebraic structures and number theory which form the basis for many daily computations.

Course Outcomes

COs	Description
CO1	Use logical notation to define and reason sets and relations
CO2	Explain applications of elementary properties of modular arithmetic in Computer science.
CO3	Calculate number of outcomes possible in permutations and combinations
CO4	Analyze sets and relations
CO5	Apply graph theory concepts in solving practical problems.
CO6	Understand and illustrate binary operations in group.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	2	2	1	1	1	1
CO2	3	3	2	3	3	3	2	1	1	1	2	1
CO3	3	3	2	3	3	2	3	3	1	1	2	2
CO4	1	1	1	2	2	1	1	3	3	1	3	2
CO5	3	3	3	2	1	1	2	1	1	1	2	1
CO6	3	3	3	2	1	2	2	1	2	1	1	1

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Logic and Counting -Logic: Propositional – Predicate – Truth tables - Sequences and summations - Proof methods Counting: Sum and product rule – Inclusion exclusion principle - Pigeonhole principle – Permutations – Combinations

Unit II

      Sets and Relations -Sets: Basic operations – Union – Intersection – Cartesian product – Difference Relations: Properties of relations – Equivalence of relations – Hasse diagram

Unit III

      Graph Theory-Definition of graph – Undirected graph– Directed graph – Complete graph – Bipartite graph - Connectivity - Partitioning – Clustering – Coloring - Heuristics – Cuts – Modularity – Trees.

Unit IV

      Group-Definition of groups – Generators – Cosets – Definition of rings – Definition of Fields.

Unit V

      Number Theory-Modular arithmetic – Euclids algorithm – Prime number factorization – Inverse calculation – Chinese remainder theorem.

Textbook

1. Rosen, Discrete Mathematics and its Applications, 7th edition, Mc Graw hill international editions.

References

1. R. P. Grimaldi, "Discrete and Combinatorial Mathematics", Pearson Education, Fifth Edition, 2007.
2. Thomas Koshy, "Discrete Mathematics with Applications", Academic Press, 2005.
3. Burton, Elementary Number Theory, 7th edition, Mc Graw hill India

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25MAT232A   Linear Algebra for Data Science   3 1 0 - 4

Course Objective

- **Understand Core Concepts**: Develop a solid understanding of fundamental linear algebra concepts, including vectors, matrices, linear transformations, and systems of linear equations.
- **Perform Matrix Operations**: Gain proficiency in performing matrix operations such as addition, multiplication, inversion, and finding determinants, and understand their theoretical and practical significance.
- **Analyse Vector Spaces**: Explore the structure and properties of vector spaces and subspaces, including concepts like basis, dimension, and linear independence.

- **Apply Eigenvalues and Eigenvectors**: Learn to compute and interpret eigenvalues and eigenvectors and understand their applications in areas such as diagonalization and systems of differential equations.
- **Solve Real-World Problems**: Apply linear algebra techniques to solve real-world problems in fields such as engineering and computer science.

Course Outcomes

COs	Description
CO1	Develop proficiency in matrix operations, including elementary row operations to help solve linear systems
CO2	Understand and explain the basic concepts of linear equations, vector space, subspace, basis, linear independence, and dimension.
CO3	Understand and explain the basic concepts of inner product space, norm, angle, Orthogonality, projection and the Gram-Schmidt orthogonalization process.
CO4	Learn to compute and interpret eigenvalues and eigen vectors and understand their applications in areas such as diagonalization and systems of differential equations.
CO5	Apply Linear Algebra techniques to solve some real-world problems in Computer Science

CO-PO Mapping
3-strong, 2-moderate, 1-weak

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3	3	2	2	2	-	-	-	1	-	1	2
CO2	3	3	2	2	2	-	-	-	1	-	1	2
CO3	3	2	2	2	2	-	-	-	1	-	1	2
CO4	3	2	2	3	2	-	-	-	1	-	1	1
CO5	2	3	3	2	2	1	1	1	2	2	2	2

Syllabus

Unit I

Properties of matrices and matrix operations in solving linear systems. Gaussian elimination and reduction of matrices to row-echelon form to solve linear systems, Determinants, inverse and transpose of matrices, LU Decomposition of matrices

Unit II

Vector spaces - Subspaces - Linear independence - Basis – Dimension. **Inner p**roducts, Orthogonal basis - Gram-Schmidt Process - Change of basis - Orthogonal complements - Projection on subspace - Least Square Principle. QR- Decomposition.

Unit III

Eigen Values and Eigen Vectors,—transformations - Diagonalisation and its applications. Singular Value Decomposition

Unit IV

Case Studies: Applications on least square and image transformations.

Lab Practice Problems: Matrices, Matrix operations. Solving system of linear equations, rank and nullity. Orthogonality. Matrix of linear transformations. Affine transformations, scaling, shifting and rotation of images. Eigen values and eigen vectors and matrix decompositions.

Textbooks

1. Howard Anton and Chris Rorrs, "Elementary Linear Algebra", Ninth Edition, John Wiley & Sons, 2000.

References

1. D. Poole, Linear Algebra: A Modern Introduction, 4th Edition, Brooks/Cole, 2015.
2. Gilbert Strang, "Linear Algebra and its Applications", Fourth Edition, Harcourt College Publishers, 2007.

PROFESSIONAL ELECTIVES - REGULAR STREAM

SI No.	Course Code	Subject	L_T_P	Cr
1	25CSA331A	Advanced Programming in Python	2 0 2	3
2	25CSA332A	Digital Image processing	2 0 2	3
3	25CSA333A	Cloud Computing Foundation	2 0 2	3
4	25CSA334A	Switching, Routing and Wireless Essentials	2 0 2	3
5	25CSA335A	Computational Biology	2 0 2	3
6	25CSA336A	Business Analytics	2 0 2	3
7	25CSA337A	Advanced Java and J2EE	2 0 2	3
8	25CSA338A	Enterprise Networking, Security and Automation	2 0 2	3
9	25CSA339A	Block chain Technologies	2 0 2	3
10	25CSA340A	Introduction to VR Programming	2 0 2	3
11	25CSA341A	Distributed Systems	2 0 2	3
12	25CSA342A	Introduction to IOT	2 0 2	3

25CSA331A   Advanced Programming in Python   2 0 2 - 3

Course Description

- This course builds upon foundational Python knowledge to explore advanced features and applications. Students will develop skills in object-oriented programming, functional programming file handling, Exception handling and working with popular libraries such as NumPy and Pandas.

Course Outcomes

COs	Description
CO1	Design, write, debug, and run programs encoded in the Python language.
CO2	Write modular, reusable, and maintainable Python code using OOP and functional constructs.
CO3	Work with file systems, and APIs using Python
CO4	Utilize libraries in Python for data analysis.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3	3	2	-	-	-	-	-	-	-	1	
CO2	3	3	3	-	2	-	-	-	-	-	1	
CO3	3	2	2	-	2	-	-	-	-	-	1	
CO4	3	3	2	-	1	-	-	-	-	-	-	

Syllabus

Unit I

Python Fundamentals: Introduction to Python. Variables, literals, data types, type conversion. Operators, Arithmetic and logical expressions, Control flow: if, elif, else, loops -. for, foreach, while, etc. Functions, recursion, lambda functions.

Unit II

Built-in data structures and Applications-Lists, tuples, sets, Strings, String vs lists, Dictionaries and their applications, Regular expressions.

Unit III

Introduction to object-oriented programming in Python : Classes and objects, Inheritance, encapsulation, polymorphism, Operator overloading, Abstract classes and interfaces, Property decorators, File I/O and exception handling, Exception handling and debugging (try-except, logging, pdb). Exception as an object.

Unit IV

Advanced Python and Data Analysis: File handling: reading/writing structured data. List, dictionary, and set comprehensions. Iterators and generators (yield). Anonymous functions, Functional tools: map, filter, reduce. Closures and decorators,

Modularization: using modules and creating packages. Introduction to virtual environments and pip, Python Standard Library modules, Introduction to Pandas and NumPy for data analysis.

Textbooks

1. Programming in Python: A Complete Guide – T R Pandey & Jyoti Prakash, Pearson India, 2022.
2. Python Programming: An Introduction to Computer Science (4th Edition) – John Zelle, Franklin, Beedle & Associates, 2023.
3. Python for Data Analysis (3rd Edition) – Wes McKinney, O'Reilly Media, 2022.

References

1. Python: Essential Reference by David M. Beazley Released July 2009, Publisher(s): Addison-Wesley Professional
2. Effective Python: 90 Specific Ways to Write Better Python (2nd Edition) – Brett Slatkin, Addison-Wesley, 2020.

25CSA332A	Digital Image processing	2 0 2 -3

Course Objective(s)

- This course equips the students with the knowledge and skills necessary to understand, analyze, and manipulate digital images. Students will learn various techniques to enhance digital images for better visualization and analysis.

Course Outcomes

COs	Description
CO1	To enable students to learn the fundamental concepts of digital image processing and its working protocols.
CO2	Learn image enhancement techniques in spatial and frequency domain so as to devise algorithms or mathematical models for real time image enhancement problems.
CO3	To enable students to implement algorithms for handling intensive image restoration problems.
CO4	Development of segmentation algorithms used to detect and extract the region of interest from images.
CO5	Interpretation and use of feature extraction and image representation techniques to carry out image labeling and automatic image understanding.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	-	-	-	-	-	-	-	-	1

CO3	2	3	2	-	-	-	-	-	-	-	-	1
CO4	2	3	3	-	-	-	-	-	-	-	-	1
CO5	3	3	3	-	-	-	-	-	-	-	-	1

Syllabus

Unit I

Introduction and Fundamentals of Image Processing: Origins of Digital Image Processing – Examples - Fundamental Steps in Digital Image Processing - Elements of Visual Perception - A Simple Image Formation Model - Basic Concepts in Sampling and Quantization.

Unit II

Representing Digital Images- Zooming and Shrinking Digital Images - Some Basic Relationships between Pixels - Linear and Nonlinear Operations - Connectivity and Relations between Pixels- Simple Operations- Arithmetic, Logical, Geometric Operations.

Unit III

Image Enhancement in the Spatial Domain and Frequency Domain: Some Basic Gray Level Transformations - Histogram Processing – Basics of Spatial Filtering - Smoothing Filters- Mean, Median, Mode Filters - Edge Enhancement Filters – Sobel, Laplacian, Robert, Prewitt filter, Contrast Based Edge Enhancement Techniques.

Unit IV

Design of Low Pass Filters - High Pass Filters- Edge Enhancement - Smoothening Filters in Frequency Domain. Butter Worth Filter, Homomorphic Filters in Frequency Domain- Comparative Study of Filters in Frequency Domain and Spatial Domain.

Unit V

Edge Detection - Line Detection - Edge Linking and Boundary Extraction - Thresholding Algorithms- Region Based Segmentation - Region Growing – Connected Components Labeling - Region Growing and Region Adjacency Graph (RAG), Split and Merge Algorithms - Morphology - Dilation, Erosion, Opening and Closing.

Textbooks

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Third Edition, Addison
   Wesley, 2007.

References

1. Arthur R. Weeks, Jr., "Fundamentals of Electronic Image Processing", First Edition, PHI,1996.
2. Milan Sonka, Vaclav Hlavac and Roger Boyle, "Image processing, Analysis, and Machine Vision", Fourth Edition, Vikas Publishing House, 2014.

25CSA333A	Cloud Computing Foundation	2 0 2 -3

Course Description

- The curriculum enables learners to develop technical proficiency in cloud computing and launch or pivot to careers in a cloud-first world.
- This course is an ideal foundation for diverse career paths including those in IT infrastructure, data analytics, and cloud-native application development.

Course Outcomes

COs	Description
CO1	Describe the different ways a user can interact with Google Cloud and discover the different compute options in Google Cloud
CO2	Implement a variety of structured and unstructured storage models.
CO3	Discuss the different application managed service options in the cloud
CO4	Outline how security in the cloud is administered in Google Cloud and Demonstrate how to build secure networks in the cloud
CO5	Identify cloud automation and management tools and Discover a variety of managed big data services in the cloud

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	P09	PO10	PO11	PSO
CO1	3	2	2	1	3	1	-	-	1	1	1	2
CO2	3	3	2	2	2	1	-	-	-	-	-	2
CO3	2	2	2	2	2	2	-	-	-	-	1	1
CO4	-	-	3	3	3	-	2	-	-	-	1	2
CO5	3	2	2	-	-	2	-	-	-	-	1	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

So, What's the Cloud Anyway? What the cloud is and why it's a technological and business game changer; Cloud computing, Cloud versus traditional architecture, IaaS, PaaS, and SaS.- IaaS versus PaaS versus SaaS, Google Cloud architecture

Unit II

Start with a Solid Platform The different ways a user can interact with the Google Cloud Platform (GCP) The GCP Console, Understanding projects, Billing in GCP, Install and configure Cloud SDK, Use Cloud Shell, GCP APIs. , Cloud Console Mobile App

Unit III

Use GCP to Build Your Apps Discover the different compute options in GCP. Compute options in the cloud, Configuring elastic apps with autoscaling, Exploring PaaS with App Engine, Containerizing and orchestrating apps with Google Kubernetes Engine

Unit IV

Where Do I Store This Stuff? Implement a variety of structured and unstructured storage models, Storage options in the cloud, Structured and unstructured storage in the cloud, Unstructured storage using Cloud Storage- ,SQL managed services, Exploring Cloud SQL, Cloud Spanner as a managed service, NoSQL managed service options, Cloud Datastore, a NoSQL document store, Cloud Bigtable as a NoSQL option

Unit V

There's an API for That! Discuss the different application managed service options in the cloud. The purpose of APIs, Cloud Endpoints, Using Apigee Edge, Managed message services, Exploring Cloud SQL, Cloud Pub/Sub

Unit VI

You Can't Secure the Cloud, right? Outline how security in the cloud is administered in GCP. Introduction to security in the cloud, The shared security model, Encryption options-, Authentication and authorization with Cloud IAM, Identify Best Practices for Authorization using Cloud IAM

Unit VII

It Helps to Network How to build secure networks in the cloud. Introduction to networking in the cloud, Defining a Virtual Private Cloud, Public and private IP address basics, Google's network architecture, Routes and firewall rules in the cloud, Multiple VPC networks, Building hybrid clouds using VPNs, interconnecting, and direct peering ,Different options for load balancing

Unit VIII

Let Google Keep an Eye on Things Cloud automation and management tools. Introduction to Infrastructure as Code, Cloud Deployment Manager, Public and private IP address basics., Monitoring and managing your services, applications, and infrastructure Stack driver

Unit IX

You Have the Data, but What Are You Doing with It? Discover a variety of managed big data services in the cloud. Introduction to big data managed services in the cloud Leverage big data operations with Cloud Dataproc ,Build Extract, Transform, and Load pipelines using Cloud Dataflow, BigQuery, Google's Enterprise Data Warehouse

Unit X

Let Machines Do the Work Explain what machine learning is, the terminology used, and its value proposition. Introduction to machine learning in the cloud, Building bespoke machine learning models with AI Platform. ,Cloud AutoML, Google's pre-trained machine learning APIs.

Textbooks/References

1. https://learndigital.withgoogle.com/digitalgarage/course/gcloud-computing-foundations
2. Bahga, Arshdeep., Madisetti, Vijay. Cloud Computing: A Hands-on Approach. United Kingdom: Arsheep Bahga & Vijay Madisetti, 2014.
3. Mastering Cloud Computing: Foundations and Applications Programming,Rajkumar Buyya, Christian Vecchiola, S.Thamarai Selvi

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25CSA334A   Switching, Routing and Wireless Essentials   2 0 2 -3

Course Description

- 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 Outcome

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3	3	1	1	1	-	-	-	-	-	-	3
CO2	3	3	1	1	3	-	-	-	-	-	-	2
CO3	3	3	2	2	3	-	-	-	-	-	-	2
CO4	3	3	1	1	3	-	-	-	-	-	-	2

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) Part 2 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.

25CSA335A   Computational Biology   2 0 2 -3

Course Description

- Computational Biology is an interdisciplinary field that applies techniques from computer science, applied mathematics, and statistics to address biological questions. This course introduces fundamental algorithms, data structures, and computational techniques used to analyze and interpret biological data, with applications in genomics, structural biology, systems biology, and phylogenetics.

Course Outcomes

COs	Description
CO1	Explain the structure and functions of biomolecules, molecular biology processes (replication, transcription, translation), and the central dogma with post-transcriptional and post-translational modifications.
CO2	Analyse genomic data, DNA/protein sequencing methods, genetic variations, and their evolutionary significance.
CO3	Apply sequence alignment techniques (pairwise, MSA) and database search tools (BLAST, FASTA, HMMER) for biological data analysis.
CO4	Evaluate protein structure at different levels (primary, secondary, tertiary, quaternary) and relate structure to biological function.
CO5	**Utilise** biological databases (NCBI, UniProt, PDB, KEGG, Drug Bank) and scripting/Python to extract, process, and analyse biological data.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3	2	1	1	1	1	-	1	-	-	2	3
CO2	3	3	2	2	2	1	-	1	-	-	2	1
CO3	2	3	2	2	3	-	-	1	-	-	3	2
CO4	3	2	2	2	2	1	-	1	-	-	2	1
CO5	3	2	2	3	3	-	1	2	1		3	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Biomolecules and molecular biology-Classification of Bio-molecules , DNA, RNA, Protein and amino acids, Structure of cell, cell division, Chargaff's Rules, Central Dogma of Molecular Biology- Replication, Transcription, Translation, Protein Synthesis.
Post-transcriptional & post translational modifications, RNA processing, RNA splicing and RNA editing. Sense/coding and anti-sense/template strands, Genetic code, wobble hypothesis. Programming using Python for Biology (Basic Applications)

Unit II

Genomics and Sequencing-Genomics, Introduction to DNA and Protein Sequencing, Human Genome Project, Genetic Variants of Evolutionary Patterns: Mutations and Polymorphisms.

Unit III

Sequence analysis-Sequence Alignment - Pairwise alignment: Needleman-Wunsch, Smith-Waterman, Multiple sequence alignment (MSA): Clustal Omega, MUSCLE. Database Search Tools: BLAST, FASTA, HMMER

Unit IV

Protein structure and function, Protein Primary structure, Amino acid residues, Secondary, Tertiary, Quaternary Structure of Protein, Protein Scructure Prediction

Unit V

Databases, Tools and File Formats- Biological Databases: Nucleotide Databases: NCBI, EMBL, GenBank, Protein Databases: UniProt, Pfam, Structure Databases: PDB, RCSB, Pathway & Drug Databases: KEGG, GO, DrugBank, Introduction to Bioinformatics Tools and File Formats: FASTA, FASTQ, PDB, Extracting Data from Databases using Scripting (awk, bash) / Python

Textbooks/References

- Fundamental Concepts of Bioinformatics – Dan E. Krane and Michael L. Raymer, Pearson Education, 2022.
- Bioinformatics: Sequence and Genome Analysis – David W. Mount, 2nd Edition, Cold Spring Harbor Laboratory Press, 2021 (reprint).
- Bioinformatics and Functional Genomics – Jonathan Pevsner, 3rd Edition, Wiley-Blackwell, 2019.
- Managing Your Biological Data with Python, Allegra Via, Kristian Rother, Anna Tramontano, Chapman & Hall/CRC, Computational Biology Series

25CSA336A	Business Analytics	2 0 2 -3

Course Description

- This course equips students with the ability to critically analyze and solve real-world business decision problems using data. It introduces statistical and probabilistic methods, data visualization, data mining, and forecasting techniques. Emphasis is placed on modeling, tool usage (e.g., R/Python/Excel/Tableau), and case studies from different business domains.

Course Outcomes

COs	Description
CO1	Apply best practices of data visualization and storytelling to support business decision-making
CO2	Analyze, clean, and explore datasets to extract meaningful business insights.
CO3	Select and implement appropriate statistical and data mining techniques for solving business problems.
CO4	Demonstrate proficiency in business analytics tools (e.g., Python, R, Excel, Tableau/Power BI).
CO5	Apply time series forecasting techniques to real-world business scenarios.

CO-PO Mapping

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3`	2	1	2	2	1	1	1	1	1	1	3
CO2	2	3	2	3	2	2	1	1	1	2	2	1
CO3	1	2	3	2	2	3	2	2	2	3	2	2
CO4	2	2	2	3	3	2	1	1	1	2	3	2
CO5	1	1	1	2	1	2	3	3	3	2	3	1

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Business Analytics; Descriptive Statistics – Types of Data, Measures of Central Tendency/Dispersion, Data Cleansing; Exploratory Data Analysis (EDA). Data Visualization – Design Techniques, Tables, Charts, Advanced Visualizations, Dashboards, Case Studies.

Unit II

Inferential Analysis – Statistical Inference, Hypothesis Testing; Descriptive Data Mining – Clustering, Association Rules; Performance Evaluation; Overview of Key Classification and Prediction Techniques (Regression, Decision Trees);

Unit III

Introduction to Forecasting, Time Series – Level, Trend, Seasonality, Smoothing Techniques – Moving Average, Exponential Smoothing; ARIMA and model selection.

Unit IV

Case Studies in EDA, Visualization and story telling, Case Studies in Marketing & Customer Analytics, Case Studies in Sales and Operations Forecasting.

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.

25CSA337A	Advanced Java and J2EE	2 0 2-3

Course Description

- This course is designed to teach the student how to write, test, and debug advanced-level Object-Oriented programs using Java with a heavy emphasis toward network and web programming. The course covers Graphical User Interface (GUI) networking, database manipulation, Networking and N-Tier programming.

Course Outcomes

COs	Description
CO1	Apply Java networking and JDBC concepts to develop client-server applications that perform database operations using sockets and Swing controls.
CO2	Develop and deploy Servlets that handle client requests, read parameters, and generate dynamic responses using the Servlet API.
CO3	Design and implement dynamic web pages using JSP syntax, implicit objects, and session management within the J2EE framework.

CO4	Apply HTTP request/response handling, cookies, and session tracking techniques to maintain user interactions and manage web application errors.
CO5	Build enterprise-level applications using EJB concepts and integrate Hibernate with the Spring framework following the MVC architecture.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3	2	3	2	3	-	-	1	2	2	2	3
CO2	3	2	3	2	3	-	-	1	2	2	2	2
CO3	3	2	3	2	3	-	-	1	2	2	2	2
CO4	3	2	3	3	3	1	-	1	2	2	2	2
CO5	3	3	3	3	3	1	-	1	2	3	3	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Networking: Classes to be covered Socket, Server Socket, IP Address, URL connections – Swing controls – JDBC - Writing JDBC applications using select, insert, delete, update.

Unit II

SERVLETS: Introduction to Servlets (Life cycle of servlets, Java Servlets Development Kit, creating, Compiling and running servlet). The servlet API: javax. servlet package. Reading the servlet Parameters, Reading Initialization parameter. The javax.servlet.http.

Unit III

JAVA SERVER PAGES: Configuring Tomcat JSP/Servlet server. Brief Introduction to J2EE Architecture. Advantage of JSP technology. JSP Architecture, JSP Access Model. JSP Syntax Basic (Directions, Declarations, Expression, Scriplets, Comments) JSP Implicit Object (Out, Http Servlet Request, Http Servlet Respose, Exception Handling, Session Management.

Unit IV

Package Handling HTTP Request and Response (GET/ POST Request), Using Cookies, Session Tracking. Exception Handling.

Unit V

Introduction to EJB – Understanding MVC – Building Controllers, models and views – Integrating hibernate with spring.

Textbooks

1. Bates, B., Sierra, K., & Basham, B., Head First Servlets and JSP, O'Reilly Media, 2nd Edition, 2008.
2. Janson, B. & Hall, P., Servlet and JSP: A Tutorial, Prentice Hall, 2nd Edition, 2014.
3. Bauer, C., King, G., & Gregory, G., Java Persistence with Hibernate, Manning Publications, 2nd Edition, 2015.
4. Panda, D., Rahman, R., & Lane, D., EJB 3 in Action, Manning Publications, 2nd Edition, 2014.
5. Friesen, J., Beginning Jakarta EE: Enterprise Edition for Java – From Novice to Professional, Apress, 1st Edition, 2020.
6. Keogh, J., Java Server Programming: Java EE 7 Black Book, Dreamtech Press, 1st Edition, 2014.
7. Janson, B., Java EE to Jakarta EE 10 Recipes: A Problem-Solution Approach for Enterprise Java, Apress, 1st Edition, 2022

References

1. Java 6 Programming, Black Book, Dreamtec
2. Java Server Programming, Java EE6 (J2EE 1.6), Black Book, Dreamtech
3. Advanced Java Technology, By M.T. Savaliya, Dreamtech

25CSA338A 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

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	P09	PO10	PO11	PSO
CO1	3	3	1	1	1	-	-	-	-	-	-	-
CO2	3	3	1	1	3	-	-	-	-	-	-	-
CO3	3	3	2	2	3	-	-	-	-	-	-	-
CO4	3	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-Multiaccess 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.

Textbooks/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

25CSA339A	Block chain Technologies	2 0 2 -3

Course Description

- This course provides an overview of Blockchain Technology and Cryptography, covering blockchain architecture, consensus mechanisms, and cryptographic principles such as hash functions, public key cryptography, and digital signatures. It explores major platforms like Bitcoin, Ethereum, and Hyperledger, along with topics including mining, smart contracts, altcoins, scalability, and blockchain security. The course equips learners with a clear understanding of how blockchain ensures secure, transparent, and decentralized digital transactions across industries.

Course Outcome

COs	Description
CO1	Enable students to explore the fundamentals of Blockchain, Types & Generations of Blockchains, Enterprise Blockchains, Blockchain Mechanics & Optimizations and Blockchain Consensus Algorithms
CO2	Demonstrate Blockchain IRL, Network Attacks, Scaling and Future of Blockchains
CO3	Describe Bitcoin, Altcoins and Forking
CO4	Enable students to explore Attack on Digital assets, Cryptocurrencies for the Masses, Funding Crypto development, destroying Cryptocurrencies, Digital Asset applications and Enterprise Real-World applications

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	P08	PO9	PO10	PO11	PSO
CO1	3	2	2	2	2	2	-	-	3	1	1	3
CO2	3	2	2	3	3	2	-	-	3	2	1	2
CO3	3	2	3	3	3	2	-	-	3	2	2	2
CO4	2	3	3	3	3	2	-	-	3	3	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, Types of Blockchains, Enterprise Blockchains, Generation of Blockchains, Introduction to Cryptography, Public Key Cryptography, Cryptographic primitives – Cryptographic hash functions and Digital signatures, Elliptic Curve Digital Signature Algorithm (ECDSA)

Unit II

Blockchain Mechanics and Optimizations – Bitcoin Structure, Architecture, GHOST Protocol, Mining Process, Verification Process, Blockchain Demos, Blockchain Consensus Algorithms – Proof-of-Work (POW), Proof-of-Stake (POS), Delegated POS (DPOS), Practical BFT (PBFT)

Unit III

Bitcoin IRL – Public & Private Keys, Address, Hot and Cold Storages, Wallets, Lite Clients & Full nodes, Miners, Block & Transaction Incentives, Mining Infrastructure, Mining Pools & Organizations, Bitcoin Scripting Language ,Altcoins, Forking of Cryptocurrencies, Anonymity, Attacks on Blockchain Assets, Scaling of Blockchains, Cryptocurrencies for the Masses, Funding Crypto development, Future of Blockchain, how to destroy Cryptocurrencies?
Introduction to Ethereum & Hyperledger DLTs

Textbook/References

1. Bitcoin and Cryptocurrency Technologies by Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, First Edition 2016
2. Mastering Bitcoin by Andreas Antonopoulos, Third Edition 2023
3. Imran Bashir, Mastering Blockchain, Packt Publishing, 2018.

25CSA340A   Introduction to VR Programming   2 0 2 -3

Course Description:

- Introduce the fundamentals of Virtual Reality (VR), including historical development, benefits, and real-time graphics requirements.
- Develop understanding of 3D computer graphics, geometric modelling, transformations, and virtual environment design.
- Explore animation, interaction models, and simulation techniques in virtual environments.
- Familiarize students with VR hardware, software, and human factors influencing immersive experiences.

Course Outcomes

COs	Description
CO1	Explain the fundamental concepts, history, benefits, and requirements of Virtual Reality and Virtual Environments.
CO2	Apply principles of 3D computer graphics, geometric modelling, and transformations to construct and render virtual environments.
CO3	Design and implement interactive and animated virtual environments using interpolation, deformation, particle systems, and collision detection techniques.
CO4	Analyze and simulate real-world physical systems such as object dynamics, collisions, pendulums, springs, and flight motion within VR environments.
CO5	Integrate VR hardware, software, and human sensory factors to develop effective and immersive VR systems.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO

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

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Virtual Reality - Virtual Reality and Virtual Environment: Introduction, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark 3D Computer Graphics: Introduction, The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, 3D clipping, Colour theory, Simple 3D modelling, Hlumination models, Reflection models, Shading algorithms, Radiosity, Hidden Surface Removal, Realism-Stereographic image.

Unit II

Geometric Modelling - Geometric Modelling: Introduction, from 2D to 3D, 3D space curves, 3D boundary representation Geometrical Transformations: Introduction, Frames of reference, Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems. Virtual Environment - Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Non-linear interpolation, the animation of objects, linear and non-linear translation, shape & object inbetweening, free from deformation, particle system.

Unit III

Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft. VR Hardware and Software - Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modelling virtual world, Physical simulation, VR_ toolkits, Introduction to VRM.

Text books/References:

1. John Vince, "Virtual Reality Systems ", Pearson Education Asia, 2007.
2. Anand R., "Augmented and Virtual Reality", Khanna Publishing House, Delhi.
3. Adams, "Visualizations of Virtual Reality", Tata McGraw Hill, 2000.
4. Grigore C. Burdea, Philippe Coiffet , "Virtual Reality Technology", Wiley Inter Science, 2™ Edition, 2006.
5. William R. Sherman, Alan B. Craig, "Understanding Virtual Reality: Interface, Application and Design", Morgan Kaufmann, 2008.

25CSA341A	Distributed Systems	2 0 2 -3

Course Description

The course focuses on the fundamentals of distributed systems. It deals with the layer of software that needs to be built on top of computer networks to enable the development of distributed applications. It also focuses on the design, implementation and management of distributed systems.

Course Outcomes

COs	Description
CO1	Explain the fundamental concepts, goals, and architectures of distributed systems and distinguish between traditional and modern approaches.
CO2	Analyze process management techniques such as threads, virtualization, client-server models, and evaluate communication mechanisms including RPC, RMI, and multicast.
CO3	Apply naming schemes, synchronization techniques, and election/mutual exclusion algorithms to solve coordination problems in distributed environments.
CO4	Explain consistency models, replication strategies, and fault tolerance mechanisms (commit protocols, recovery methods, resilient multicast) for reliable distributed system design.
CO5	Compare paradigms such as object-based, file-based, web-based, and coordination-based systems to design secure and scalable distributed solutions

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PSO

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

3-strong, 2-moderate, 1-weak

Syllabus:

Unit I

Introduction: Distributed systems and their goals, hardware and software concepts, types of distributed systems, traditional and modern architectures for distributed systems.

Unit II

Processes: Threads, Virtualization, Clients, servers, code migration and software agents. Communication: Basics of communication, remote procedure calls, remote object invocation, message-oriented, stream-oriented communication, multicast Communication.

Unit III

Naming: Naming and locating entities, removing unreferenced entities, Flat, Structured and Attribute-based naming
Synchronization: Synchronization in distributed systems, logical time, global state, elections and mutual exclusion.

Unit IV

Consistency and replication: Data centric, client centric, Data replication, scalability, and consistency protocols
Fault tolerance: Making distributed systems fault tolerant; distributed commit, reliable and resilient multicasting, Recovery
Security: Secure communication and authorization in distributed systems.

Unit V

Review of major distributed systems paradigms: object systems, file systems, web-based systems, and coordination-based systems

Textbooks

1. Distributed Systems: Principles and Paradigms. Andrew S. Tanenbaum and Maarten van Steen. Prentice Hall, 4th edition, 2023
2. Distributed Systems: Theory and Applications by Ratan K. Ghosh & Hiranmay Ghosh (2023)

References

1. Distributed Computing, Fundamentals, Simulations and Advanced topics, 2nd Edition, HagitAttiya and Jennifer Welch, Wiley India
2. Distributed Systems: Concepts and Design, G. Coulouris, J. Dollimore, and T. Kindberg, 5th Edition, Addison-Wesley

25CSA342A	Introduction to IOT	2 0 2 -3

Course Description

- This course familiarises the student in the various technologies and standards that are used to connect multiple devises to the Internet. This course also provides comprehensive knowledge on IOT architecture, communication protocols, IOT devices and an introduction to data driven insights in IOT.

Course Outcomes

COs	Description
CO1	Explain the fundamental concepts, evolution, and impact of IoT; analyse IoT network architectures, functional stacks, and the challenges in IoT system design.
CO2	Identify and describe various IoT devices, sensors, actuators, and smart objects; apply communication technologies to connect and manage IoT-enabled systems such as Smart City architectures.
CO3	Analyze the role of IP as the IoT network layer; evaluate and apply optimized communication and application protocols to ensure interoperability and efficiency in IoT systems.
CO4	Apply data analytics and machine learning concepts for IoT data processing; examine network analytics and implement best practices for securing IoT and OT environments.
CO5	Configure and implement IoT solutions using Raspberry Pi by setting up hardware, operating systems, and remote connectivity for real-world IoT applications.

CO-PO Mapping

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3	2	3	2	3	1	-	1	2	2	2	2
CO2	3	3	2	3	3	1	-	1	2	2	2	3
CO3	3	3	3	3	3	2	-	1	2	2	2	2
CO4	3	3	2	3	3	2	2	1	3	3	3	1
CO5	3	3	3	3	2	1	-	1	2	3	3	1

3-strong, 2-moderate, 1-weak

Syllabus:

Unit I

Introduction What is IoT, Genesis of IoT, IoT and Digitization, IoT Impact, Convergence of IT and IoT, IoT Challenges, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack.

Unit II

Fundamental devices in IoT Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies, Smart City IoT Architecture.

Unit III

Protocols for IoT IP as the IoT Network Layer, The need for Optimization, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods.

Unit IV

Data and Network Analytics in IoT An Introduction to Data Analytics for IoT, Machine Learning, Network Analytics, Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, IT and OT Security Practices.

Unit V

Implementing IoT IoT Physical Devices and Endpoints. IoT Physical Devices and Endpoints - RaspberryPi: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout, Operating Systems on RaspberryPi, Configuring RaspberryPi, Connecting Raspberry Pi via SSH.

Textbooks
1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry,"IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", 1stEdition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
2. Srinivasa K G, "Internet of Things" , CENGAGE Leaning India, 2017.

Textbooks / References
1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014. (ISBN: 978-8173719547).
2. Raj Kamal, "Internet of Things: Architecture and Design Principles", 1st Edition, McGraw Hill Education, 2017. (ISBN: 978-9352605224).

PROFESSIONAL ELECTIVES - AI AND DS STREAM

SI No.	Course Code	Subject	L_T_P	Cr
1	25CSA351A	Cloud Computing Foundation	2 0 2	3
2	25CSA352A	Exploratory Data Analysis using Python	2 0 2	3
3	25CSA353A	Big Data Analytics and Visualization	2 0 2	3
4	25CSA354A	Business Analytics	2 0 2	3
5	25CSA355A	Data Analysis using Microsoft Excel	2 0 2	3
6	25CSA356A	Data Governance	2 0 2	3
7	25CSA357A	Natural Language Processing	2 0 2	3
8	25CSA358A	Data Visualization using Power BI	2 0 2	3
9	25CSA359A	Text Mining and Analytics	2 0 2	3
10	25CSA360A	Applications of Machine Learning	2 0 2	3
11	25CSA361A	Tableau for Business Intelligence	2 0 2	3
12	25CSA362A	Artificial Neural Networks and Applications	2 0 2	3

25CSA351A	Cloud Computing Foundation	2 0 2 -3

Course Description

- The curriculum enables learners to develop technical proficiency in cloud computing and launch or pivot to careers in a cloud-first world.
- This course is an ideal foundation for diverse career paths including those in IT infrastructure, data analytics, and cloud-native application development.

Course outcomes

COs	Description
CO1	Describe the different ways a user can interact with Google Cloud and discover the different compute options in Google Cloud
CO2	Implement a variety of structured and unstructured storage models.
CO3	Discuss the different application managed service options in the cloud
CO4	Outline how security in the cloud is administered in Google Cloud and Demonstrate how to build secure networks in the cloud
CO5	Identify cloud automation and management tools and Discover a variety of managed big data services in the cloud

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	P09	PO10	PO11	PSO
CO1	3	2	2	1	3	1	-	-	1	1	1	2
CO2	3	3	2	2	2	1	-	-	-	-	-	2
CO3	2	2	2	2	2	2	-	-	-	-	1	1
CO4	-	-	3	3	3	-	2	-	-	-	1	2
CO5	3	2	2	-	-	2	-	-	-	-	1	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

So, What's the Cloud Anyway? What the cloud is and why it's a technological and business game changer; Cloud computing, Cloud versus traditional architecture, IaaS, PaaS, and SaS.- IaaS versus PaaS versus SaaS, Google Cloud architecture

Unit II

Start with a Solid Platform The different ways a user can interact with the Google Cloud Platform (GCP) The GCP Console, Understanding projects, Billing in GCP, Install and configure Cloud SDK, Use Cloud Shell, GCP APIs. , Cloud Console Mobile App

Unit III

Use GCP to Build Your Apps Discover the different compute options in GCP. Compute options in the cloud, Configuring elastic apps with autoscaling, Exploring PaaS with App Engine, Containerizing and orchestrating apps with Google Kubernetes Engine

Unit IV

Where Do I Store This Stuff? Implement a variety of structured and unstructured storage models, Storage options in the cloud, Structured and unstructured storage in the cloud, Unstructured storage using Cloud Storage- ,SQL managed services, Exploring Cloud SQL, Cloud Spanner as a managed service, NoSQL managed service options, Cloud Datastore, a NoSQL document store, Cloud Bigtable as a NoSQL option

Unit V

There's an API for That! Discuss the different application managed service options in the cloud. The purpose of APIs, Cloud Endpoints, Using Apigee Edge, Managed message services, Exploring Cloud SQL, Cloud Pub/Sub

Unit VI

You Can't Secure the Cloud, right? Outline how security in the cloud is administered in GCP. Introduction to security in the cloud, The shared security model, Encryption options-, Authentication and authorization with Cloud IAM, Identify Best Practices for Authorization using Cloud IAM

Unit VII

It Helps to Network How to build secure networks in the cloud. Introduction to networking in the cloud, Defining a Virtual Private Cloud, Public and private IP address basics, Google's network architecture, Routes and firewall rules in the cloud, Multiple VPC networks, Building hybrid clouds using VPNs, interconnecting, and direct peering ,Different options for load balancing

Unit VIII

Let Google Keep an Eye on Things Cloud automation and management tools. Introduction to Infrastructure as Code, Cloud Deployment Manager, Public and private IP address basics., Monitoring and managing your services, applications, and infrastructure Stack driver

Unit IX

You Have the Data, but What Are You Doing with It? Discover a variety of managed big data services in the cloud. Introduction to big data managed services in the cloud Leverage big data operations with Cloud Dataproc ,Build Extract, Transform, and Load pipelines using Cloud Dataflow, BigQuery, Google's Enterprise Data Warehouse

Unit X

Let Machines Do the Work Explain what machine learning is, the terminology used, and its value proposition. Introduction to machine learning in the cloud, Building bespoke machine learning models with AI Platform. ,Cloud AutoML, Google's pre-trained machine learning APIs.

Textbooks/References

1. https://learndigital.withgoogle.com/digitalgarage/course/gcloud-computing-foundations
2. Bahga, Arshdeep., Madisetti, Vijay. Cloud Computing: A Hands-on Approach. United Kingdom: Arsheep Bahga & Vijay Madisetti, 2014.
3. Mastering Cloud Computing: Foundations and Applications Programming,Rajkumar Buyya, Christian Vecchiola, S.Thamarai Selvi

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25CSA352A   Exploratory Data Analysis using Python   2 0 2 -3

Course Objective(s)

- From this course, students can gain a solid foundation in data analysis using Python and gain knowledge of the various tools and techniques used in exploratory data analysis and visualization.

Course Outcomes

COs	Description
CO1	To anlayze the structure, syntax, and semantics of Python language.
CO2	Analyze the basic Python libraries and their usage in preprocessing and visualization of data.
CO3	Apply the appropriate manipulations in different data types of Python.
CO4	Demonstrate various real-time scenarios to build the practical application using Python.
CO5	Explore different Python packages of data analysis for real-world problems.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO

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

Syllabus

Unit I

Introduction to Python: Python variables, Python basic Operators, Understanding python blocks. Python Data Types, Declaring and using Numeric data types: int, float etc.

Unit II

Python Program: Flow Control-Conditional blocks: if, else and else if, Looping- Simple for loops in python, For loop using ranges, Use of while loops, string, list and dictionaries, Loop manipulation using pass, continue, break and else. Programming using Python conditional and loop blocks.

Unit III

Python Complex data types: String- Using string in-built functions and string operations, List-list slicing, functions and methods in list, and List manipulation. Dictionary-Functions and methods in dictionary, dictionary manipulations Iterators and iterables Python Functions, organizing python codes using functions, File Handling-Read, Write, Create and Delete

Unit IV

Demonstration: The Numerical Python Library (NumPy), Pandas. The Series Data Structure, Querying a Series, Pandas - Data frames -The Data Frame Data Structure, Indexing and Loading, Querying a Data Frame, Handling missing values.

Unit V

Understanding the Python Packages for Data Science- SciKit Learn, MatPlot Lib, Importing and Exporting Data in Python, Getting Started Analyzing Data in Python, Understanding the Data,Data Formatting, Python, Data Summarization, aggregation and grouping of data.

Textbooks/References

1. Yashavant kanetkar, Aditya Kanetkar,"Let us Python",3rd Edition,bpb publication

2. Wesley J. Chun, "Core Python Applications Programming", 3rd Edition , Pearson Education, 2016
3. Jeeva Jose & P.Sojan Lal, "Introduction to Computing and Problem Solving with PYTHON", Khanna Publishers, New Delhi, 2016
4. Downey, A. et al., "How to think like a Computer Scientist: Learning with Python", John Wiley, 2015
5. John Zelle, "Python Programming: An Introduction to Computer Science", Second edition, Course Technology Cengage Learning Publications, 2013, ISBN 978- 15902824.

25CSA353A   Big Data Analytics and Visualization   2 0 2 -3

Course Description

The course begins with a basic concept of big data and discusses the different methods to analyse and visualize on these kinds of data. This course helps the student to develop the skillset to build effective solutions for Big Data issues using Hadoop and its Eco-System.

Course Outcomes

COs	Description
CO1	Understand the basic concepts in Big Data Analytics and demonstrate the ability to choose the right solution for a task involving big data, including databases, architectures, and cloud services.
CO2	Understand and illustrate the different methods to explore and analyze big data.
CO3	Develop the skillset to build effective solutions for Big Data issues using modern tools.
CO4	Demonstrate different data visualization techniques and standard tools.
CO5	Understand real-life issues faced by different organizations and demonstrate its effective solutions through case studies.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3	2	2	2	3	-	-	-	-	-	2	2

CO2	3	3	2	3	3	-	-	-	-	-	2	1
CO3	3	3	3	2	3	-	-	2	-	2	2	2
CO4	2	2	2	2	3	-	-	-	3	-	2	1
CO5	2	3	3	2	2	2	2	2	3	3	3	1

Syllabus

Unit I

Introduction to Big Data, Types of Digital Data, Characteristics of Big Data, Evolution of Big Data, Definition of Big Data, Cloud Data Lake and Data Warehouse concepts, Challenges with Big Data, Ethics, Privacy, and Responsible AI in Big Data, Big data sources, Best practices in Big Data Analytics, Introduction to Data Modelling

Unit II

Introduction to elementary data analysis: Measures of center: Mean, Median, Mode, Variance, Standard deviation, Range, Normal Distribution :Center, Spread, Skewed Left, Skewed Right, Outlier, Correlation Patterns, Magnitude and Direction in relationship, Exploratory Data Analysis (EDA) with Pandas/NumPy/Matplotlib/Seaborn

Unit III

History of Visualization, Goals of Visualization, Types of Data Visualization: Scientific Visualization, Information Visualization, Visual Analytics, Impact of visualization, Big Data Visualization Tools: Tableau, Google Chart, Power BI, Plotly, D3.js, and Python-based libraries, Dashboarding concepts, Storytelling with Data & Cognitive Load in Visualization

Unit IV

Introduction to Big Data Processing and Apache Hadoop, HDFS Concepts, Map Reduce Framework, Anatomy of a Map Reduce Job Run, Job Scheduling, Shuffle and Sort, Task Execution, Modern Orchestration tools

Unit V

Apache Spark, Apache Flink, Apache Hive, Case studies: Analyzing big data with twitter, Big data for Ecommerce, Big data for blogs, customer churn prediction,

Textbooks

1. Seema Acharya, Subhasini Chellappan, "Big Data Analytics", Wiley, 2015

2. Frank J Ohlhorst, "Big Data and Analytics: Turning Big Data into Big Money", Wiley and SAS Business   Series, 2012.

3. Tom White, "Hadoop: The Definitive Guide" Third Edition, O'reily Media, 2012.

References

1. Michael C. Reingruber, William W. Gregory "The Data Modeling Handbook: A Best- Practice Approach to Building Quality Data Models", Wiley QED publications, First Edition.

2. Philip Bobko, "Correlation and Regression: Applications for Industrial Organizational Psychology and Management", First Edition

3-strong, 2-moderate, 1-weak

25CSA354A	Business Analytics	2 0 2 -3

Course Description

- This course equips students with the ability to critically analyze and solve real-world business decision problems using data. It introduces statistical and probabilistic methods, data visualization, data mining, and forecasting techniques. Emphasis is placed on modeling, tool usage (e.g., R/Python/Excel/Tableau), and case studies from different business domains.

Course Outcomes

COs	Description
CO1	Apply best practices of data visualization and storytelling to support business decision-making.
CO2	Analyze, clean, and explore datasets to extract meaningful business insights.
CO3	Select and implement appropriate statistical and data mining techniques for solving business problems.
CO4	Demonstrate proficiency in business analytics tools (e.g., Python, R, Excel, Tableau/Power BI).
CO5	Apply time series forecasting techniques to real-world business scenarios.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO

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

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Business Analytics; Descriptive Statistics – Types of Data, Measures of Central Tendency/Dispersion, Data Cleansing; *Exploratory Data Analysis (EDA)*. Data Visualization – Design Techniques, Tables, Charts, Advanced Visualizations, Dashboards

Unit II

Inferential Analysis – Statistical Inference, Hypothesis Testing; Descriptive Data Mining – Clustering, Association Rules; Performance Evaluation; Overview of Key Classification and Prediction Techniques (*Regression, Decision Trees*);

Unit III

Introduction to Forecasting, Time Series – Level, Trend, Seasonality, Smoothing Techniques – Moving Average, Exponential Smoothing; *ARIMA and model selection*.

Unit IV

Visualization Case study, Case Studies in *Marketing & Customer Analytics,* Case Studies in *Sales and Operations Forecasting*.

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.
6. Provost & Fawcett, *Data Science for Business* (O'Reilly, 2013)

25CSA355A   Data Analysis using Microsoft Excel   2 0 2 -3

Course Objective
- To understand the basics of data analysis using Microsoft Excel
- To understand the application of Financial, statistical and presentation tools in excel.

Course Outcome

COs	Description
CO1	Demonstrate the fundamentals of business analytics and types of data.
CO2	Apply Excel functions for data cleaning, transformation, and analysis.
CO3	Perform statistical analysis and hypothesis testing using Excel and Data Analysis ToolPak.
CO4	Use What-if analysis, Pivot Tables, and Power Pivot for business decision support.
CO5	Design interactive dashboards and advanced visualizations in Excel for effective reporting.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3	2	1	-	1	1			1		2	2
CO2	2	2	2	1	3			1	1		2	2
CO3	2	3	2	2	3			1	1		2	3
CO4	2	2	3	2	3	1		2	1	2	2	1
CO5	1	2	3	2	3	1	1	2	3	2	3	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

   Introduction to Business Analytics- Introduction to Business Analytics – Importance and Benefits, Types of Data: Structured, Semi-structured, and Unstructured, Applications of Business Analytics in different domains, Analytics Methods – Descriptive, Diagnostic, Predictive, and Prescriptive.

Unit II

   Working with Excel Functions and Charts- Excel interface overview, Data Cleaning and Preparation, Text, Logical, Lookup, Math & Statistical Functions, Conditional Formatting, Charts and Graphs, Trend Line Analysis, Combination Charts.

Unit III

   Statistical Analysis with Excel- Descriptive Statistics using Excel, Statistical Functions, Data Analysis ToolPak – t-test, Chi-Square, ANOVA, Correlation and Regression Analysis, Interpreting Results for Decision Making.

Unit IV

   What-if Analysis and Pivoting- What-if Analysis – Data Tables, Scenario Manager, Goal Seek; Pivot Tables and Pivot Charts; Power Pivot for large datasets.

Unit V

   Dashboarding and Visualisation- Advanced Graphs in Excel, Advanced Conditional Formatting, Designing Interactive Dashboards for Business Insights, Best Practices in Dashboard Presentation.

Textbooks/References

1. Manish Nigam, *Advance Excel 2019 Training Guide: Tips and Tricks to Kick Start Your Excel Skills*, BPB Publications.
2. Wayne L. Winston, *Microsoft Excel 2019: Data Analysis and Business Modeling*, PHI Learning.
3. Michael Alexander & Dick Kusleika, *Excel 2019 Power Programming with VBA*, Wiley.
4. Conrad Carlberg, *Business Analysis with Microsoft Excel*, Pearson.

25CSA356A	Data Governance	2 0 2 -3

Course Objective(s)

- To ensure legal and regulatory compliance by aligning policies and procedures with data handling regulations.
- To improve data quality and usability through effective lifecycle management.

- To equip learners with knowledge of governance frameworks, stewardship roles, and risk management practices.
- To understand the impact of Big Data on governance strategies and organizational policies.

Course Outcomes

COs	Description
CO1	Analyse how organisations use data governance to address challenges of data management and articulate governance challenges.
CO2	Create and document the steps necessary to implement a data governance program.
CO3	Evaluate data governance maturity models and apply them to mitigate regulatory and operational risks.
CO4	Develop a data governance document describing business needs, data policy standards, and stakeholder roles.
CO5	Assess the impact of Big Data on organisational policies and emerging data governance frameworks.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	2	3	2	2	1	2	2	1	2	1	2	2
CO2	3	3	3	2	2	2	2	2	2	2	2	2
CO3	2	3	2	3	2	3	2	1	1	1	2	3

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

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Data, Data's role in representing objects, events and concepts - Relationship between data and information Data ownership and the relationships between people in a business enterprise -Importance of data in organization - Assess the business issues that data management can resolve -Challenges inherent in data management and governance

Unit II

Data Governance -The Need for Data Governance - How Data Governance fits into Organizational Strategy Data Governance Maturity Models -Data Governance Life Cycle - how to Manage Risk with Data Governance - Organizational Culture Affects Data Governance - Articulate the Challenges of Data Governance

Unit III

Metadata Framework - Evaluate and Explain Master Data Management - Types of Assets that Require
Governance - Analyze and Describe Metadata Use for Data Governance - Evaluate the Varying Data Models and Their Bearing on Governance
Regulatory and Operational Risk Through Data Governance - The Relationship Between IT and Business in an Organization - Information Governance Framework -

Optimize Performance with Data Governance - Formal Structure Impacts Data Governance - Create a Data Governance Document that Describes the Business Need for Data Governance

Unit IV

Data Stewardship and Governance – How they fit together – Types of data stewardship – Roles and
responsibilities

Unit V

Application of Data Governance in Business – Challenges of Data Governance in a Big Data world - Framework for successful Data Governance strategies - Information Exchanges

Textbooks/References

1. Neera Bhansali, Data Governance: Creating Value from Information Assets, Auerbach Publications, 2013.
2. Harkish Sen, Data Governance: Perspectives and Practices, Technics Publications, 2019.
3. David Plotkin, Data Stewardship: An Actionable Guide to Effective Data Management and Data Governance, Elsevier, 2014.

25CSA357A	Natural Language Processing	2 0 2 -3

Course Description

- This course is devoted to the study of phonological, morphological and syntactic processing. These areas will be approached from both a linguistic and an algorithmic perspective. The course will focus on the computational properties of natural languages and of the algorithms used to process them, as well as the match between grammar formalisms and the linguistic data that needs to be covered.

Course Outcomes

CO1	Illustrate approaches to syntax and semantics, fundamental mathematical models and algorithms in the field of NLP including hidden Markov models, –Ngram Models and probabilistic models.
CO2	Devise solutions for a range of natural language components using existing algorithms, techniques and frameworks, including part-of-speech tagging, language modelling, parsing, context modelling and semantic role labelling.
CO3	To give an overview of the major technologies in speech recognition and synthesis including tools for acoustic analysis.
CO4	To evaluate the outcomes of various language processing and representation models.
CO5	To get exposed to hands-on experience of using NLP tools and apply existing statistical and deep learning techniques to language applications such as machine translation.

CO-PO Mapping

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3	1	1	-	-	-	-	-	-	-	-	1

CO2	2	1	1	3	-	-	-	-	-	-	-	1
CO3	1	1	3	-	-	-	-	-	-	-	-	1
CO4	2	1	3	-	-	-	-	-	-	-	-	3
CO5	1	2	3	1	2	1	1	-	-	1	-	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction: Words -Morphology and Finite State transducers -Computational Phonology and Pronunciation Modelling –Probabilistic models of pronunciation and spelling–Ngram Models of syntax- Hidden markov models and Speech recognition –Word classes and Part of Speech Tagging.

Unit II

Context free Grammars for English–Parsing with Context free Grammar–Features and unification–Lexicalized and Probabilistic Parsing-Language and Complexity-Semantics: Representing meaning -Semantic analysis -Lexical semantics –Word sense disambiguation and Information retrieval.

Unit III

Pragmatics: Discourse –Dialog and Conversational agents –Natural language generation, Statistical alignment and Machine translation: Text alignment –word alignment –statistical machine translation.

Textbooks

1. Daniel and Martin JH, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, 2009.

References

1. Manning C D and Schutze H, "Foundations of Statistical Natural Language processing ", First Edition, MIT Press, 1999.
2. AllenJ, "Natural Language Understanding", Second Edition, Pearson Education,2003

25CSA358A   Data Visualization using Power BI   2 0 2 -3

Course Objective

- To provide students with a strong foundation in data visualization principles and strategies, and enable them to effectively represent and interpret data through appropriate plots and storytelling techniques.
- To equip students with practical proficiency in Power BI by connecting, preparing, and analyzing data from diverse sources, and developing interactive dashboards for insightful decision-making.

Course Outcome

COs	Description
CO1	Explain the fundamental concepts of data visualization, types of data, and design principles for effective communication.
CO2	Demonstrate the ability to import, join, and blend data from various sources using Power BI Desktop and connect to live data streams.
CO3	Apply appropriate visualization techniques and storytelling methods to represent multi-dimensional data and generate meaningful insights.
CO4	Design and develop interactive dashboards, metrics, and scorecards in Power BI to support advanced data analysis.

CO-PO Mapping

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3	2	2	2	2	-	-	-	1	-	2	2
CO2	3	2	2	2	3	-	1	-	1	2	2	2
CO3	2	3	3	2	3	-	-	-	2	1	3	2
CO4	2	3	3	2	3	-	-	1	2	-	2	11

3-strong, 2-moderate, 1-weak

Syllabus

Unit I
Introduction to Data Visualization - Introduction to Data Visualization, Types of Data, Data Visualization designing strategies and principles.

Unit II
Introduction to Tool Power BI-Introduction to Power BI, Types of services offered by Power BI, Setup Power BI Desktop Application, Interface of Power BI, Importing Data into Power BI from various Sources. Joining and Blending Data. Connecting to Live Data.

Unit III
Story telling through Data using Power BI -Representing and visualizing multiple variables, Types of plots, Understating the suitability of the graphs with respect to data. Visualizing multiple dimensions in 2D.

Unit IV
Dashboards and Communicating using Data Visualization in Power BI-Data Analysis, understanding metrics and scorecards, Building dashboards and automation, Advanced Interactive visualization.

Textbooks/References
1. Cole Nussbaumer Knaflic – Storytelling with Data Visualization Guide for Business Professionals – 1st edition, Wiley.
2. Alberto Ferrari and Marco Russo – Introducing Microsoft Power BI, Microsoft Press.
3. Alberto Ferrari and Marco Russo - Analysing the Data with Microsoft Power BI and Power Pivot for Excel – 1 January 2019, Microsoft Press.

25CSA359A	Text Mining and Analytics	2 0 2 -3

Course Objective(s)

- This course helps to understand how deal text in NLP
- It deals with the various parsing approaches: Grammar free, Constituent free and Context aware

parsing.

- Enables the student to identify and find the next probable word in the corpus.

Course Outcomes

COs	Description
CO1	Explain the fundamental concepts, strategies, and applications of text mining and information retrieval.
CO2	Apply text preprocessing and NLP tools to prepare textual data for analysis.
CO3	Implement basic machine learning models for classification, clustering, and retrieval of textual data.
CO4	Analyze and evaluate the performance of models using appropriate metrics for text data.
CO5	Interpret and communicate the results of text mining and machine learning analysis in a meaningful way.

CO-PO Mapping

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3	2	1	-	1	1	-	-	1	-	2	2
CO2	2	2	2	1	3	-	-	1	1	-	2	2
CO3	2	3	3	2	3	-	-	1	1	1	2	1
CO4	2	3	2	3	3	-	-	2	1	1	2	1
CO5	1	2	2	2	2	1	1	2	3	2	3	2

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Overview: Origins and challenges of NLP Language and Grammar-Processing Indian Languages- NLP Applications Information Retrieval. Language Modeling: N-grams + brief intro to embeddings (Word2Vec/Glove)

Unit II

Word Level Analysis: Regular Expressions -Morphological Parsing- Spelling Error Detection and correction-Words and Word classes-Part-of Speech Tagging. tokenization, stopword removal, stemming, lemmatization, Syntactic Analysis – Context-free grammar, NLTK/spaCy for POS tagging & parsing.

Unit III

Named entities, relation extraction, semantic role labeling, Sentiment Analysis & Opinion Mining, Text classification

Unit IV

Search engines (basic IR with TF-IDF, BM25), Topic modeling (LDA or BERTopic at a simplified level), Case studies: Social media trend analysis, Fake news detection, Resume parsing for HR analytics.

Unit V

Text Summarization (simple extractive methods), Conversational AI basics (chatbots with rule-based vs ML-based), Generative AI concepts, Ethics in NLP (bias, misinformation, data privacy)

Textbooks

1. Bird, Klein, Loper – Natural Language Processing with Python (NLTK Book), 2nd Ed. (hands-on, student-friendly).
2. Lewis Tunstall, Leandro von Werra, Thomas Wolf – Natural Language Processing with Transformers (O'Reilly, 2022) (modern, practical, Hugging Face based).
3. Christopher Manning et al. – Foundations of Statistical Natural Language Processing (2008)
4. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", 3rd Edition, Prentice Hall, 2023.
5. James Allen, "Natural Language Understanding", 2nd edition, Benjamin/ Cummings publishing company, 1995.
6. Gerald J. Kowalski and Mark.T. Maybury, "Information Storage and Retrieval systems", Kluwer academic Publishers, 2000

25CSA360A   Applications of Machine Learning   2 0 2 -3

Course Description

- 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 is applied in real-world applications such as recommendation systems, dimensionality reduction, and web advertising.

CO	Description
CO2	Implement suitable machine learning algorithms for solving application-driven problems.
CO3	Analyze and compare the performance of different ML approaches in specific applications.
CO4	Design and evaluate a complete machine learning system by integrating various components of the ML pipeline.

PO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3	2	1	-	1	2	-	-	2		2	2
CO2	2	3	2	2	3	-	-	1	1	1	2	2
CO3	2	3	2	3	3	-	-	1	1	1	2	2
CO4	2	3	3	3	3	1	1	2	2	2	3	3

CO-PO Mapping

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, Content-Based Recommendations, Discovering Features of Documents, Collaborative Filtering, Usage of UV decomposition in Recommendation systems.

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,

Unit III

Application of dimensionality reduction, PCA, for Image Processing – compression and Visualization.

Independent component Analysis (ICA) for speech processing

Unit IV

Mining Social network graphs – Clustering of Social Network Graphs, Partitioning of Graphs, and Finding Overlapping Communities.

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.
3. Selected papers.

25CSA361A   Tableau for Business Intelligence   (2 0 2 -3)

Course Objective

- To provide students with a strong foundation in Business Intelligence and Tableau, covering data connections, preparation, extraction, blending, and advanced operations such as calculations, filtering, grouping, and set management.
- To enable students to design, develop, and present insightful dashboards and diverse data visualisations, applying forecasting, trend analysis, and formatting techniques for effective decision-making and communication.

Course Outcome

COs	Description
CO1	Demonstrate the ability to connect Tableau to various data sources and manage data through extraction, joining, blending, and formatting.
CO2:	Apply Tableau operators, built-in functions, table calculations, and Level of Detail (LOD) expressions to analyse and transform datasets.
CO3:	Create and customise a wide range of visualisations (e.g., histograms, tree maps, Pareto, funnel, scatter plots) and dashboards to communicate insights effectively.
CO4:	Present business insights through forecasting, trend analysis, and well-structured Tableau dashboards for informed decision-making.

CO-PO Mapping

PO	PO1	PO2	PO3	PO4	PO5	PO6		PO8	PO9			PSO

CO							PO7			PO10	PO11	
CO1	3	2	2	2	3	1	-	1	1	-	2	1
CO2	3	3	2	2	3	-	-	-	1	-	2	3
CO3	2	3	3	2	3	1	-	1	1	1	2	2
CO4	2	3	3	2	3	1	1	-	1	1	3	1

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Tableau Data Visualization-Business Intelligence Tools-Downloading Tableau-Introduction to Tableau-set up-Introducing Tableau file and data types- data terminologies – navigation- menus - Connecting to data source (Excel, Text Files)-data view - Connecting to Databases - Displaying the data underlying a workbook Adding, duplicating, and renaming worksheets-Reordering, clearing, and deleting worksheets-Changing a worksheet's tab color-Saving your changes-Saving your workbook.

Unit II

Data Extractions and formatting Working with Data- extracting – applying extract filters – field operations – Meta data- data joining – data blending. Formatting - Dashboard Development-Sharing - Presenting Tableau operators and built-in functions-Creating a calculated field-Creating a calculated field on a shelf-Adding a table calculation-Using LOD expressions-Creating calculations in dialog boxes.

Unit III

Functions and Calculations Calculating averages, medians, minimums, and maximums-Displaying the Summary Card- Calculating percentages of a table total- Forecasting future values -Sorting based on a field's values-Combining fields to sort by more than one criteria-Creating a selection filter-Creating a wildcard filter-Creating a condition filter-Creating a top filter-Adding a Quick Filter to a worksheet-Editing, clearing, and deleting filters-Filtering data using parameters-Editing and deleting parameters

Unit IV

Group Editing Defining a group-Defining a group for "other" values-Finding members of a group-Editing and deleting groups-Defining a set-Creating summaries using sets-Combining Sets-Editing and deleting sets.

Unit V

Data visualization Pivoting data-Creating Histograms, line charts, pie chart, bar chart, scatter plots, Tree maps, word clouds and bubble charts. Creating Pareto charts, Waterfall Charts-

Bump Charts-Funnel Chart-Adding a text box to a chart-Formatting chart elements-Changing the color sequence in charts, Adding a trend line to a chart-Forecasting

Textbooks
- Learning Tableau 2024 – Sixth Edition, Joshua N. Milligan
- Mastering Data Visualization with Tableau: Empowering Business Decisions with Tableau, Arpana Chaturvedi & Praveen Malik, 2024

References
- Mastering Tableau 2021: Implement advanced business intelligence techniques and analytics with Tableau, 3rd Edition Paperback – 31 May 2021 , Marleen Meier , David Baldwin , Kate Strachnyi
- Getting Started with Tableau 2019.2 by Tristan Guillevin
- Tableau: Creating Interactive Data Visualizations, Jen Stirrup , Ashutosh Nandeshwar , Ashley Ohmann, Matt Floyd, 2016

25CSA362A Artificial Neural Networks and Applications   (2 0 2 -3)

Course Objective

- To help students understand the fundamentals of artificial neural networks (ANNs) and their real-world applications. The students must be able to develop practical knowledge in designing, training, and evaluating neural network models using modern tools and datasets.

Course Outcome

COs	Description
CO1	To demonstrate the biological and mathematical foundations of neural networks.
CO2	To illustrate basic neural network architecture and the backpropagation algorithm.
CO3	To implement and evaluate ANN models for classification and regression tasks.
CO4	To apply ANN techniques to real-world problems in domains such as image recognition and prediction.

CO – PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO
CO1	3	2	1	1	2				1		2	2

CO2	3	2	2	1	3				1		2	2
CO3	2	3	3	2	3			1	1		2	2
CO4	2	2	3	3	3	2	1	2	2	1	3	1

3-strong, 2-moderate, 1-weak

Syllabus

Unit I

Introduction to Neural Networks: Biological Neuron vs. Artificial Neuron, Evolution of Neural Networks – Perceptron and Multilayer Perceptron (MLP), Basics of Machine Learning – Supervised and Unsupervised Learning, Structure and Functioning of a Single Neuron – Activation Functions (Sigmoid, ReLU, Tanh, Softmax), Perceptron Algorithm – Limitations – XOR Problem, Applications of ANN in real-world domains

Unit II

Feedforward Neural Networks and Backpropagation: Multilayer Perceptrons – Architecture and Forward Propagation, Backpropagation Algorithm – Gradient Descent – Learning Rate – Loss Functions (MSE, Cross-Entropy), Epochs, Batch Size, and Overfitting, Weight Initialization – Vanishing Gradient Problem, Evaluation Metrics – Accuracy, Precision, Recall, F1 Score, Use of tools: Implementation using Python and Keras/TensorFlow

Unit III

Training, Tuning, and Regularization: Training Techniques – Early Stopping – Dropout – Batch Normalization, Hyperparameter Tuning – Grid Search, Random Search, Cross-Validation Techniques, Model Interpretability – Confusion Matrix – ROC-AUC, Introduction to Transfer Learning – Pretrained Models (VGG, ResNet, BERT)
Basics of exporting a trained ANN model, Using saved models for prediction (in Python), lightweight deployment using Gradio/Streamlit (optional)

Unit IV

Overview of ANN Applications across multiple domains: Computer Vision: Image classification, handwritten digit recognition (MNIST), facial expression recognition, Natural Language Processing (NLP): Text classification (spam detection, sentiment analysis), keyword detection, Time Series Forecasting: Stock price prediction, weather forecasting using feedforward networks, Healthcare Applications: Disease prediction (e.g., diabetes, heart disease), patient risk stratification, Business Intelligence: Sales forecasting, customer churn prediction, recommendation systems, Agriculture and Environment: Crop yield prediction, pest classification using ANN-based models; Classifying handwritten digits using MLP on MNIST, Predicting diabetes using the Pima Indian Diabetes dataset; Classifying movie reviews as positive/negative (text sentiment)

Textbooks/References
1. Simon Haykin, *Neural Networks and Learning Machines*, 3rd Edition, Pearson Education, 2009.

2. Michael Nielsen, *Neural Networks and Deep Learning: A Free Online Book*, Determination Press, 2015. (Available at: neuralnetworksanddeeplearning.com)

3. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, 3rd Edition, O'Reilly Media, 2022.

4. Charu C. Aggarwal, *Neural Networks and Deep Learning: A Textbook*, Springer International Publishing, Second Edition, 2023.