Syllabus
Sem V and VI

- ❖ Computer Science and Engineering (CS)
- ❖ Computer Engineering (KE)
- ❖ Artificial Intelligence & Data Science (AIDS)
- ❖ Computer Science and Engineering (Data Science) (DS)

SEM V

5CS220PC / 5DS220PC / 5KE220PC / 5AD220PC - Database Management Systems

Course Prerequisites
Discrete Mathematics, Data Structures and Algorithms

Course Objectives
The course aims to:

- To understand database concepts, design principles, and ER/EER modeling.
- To develop SQL skills for efficient database operations and procedural programming.
- To apply normalization techniques for designing well-structured relational databases.
- To explore database transactions, concurrency control methods, and recovery mechanisms.
- To analyze NoSQL database models and their role in managing unstructured data.

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

1. Recognize the need of database management system
2. Design ER and EER diagram for real life applications
3. Formulate SQL queries
4. Apply the concept of normalization to relational database design.
5. Describe the concept of transaction, concurrency and recovery
6. Evaluate NoSQL database types and explain their suitability for handling unstructured data.

SYLLABUS
Unit I: Introduction to DBMS & ER Model (6 Lectures, 10 Marks)
Database system application, Purpose of Database Systems, View of Data, Database Languages, Database Architecture, Database Users and Administrators, The Entity-Relationship Model, Constraints, keys, Removing Redundant Attributes in Entity Sets, Entity-Relationship Diagrams, Reduction to Relational Schemas, Entity-Relationship Design Issues, Extended E-R Features.

Unit II: Introduction to SQL (6 Lectures, 10 Marks)
Overview of the SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operations, Set Operations, Null Values, Aggregate Functions, Nested Sub queries, Join Expressions, Views, Integrity Constraints, SQL Data Types and Schemas, Authorization, Triggers.

Unit III: SQL – Relational Database Design (6 Lectures, 10 Marks)
Features of Good Relational Designs, Atomic Domains and First Normal Form, Decomposition Using Functional Dependencies, Functional-Dependency Theory, BCNF, Decomposition Using Multivalued Dependencies, More Normal Forms.

Unit IV: Query Processing and Query Optimization (6 Lectures, 10 Marks)
Query Processing: Overview, Measures of Query Cost, Selection, Join Operation, Evaluation of Expressions, Query Optimization: Overview, Transformation of Relational Expressions, Estimating Statistics of Expression Results.

Unit V: Transactions and Concurrency Control (6 Lectures, 10 Marks)
Transaction Concept, A Simple Transaction Model, Storage Structure, Transaction Atomicity and Durability, Transaction Isolation, Serializability, Transaction, Isolation and Atomicity, Transaction Isolation Levels, Implementation of Isolation Levels, Lock-Based Protocols, Deadlock Handling, Multiple Granularity, Timestamp-Based Protocol.

Unit VI: NoSQL Database and MongoDB (6 Lectures, 10 Marks)
Introduction to NoSQL Database, NoSQL data models, CAP theorem and BASE Properties, Comparative study of SQL and NoSQL, MongoDB: CRUD Operations, Indexing and Aggregation.

Text Book

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, Sixth Edition, McGraw-Hill.
2. D T Editorial Services "BIG DATA Black Book", Dreamtech Press ISBN 13 : 9789351199311

Reference Books

1. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, McGraw-Hill
2. Shamkant B. Navathe, RamezElmasri, Database Systems, Pearson Higher Education
3. Garcia-Molina, Ullman, Widom: Database System Implementation, Pearson education.
4. Kristina Chodorow, Michael Dierolf, "MongoDB: The Definitive Guide", O Reilly Publications, ISBN: 978-1-449-34468-9
5. Adam Fowler, "NoSQL For Dummies", John Wiley & Sons, ISBN-1118905628
6. Kevin Roebuck, "Storing and Managing Big Data - NoSQL, HADOOP and More", Emereopty Limited, ISBN: 1743045743, 9781743045749

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation , – → No correlation)

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

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5CS221PC / 5DS221PC / 5KE221PC - COMPILER DESIGN

Course Prerequisites: Basic knowledge of Discrete Mathematics, Theory of Computation

Course Objectives:

Throughout the course, students will be expected to demonstrate their understanding of Compiler Design by being able to do each of the following:

- To learn concepts of programming language translation and phases of compiler design
- To understand the common forms of parsers.
- To study concept of syntax directed definition and translation scheme for the representation of language
- To illustrate the various optimization techniques for designing various optimizing compilers.

Course Outcomes: After successful completion of the course, the students will be able to-

1. Describe the fundamentals of compiler and various phases of compilers.
2. Design and implement LL and LR parsers.
3. Solve various parsing techniques like SLR, CLR, LALR.
4. Examine the concept of Syntax-Directed Definition and translation.
5. Assess the concept of Intermediate-Code Generation and run-time environment.
6. Explain the concept of code generation and code optimization.

SYLLABUS

Unit I: Introduction to Compiler: **(6 Lectures, 10 Marks)**

Introduction to Compilers: Language Processor, The Structure of a Compiler. Lexical Analysis: The role of lexical analyzer, Input Buffering, Specification of tokens, Recognition of tokens, The lexical analyzer generator Lex.

Unit II: Syntax Analysis; **(6 Lectures, 10 Marks)**

Syntax Analysis: The role of the parser, Review of context free grammar for syntax analysis: Parse Tree and Derivation, Ambiguity in Grammar, Elimination of left recursion and left factoring. Top down parsing: recursive descent parsing, predictive parsers, Transition diagrams for predictive parsers, FIRST and FOLLOW, LL (1) Grammars, Non recursive predictive parsing, Error recovery in predictive parsing.

Unit III: Bottom-Up Parsing: **(6 Lectures, 10 Marks)**

Bottom up parsing: Handle pruning, Stack implementation of Shift Reduce Parsing, conflicts during shift reduce parsing Introduction to LR parsing: Simple LR, Items and the LR(0) Automation, The LR-Parsing algorithm, Construction of SLR parsing table, More powerful LR Parsers: canonical LR(1) Items, Constructing LR(1) sets of items and canonical LR(1) parsing tables, Constructing LALR parsing tables

Unit IV: Syntax-Directed Translation: **(6 Lectures, 10 Marks)**

Syntax directed definitions, Inherited and synthesized attributes, Evaluation orders of SDD's: Dependency Graphs, S-attributed definitions, L-attributed definition. Construction of syntax trees. Syntax-directed Translation Schemes.

Unit V: Intermediate Code Generation (6 Lectures, 10 Marks)

Variants of Syntax Trees: Directed Acyclic Graphs (DAG), Three Address Code. Run Time Environments: Storage Organization, Static versus Dynamic Storage Organization, Stack Allocation of Space: Activation trees, Activation Records, Calling Sequences, Introduction to Garbage Collection: Design Goals for Garbage Collectors.

Unit VI: Code Generation (6 Lectures, 10 Marks)

Issues in Design of a Code generator, The Target Language, Address in the target code, Basic blocks and flow graphs. Optimization of Basic Blocks, Peephole Optimization and The Principal sources of Optimization: global common subexpression, copy propagation, Dead-code elimination.

Text Book: Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, *Compilers: Principles, Techniques and Tools*, Second Edition, Pearson Education.

Reference Books:

1. D. M. Dhamdhere, Compiler Construction – Principles and Practice, 2nd Edition, Macmillan India.
2. Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, Compilers: Principles, Techniques and Tools, Pearson Education (Low Price Edition).
3. Andrew Appel, Modern Compiler Implementation in C, Cambridge University Press.
4. K. C. Louden, Compiler Construction – Principles and Practice, India Edition, Cengage.
5. J. P. Bennett, Introduction to Compiling Techniques, 2nd Edition, Tata McGraw-Hill.
6. Manoj B. Chandak, Khushboo P Khurana; Compiler Design; Universities Press, 2018
7. V. Raghavan; Principles of Compiler Design, McGraw Hill Education (India), 2010.

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

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5AD221PC - MACHINE LEARNING TECHNIQUES

Course Prerequisites: Basic knowledge of Artificial Intelligence

Course Objectives:
- To explain the basic concepts, models, and learning mechanisms of artificial neural networks.
- To impart knowledge of backpropagation-based neural networks and optimization techniques.
- To introduce associative memory models and Adaptive Resonance Theory for pattern recognition tasks.
- To introduce fundamental machine learning paradigms and regression techniques for modelling and analyzing data.
- To develop an understanding of classification algorithms and performance evaluation methods.
- To familiarize students with clustering techniques and dimensionality reduction methods for unsupervised learning.

Course Outcomes (COs)*:*
After successful completion of the course, students will be able to:
1. Explain neural network architectures, learning methods, and gradient-based optimization concepts.
2. Apply backpropagation algorithms to train multilayer neural networks and address overfitting.
3. Analyze associative memory networks and ART models for classification and recognition applications.
4. Apply regression techniques and evaluation metrics to solve predictive modelling problems.
5. Implement and evaluate classification algorithms using appropriate performance measures.
6. Analyze data using clustering and dimensionality reduction techniques for pattern discovery.

SYLLABUS

Unit I: *(8 Hours)*
Fundamental of Neural Network Hours: Basic concepts of Neural Network, Human Brain, Model of artificial neurons, Mcculloch Pitts model, characteristics of Neural Network, Learning methods, taxonomy of Neural Network architecture, Perceptron model, Perceptron learning algorithm, Linear separability and XOR problem, error correction and Gradient descent, Batch vs SGD vs Mini-batch, Learning rate schedules, Brief intro to: Momentum, Adam (conceptual)

Unit II: *(8 Hours)*
Backpropagation Networks Hours: Supervised Learning with Neural Networks, Architecture of Backpropagation Network, Multilayer Perceptron, Chain rule in neural networks, Back propagation algorithm, Back Propagation learning, training of network, calculation of error, Gradient descent, Method of steepest descent algorithm, effect of learning rate, Loss functions and optimization, Overfitting and generalization

Unit III: *(6 Hours)*
Auto-Correlation, Hetero-Correlation (Cross-Correlation) , Multiple Training Encoding Strategy , Hopfield Network , Error Performance of Hopfield Network , Exponential BAM (Bidirectional Associative Memory), Associative Memory for Real-Coded Pattern Pairs, Concept of Adaptive Resonance Theory (ART), Cluster Structure and Category Formation in ART, ART1: Architecture (Conceptual), ART2: Conceptual Overview, Character Recognition Using ART1.

Unit IV: *(6 Hours)*
ML Techniques overview, Supervised Learning, unsupervised learning, reinforcement learning. Introduction to Regression, Linear Regression with one variable, Relationship between attributes using Covariance and Correlation, Model Evaluation in Regression, Evaluation Metrics in Regression Models, Gradient decent for Linear regression, Multiple Linear Regression, Non-Linear Regression, Time series analysis, ARIMA Model, Hypothesis testing of Regression Model and ARIMA Model.

Unit V: *(6 Hours)*
Binary Classification Naïve Bayes Classifier, K-Nearest Neighbors Classifier, Decision Tree Classifier, logistic regression, Advanced Methods for Classification: SVM, Ensembles methods, Bagging-Random Forest, Cross-validation & regularization, Measure of performance, Error analysis, Confusion matrix, ROC, Cross-validation & regularization.

Unit VI: *(6 Hours)*
Clustering, Distance measures, Different clustering methods (Distance, Density, Hierarchical), Iterative distance- based clustering; Dealing with continuous, categorical values in K-Means, Constructing a hierarchical cluster, Gaussian mixer model. EM-algorithm for mixture of Gaussians. UnsupervisedLearning: EigenAnalysis: SVD, PCA, LDA, dimension reduction, Applications in ML & NLP.

Text Books:
1. Elements of Artificial Neural Networks by Kishan Mehrotra, Chilukuri K. Mohan , Sanjay Ranka, Penram International Publishing,
2. The Elements of Statistical Learning, by Trevor Hastie, Robert Tibshirani, Jerome H. Friedman

Reference Books
1. Bishop, Christopher M., and Nasser M. Nasrabadi. Pattern recognition and machine learning. Vol. 4. No. 4. New York: springer, 2006.
2. Blum A, Hopcroft J, Kannan R. Foundations of Data Science. Cambridge University Press; 2020.
3. Machine Learning: Theory and Practice, by M.N. Murty (Author), V.S. Ananthanarayana (Author), Universities Press, 2023.
4. Machine Learning, revised and updated edition Ethem Alpaydin, The MIT Press.
5. Linear Algebra and Learning from Data, Gilbert Strang

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

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5CS222PC / 5DS222PC / 5KE222PC - COMPUTER ARCHITECTURE & ORGANIZATION

Course Prerequisites: Microprocessor and Assembly Language Programming

Course Objectives
- To understand the basic concepts, structure, and functional units of a computer system
- To explain number representation and arithmetic operations used in digital computers
- To understand addressing modes, memory organization, and memory hierarchy
- To analyze multitasking, parallel processing, and pipelining concepts in computer systems
- To explain input–output organization and communication mechanisms

Course Outcomes
After successful completion of the course, the students will be able to:
1. Explain the basic structure and functional organization of a computer system
2. Describe the internal operation of the CPU and instruction execution cycle
3. Compare and select appropriate memory and I/O devices based on system requirements
4. Apply number representation techniques and perform arithmetic operations
5. Explain concepts of parallel processing and pipelining in modern computer architectures

SYLLABUS
Unit I: Basic Structure of Computer (6 Lectures, 10 Marks)
Bus structures, memory locations and addresses, instructions and instruction sequencing, addressing modes, machine program sequencing, basic input and output operations.

Unit II: Memory Unit (6 Lectures, 10 Marks)
Basic memory concepts, memory hierarchy, semiconductor RAM memories, internal organization of memory chips, static memories, dynamic memories, read-only memories, memory speed, size and cost considerations.

Unit III: Processing Unit (6 Lectures, 10 Marks)
Fundamental concepts of processing unit, execution of a complete instruction, hardwired control, performance considerations, microprogrammed control, microinstructions, microprogram sequencing.

Unit IV: I/O Organization (6 Lectures, 10 Marks)
Accessing input–output devices, interrupts and interrupt handling, enabling and disabling interrupts, handling multiple devices, direct memory access.

Unit V: Computer Arithmetic (6 Lectures, 10 Marks)
Number representations, signed addition and subtraction, design of fast adders, multiplication of positive numbers, Booth multiplier, fast multiplication techniques, integer division.

Unit VI: Parallel Organization and Pipelining (6 Lectures, 10 Marks)
Parallel processing concepts, array processors, structure of general-purpose multiprocessors, symmetric multiprocessors, basic concepts of pipelining, pipeline throughput, speedup and pipeline hazards.

Text Book: Carl Hamacher, Zvonko Vranesic, Safwat Zaky, *Computer Organization*, Fifth Edition, Tata McGraw-Hill.

Reference Books:
1. William Stallings, *Computer Organization and Architecture: Designing for Performance*, Eighth Edition, Pearson.
2. John P. Hayes, *Computer Architecture and Organization*, McGraw-Hill.
3. David A. Patterson and John L. Hennessy, *Computer Organization and Design*, Morgan Kaufmann, Second Edition.
4. A. S. Tanenbaum, *Structured Computer Organization*, PHI Publication

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

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5AD222PC - DATA SCIENCE

Course Prerequisites
Basic knowledge of Applied Mathematics

Course Objectives:
After completing this course/unit, students will be able to:
- To understand fundamental statistical concepts, classify data by type and measurement scale, and select appropriate statistical techniques accordingly.
- To acquire, preprocess, explore, summarize, and visualize real-world data using suitable data wrangling and analytical techniques for effective decision-making.
- To build a strong mathematical foundation in linear algebra, statistics, and optimization for understanding the principles underlying data analysis and machine learning.
- To understand and apply unconstrained and constrained optimization techniques, including gradient-based, non-gradient, and least squares methods, in data science and machine learning.
- To understand and apply point estimation methods and evaluate the properties of statistical estimators in data analysis.
- To construct and interpret confidence intervals and understand their relationship with hypothesis testing.

Course Outcomes (COs)*:*
After successful completion of the course, students will be able to:
1. Identify data sources, classify datasets by measurement scale (nominal, ordinal, interval, ratio), and select appropriate statistical tools and visualization techniques based on data type.
2. Collect, clean, transform, tabulate, and visually analyze categorical and numerical data using appropriate descriptive statistics and graphical techniques to extract meaningful insights.
3. Apply linear algebraic and geometric concepts—such as matrices, eigenvalues, factorizations, projections, and distance measures—to formulate and interpret data science and machine learning problems
4. Formulate and solve optimization problems in data science and machine learning using optimality conditions, gradient methods, KKT conditions, and least squares techniques.
5. Construct and interpret point estimators using MLE, method of moments, and least squares, and relate estimation methods to engineering and data science applications

6. Construct and interpret confidence intervals for means, proportions, and variances, and apply interval estimation in engineering, data science, and research contexts.

SYLLABUS

Unit I: *(8 Hours)*
Definition and Scope of Data Science, Types of Data and Measurement Scales, Introduction to statistics, sources of data, Types of Data: Concepts of a statistical population and sample from a population; qualitative and quantitative data; nominal and ordinal data; cross sectional and time series data; discrete and continuous data; frequency and non- frequency data. Different types of scales - nominal, ordinal, ratio and interval, Unstructured Data ,Text, Image, Audio, Video data Structured vs Unstructured Data.

Unit II: *(8 Hours)*
Data Acquisition, Data wrangling, Cleaning, and Exploration, , Data Preprocessing and Transformation, Exploratory Data Analysis (EDA), Visualization for understanding data, Different types of presentations of data, data tabulation, describing categorical data, frequency distribution of categorical data, Describing numerical data, frequency table for numerical data, Histograms; Pie Charts; Bar Charts: Pareto Chart, Scatter Plots (Degree of Association); Line Charts, Box plots, Heatmaps, Correlation matrix visualization, Dashboard tools (basic exposure).

Unit III: *(6 Hours)*
Mathematical foundations of Data Science: Importance of linear algebra, statistics and optimization from a data science perspective, Matrices and their properties (determinants, traces, rank, nullity, etc.); Eigenvalues and eigenvectors; Matrix factorizations; Inner products; Distance measures; Projections; Notion of hyperplanes; half-planes.

Unit IV: *(6 Hours)*
Optimization: Unconstrained optimization; Necessary and sufficiency conditions for optima; Gradient descent methods; Constrained optimization, KKT conditions; Introduction to non-gradient techniques; Introduction to least squares optimization; Optimization view of machine learning.

Unit V: *(6 Hours)*
Recap of Probability Theory, Introduction to Common probability distributions, introduction to Sampling and distributions, theory, Introduction to Point Estimation, Properties of Estimators, Method of Maximum Likelihood Estimation, Large Sample Properties of MLE (Without Proof), Other Methods of Point Estimation: Method of Moments, Method of Least Squares, Method of Minimum Chi-Square.

Unit VI: *(6 Hours)*
Introduction to Interval Estimation, Duality Between Confidence Intervals and Hypothesis Tests, Confidence Intervals for Single Population Parameters, Confidence Intervals for Two Population Parameters, Estimation of Sample Size, Testing of Hypotheses, Introduction to Hypothesis Testing, One-Sample Tests of Hypothesis, Testing Hypotheses about Population Mean, Testing Hypotheses about Population Proportion, Testing Hypotheses about Population Variance, Neyman–Pearson Fundamental Lemma, Likelihood Ratio Tests.

Text Book
1. Business Statistics, For Contemporary Decision Making Ken BlackWiley
2. Introduction to Linear Algebra G. Strang Wellesley-Cambridge Press, Fifth edition, USA,2016.
3. An Introduction to Optimization: With Applications to Machine Learning, 5th Edition Edwin K. P. Chong, Wu-Sheng Lu, Stanislaw H. Zak, Wiley.

Reference Books
1. Doing Data Science Cathy O’Neil and Rachel Schutt O’Reilly Media, 2013.
2. Statistical Inference –Testing of Hypotheses Manoj Kumar Srivastava and Namita Srivastava Prentice Hall of India, 2014
3. Essential Math for Data Science Thomas Nield O'REILLY
4. Data Science and Analytics V. K. Jain; Khanna Publication
5. Optimization by Vector Space Methods David G. Luenberger John Wiley & Sons,NY, 1969.
6. Practical Statistics for Data Scientists, 2nd Edition Peter Bruce, Andrew Bruce, Peter Gedeck O'REILLY.

Tentative CO-PO Mapping:
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CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	–	2	–	–	–	–	–	–	2
CO2	2	3	3	2	3	–	–	–	–	–	–	2
CO3	3	3	2	2	–	–	–	–	–	–	–	2
CO4	3	3	3	2	–	–	–	–	–	–	–	2
CO5	3	3	2	3	–	–	–	–	–	–	–	2
CO6	2	3	2	3	–	–	–	–	–	–	–	3

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5CS223PE1 / 5DS223PE1 - DATA SCIENCE AND STATISTICS

Course Prerequisites
Basic knowledge of Mathematics

Course Objectives
- To understand the need, scope, and applications of data science and statistics
- To apply statistical data analysis techniques for business and engineering decision-making
- To understand and apply data modeling and analytical strategies
- To develop skills for effective data collection, preprocessing, and management
- To introduce machine learning techniques for data-driven insights

Course Outcomes
After successful completion of the course, the students will be able to:
1. Explain the fundamentals, scope, and need of data science and statistics
2. Apply descriptive and inferential statistical techniques for data analysis
3. Perform regression analysis including linear and multiple linear regression
4. Build and evaluate basic supervised and unsupervised learning models
5. Analyze data-driven outcomes and make informed decisions

SYLLABUS
Unit I: Introduction to Data Science (6 Lectures, 10 Marks)
Introduction to data science, relationship of data science with other fields, relationship between data science and information science, computational thinking, skills required for data science, tools for data science, ethics, bias, and privacy issues in data science, data types, data collection methods, data preprocessing techniques.

Unit II: Data Analytics and Statistical Techniques (6 Lectures, 10 Marks)
Introduction to data analysis and data analytics, descriptive analytics, diagnostic analytics, predictive analytics, prescriptive analytics, exploratory data analysis, mechanistic analysis, introduction to regression analysis.

Unit III: Python for Data Science (6 Lectures, 10 Marks)
Introduction to Python for data science, accessing Python environments, basic Python examples, control structures, importing datasets, data visualization and plotting, correlation analysis, linear regression, multiple linear regression using Python.

Unit IV: Machine Learning for Data Science (6 Lectures, 10 Marks)
Introduction to machine learning, supervised and unsupervised learning paradigms, classification concepts, clustering concepts, regression in machine learning, gradient descent and optimization basics.

Unit V: Supervised Learning Techniques (6 Lectures, 10 Marks)
Introduction to supervised learning, logistic regression, softmax regression, k-nearest neighbors classification, decision trees, random forest, naïve Bayes classifier.

Unit VI: Unsupervised Learning and Advanced Concepts (6 Lectures, 10 Marks)
Introduction to unsupervised learning, agglomerative clustering, divisive clustering, expectation maximization algorithm, overview of reinforcement learning concepts and applications.

Text Book: Chirag Shah, *A Hands-on Introduction to Data Science*, Cambridge University Press, 2020.

Reference Books:
1. Cathy O'Neil and Rachel Schutt, *Doing Data Science*, First Edition, O'Reilly Media, 2014.
2. Jiawei Han, Jian Pei, Micheline Kamber, *Data Mining: Concepts and Techniques*, Morgan Kaufmann.
3. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, *An Introduction to Statistical Learning with Applications in R*, First Edition, Springer, 2013.

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

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5CS223PE2 / 5KE223PE2 / 5AD223PE2 - INTRODUCTION TO CYBER SECURITY

Course Prerequisites: Computer Programming, Data Structures, Data Communication and Networking

Course Objectives
- To understand the fundamentals of cybercrime and information security
- To familiarize various cyber threats, attacks, and cyber offenses

- To understand cybercrime related to mobile and wireless devices
- To learn tools and methods used in cybercrime and cyber attacks
- To understand access control, authentication, intrusion detection, and prevention mechanisms

Course Outcomes:
After successful completion of the course, the students will be able to:
1. Explain the fundamentals of cybercrime and cyber offenses
2. Identify cyber threats, attacks, and system vulnerabilities
3. Explore industry practices, standards, and commonly used cybersecurity tools
4. Explain access control and authentication mechanisms
5. Describe intrusion detection and intrusion prevention techniques

SYLLABUS

Unit I: Introduction to Cybercrime (6 Lectures, 10 Marks)
Introduction to cybercrime, cybercrime and information security, classification of cybercrimes, legal perspectives of cybercrime, cybercrimes in Indian context, Information Technology Act 2000, global perspective on cybercrimes, evolution of cybercrime era.

Unit II: Cyber Offenses and Attacks (6 Lectures, 10 Marks)
Introduction to cyber offenses, types of cyber attacks, social engineering attacks, cyber stalking, cyber cafés and cybercrime, botnets, attack vectors, overview of cloud computing security issues.

Unit III: Cybercrime in Mobile and Wireless Devices (6 Lectures, 10 Marks)
Introduction to mobile and wireless devices, proliferation and trends in mobility, credit card frauds in mobile and wireless computing, security challenges posed by mobile devices, registry settings for mobile devices, authentication service security, attacks on mobile and cellular phones, security implementations for mobile devices in organizations, organizational security policies and measures for mobile computing and laptops.

Unit IV: Tools and Methods Used in Cybercrime (6 Lectures, 10 Marks)
Introduction to cybercrime tools, proxy servers and anonymizers, phishing attacks, password cracking techniques, key loggers and spyware, viruses and worms, Trojan horses and backdoors, steganography, denial of service and distributed denial of service attacks, SQL injection, buffer overflow attacks, attacks on wireless networks.

Unit V: Access Control, Authorization and Authentication (6 Lectures, 10 Marks)
Access control concepts and definitions, access rights, access control systems, authorization concepts, types of authorization systems, authorization principles and granularity, web access control and authorization, authentication concepts, multi-factor authentication and effectiveness, authentication elements, types of authentication, authentication methods.

Unit VI: Intrusion Detection and Prevention Systems (6 Lectures, 10 Marks)
System intrusion concepts, intrusion detection systems, types of intrusion detection systems, changing nature of IDS tools, response to system intrusion, challenges in intrusion detection systems, implementation of intrusion detection systems, intrusion prevention systems, intrusion detection and prevention tools.

Text Books:
1. Nina Godbole, Sunit Belapure, *Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives*, Wiley India Pvt. Ltd., 2013.
2. Joseph Migga Kizza, *A Guide to Computer Network Security*, Springer, 2009.

Reference Books
1. V. K. Pachghare, *Cryptography and Information Security*, PHI Learning Private Limited.
2. Nina Godbole, *Information Systems Security*, Wiley India.
3. Kenneth J. Knapp, *Cyber Security and Global Information Assurance*, Information Science Publishing.
4. James Graham, Richard Howard, Ryan Olson, *Cyber Security Essentials*, CRC Press.
5. Jeetendra Pande, *Introduction to Cyber Security*, Uttarakhand Open University, 2017.

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

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5CS223PE3 - INTERNET OF THINGS

Course Prerequisites
Basic knowledge of Internet and Microprocessor & Assembly Language Programming

Course Objectives
- To understand the fundamentals, characteristics, and architecture of Internet of Things
- To study IoT system design methodology and various IoT platforms
- To understand the applications and societal impact of IoT solutions
- To design and implement IoT applications using sensors and embedded devices
- To integrate IoT systems with cloud services and communication protocols

Course Outcomes
After successful completion of the course, the students will be able to:
1. Explain the basic concepts, architecture, and components of Internet of Things
2. Describe IoT design methodology and platforms used for IoT solutions
3. Interface and integrate various sensors with IoT development boards
4. Design and implement IoT-based real-time applications
5. Analyze IoT use cases across domains such as smart homes, cities, and agriculture

SYLLABUS

Unit I: (6 Lectures, 10 Marks)
IoT Definition & Characteristics; Physical Design (Devices & Protocols) and Logical Design (Functional Blocks & APIs); Enabling Technologies: WSN, Cloud, Big Data, and Embedded Systems; IoT Levels and Deployment Templates; Applications in Smart Homes, Cities, Energy, Agriculture, and Healthcare.

Unit II: (6 Lectures, 10 Marks)
Introduction to M2M; Key Differences between IoT and M2M; Introduction to SDN (Software Defined Networking) and NFV (Network Function Virtualization) for IoT; IoT Systems Management: Overview of SNMP and its limitations; Network Operator Requirements; Introduction to NETCONF and YANG; IoT System Management using NETCONF-YANG frameworks.

Unit III: (6 Lectures, 10 Marks)
IoT Design Methodology; Case Study: Weather Monitoring System; Logical Design using Python; Python Essentials: Data Types, Control Flow, and Functions; Modules, Packages, and File Handling; Date/Time Operations and Classes; Key Python Packages for IoT Development.

Unit IV: (Hours: 07)
Raspberry Pi Board Overview and Linux OS; Raspberry Pi Interfaces: Serial, SPI, and I2C Programming Raspberry Pi with Python; Practical Interfacing: Controlling LEDs, Switches, and Light Sensors; Overview of Other IoT Platforms: pcDuino, BeagleBone Black, and Cubieboard.

Unit V: (6 Lectures, 10 Marks)
Introduction to Python Web Servers; Building a Lightweight IoT Server using Flask; Handling HTTP Methods (GET, POST) for Sensor Data; Designing RESTful APIs for Device Interaction in Python; Introduction to Open-Source MQTT Brokers (Eclipse Mosquitto); Data Orchestration with Node-RED; Overview of Local IoT Dashboards: Storing and Visualizing Data using ThingsBoard Community Edition and SQLite Database integration with Python.

Unit VI: (6 Lectures, 10 Marks)
Home Automation: IoT-based Intrusion Detection System using PIR and Sound Sensors; Environment: Weather Monitoring System with Cloud Logging (DHT11, BMP180); Smart Cities: Ultrasonic Sensor-based Smart Parking Slot Management; Agriculture: Smart Irrigation System using Soil Moisture Sensors and Automated Pump Control via Relay.

Text Book: Arshdeep Bahga, Vijay Madisetti, *Internet of Things – A Hands-on Approach*, Universities Press.

Reference Books

1. K. A. Lambert, B. L. Juneja, *Fundamentals of Python*, Cengage Learning, 2012.
2. David Hanes, *IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things*, Cisco Press, 2017.
3. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, *From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence*, Academic Press, 2014.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5DS223PE2 - COGNITIVE TECHNOLOGIES

Course Prerequisites
Basic knowledge of Artificial Intelligence, Programming, and Data Structures

Course Objectives
- To introduce the concepts, principles, and approaches of cognitive technologies
- To understand key components and architectures of cognitive systems
- To explore the role of NLP, analytics, cloud, and distributed computing in cognitive computing
- To study IBM Watson as a representative cognitive computing platform
- To understand emerging trends and future applications of cognitive technologies

Course Outcomes
After successful completion of the course, the students will be able to:
1. Explain cognitive computing concepts and principles of cognitive systems
2. Analyze the role of natural language processing in cognitive systems
3. Apply advanced analytics techniques in cognitive computing scenarios
4. Explain the role of cloud and distributed computing in cognitive applications
5. Design and assess the process of building cognitive applications
6. Identify emerging areas and future applications of cognitive computing

SYLLABUS

Unit I: Foundations of Cognitive Computing and Design Principles (6 Lectures, 10 Marks)
Foundations of cognitive computing, cognitive computing as a new generation, uses of cognitive systems, characteristics of cognitive systems, gaining insights from data, domains suitable for cognitive computing, artificial intelligence as the foundation of cognitive computing, understanding cognition, systems of judgment and choice, elements of a cognitive system, infrastructure and deployment modalities, design principles of cognitive systems, components of a cognitive system, building the corpus, data ingestion, machine learning, hypothesis generation and scoring, presentation and visualization services.

Unit II: NLP and Big Data in Cognitive Systems (6 Lectures, 10 Marks)
Role of natural language processing in cognitive systems, semantic web, applying NLP to business problems, relationship between big data and cognitive computing, human-generated data, defining big data, architectural foundations for big data, analytical data warehouses, Hadoop ecosystem, data in motion and streaming data, integration of big data with traditional data sources.

Unit III: Knowledge Representation and Advanced Analytics (6 Lectures, 10 Marks)
Knowledge representation in taxonomies and ontologies, developing cognitive systems, defining taxonomies and ontologies, models for knowledge representation, role of advanced analytics in cognitive computing, capabilities of advanced analytics, creating value using analytics, impact of open-source tools on advanced analytics.

Unit IV: Cloud and Distributed Computing for Cognitive Computing (6 Lectures, 10 Marks)
Role of cloud and distributed computing in cognitive systems, leveraging distributed computing for shared resources, importance of cloud services for cognitive computing, characteristics and service models of cloud computing, delivery models, workload management, security and governance, data integration and management in the cloud, business implications of cognitive computing, disruptive models, business knowledge and planning, building business-specific cognitive solutions.

Unit V: IBM Watson and Building Cognitive Applications (6 Lectures, 10 Marks)
IBM Watson as a cognitive system, Watson overview, DeepQA architecture, Watson for Jeopardy and commercial applications, emerging cognitive platforms, defining objectives and domains, understanding users, defining questions and insights, creating and refining corpora, training and testing cognitive systems, building cognitive healthcare applications, cognitive computing in healthcare ecosystem, applications for health, wellness, electronic medical records, and clinical teaching.

Unit VI: Emerging Areas and Future Applications (6 Lectures, 10 Marks)
Cognitive computing for smarter cities, cognitive computing in government, characteristics of smart cities, open data movement, internet of everything, data ownership and value, preventative healthcare, smart transportation, workforce analytics, cognitive community infrastructure, emerging cognitive computing markets, vertical industries, future applications of cognitive computing, next-generation requirements, technical advancements and emerging innovations.

Text Book: Judith Hurwitz, Marcia Kaufman, Adrian Bowles, *Cognitive Computing and Big Data Analytics*, John Wiley & Sons, 2015.

Reference Books:

1. José Luis Bermúdez, *Cognitive Science: An Introduction to the Science of the Mind*, Second Edition, Cambridge University Press.
2. Jay Friedenberg, Gordon Silverman, *Cognitive Science: An Introduction to the Study of Mind*, Sage Publications, 2014.
3. Huimin Lu (Ed.), *Cognitive Internet of Things: Frameworks, Tools and Applications*, Springer Nature, 2020.
4. Danish Contractor, Aaditya Telang (Eds.), *Applications of Cognitive Computing Systems and IBM Watson*, Springer Nature Singapore, 2017.
5. Steven Bird, Ewan Klein, Edward Loper, *Natural Language Processing with Python*, O'Reilly Media, 2009.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5KE223PE1 - INTERNET OF EVERYTHING

Course Prerequisites

Basic knowledge of Computer Networks, Internet of Things, and Programming Fundamentals

Course Objectives

- To understand the concept, scope, and evolution of Internet of Everything (IoE)
- To differentiate IoE from IoT and study its architectural components
- To explore data, people, processes, and things as core pillars of IoE
- To study enabling technologies such as cloud, big data, AI, and edge computing in IoE
- To analyze real-world IoE applications across smart environments and industries

Course Outcomes

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

1. Explain the concept, architecture, and components of Internet of Everything
2. Differentiate between IoT, IoE, and related paradigms
3. Analyze the role of data, people, processes, and things in IoE ecosystems
4. Apply enabling technologies such as cloud, analytics, and AI in IoE use cases
5. Evaluate IoE applications and challenges in smart and connected environments

SYLLABUS

Unit I: Introduction to Internet of Everything (6 Lectures, 10 Marks)

Evolution of internet technologies, Internet of Things overview, limitations of IoT, concept and definition of Internet of Everything, IoE vs IoT, IoE value proposition, digital transformation and IoE, convergence of people, process, data and things, business and societal impact of IoE

Unit II: IoE Architecture and Components (6 Lectures, 10 Marks)

IoE reference architecture, layered architecture of IoE, sensing and actuation layer, communication layer, data management layer, application layer, role of people and processes in IoE, device connectivity models, interoperability and standardization challenges

Unit III: Enabling Technologies for IoE (6 Lectures, 10 Marks)

Sensors and actuators, RFID and smart devices, communication technologies for IoE, cloud computing for IoE, edge and fog computing, big data analytics, artificial intelligence and machine learning in IoE, APIs and service orchestration

Unit IV: Data Management, Analytics and Intelligence (6 Lectures, 10 Marks)

Data generation in IoE environments, data acquisition and ingestion, real-time and batch data processing, stream analytics, context-aware computing, predictive analytics, decision support systems, visualization of IoE data

Unit V: IoE Applications and Use Cases (6 Lectures, 10 Marks)

Smart homes and smart buildings, smart cities, intelligent transportation systems, industrial IoE and Industry 4.0, healthcare and wearable technologies, agriculture and environmental monitoring, retail and supply chain management

Unit VI: Security, Privacy and Future Trends in IoE (6 Lectures, 10 Marks)

Security challenges in IoE, privacy and data protection issues, trust management, authentication and access control, ethical issues in connected environments, regulatory and compliance aspects, emerging trends in IoE, future research directions and opportunities

Text Book: Dave Evans, *The Internet of Everything: How More Relevant and Valuable Connections Will Change the World*, Cisco Press, 2015.

Reference Books

1. Olivier Hersent, David Boswarthick, Omar Elloumi, *The Internet of Things: Key Applications and Protocols*, Wiley.
2. Arshdeep Bahga, Vijay Madisetti, *Internet of Things: A Hands-On Approach*, Universities Press.

3. Rajkumar Buyya et al., *Internet of Things: Principles and Paradigms*, Morgan Kaufmann.
4. Dieter Uckelmann, Mark Harrison, Florian Michahelles, *Architecting the Internet of Things*, Springer.
5. Fei Hu, *Internet of Things: A Comprehensive Guide to Architecting IoT Solutions*, CRC Press.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5CS223PE2 / 5KE223PE2 / 5AD223PE2 - INTRODUCTION TO CYBER SECURITY

Course Prerequisites
Computer Programming, Data Structures, Data Communication and Networking

Course Objectives
- To understand the fundamentals of cybercrime and information security
- To familiarize various cyber threats, attacks, and cyber offenses
- To understand cybercrime related to mobile and wireless devices
- To learn tools and methods used in cybercrime and cyber attacks
- To understand access control, authentication, intrusion detection, and prevention mechanisms

Course Outcomes
After successful completion of the course, the students will be able to:
6. Explain the fundamentals of cybercrime and cyber offenses
7. Identify cyber threats, attacks, and system vulnerabilities
8. Explore industry practices, standards, and commonly used cybersecurity tools
9. Explain access control and authentication mechanisms
10. Describe intrusion detection and intrusion prevention techniques

SYLLABUS

Unit I: Introduction to Cybercrime (6 Lectures, 10 Marks)
Introduction to cybercrime, cybercrime and information security, classification of cybercrimes, legal perspectives of cybercrime, cybercrimes in Indian context, Information Technology Act 2000, global perspective on cybercrimes, evolution of cybercrime era.

Unit II: Cyber Offenses and Attacks (6 Lectures, 10 Marks)
Introduction to cyber offenses, types of cyber attacks, social engineering attacks, cyber stalking, cyber cafés and cybercrime, botnets, attack vectors, overview of cloud computing security issues.

Unit III: Cybercrime in Mobile and Wireless Devices (6 Lectures, 10 Marks)
Introduction to mobile and wireless devices, proliferation and trends in mobility, credit card frauds in mobile and wireless computing, security challenges posed by mobile devices, registry settings for mobile devices, authentication service security, attacks on mobile and cellular phones, security implementations for mobile devices in organizations, organizational security policies and measures for mobile computing and laptops.

Unit IV: Tools and Methods Used in Cybercrime (6 Lectures, 10 Marks)
Introduction to cybercrime tools, proxy servers and anonymizers, phishing attacks, password cracking techniques, key loggers and spyware, viruses and worms, Trojan horses and backdoors, steganography, denial of service and distributed denial of service attacks, SQL injection, buffer overflow attacks, attacks on wireless networks.

Unit V: Access Control, Authorization and Authentication (6 Lectures, 10 Marks)
Access control concepts and definitions, access rights, access control systems, authorization concepts, types of authorization systems, authorization principles and granularity, web access control and authorization, authentication concepts, multi-factor authentication and effectiveness, authentication elements, types of authentication, authentication methods.

Unit VI: Intrusion Detection and Prevention Systems (6 Lectures, 10 Marks)
System intrusion concepts, intrusion detection systems, types of intrusion detection systems, changing nature of IDS tools, response to system intrusion, challenges in intrusion detection systems, implementation of intrusion detection systems, intrusion prevention systems, intrusion detection and prevention tools.

Text Books
1. Nina Godbole, Sunit Belapure, *Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives*, Wiley India Pvt. Ltd., 2013.

2. Joseph Migga Kizza, *A Guide to Computer Network Security*, Springer, 2009.

Reference Books

1. V. K. Pachghare, *Cryptography and Information Security*, PHI Learning Private Limited.
2. Nina Godbole, *Information Systems Security*, Wiley India.
3. Kenneth J. Knapp, *Cyber Security and Global Information Assurance*, Information Science Publishing.
4. James Graham, Richard Howard, Ryan Olson, *Cyber Security Essentials*, CRC Press.
5. Jeetendra Pande, *Introduction to Cyber Security*, Uttarakhand Open University, 2017.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5KE223PE3 - AUGMENTED & VIRTUAL REALITY

Course Prerequisite:
Basics of Computers & Multimedia

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of
Virtual and Augmented Reality by being able to do each of the following:

- To introduce the relevance of this course to the existing technology through demonstrations, case
- studies and applications with a futuristic vision along with socio-economic impact and issues
- To understand virtual reality, augmented reality and using them to build Biomedical engineering
- applications
- To know the intricacies of these platform to develop PDA applications with better optimality

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:
Describe Virtual reality & its applications.

1. Discuss virtual reality world and types.
2. Examine geometry of virtual world and the physiology of human vision
3. Investigate Visual Perception, Motion and Tracking
4. Inspect Physics of Sound and the Physiology of Human Hearing.
5. Explain Augmented reality & examples based on Augmented reality

Unit I: (Hours: 07)
Introduction to Virtual Reality: Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality.

Unit II: (Hours: 07)
Representing the Virtual World: Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR

Unit III: (Hours: 07)
The Geometry of Virtual Worlds &The Physiology of Human Vision: Geometric Models, Changing Position and Orientation, Axis- Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.

Unit IV: (Hours: 07)
Visual Perception, Motion & Tracking: Visual Perception -Perception of Depth, Motion, & Color, Ray Motion in Real and Virtual Worlds- Velocities and Accelerations, Tracking 2D & 3D Orientation, Tracking Position and Orientation.

Unit V: (Hours:07)
Interaction & Audio: Interaction - Motor Programs and Remapping, Locomotion, Manipulation, Social Interaction. Audio - The Physics of Sound, The Physiology of Human Hearing, Auditory Perception, Auditory Rendering.

Unit VI: (Hours: 07)
Basics of Augmented Reality: Introduction to Augmented Reality , Examples based on Augmented reality , Mixed Reality Continuum ,Computer Vision for Augmented Reality , Confluence of Virtual Reality and Augmented Reality , Requirements of AR Authoring ,Taking AR Outdoors.

Text Books:

1. M. LaValle, “Virtual Reality, Steven”, Cambridge University Press, 2016.

2. Augmented Reality: Principles and Practice (Usability) by Dieter Schmalstieg & Tobias Hollerer, Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN: 9780321883575

Reference Books:

1. William R Sherman and Alan B Craig, "Understanding Virtual Reality", Interface, Application and Design, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
2. Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann, 2004
3. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Inter science, India, 2008
4. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.
5. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
6. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
7. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Merging Real and Virtual Worlds", 2005
8. Jason Jerald - The VR Book: Human-Centred Design for Virtual Reality. Association for Computing Machinery and Morgan and Claypool, New York, NY, USA.
9. Dieter Schmalstieg and Tobias Hollerer - Augmented Reality: Principles and Practice (Usability), Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016.
10. Steve Aukstakalnis - Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability), Addison-Wesley Professional; 1st edition, 2016.
11. Robert Scoble and Shel Israel - The Fourth Transformation: How Augmented Reality and Artificial Intelligence Will Change Everything, Patrick Brewster Press; 1st edition, 2016.
12. Tony Parisi - Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile, OReilly Media; 1st edition, 2015.
13. Programming 3D Applications with HTML5 and WebGL: 3D Animation and Visualization for Web Pages, Tony Parisi, OReilly Media; 1st edition, 2014.
14. John Vince - Virtual Reality Systems, Addison Wesley, 1995.
15. Howard Rheingold - Virtual Reality: The Revolutionary Technology and how it Promises to Transform Society, Simon and Schuster, 1991.

Supplementary Resources:

1. http://lavalle.pl/vr/book.html

Mapped with MOOCS/other Courses:

1. https://nptel.ac.in/courses/106/106/106106138/
2. https://nptel.ac.in/courses/106105195/13
3. https://www.coursera.org/learn/introduction-virtual-reality.

Tentative CO-PO Mapping:

(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

5AD223PE1 - BUSINESS INTELLIGENCE

Course Prerequisites

Database Management System

Course Objectives:

After completing this course/unit, students will be able to:

- To introduce the concepts and components of Business Intelligence (BI)
- To evaluate the technologies that make up BI (data warehousing, OLAP)
- To identify the technological architecture of BI systems·
- To explain different data preprocessing techniques
- To identify machine learning model as per business need
- To understand the BI applications in marketing, logistics, finance and telecommunication sector

Course Outcomes (COs)*:*

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

1. Differentiate the concepts of Decision Support System & Business Intelligence
2. Use Data Warehouse & Business Architecture to design a BI system.
3. Build graphical reports
4. Apply different data preprocessing techniques on dataset
5. Implement machine learning algorithms as per business needs
6. Identify role of BI in marketing, logistics, and finance and telecommunication sector

SYLLABUS

Unit I: Introduction to Decision support systems and Business intelligence *(7 Hours)*
Decision support systems: Definition of system, representation of the decision-making process, evolution of information systems, Decision Support System, Development of a decision support system, the four stages of Simon's decision-making process, and common strategies and approaches of decision makers. **Business Intelligence**: BI, its components & architecture, previewing the future of BI, crafting a better experience for all business users, End user assumptions, setting up data for BI, data, information and knowledge, The role of mathematical models, Business intelligence architectures, Ethics and business intelligence.

Unit II: The Architecture of DW and BI *(7 Hours)*
BI and DW architectures and its types - Relation between BI and DW, OLAP (Online analytical processing) definitions - Different OLAP Architectures, Data Models-Tools in Business Intelligence-Role of DSS, EIS, MIS and digital Dash boards – Need for Business Intelligence Difference between OLAP and OLTP - Dimensional analysis - OLAP models - - defining schemas: Stars, snowflakes and fact constellations.

Unit III: Reporting Authoring *(7 Hours)*
Building reports with relational vs Multidimensional data models; Types of Reports – List, crosstabs, Statistics, Chart, map, financial etc; Data Grouping & Sorting, Filtering Reports, Adding Calculations to Reports, Conditional formatting, Adding Summary Lines to Reports. Drill up, drill- down, drill-through capabilities. Run or schedule report, different output forms – PDF, excel, csv, xml etc.

Unit IV: Data preparation *(7 Hours)*
Data validation: Incomplete data , Data affected by noise .**Data transformation**: Standardization , Feature extraction. **Data reduction** : Sampling, Feature selection, Principal component analysis, Data discretization. **Data exploration** : **1.Univarate analysis** :Graphical analysis of categorical attributes ,Graphical analysis of numerical attributes , Measures of central tendency for numerical attributes , Measures of dispersion for numerical attributes, Identification of outliers for numerical attributes **2.Bivariate analysis**: Graphical analysis , Measures of correlation for numerical attributes , Contingency tables for categorical attributes, **3.Multivariate analysis**: Graphical analysis , Measures of correlation for numerical attributes.

Unit V: Impact of Machine learning in Business Intelligence Process *(7 Hours)*
Classification: Classification problems, Evaluation of classification models, Bayesian methods, Logistic regression. **Clustering:** Clustering methods, Partition methods, Hierarchical methods, Evaluation of clustering models. **Association Rule**: Structure of Association Rule, Apriori Algorithm.

Unit VI: BI Applications *(7 Hours)*
Tools for Business Intelligence, Role of analytical tools in BI, Case study of Analytical Tools: WEKA, KNIME, Rapid Miner, R; Data analytics, Business analytics, ERP and Business Intelligence, BI and operation management, BI in inventory management system, BI and human resource management, BI Applications in CRM, BI Applications in Marketing, BI Applications in Logistics and Production, Role of BI in Finance, BI Applications in Banking, BI Applications in Telecommunications, BI in salesforce management.

Text Books:

1. Fundamental of Business Intelligence, Grossmann W, Rinderle-Ma, Springer,2015
2. R. Sharda, D. Delen, & E. Turban, Business Intelligence and Analytics. Systems for Decision Support, 10th Edition. Pearson/Prentice Hall, 2015.

Reference Books:

1. Paulraj Ponnian, "Data Warehousing Fundamentals", John Willey.
2. Introduction to business Intelligence and data warehousing, IBM, PHI
3. Business Intelligence: Data Mining and Optimization for Decision Making, Carlo Vercellis, Wiley,2019
4. Data Mining for Business Intelligence, WILEY
5. EMC Educational Services, Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, Wiley ISBN-13 978 1118876138
6. Ken W. Collier, Agile Analytics: A value driven Approach to Business Intelligence and Data Warehousing, Pearson Education,2012, ISBN-13 978 8131786826

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5CS224PC / 5DS224PC / 5KE224PC / 5AD224PC - DATABASE MANAGEMENT SYSTEMS LAB

Course Prerequisites
Basic concepts of programming, basic concepts of data structures

Course Objectives
- To understand the ER model for capturing semantics of real-world applications and database design
- To study the relational data model used in commercial database systems
- To implement structured query language for database creation, manipulation, and querying
- To enforce integrity and security constraints in databases
- To develop hands-on skills using relational and NoSQL databases

Course Outcomes
After successful completion of the course, the students will be able to:
1. Design ER models for real-world database applications
2. Design and develop relational and NoSQL databases
3. Apply normalization techniques to database schemas
4. Write and execute SQL queries for data retrieval and manipulation
5. Implement integrity constraints, triggers, views, and indexes
6. Develop database-driven applications using host languages and web technologies

LIST OF EXPERIMENTS:
*This is a sample list of experiments. Minimum **12 experiments** must be performed covering the entire syllabus. At least **two experiments** shall be beyond syllabus based on the learning of syllabus.*

Practical 1
Study a database modelling tool, take a description of an enterprise, create the corresponding ER diagram and build a database model using a modelling tool, logical and physical modelling, adding entities, attributes and relationships including one-to-one, one-to-many and many-to-many, forward and reverse engineering, schema generation steps.
Practical 2
Study and implement DDL commands, create tables based on the ER model, insert data, alter and drop tables, study cascaded delete operations.
Practical 3
Study and implement DML commands – I, SQL queries using SELECT, FROM and WHERE clauses, predicates using AND, OR and NOT, rename operation, tuple variables, string operations using LIKE, matching beginning and ending patterns, substring operations, matching exact and minimum number of characters, ORDER BY clause, HAVING clause.
Practical 4
Study and implement DML commands – II, set membership operations, IN and NOT IN, SOME and ALL, EXISTS and NOT EXISTS, testing emptiness, testing absence of duplicates, nested queries.
Practical 5
Study and implement aggregation functions, SQL queries using MIN, MAX, AVG, SUM and COUNT functions with minimum three queries for each function.
Practical 6
Write SQL queries to create and use views and indexes.
Practical 7
Write SQL queries to perform modifications on database records.
Practical 8
PL/SQL programming fundamentals.
Practical 9
Database access using cursors, write a trigger to find names and cities of customers having more than a specified amount in any account.
Practical 10
Triggers, write a trigger for handling overdrafts by setting account balance to zero and creating a loan entry, write a trigger to handle blank city values.
Practical 11
Procedures and functions, write and demonstrate at least two stored procedures and two functions.
Practical 12 ***(Beyond Syllabus)***
Web programming with PL/SQL, HTTP basics, printing HTML tables, passing parameters, processing HTML forms, handling multi-valued parameters.
Practical 13 ***(Beyond Syllabus)***
Develop JDBC applications to retrieve and manipulate database data using Java, C or C++.
Practical 14 ***(Beyond Syllabus)***
Web programming using Java Servlets, servlet basics, HTTP servlet API, HTML form processing, database connectivity.
Practical 15 ***(Beyond Syllabus)***
PHP-based database application, development of a simple PHP application to access database.

Mini Project (Compulsory)
Based on concepts covered, develop a mini project using relational or NoSQL database.

Suggested Topics:
Bank database, university database, airline flight information system, library database application, student database system, video chain database, banking database, BibTeX database, music store database, online auction system, web survey management system.

Text Book
Korth, Sudarshan, Silberschatz, *Database System Concepts*, McGraw-Hill. MySQL Reference Manual.

Reference Books

1. Kevin Roebuck, *Storing and Managing Big Data – NoSQL, Hadoop and More*, Emereo Pty Ltd.
2. Kristina Chodorow, Michael Dirolf, *MongoDB: The Definitive Guide*, O'Reilly Media.
3. Adam Fowler, *NoSQL for Dummies*, John Wiley & Sons.
4. C. J. Date, *An Introduction to Database Systems*, Addison-Wesley.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

5CS225PC / 5DS225PC / 5KE225PC - COMPILER DESIGN LAB

Course Prerequisite:
Basic knowledge of C Programming, Data Structures, Theory of Computation.

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of Compiler Design by being able to do each of the following:

- Know the basic components of a Compiler.
- To implement Lexical Analyzer using Lex tool and Syntax Analyzer using Yaac Tool.
- To implement various parsing methods.
- To implement code optimization techniques.

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:

1. Identify the fundamentals of compiler and its phases.
2. Use the powerful compiler generation tools such as Lex and Yacc.
3. Write a lexical scanner, either from scratch or using Lex.
4. Develop program for solving parser problems.
5. Examine the various optimization techniques.

List of Experiments: This is the sample list of Experiments; minimum 12 experiments are to be performed covering the entire syllabus. At least two experiments should be beyond syllabi based on learning of syllabi

List of Experiments based on Syllabus: (Maximum 20)

1. Design a lexical analyzer for given language and the lexical analyzer should ignore redundant spaces, tabs and new lines. It should also ignore comments. Although the syntax specification states that identifiers can be arbitrarily long, you may restrict the length to some reasonable value. Simulate the same in C language.
2. Write a C program to identify whether a given line is a comment or not.
3. Implement a C program to check parenthesis of regular expression is balanced or not.
4. Implement a C program to construct NFA from regular expression.
5. Implement a C program to simulate Deterministic Finite Automation (DFA) for a string which ending with 'a', 'a*b+', 'abb'.
6. Write a C program to construct of DFA from NFA.
7. Implement a Lex program to verify the parenthesis of a given expression is balanced.
8. Implement a Lex program to recognize the token like Digit, Identifier & Delimiter.
9. Implement the Lexical Analyzer using JLex, flex or other lexical analyzer generating tools.
10. Implement a Lex program to a valid arithmetic expression and to recognize the identifier and operators present.
11. Implement a Lex program to count words, characters, lines, vowels and consonants from given input.
12. Implement a Lex program to check given number is positive negative or zero.
13. Implement a Lex program to generate string which is ending with zeros.
14. Implement LEX and Yacc tool to implement desk calculator.
15. Write a C program for constructing of SLR parsing.
16. Write a C program for constructing of LL (1) parsing.
17. Write a C program for constructing of LALR parsing.
18. Write a C program for constructing recursive descent parsing.
19. Write a C program to implement Program semantic rules to calculate the expression that takes an expression with digits, + and * and computes the value.
20. Write a C program for Tokenizing the file which reads a source code in C/C++ from an unformatted file and extract various types of tokens from it
21. Write functions to find FIRST and FOLLOW of all the variables / given grammar.
22. Implement a Shift Reduce Parser for the following productions.E → E+E / E*E / a / b
23. Implement a symbol table containing functions create(), modify(), search(), display() and delete().
24. Implement three address Code for the input a=b*c.

25. Implement Recursive Decent Parser for the productions.

List of Experiments beyond Syllabus: (Maximum 05)
1. Convert the BNF rules into Yacc form and write code to generate Abstract Syntax Tree.
2. Write a C program to generate machine code from abstract syntax tree generated by the parser.
3. Write a Lex program to find out total number of vowels, and consonants from the given input string.
4. Implementation of Finite State machines DFA, NFAs .
5. Computation of Leading & Trailing Sets.

Text Book: Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman Compilers: "Principles, Techniques and Tools", Pearson Education, Second Edition.

Reference Books:
1. Doug Brown, John Levine, and Tony Mason, "Lex & Yacc", O'Reilly & Associates, Inc., Second Edition.
2. Andrew Appel, "Modern Compiler Implementation in C", Cambridge University press.
3. K C. Louden "Compiler Construction - Principles and Practice" India Edition, CENGAGE.
4. Dick Grune, Kees van Reeuwijk, Henri E. Bal, Ceriel J.H. Jacobs and Koen Langendoen,
5. "Modern Compiler Design", Second Edition, John Wiley & Sons Publication.
6. Keith Cooper and Linda Torczon, "Engineering: A Compiler", Second Edition, Morgan Kaufmann Publication.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5AD225PC - DATA SCIENCE LAB

Type: Practical | **Credits:** 1

Course Prerequisite
• Basic knowledge of statistics and probability
• Elementary programming knowledge (Python / R / Excel)
• Fundamental understanding of data handling and mathematical concepts

Course Objectives
• To provide hands-on exposure to data acquisition, preprocessing, and exploratory data analysis techniques.
• To develop practical skills in applying statistical and mathematical concepts for data analysis.
• To enable students to perform visualization and interpretation of real-world datasets.
• To implement estimation, optimization, and statistical inference techniques using computational tools.
• To develop analytical thinking for solving data-driven engineering and business problems.

Course Outcomes (COs)
After successful completion of the course, students will be able to:
1. **CO1:** Perform data acquisition, cleaning, preprocessing, and classification of datasets based on data types and measurement scales.
2. **CO2:** Apply descriptive statistics and exploratory data analysis techniques to summarize and visualize datasets.
3. **CO3:** Apply linear algebra and mathematical concepts using computational tools for data analysis problems.
4. **CO4:** Implement optimization and regression-based approaches for data modeling and analysis.
5. **CO5:** Perform statistical estimation, confidence interval construction, and hypothesis testing for real-world datasets.

Tentative List of Practical Experiments (Any 10–12 to be performed)
1. Study of data science environment (Python/Jupyter/Colab/R) and dataset handling.
2. Data acquisition from CSV, Excel, APIs, and public datasets.
3. Data cleaning: handling missing values, duplicates, and inconsistent data.
4. Data transformation and preprocessing techniques (normalization, scaling, encoding).
5. Exploratory Data Analysis (EDA) using descriptive statistics.
6. Visualization using charts: histogram, bar chart, box plot, scatter plot, heatmap.
7. Correlation analysis and visualization of relationships between variables.
8. Matrix operations and vector computations using NumPy.
9. Linear regression implementation and least squares estimation.
10. Gradient descent demonstration for optimization problems.
11. Implementation of probability distributions and sampling experiments.
12. Point estimation using MLE and method of moments (simulation-based).

13. Construction of confidence intervals for mean and proportion.
14. Hypothesis testing using one-sample and two-sample tests.
15. Mini Project: End-to-end data analysis including preprocessing, visualization, modeling, and interpretation.

Recommended Tools and Platforms:
• Python (NumPy, Pandas, Matplotlib, Seaborn)
• Jupyter Notebook / Google Colab
• MS Excel (Analysis Toolpak)
• Public datasets (Kaggle, UCI Repository, data.gov.in)

Text Books:
1. Wes McKinney, *Python for Data Analysis*, O'Reilly Media.
2. Peter Bruce, Andrew Bruce, Peter Gedeck, *Practical Statistics for Data Scientists*, O'Reilly Media.

Reference Books:
1. Cathy O'Neil and Rachel Schutt, *Doing Data Science*, O'Reilly Media.
2. Thomas Nield, *Essential Math for Data Science*, O'Reilly.
3. V. K. Jain, *Data Science and Analytics*, Khanna Publication.
4. Fabio Nelli, *Python Data Analytics*, Apress.
5. Joel Grus, *Data Science from Scratch*, O'Reilly Media.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5CS226PE/5DS226PE - PROGRAMME ELECTIVE COURSE I LAB –

Data Science and Statistics

Course Prerequisite:
Basic knowledge of Mathematics

Course Objectives:
After completion of this laboratory course, students will be able to:
- Gain hands-on understanding of data science workflows and statistical analysis techniques.
- Apply descriptive, diagnostic, predictive, and prescriptive analytics to real datasets.
- Implement data preprocessing, visualization, regression, and classification models using Python.
- Analyze data-driven outcomes to support decision-making in business and engineering contexts.

Course Outcomes (Expected Outcome):
On successful completion of the course, students will be able to:
1. Perform data collection, cleaning, and preprocessing for data science tasks.
2. Apply statistical analysis techniques to explore and interpret datasets.
3. Build and evaluate regression models for predictive analytics.
4. Develop and assess classification and clustering models using machine learning algorithms.
5. Interpret analytical results and make data-driven decisions.

List of Experiments:

Part A: Introduction to Data Science & Data Handling
1. Introduction to data science tools (Python, Jupyter, Anaconda).
2. Study of data types and data collection methods.
3. Data loading and basic preprocessing using Pandas.
4. Handling missing values and outliers.
5. Exploratory Data Analysis (EDA) using summary statistics.

Part B: Statistical Analysis & Visualization
1. Measures of central tendency and dispersion.
2. Data visualization using Matplotlib and Seaborn.
3. Correlation analysis and interpretation.
4. Hypothesis testing (t-test, chi-square test).
5. ANOVA and inference.

Part C: Regression Analysis
1. Implementation of Simple Linear Regression.
2. Implementation of Multiple Linear Regression.
3. Model diagnostics: R^2, Adjusted R^2, residual analysis.
4. Comparison of regression models.
5. Case study on regression-based prediction.

Part D: Machine Learning for Data Science
1. Implementation of K-Nearest Neighbors (KNN) classifier.
2. Logistic Regression for classification.
3. Decision Tree classifier and visualization.
4. Random Forest classifier and feature importance.
5. Performance evaluation: confusion matrix, precision, recall, F1-score.

Part E: Unsupervised Learning & Advanced Topics
1. Implementation of K-Means clustering.
2. Hierarchical clustering (agglomerative/divisive).
3. Expectation Maximization (EM) algorithm (demo).
4. Introductory experiment on Reinforcement Learning (demo).
5. Mini Project: End-to-end data science problem (EDA → model → interpretation).

Text Book: Chirag Shah – A Hands-on Introduction to Data Science, Cambridge University Press.

Reference Books:

1. Cathy O'Neil & Rachel Schutt – Doing Data Science, O'Reilly.
2. Jiawei Han, Jian Pei, Micheline Kamber – Data Mining: Concepts and Techniques.
3. Gareth James et al. – An Introduction to Statistical Learning, Springer.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5CS226PE/5KE226PE/5AD226PE - PROGRAMME ELECTIVE COURSE I LAB –

INTRODUCTION TO CYBER SECURITY

Course Prerequisite:
Computer Programming , Data Structures, Data Communication & Networking

Course Objectives:
After completion of this laboratory course, students will be able to:
- Gain hands-on understanding of cybercrime, cyber threats, and security fundamentals.
- Explore and use basic cybersecurity tools and techniques to identify vulnerabilities and attacks.
- Implement access control, authentication, and intrusion detection mechanisms.
- Analyze real-world cybercrime scenarios, mobile security issues, and defense strategies.

Course Outcomes (Expected Outcome):
On successful completion of the course, students will be able to:
1. Identify and classify cybercrimes, cyber offenses, and attack vectors.
2. Demonstrate common cyberattack techniques and corresponding defense mechanisms.
3. Use industry-standard cybersecurity tools for scanning, monitoring, and analysis.
4. Implement authentication and access control mechanisms.
5. Configure and analyze intrusion detection and prevention systems.

List of Experiments:

Part A: Cybercrime & Security Fundamentals
1. Study of cybercrime types, threats, and legal perspectives (Indian IT Act).
2. Identification of cyber threats and vulnerabilities in sample systems.
3. Case study analysis of real-world cybercrime incidents.
4. Study of social engineering techniques and defense mechanisms.

5. Demonstration of cyber stalking and online fraud scenarios (simulation).

Part B: Cyber Offenses & Mobile Security
1. Study of botnets and attack vectors.
2. Analysis of mobile and wireless security threats.
3. Demonstration of credit card fraud mechanisms (simulation).
4. Study of mobile device security configurations.
5. Organizational policies for mobile and laptop security.

Part C: Tools & Methods Used in Cybercrime
1. Use of proxy servers and anonymizers (study/demo).
2. Phishing attack detection and awareness exercise.
3. Demonstration of password cracking techniques (ethical lab setup).
4. Study of keyloggers, spyware, and malware.
5. Demonstration of DoS and DDoS attacks (controlled environment).

Part D: Web & Network Attacks
1. Study and demonstration of SQL Injection attacks.
2. Buffer overflow attack demonstration (introductory).
3. Attacks on wireless networks (WEP/WPA study).
4. Steganography techniques for data hiding.
5. Malware analysis basics (static analysis demo).

Part E: Access Control, Authentication & IDS
1. Implementation of access control models (DAC, MAC, RBAC).
2. Implementation of authentication mechanisms (password, OTP, certificate-based).
3. Study and configuration of Intrusion Detection Systems (IDS).
4. Study and configuration of Intrusion Prevention Systems (IPS).
5. Mini Project: Cybersecurity defense setup for a small organization.

Text Books:

1. Nina Godbole & Sunit Belapure – Cyber Security: Understanding Cyber Crimes, Wiley India.
2. Joseph Migga Kizza – A Guide to Computer Network Security, Springer.

Reference Books:

1. V. K. Pachghare – Cryptography and Information Security, PHI Learning.
2. Nina Godbole – Information Systems Security, Wiley India.
3. Kenneth J. Knapp – Cyber Security & Global Information Assurance.
4. James Graham et al. – Cyber Security Essentials, CRC Press.
5. Jeetendra Pande – Introduction to Cyber Security, UOU.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5CS226PE - PROGRAMME ELECTIVE COURSE I LAB –

INTERNET OF THINGS

Course Prerequisite:
Basic knowledge of Internet, Microprocessor & Assembly Language Programming

Course Objectives:
After completion of this laboratory course, students will be able to:
- Gain hands-on understanding of IoT architecture, platforms, and protocols.
- Design and implement IoT applications using sensors, embedded devices, and cloud platforms.
- Interface physical devices and endpoints with software systems using Python.
- Develop real-time IoT solutions addressing societal and industrial problems..

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:
1. Implement IoT system architectures using sensors, controllers, and cloud platforms.
2. Interface and program IoT hardware such as Raspberry Pi and sensors using Python.
3. Deploy and manage IoT applications using networking and cloud services.

4. Analyze real-time data generated from IoT devices.
5. Design and demonstrate complete IoT solutions for real-world applications.

List of Experiments:

Part A: IoT Fundamentals & Platforms

1. Study of IoT architecture, layers, and deployment models.
2. Identification and comparison of IoT communication protocols (MQTT, HTTP, CoAP).
3. Study of IoT platforms and system management concepts.
4. Case study analysis of domain-specific IoT applications.
5. Introduction to Python for IoT application development.

Part B: Python for IoT & Logical Design

1. Python programming basics for IoT (data types, control structures).
2. File handling and date/time operations in Python.
3. Use of Python libraries for IoT (requests, paho-mqtt).
4. Logical design of IoT systems using Python.
5. Implementation of RESTful API calls using Python.

Part C: IoT Devices & Sensor Interfacing

1. Introduction to Raspberry Pi hardware and OS setup.
2. Controlling LED using Raspberry Pi and Python.
3. Interfacing switch and push button with Raspberry Pi.
4. Interfacing light sensor / temperature sensor with Raspberry Pi.
5. Communication using I2C, SPI, and Serial interfaces.

Part D: Cloud Integration & Networking

1. Data upload to cloud storage platforms (ThingSpeak/Xively).
2. Implementation of MQTT-based messaging.
3. Design of RESTful Web API for IoT applications.
4. Deployment of IoT applications using AWS IoT / Cloud services.
5. Real-time IoT data visualization dashboard.

Part E: Case Studies & Mini Project

1. Smart Home Automation (lighting / intrusion detection).
2. Weather Monitoring System using sensors and cloud.
3. Smart Irrigation System using IoT sensors.
4. Air Pollution Monitoring System.
5. Mini Project: Complete IoT solution addressing a real-world problem.

Text Book: Arshdeep Bahga & Vijay Madisetti – Internet of Things: A Hands-On Approach, Universities Press.

Reference Books

1. K. A. Lambert & B. L. Juneja – Fundamentals of Python, Cengage Learning.
2. David Hanes – IoT Fundamentals, Cisco Press.
3. Jan Holler et al. – From Machine-to-Machine to the Internet of Things, Academic Press.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5DS226PE – COGNITIVE TECHNOLOGIES LAB.

Course Prerequisites

Basic knowledge of Artificial Intelligence, Python Programming, Data Structures, and Databases

Course Objectives

- To provide hands-on experience with core concepts of cognitive technologies
- To implement NLP, analytics, and knowledge representation techniques used in cognitive systems
- To explore cloud-based and distributed environments for cognitive applications

- To work with IBM Watson–like cognitive platforms and APIs
- To design and demonstrate end-to-end cognitive applications

Course Outcomes (Expected Outcome)

On successful completion of the course, the students will be able to:

1. Implement fundamental components of cognitive systems using programming tools
2. Apply NLP techniques for language understanding in cognitive applications
3. Use analytics and machine learning techniques for cognitive decision-making
4. Integrate cloud and distributed services in cognitive computing solutions
5. Design, implement, and evaluate complete cognitive applications

List of Experiments

Part A: Foundations of Cognitive Computing

1. Study of cognitive computing architecture and comparison with traditional computing systems
2. Identification and classification of components of a cognitive system (data, corpus, models, services)
3. Implementation of a simple rule-based cognitive system using Python
4. Data ingestion and preprocessing for cognitive applications
5. Visualization of insights generated from structured and unstructured datasets

Part B: Natural Language Processing for Cognitive Systems

1. Text preprocessing for cognitive systems: tokenization, stop-word removal, stemming, lemmatization
2. Implementation of part-of-speech tagging and named entity recognition
3. Development of a simple question–answering system using NLP techniques
4. Semantic similarity and intent detection using word embeddings or TF-IDF
5. Sentiment analysis for cognitive decision support

Part C: Knowledge Representation & Advanced Analytics

1. Representation of knowledge using taxonomies and ontologies (conceptual / tool-based)
2. Implementation of classification models for cognitive analytics (Naïve Bayes / Decision Tree)
3. Implementation of clustering techniques for knowledge discovery
4. Application of analytics to derive insights from large datasets
5. Case study: Analytics-driven cognitive recommendation system

Part D: Cloud & Distributed Cognitive Computing

1. Deployment of a cognitive application using cloud services (IBM Cloud / AWS / Azure – demo level)
2. Use of REST APIs for accessing cognitive services
3. Study and implementation of distributed data processing for cognitive workloads
4. Security and governance considerations in cloud-based cognitive systems

Part E: Cognitive Platforms & Mini Project

1. Study of IBM Watson services (NLP, Visual Recognition, Assistant – demo/simulation)
2. Building a domain-specific cognitive application (Healthcare / Education / Smart City)
3. Mini Project (Compulsory):
   Design and implement an end-to-end cognitive application involving data ingestion, NLP/analytics, and cloud deployment

Suggested Mini Project Domains

Healthcare decision support system, smart city cognitive dashboard, cognitive chatbot, sentiment-based recommendation system, intelligent document analysis, workforce analytics system

Text Book:

Judith Hurwitz, Marcia Kaufman, Adrian Bowles, *Cognitive Computing and Big Data Analytics*, John Wiley & Sons, 2015

Reference Books

1. José Luis Bermúdez, *Cognitive Science: An Introduction to the Science of the Mind*, Cambridge University Press
2. Jay Friedenberg, Gordon Silverman, *Cognitive Science: An Introduction to the Study of Mind*, Sage
3. Huimin Lu (Ed.), *Cognitive Internet of Things*, Springer Nature
4. Danish Contractor, Aaditya Telang (Eds.), *Applications of Cognitive Computing Systems and IBM Watson*, Springer
5. Steven Bird, Ewan Klein, Edward Loper, *Natural Language Processing with Python*, O'Reilly Media

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5KE226PE - PROGRAMME ELECTIVE COURSE I – LAB.

INTERNET OF EVERYTHING

Type: Practical | **Credits:** 1 | **Teaching Load:** Practical – 2 Hours/Week

Prerequisite:

- Basics of Internet of Things
- Fundamentals of Networking
- Basic Programming (Python/C/Embedded basics)

Course Objectives

After completion of this laboratory course, students will be able to:

- Gain hands-on experience with IoE components including devices, data, processes, and people.
- Design and implement end-to-end IoE applications integrating sensors, networks, and cloud services.
- Apply analytics and automation to real-time IoE data.
- Understand security, scalability, and interoperability challenges in IoE environments.
- Develop problem-oriented IoE solutions for smart systems.

Course Outcomes (COs)

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

1. Interface sensors, actuators, and smart devices for IoE applications.
2. Implement communication protocols and data exchange mechanisms in IoE systems.
3. Develop cloud-connected IoE applications with data storage and visualization.
4. Apply analytics and automation techniques on IoE-generated data.
5. Design and demonstrate a complete IoE solution addressing a real-world problem.

List of Experiments:

Part A: IoE Fundamentals & Device Connectivity

1. Study of IoE architecture and comparison with IoT.
2. Identification and configuration of IoE components: devices, data, process, people.
3. Sensor interfacing (Temperature / Light / Motion) using Arduino / Raspberry Pi / ESP32.
4. Actuator control (LED, relay, buzzer) through embedded platforms.

Part B: Communication & Networking in IoE

1. Implementation of device-to-device communication.
2. Data communication using MQTT / HTTP / CoAP protocols.
3. Publishing and subscribing sensor data using MQTT broker.
4. Device-to-cloud communication using REST APIs.

Part C: Cloud, Data & Visualization

1. Uploading sensor data to IoE cloud platforms (ThingSpeak / AWS IoT / Azure IoT Hub – demo).
2. Real-time data visualization using dashboards and charts.
3. Data storage and retrieval from cloud databases (NoSQL / Time-series DB).

Part D: Analytics, Automation & Security

1. Rule-based automation using sensor thresholds.
2. Basic analytics on IoE data (trend analysis, anomaly detection – demo).
3. Implementation of authentication and access control for IoE devices.
4. Study of IoE security threats and mitigation techniques.

Part E: Mini Project

- Mini Project: Design and implement a complete IoE solution, such as:
- Smart Energy Monitoring System
- Smart Agriculture / Irrigation System
- Smart Campus Infrastructure

- Healthcare Monitoring System
- Industrial IoE Monitoring System

(Problem → Design → Implementation → Demonstration → Report)

Recommended Tools & Platforms

- Arduino / Raspberry Pi / ESP32
- Python / Embedded C
- MQTT Broker (Mosquitto)
- Cloud Platforms: ThingSpeak / AWS IoT / Azure IoT
- Visualization: Grafana / Cloud Dashboards

Text Books:

1. Arshdeep Bahga & Vijay Madisetti, *Internet of Things: A Hands-On Approach*, Universities Press.
2. David Hanes et al., *IoT Fundamentals*, Cisco Press.

Reference Books

1. Jan Holler et al., *From Machine-to-Machine to the Internet of Things*, Academic Press.
2. Olivier Hersent et al., *The Internet of Things: Key Applications and Protocols*, Wiley.
3. Perry Lea, *Internet of Things for Architects*, Packt Publishing.

Tentative CO-PO Mapping:

(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5KE226PE - PROGRAMME ELECTIVE COURSE I – LAB.

AUGMENTED & VIRTUAL REALITY LAB

Course Prerequisite

Basics of Computers, Multimedia Concepts, Fundamentals of Programming (C / Python / JavaScript preferred)

Course Objectives

After completion of this laboratory course, students will be able to:

- Gain hands-on experience with core concepts of Virtual Reality (VR) and Augmented Reality (AR).
- Understand and implement VR world geometry, transformations, perception, and interaction techniques.
- Design and develop basic AR and VR applications using modern tools and SDKs.
- Apply computer vision and tracking techniques for AR applications.
- Develop immersive applications addressing real-world use cases.

Course Outcomes (COs)

On successful completion of the course, students will be able to:

1. Create basic VR environments and understand immersive system components.
2. Implement geometric transformations and navigation in virtual worlds.
3. Develop interactive VR applications using input devices and interaction techniques.
4. Build simple AR applications using markers, tracking, and overlays.
5. Analyze perception, motion, audio, and usability aspects in AR/VR systems.

List of Experiments

Part A: VR Fundamentals & Tools

1. **Introduction to AR/VR Tools**
   Study and installation of AR/VR development tools (Unity 3D, Unreal Engine – demo, Blender – demo), overview of VR headsets and sensors.
2. **Creating a Basic Virtual World**
   Design a simple 3D virtual environment using Unity, adding terrain, lighting, and camera setup.
3. **Understanding Coordinate Systems & Transformations**
   Implement translation, rotation, and scaling of 3D objects, observe effects of transformations in virtual space.

Part B: Geometry, Vision & Navigation

4. **Virtual Camera & Viewing Transformations**
   Implement camera movement, view frustum, perspective projection, and navigation controls.
5. **Human Vision & Depth Perception Simulation**
   Demonstrate stereoscopic vision concepts and depth perception using VR scene settings.
6. **Navigation & Locomotion Techniques**
   Implement locomotion methods such as walk, teleportation, and fly-through navigation.

Part C: Interaction, Motion & Audio

7. **User Interaction Techniques**
   Implement object selection, manipulation, and interaction using keyboard/mouse or VR controllers.
8. **Motion & Tracking Simulation**
   Simulate 2D/3D tracking of position and orientation using sensors or input devices.
9. **Audio in Virtual Environments**
   Implement spatial audio, sound sources, and basic auditory rendering in VR scenes.

Part D: Augmented Reality Development

10. **Introduction to Augmented Reality SDKs**
    Study ARCore / ARKit / Vuforia, marker-based vs marker-less AR, AR system pipeline.
11. **Marker-Based AR Application**
    Develop an AR application that overlays 3D objects on image markers using Vuforia.
12. **Marker-less / Location-Based AR (Demo)**
    Demonstration of plane detection and real-world anchoring of virtual objects.

Part E: Advanced Applications & Mini Project

13. **Computer Vision for AR (Beyond Syllabus)**
    Implement basic computer vision tasks such as image detection or object recognition (OpenCV demo).
14. **Mini Project (Compulsory)**
    Develop a complete AR/VR application based on any one domain:
    - Virtual campus / museum tour
    - AR-based learning module
    - VR-based training simulation
    - AR visualization for engineering / medical concepts

Suggested Tools & Platforms

- Unity 3D (with C#)
- Vuforia SDK / ARCore (introductory)
- Blender (for 3D assets – optional)
- OpenCV (demo)
- VR Headsets (Google Cardboard / Oculus – if available)

Text Books

1. M. LaValle, *Virtual Reality*, Cambridge University Press, 2016.
2. Dieter Schmalstieg, Tobias Hollerer, *Augmented Reality: Principles and Practice*, Pearson, 2016.

Reference Books

1. William R. Sherman, Alan B. Craig, *Understanding Virtual Reality*, Morgan Kaufmann.
2. Alan B. Craig, *Understanding Augmented Reality*, Morgan Kaufmann.
3. Jason Jerald, *The VR Book: Human-Centered Design for Virtual Reality*.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5AD226PE - PROGRAMME ELECTIVE COURSE I LAB

BUSINESS INTELLIGENCE

Type: Practical | **Credits:** 1

Course Prerequisite
• Basic knowledge of Database Management Systems
• Basic understanding of statistics and data handling
• Familiarity with spreadsheets and basic programming concepts

Course Objectives
• To provide hands-on exposure to Business Intelligence tools and reporting environments.
• To develop practical skills in data preparation, transformation, and exploratory analysis for BI applications.
• To enable students to design dashboards and analytical reports for decision-making.
• To implement basic machine learning techniques used in Business Intelligence workflows.
• To understand the application of BI tools in real-world business scenarios.

Course Outcomes (COs)
After successful completion of the course, students will be able to:
1. **CO1:** Perform data extraction, cleaning, and preparation for business intelligence applications.
2. **CO2:** Design and generate analytical reports and dashboards using BI tools.
3. **CO3:** Apply data preprocessing and exploratory analysis techniques on business datasets.
4. **CO4:** Implement basic machine learning techniques for classification, clustering, and association analysis in BI context.
5. **CO5:** Analyze business datasets and interpret analytical results for decision-making in different application domains.

Tentative List of Practical Experiments (Any 10–12 to be performed)
1. Study of Business Intelligence environment and tools (WEKA / KNIME / RapidMiner / Power BI / Tableau).
2. Data import from multiple sources (CSV, Excel, database connections).
3. Data cleaning and validation (handling missing values, noise, duplicates).
4. Data transformation and preprocessing (normalization, discretization, feature selection).
5. Creation of data summaries and descriptive analytics reports.
6. Designing charts and visual reports using BI tools.
7. Creating dashboards with filters, drill-down and drill-through features.
8. OLAP operations: slicing, dicing, roll-up, and drill-down analysis (conceptual implementation).
9. Implementation of classification models (Naïve Bayes / Logistic Regression) using BI tools.
10. Clustering analysis using partition or hierarchical methods.
11. Association rule mining using Apriori algorithm.
12. Case study analysis using business dataset (marketing / finance / logistics / CRM).
13. Mini Project: End-to-end BI solution including data preparation, visualization, analysis, and reporting.

Recommended Tools and Platforms
• Power BI / Tableau Public
• WEKA / KNIME / RapidMiner
• MS Excel (Pivot Tables, Analysis Toolpak)
• Python (Optional – Pandas, Matplotlib)
• Public datasets (Kaggle, data.gov.in)

Text Books:
1. R. Sharda, D. Delen, & E. Turban, *Business Intelligence and Analytics: Systems for Decision Support*, Pearson.
2. Grossmann W., Rinderle-Ma, *Fundamentals of Business Intelligence*, Springer.

Reference Books
1. Paulraj Ponnian, *Data Warehousing Fundamentals*, Wiley.
2. Carlo Vercellis, *Business Intelligence: Data Mining and Optimization for Decision Making*, Wiley.
3. EMC Educational Services, *Data Science and Big Data Analytics*, Wiley.
4. Ken W. Collier, *Agile Analytics: A Value Driven Approach to Business Intelligence and Data Warehousing*, Pearson.
5. Introduction to Business Intelligence and Data Warehousing, IBM, PHI.

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

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5CS227MD - DATABASE MANAGEMENT SYSTEMS

Subject Code: 5CS227MD
Subject Title: Database Management Systems
Type: Theory
Credits: 2
Total Contact Hours: 22–23 hours

Prerequisite: Basics of data representation and logical thinking

Course Objectives:

- To introduce the fundamental concepts and architecture of database systems.
- To understand data models and relational databases with practical query design.
- To explore normalization, indexing, and database design methodologies.
- To expose students to real-world applications using databases and SQL.

Course Outcomes (COs):

1. **CO1:** Understand the basics of database systems and relational models. (Unit 1)
2. **CO2:** Design normalized relational databases and write SQL queries. (Unit 2)
3. **CO3:** Apply concepts of indexing, transactions, and database design in real-world scenarios. (Unit 3)

UNIT-WISE SYLLABUS

Unit 1: Introduction to Databases (7 hrs)
Characteristics of Database Approach, Components of a DBMS and Architecture, Data Models: Hierarchical, Network, Relational, ER Model: Entity, Attributes, Relationships, ER Diagrams,
Overview of Relational Model.

Unit 2: Relational Database Design and SQL (8 hrs)
Relational Algebra Basics, SQL Basics: DDL, DML, DCL Commands, Queries: SELECT, WHERE, JOINs, GROUP BY, HAVING, Functions and Subqueries, Normalization: 1NF, 2NF, 3NF, BCNF.

Unit 3: Indexing, Transactions and Application (7 hrs)
Indexing: B+ Tree, Hashing Techniques, Transactions and ACID Properties, Concurrency Control and Recovery, Case Study: Library, Hospital or Inventory Management System, Introduction to NoSQL (basic concept only).

Text Book: Ramez Elmasri, Shamkant Navathe, "Fundamentals of Database Systems," Pearson Education, 7th Edition, 2016.

Reference Books:

1. Silberschatz, Korth and Sudarshan, "Database System Concepts," McGraw Hill, 6th Edition.
2. C. J. Date, "An Introduction to Database Systems," Addison Wesley, 8th Edition.
3. Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems," McGraw Hill.
4. Peter Rob & Carlos Coronel, "Database Systems: Design, Implementation, and Management," Cengage Learning.
5. Alan Beaulieu, "Learning SQL," O'Reilly Media, 2nd Edition.
6. Pramod J. Sadalage, Martin Fowler, "NoSQL Distilled," Addison-Wesley.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	1	–	–	–	–	–	–	2
CO2	3	3	2	1	2	–	–	–	–	–	–	2
CO3	3	3	3	2	2	–	–	–	–	–	–	3

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5DS227MD - DATA WRANGLING & PREPROCESSING TECHNIQUES

Type: Theory | **Credits**: 2 | **Total Contact Hours**: 22–25 hours

Prerequisite:

Basics of computing, elementary programming in Python, and fundamentals of data structures/statistics.

Course Objectives:

- To introduce the need and techniques for cleaning and preparing raw data for analysis.
- To provide hands-on exposure to data wrangling tasks using modern tools and libraries.
- To enable learners to handle missing values, categorical variables, outliers, and inconsistent data.
- To understand the significance of preprocessing as a foundational step in data analytics and modeling.

Course Outcomes (COs):

1. **CO1**: Identify data quality issues and their impact on analysis. *(Unit 1)*
2. **CO2**: Apply standard preprocessing techniques for data transformation and formatting. *(Unit 2)*
3. **CO3**: Perform practical data wrangling using tools/libraries on real-world datasets. *(Unit 3)*

UNIT-WISE SYLLABUS

Unit I: Introduction to Data Wrangling *(7 Hrs)*
What is Data Wrangling and why it matters?, Common problems in raw data: duplicates, missing data, inconsistent formatting, Overview of data formats: CSV, JSON, Excel, APIs, Data Loading: Reading files in Python (Pandas), previewing and summarizing datasets, Real-world examples of messy datasets.

Unit II: Cleaning and Transforming Data *(8 Hrs)*
Handling Missing Values: Deletion, Imputation techniques (mean, median, mode), Removing Duplicates and Outliers, Parsing Dates, Converting Data Types, Encoding Categorical Variables: Label Encoding, One-Hot Encoding, Feature Scaling: Normalization and Standardization.

Unit III : Practical Data Wrangling Techniques *(7 Hrs)*
String manipulation and regular expressions for cleaning text, Combining DataFrames: Merging, Joining, Concatenation, Reshaping and Pivoting data, Feature Engineering basics, Case Study: Cleaning a public dataset (e.g., weather data, health records, pollution datasets).

Text Books:

1. **Wickham, Hadley & Grolemund, Garrett**. *"R for Data Science: Import, Tidy, Transform, Visualize, and Model Data"*, O'Reilly, 2017.
2. **McKinney, Wes**. *"Python for Data Analysis"*, O'Reilly Media, 2nd Edition, 2018.

Reference Books:

1. Ron Cody, "Data Cleaning Techniques in SAS", SAS Institute, 2nd Edition, 2017.
2. Jacqueline Kazil & Katharine Jarmul, "Data Wrangling with Python", O'Reilly, 2016.
3. Vijay Kotu & Bala Deshpande, "Data Science: Concepts and Practice", Morgan Kaufmann, 2014.
4. Joel Grus, "Data Science from Scratch", O'Reilly Media, 2019.
5. John W. Foreman, "Data Smart: Using Data Science to Transform Information into Insight", Wiley, 2013.
6. Allen B. Downey, "Think Stats: Probability and Statistics for Programmers", 2nd Ed., Green Tea Press, 2014.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5KE227MD - SOFTWARE ENGINEERING PRINCIPLES

Type: Theory | **Credits**: 2 | **Total Contact Hours**: 22–25 hours

Prerequisite: Fundamentals of programming and problem-solving techniques.

Course Objectives:

- To introduce fundamental concepts and practices in software engineering.
- To expose students to structured software development methodologies.
- To develop the ability to understand, model, and design small-scale software systems.
- To create awareness about quality assurance and software project lifecycle.

Course Outcomes (COs):

1. **CO1**: Understand the basic principles and lifecycle models of software development. *(Unit 1)*
2. **CO2**: Analyze user requirements and design structured software solutions. *(Unit 2)*
3. **CO3**: Apply best practices for testing, maintenance, and project management. *(Unit 3)*

SYLLABUS

Unit 1: Introduction to Software Engineering (7 hrs)
Definition, Scope, and Importance of Software Engineering, Characteristics of Software, Software Development Life Cycle (SDLC) Models: Waterfall, Spiral, Agile; Roles and Responsibilities of Software Engineers, Software Process Models.

Unit 2: Software Requirements and Design (8 hrs)
Software Requirement Types: Functional and Non-functional, Requirement Gathering Techniques, Software Requirement Specification (SRS); Basics of Software Design: Modularization, Data Flow Diagrams, UML Use Case and Class Diagrams, Design Principles.

Unit 3: Testing, Maintenance and Project Management (7 hrs)
Software Testing Fundamentals: Unit Testing, Integration Testing, System Testing, Test Case Design; Introduction to Software Maintenance; Software Project Management: Cost Estimation, Scheduling, Risk Management; Software Quality Assurance, Introduction to CASE Tools.

Text Book: Roger S. Pressman and Bruce R. Maxim, *Software Engineering: A Practitioner's Approach*, 8th Edition, McGraw-Hill Education, 2014.

Reference Books:

1. Ian Sommerville, Software Engineering, 10th Edition, Pearson Education, 2015.
2. Pankaj Jalote, An Integrated Approach to Software Engineering, Springer, 2012.
3. Rajib Mall, Fundamentals of Software Engineering, PHI Learning, 2014.
4. Richard Fairley, Software Engineering Concepts, McGraw-Hill, 1985.
5. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, Fundamentals of Software Engineering, Pearson, 2nd Edition, 2003.
6. Watts Humphrey, Managing the Software Process, Addison-Wesley, 1989.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO4	PO5	PO6	PO10	PO11	PO12
CO1	3	2						2
CO2	2	3	2	1				2
CO3		2	3	3	2	2	2	3

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5AD227MD - INTRODUCTION TO MACHINE LEARNING

Type: Theory | **Credits**: 2

Prerequisite:

- Basic knowledge of Python Programming and Mathematics
- Understanding of Statistics and Probability

Course Objectives:

- To introduce fundamental concepts, types, and applications of machine learning.
- To understand the underlying mathematical foundations for supervised and unsupervised learning algorithms.
- To explore evaluation techniques for model performance.

Course Outcomes (COs):

1. **CO1**: Understand key machine learning concepts and categories. (Unit 1)
2. **CO2**: Apply basic supervised and unsupervised ML algorithms. (Unit 2)
3. **CO3**: Evaluate ML models using performance metrics. (Unit 3)

Unit-wise Syllabus:

Unit 1: Introduction to Machine Learning (7 Hrs)
What is Machine Learning?, Types of Machine Learning: Supervised, Unsupervised, Reinforcement (Overview), Applications of Machine Learning in Real-world Problems, ML Pipeline: Problem definition, Data Collection, Preprocessing, Model Building, Evaluation.

Unit 2: Supervised and Unsupervised Learning (8 Hrs)
Supervised Learning Algorithms: Linear Regression, Logistic Regression, Decision Trees, Unsupervised Learning Algorithms: K-Means Clustering, Hierarchical Clustering, Feature Selection and Dimensionality Reduction (PCA Overview).

Unit 3: Model Evaluation and Validation (7 Hrs)
Evaluation Metrics: Accuracy, Precision, Recall, F1 Score, Confusion Matrix, ROC Curve, Cross Validation, Bias-Variance Tradeoff, Overfitting and Underfitting.

Textbook(s):

Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow," O'Reilly Media, 2nd Edition, 2019.

Reference Books:

1. Tom M. Mitchell, "Machine Learning," McGraw Hill Education, 2017.
2. Ethem Alpaydin, "Introduction to Machine Learning," MIT Press, 4th Edition, 2020.
3. Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, "An Introduction to Statistical Learning," Springer, 2013.
4. Andreas Müller and Sarah Guido, "Introduction to Machine Learning with Python," O'Reilly Media, 2016.
5. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective," MIT Press, 2012.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO12
CO1	3	2				1
CO2	2	3	3	2	3	2
CO3		3	2	3	2	2

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5CS228MD - WEB TECHNOLOGIES AND DEVELOPMENT

Type: Theory | **Credits:** 2 | **Total Contact Hours:** 22–23 hours

Prerequisite:

Basic programming knowledge (Python/C/C++), familiarity with internet usage.

Course Objectives:

- To introduce the foundational concepts of web technologies and web development.
- To understand how websites work, including HTML, CSS, and JavaScript.
- To familiarize students with basic client-server architecture and web hosting.
- To provide practical exposure to developing static and interactive web pages.

Course Outcomes (COs):

1. **CO1:** Understand the structure and functioning of web applications and web servers. *(Unit 1)*
2. **CO2:** Design and develop static and interactive web pages using HTML, CSS, and JavaScript. *(Unit 2)*
3. **CO3:** Explain and apply basic principles of web hosting, forms, and client-server communication. *(Unit 3)*

Unit-wise Syllabus:

Unit 1: Introduction to Web Technologies (7 hrs)
Basics of Internet and Web, Web Browsers and Web Servers, URLs, HTTP, HTTPS Protocols, Introduction to HTML5: Elements, Attributes, Forms, Media Tags.

Unit 2: Styling and Interactivity (8 hrs)
CSS: Syntax, Selectors, Box Model, Flexbox, Responsive Design with Media Queries, JavaScript: Basics, Variables, Functions, Events, DOM Manipulation, Validating Forms and Basic Interactions using JavaScript.

Unit 3: Web Application Development Basics (7 hrs)
Introduction to Client-Server Architecture, Web Hosting Basics: Domains, Hosting, FTP, Introduction to Frontend Frameworks (Bootstrap) and Backend Concepts (overview), Overview of APIs and JSON.

Textbook(s):

Jon Duckett, "HTML and CSS: Design and Build Websites," Wiley, 2011.

Reference Books:

1. Robin Nixon, "Learning PHP, MySQL, JavaScript & CSS," O'Reilly Media, 2018.

2. Mark Myers, "A Smarter Way to Learn JavaScript," CreateSpace Publishing, 2020.
3. Ethan Brown, "Web Development with Node and Express," O'Reilly, 2019.
4. Eric Freeman & Elisabeth Robson, "HeadFirst HTML and CSS," O'Reilly, 2012.
5. David Flanagan, "JavaScript: The Definitive Guide," O'Reilly Media, 2020.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	2	–	–	–	–	–	–	2
CO2	3	3	3	1	3	–	–	–	–	1	–	2
CO3	2	2	2	1	3	–	–	–	–	2	–	3

5DS228MD - DATA VISUALIZATION TECHNIQUES

Type: Theory | **Credits**: 2 | **Total Contact Hours**: 22–25 hours

Prerequisite:

Basic knowledge of data handling using Excel or Python, and understanding of fundamental statistical concepts.

Course Objectives:

- To introduce the principles and importance of data visualization in engineering and decision-making.
- To explore various types of visual representations for numerical, categorical, and temporal data.
- To provide practical exposure to visualization tools such as Excel, Tableau, and Python (Matplotlib/Seaborn).
- To enable students to create effective and meaningful visualizations for communication and analysis.

Course Outcomes (COs):

1. **CO1**: Understand the principles of effective data visualization and its role in analytics. *(Unit 1)*
2. **CO2**: Select appropriate charts and techniques based on data type and context. *(Unit 2)*
3. **CO3**: Design and implement visualizations using tools like Excel, Tableau, and Python libraries. *(Unit 3)*

UNIT-WISE SYLLABUS:

Unit 1: Fundamentals of Data Visualization *(7 Hrs)*
Introduction to Data Visualization: Importance, goals, and applications, Visual Encoding: Position, shape, size, color, motion, Choosing the right chart: Bar, Line, Pie, Histogram, Scatter, Heatmaps, Understanding your audience and context, Data-Ink Ratio and Tufte's Principles of Good Visualization.

Unit 2: Visualization for Various Data Types *(8 Hrs)*
Visualizing Categorical vs Numerical data, Time Series Visualizations: Trends and seasonality, Multi-variable Data: Stacked charts, Bubble plots, Treemaps, Geospatial Visualization: Maps and GPS-based data, Dashboards: Key Performance Indicators (KPIs) and design principles.

Unit 3: Tools & Techniques for Visualization *(7 Hrs)*
Creating Visualizations in MS Excel (Pivot charts, Conditional formatting), Introduction to Tableau or Google Data Studio: Dimensions and Measures, Filters, Basic Charts, Visualization using Python Libraries (Matplotlib, Seaborn, Plotly): Line plots, Histograms, Pair plots, Heatmaps, Case Study: Presenting insights using a public dataset.

Textbook(s):

1. **Knaflic, Cole Nussbaumer**, *"Storytelling with Data: A Data Visualization Guide for Business Professionals"*, Wiley, 2015.
2. **Nathan Yau**, *"Visualize This: The FlowingData Guide to Design, Visualization, and Statistics"*, Wiley, 2011.

Reference Books:

1. Alberto Cairo, "The Truthful Art: Data, Charts, and Maps for Communication", New Riders, 2016.
2. Ben Fry, "Visualizing Data: Exploring and Explaining Data with the Processing Environment", O'Reilly Media, 2008.
3. Claus O. Wilke, "Fundamentals of Data Visualization", O'Reilly Media, 2019.
4. Stephanie D.H. Evergreen, "Effective Data Visualization: The Right Chart for the Right Data", SAGE Publications, 2016.
5. Jeffrey Shaffer, "The Big Book of Dashboards", Wiley, 2017.
6. Hadley Wickham & Garrett Grolemund, "R for Data Science", O'Reilly Media, 2016.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5KE228MD - MOBILE APPLICATION DEVELOPMENT

Type: Theory | **Credits**: 2 | **Total Contact Hours**: 22–25 hours

Prerequisite:
Fundamentals of programming and basic understanding of web technologies.

Course Objectives:
- To introduce mobile application development concepts and platforms.
- To develop basic skills for designing and building user-friendly mobile apps.
- To expose students to the architecture, tools, and lifecycle of mobile apps.
- To encourage app development for real-life engineering and societal problems.

Course Outcomes (COs):
1. **CO1:** Understand the mobile application ecosystem and lifecycle. (Unit 1)
2. **CO2:** Design simple mobile interfaces using UI elements and layout principles. (Unit 2)
3. **CO3:** Develop functional mobile applications using a mobile development platform. (Unit 3)

SYLLABUS

Unit 1: Introduction to Mobile App Development (7 hrs)
Mobile Platforms Overview: Android, iOS, Hybrid, and Web Apps; Native vs. Cross-platform Development; App Architecture and Lifecycle, Development Tools: Android Studio, Flutter, React Native; Introduction to Kotlin or Dart.

Unit 2: UI/UX Design & Navigation (8 hrs)
Fundamentals of UI/UX for Mobile Devices, Common UI Elements: Buttons, Text Views, Lists, Forms; Layouts and Navigation: Linear, Constraint, Stack, Scroll View; Activity and Fragment Lifecycle, Designing User-Friendly Interfaces.

Unit 3: Application Development and Deployment (7 hrs)
Event Handling, Data Storage (Shared Preferences, SQLite), Connecting Apps to Web APIs (GET/POST), Debugging and Testing, Publishing Apps on Play Store/Test Flight (overview), Mini Case Study: Build a basic functional app.

Textbook(s):
Barry Burd, *Android Application Development for Dummies*, Wiley, 4th Edition, 2017.

Reference Books:
1. Dawn Griffiths & David Griffiths, Head First Android Development, O'Reilly Media, 2nd Edition, 2017.
2. Joseph Annuzzi Jr., Lauren Darcey, Shane Conder, Advanced Android Application Development, Addison-Wesley, 2014.
3. Neil Smyth, Android Studio Development Essentials, Payload Media, 2020.
4. Nishant Srivastava, Learn Flutter and Dart to Build iOS and Android Apps, Packt Publishing, 2021.
5. Marco L. Napoli, Beginning Flutter: A Hands-On Guide to App Development, Wiley, 2020.
6. Jeff Friesen, Learn Java for Android Development, Apress, 2018.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO10	PO12
CO1	3	2						2
CO2		2	3	2	3		2	3
CO3			3	3	3	2	2	3

5AD228MD - AI FOR ENGINEERING APPLICATIONS

Type: Theory | **Credits**: 2

Prerequisite:
Basics of programming, understanding of engineering problem-solving contexts.

Course Objectives:
- To introduce core AI concepts applicable to real-world engineering problems.
- To demonstrate use of AI tools for modeling, simulation, and prediction.

- To explore interdisciplinary engineering applications using AI technologies.
- To encourage analytical thinking and problem-solving through intelligent systems.

Course Outcomes (COs):
1. **CO1**: Understand basic AI methodologies used in engineering systems. (Unit 1)
2. **CO2**: Apply supervised and unsupervised learning for engineering data interpretation. (Unit 2)
3. **CO3**: Analyze practical use cases of AI in core engineering domains. (Unit 3)

UNIT-WISE SYLLABUS:

Unit 1: Introduction to AI & Knowledge Representation (7 hrs)
Overview of Artificial Intelligence and its Evolution, Knowledge Representation Methods: Rule-based Systems, Decision Trees, Introduction to Expert Systems in Engineering, AI vs Conventional Programming.

Unit 2: AI Methods in Engineering (8 hrs)
Supervised Learning (Regression, Classification), Unsupervised Learning (Clustering), Basic Neural Networks & Fuzzy Logic, Hands-on Demonstration with Scikit-learn or Google Colab.

Unit 3: Applications in Core Engineering Domains (7 hrs)
AI in Mechanical: Fault Prediction, CAD Optimization, AI in Electrical: Smart Grids, Load Forecasting, AI in Civil: Structural Health Monitoring, Traffic Pattern Analysis, AI in Chemical and Environmental Engineering: Process Optimization, Pollution Control, Challenges and Ethics in AI Deployment.

Textbook(s):
Stuart Russell & Peter Norvig, "Artificial Intelligence: A Modern Approach," Pearson, 4th Edition, 2021.

Reference Books:
1. Ethem Alpaydin, "Introduction to Machine Learning," MIT Press, 2020.
2. S. Rajasekaran & G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm," PHI, 2017.
3. Timothy J. Ross, "Fuzzy Logic with Engineering Applications," Wiley, 4th Edition, 2021.
4. Andreas C. Müller & Sarah Guido, "Introduction to Machine Learning with Python," O'Reilly, 2016.
5. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective," MIT Press, 2012.
6. Mark Watson, "Artificial Intelligence for Web Applications," Apress, 2020.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO10	PO12
CO1	3	2				2			1
CO2	2	3	2	3	3			2	2
CO3		2	3	2	2	3	2	3	2

5CS229ML - Web Technologies Lab

Type: Practical | **Credits**: 1 | **Total Contact Hours**: 30 hours

Prerequisite: Basic knowledge of HTML and programming fundamentals.
Co-requisite: Should be taken alongside or after 5CS302M – Web Technologies & Development.

Course Objectives:
- To provide hands-on experience in web development tools and technologies.
- To design and develop interactive web pages using HTML, CSS, and JavaScript.
- To introduce students to client-server architecture and form handling using scripting.

Course Outcomes (COs):
1. **CO1**: Design responsive static web pages using HTML and CSS.
2. **CO2**: Implement interactivity in web pages using JavaScript.
3. **CO3**: Develop basic client-server applications with forms and validations.

Tentative List of Practicals (Any 10 to be performed):
1. Create a basic webpage with HTML structure.
2. Design a personal portfolio using HTML and CSS.
3. Develop a webpage using lists, tables, images, and hyperlinks.
4. Create a multi-page website with internal navigation.
5. Use CSS Flexbox/Grid for responsive layout design.
6. Implement JavaScript for form validation.
7. Create a dynamic webpage using JavaScript DOM manipulation.
8. Use Bootstrap or similar framework to create responsive navigation bar.
9. Build a simple HTML form with client-side validation.
10. Create and validate a login page.

11. Integrate external CSS/JS libraries into a web project.
12. Deploy a static website using GitHub Pages or Netlify.

Tools & Resources:
1. Code Editor: VS Code / Sublime Text
2. Browser Developer Tools (Chrome/Firefox)
3. GitHub for code hosting and deployment
4. Bootstrap / Tailwind CSS (optional)

Reference Materials:

1. Jon Duckett - "HTML & CSS: Design and Build Websites", Wiley.
2. E. Freeman & E. Robson - "Head First HTML and CSS", O'Reilly.
3. Mark Myers - "A Smarter Way to Learn JavaScript", CreateSpace.
4. Ethan Brown - "Web Development with Node and Express", O'Reilly.
5. David Flanagan - "JavaScript: The Definitive Guide", O'Reilly.
6. MDN Web Docs - https://developer.mozilla.org

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	3	1	2	–	–	–	–	2	–	1
CO2	2	2	3	2	3	–	–	–	–	2	–	1
CO3	2	3	3	2	3	–	–	–	–	2	1	1

5DS229ML - DATA ANALYTICS LAB.

Type: Practical | **Credits**: 1 | **Total Contact Hours**: 30 hours

Prerequisite: Basic knowledge of Python programming and data handling techniques.

Course Objectives:

- To provide hands-on experience in analyzing real-world data using Python and relevant libraries.
- To implement data wrangling, cleaning, and exploratory data analysis techniques.
- To develop skills for visualizing and interpreting data using standard Python tools.

Course Outcomes (COs):

1. **CO1**: Perform data wrangling and cleaning operations using Python libraries.
2. **CO2**: Conduct exploratory data analysis (EDA) to derive insights from data.
3. **CO3**: Create basic visualizations and interpret patterns for decision making.

Tentative List of Practical Experiments:

1. Data Import & Export: Read/write data from CSV, Excel, and JSON using Pandas.
2. Data Cleaning: Handling missing values, duplicates, and incorrect data types.
3. Data Transformation: Normalization, encoding categorical data, parsing dates.
4. Basic Statistical Analysis: Summary statistics, correlation, and distributions.
5. EDA on a Public Dataset: Analysis of a real-world dataset (e.g., Titanic, Iris, COVID).
6. Visualization with Matplotlib: Line charts, bar plots, pie charts.
7. Advanced Visualization with Seaborn: Box plots, violin plots, pair plots, heatmaps.
8. Time Series Data Analysis: Parsing time-based data, plotting trends.
9. GroupBy and Aggregation: Data summarization using Pandas.
10. Mini Project: Perform end-to-end analysis on a selected dataset with report.

Recommended Tools and Platforms:

- Jupyter Notebook / Google Colab
- Python Libraries: Pandas, NumPy, Matplotlib, Seaborn
- Public Datasets: Kaggle, UCI Machine Learning Repository, data.gov.in

Text Book: Wes McKinney, *"Python for Data Analysis"*, O'Reilly Media, 2018.

Reference Books:

1. Joel Grus, "Data Science from Scratch", O'Reilly Media, 2019.
2. Jake VanderPlas, "Python Data Science Handbook", O'Reilly Media, 2016.
3. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow", O'Reilly Media, 2022.
4. Alberto Cairo, "The Truthful Art", New Riders, 2016.

5. Claus O. Wilke, "Fundamentals of Data Visualization", O'Reilly Media, 2019.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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5KE229ML - Mobile App Development Lab

Type: Practical | **Credits**: 1 | **Total Contact Hours**: 30 hours

Prerequisite:
Basic knowledge of programming and introductory mobile app concepts.

Course Objectives:
- To provide hands-on experience in mobile application development using Android Studio and Kotlin.
- To reinforce mobile UI/UX design concepts through practical implementation.
- To develop simple, deployable mobile applications relevant to real-world needs.

Course Outcomes (COs):
1. CO1: Set up and configure a mobile development environment.
2. CO2: Design and implement user-friendly mobile interfaces using Android components.
3. CO3: Build and test functional mobile apps with local data handling and external APIs.

Tentative List of Practical Experiments (Any 10 to be performed):
1. Installation & Configuration of Android Studio and creating a simple "Hello World" app.
2. Designing a user interface using TextView, Button, EditText, and ImageView.
3. Implementing Activity Lifecycle: Demonstrate various stages of an activity.
4. Working with Layouts: Create linear, constraint, and relative layout-based UI.
5. Creating a simple login form and displaying entered data using Kotlin.
6. Intent-based Navigation: Move from one screen/activity to another.
7. Creating a ListView/RecyclerView to display tabular data.
8. Local Data Storage using Shared Preferences.
9. Consuming REST API using Retrofit/Volley and displaying data.
10. Form validation using Kotlin and appropriate error handling.
11. Accessing device features (Camera, GPS, etc.) in a mobile app.
12. **Mini Project**: Develop and demonstrate a simple utility app (e.g., calculator, to-do app, weather app, etc.)

Recommended Tools & Platforms:
- Android Studio (latest stable version)
- Kotlin Programming Language
- Emulator or Android Device
- GitHub (for version control)
- Firebase (optional, for backend/data storage)

Reference Materials:
1. Dawn Griffiths & David Griffiths, Head First Android Development, O'Reilly Media, 2nd Edition, 2017.
2. Neil Smyth, Android Studio Development Essentials, Payload Media, 2020.
3. Jeff Friesen, Learn Java for Android Development, Apress, 2018.
4. Google Android Developer Documentation – https://developer.android.com
5. Kotlin Language Documentation – https://kotlinlang.org/docs/home.html
6. Marco L. Napoli, Beginning Flutter: A Hands-On Guide to App Development, Wiley, 2020.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO10	PO12
CO1	2				3			2
CO2		2	3	2	3		2	3
CO3			3	3	3	2	2	3

5AD229ML - MACHINE LEARNING LAB

Type: Practical | **Credits**: 1

Prerequisite: Basics of Python programming and fundamental machine learning algorithms.

Course Objectives:
- To provide hands-on experience in implementing machine learning algorithms.
- To apply data preprocessing, model training, and evaluation techniques.
- To expose students to real-world datasets and open-source ML tools.

Course Outcomes (COs):
1. **CO1**: Implement supervised learning algorithms and evaluate their performance.
2. **CO2**: Perform data preprocessing, transformation, and feature engineering.
3. **CO3**: Apply machine learning models on real-world datasets and interpret results.

Tentative List of Practicals (Any 8–10):
1. Implement Linear Regression and plot the regression line.
2. Apply Logistic Regression on binary classification problems.
3. Use Decision Tree and visualize the decision paths.
4. Perform K-Nearest Neighbors (KNN) on a classification dataset.
5. Apply K-Means Clustering and visualize clusters.
6. Preprocess a dataset using normalization and encoding.
7. Perform Principal Component Analysis (PCA) for dimensionality reduction.
8. Evaluate ML models using confusion matrix and ROC-AUC.
9. Train a simple Neural Network using Keras or TensorFlow.
10. Compare model performance using cross-validation.
11. Build a pipeline to automate preprocessing and training using Scikit-learn.

Lab Deliverables:
- Lab Journal with implementation details and outputs.
- Mini-project on real dataset (Optional but encouraged).
- Lab Viva and Continuous Assessment.

Recommended Tools:
- Google Colab / Jupyter Notebooks
- Python Libraries: Scikit-learn, Pandas, Matplotlib, Seaborn
- TensorFlow or Keras (basic usage)
- Datasets: UCI Repository, Kaggle datasets

Text Book: Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow," O'Reilly, 2nd Edition, 2019.

Reference Books:

1. Andreas C. Müller & Sarah Guido, "Introduction to Machine Learning with Python," O'Reilly, 2016.
2. Jason Brownlee, "Machine Learning Mastery With Python," 2020.
3. Tom M. Mitchell, "Machine Learning," McGraw-Hill, 1997.
4. Ethem Alpaydin, "Introduction to Machine Learning," MIT Press, 2020.
5. Mark Fenner, "Machine Learning with Python for Everyone," Pearson, 2019.
6. Sebastian Raschka, "Python Machine Learning," Packt, 3rd Edition, 2020.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO10	PO12
CO1	3	2	3	3	3		2
CO2	2	3	2	3	3	2	3
CO3	2	3	3	3	3	3	3

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5CS230OE1 / 5DS230OE1 / 5KE230OE1 / 5AD230OE1 - CYBER LAWS AND ETHICS

Semester: V | **Type**: Theory | **Credits**: 2 | **Total Contact Hours**: 22–25 Hours

Pre-requisites:
- Basic understanding of internet and computing
- Familiarity with digital communication and information sharing.

Course Objectives: By the end of the course, students will:

- To introduce the foundations of cyberspace and the nature of cybercrimes.
- To understand the national and international legal frameworks related to cyber laws.
- To develop ethical awareness and responsible behaviour in the digital environment.

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

1. Understand the nature, types, and evolution of cybercrimes and ethical issues.
2. Describe legal provisions under Indian cyber laws and global cyber regulations.
3. Apply ethical principles and legal knowledge to real-world digital issues.

SYLLABUS:

Unit I: Introduction to Cyber Space and Cyber Crimes (8 Hours)
Evolution of the digital world and rise of cybercrimes, Types and categories: hacking, phishing, identity theft, cyberbullying, Impact on individuals and organizations, Case Study: The 202X Data Breach in India

Unit II: Legal Framework Governing Cyber Space (7 Hours)
Regulation of cyberspace and need for cyber laws , Overview of Indian IT Act 2000 and key amendments, Global treaties and conventions (e.g., Budapest Convention), Case Study: Indian Cyber Law implementation under IT Act.

Unit III: Cyber Ethics and Responsible Digital Citizenship (7 Hours)
Understanding cyber ethics, digital behavior, and online responsibilities, Concepts of privacy, consent, intellectual property, and digital rights, Ethical hacking, AI ethics, and future challenges in digital society, Case Study: Ethics and Cyberbullying / Ethical Hacking in Corporates

Text Book: "Ethical Bytes: Navigating the Digital World with Integrity**"** *D. G.Harkut & K.N. Kasat*, Notion Press, 2023

Reference Books:

1. Nina Godbole & Sunit Belapure, *Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives*, Wiley India.
2. Vakul Sharma, *Information Technology Law and Practice*, Universal Law Publishing.
3. Pavan Duggal, *Cyber Law: The Indian Perspective*, Saakshar Law Publications.
4. Rodney Ryder, *Guide to Cyber Laws*, Wadhwa Publications.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	–	–	1	2	–	3	–	–	–	2
CO2	2	1	–	–	1	3	–	3	–	–	–	2
CO3	1	2	–	–	1	2	–	3	1	2	–	3

5CS230OE2 / 5DS230OE2 / 5KE230OE2 / 5AD230OE2 - INTRODUCTION TO DATA ANALYTICS

Semester: V | **Type**: Theory | **Credits**: 2 | **Total Contact Hours**: 22–25 Hours

Prerequisites:

- Basic understanding of mathematics and statistics at high school level.
- Familiarity with spreadsheets or tools like Excel.

Course Objectives:

1. To introduce the fundamental concepts and applications of data analytics in engineering and business.
2. To enable students to understand different types of data, data processing, and analysis techniques.
3. To equip students with practical knowledge of tools used in data visualization and basic modeling.
4. To develop the ability to interpret data and make informed decisions based on analytical findings.

Course Outcomes (COs):
After successful completion of the course, students will be able to:
Understand the basics of data types, sources, and the analytical process.

1. Apply basic data analysis techniques for real-world datasets.
2. Visualize data using appropriate tools and interpret results for decision-making.

SYLLABUS:

Unit 1: Fundamentals of Data Analytics (7–8 Hours)
Introduction to Data Analytics: Importance, Scope, and Applications, Types of Data: Structured, Semi-structured, and Unstructured, Data Lifecycle: Collection, Cleaning, Processing, Analysis, and Reporting, Introduction to Tools: Excel, Python, R (only basic overview), Role of Data Analytics in Engineering, Manufacturing, Business, and Public Policy.

Unit 2: Data Processing and Exploratory Analysis (7–8 Hours)
Data Preprocessing: Cleaning, Handling Missing Values, Filtering, Descriptive Statistics: Mean, Median, Mode, Standard Deviation, Introduction to Correlation and Covariance, Basics of Sampling, Data Grouping, Sorting, Hands-on Demonstration using Excel or Google Sheets.

Unit 3: Data Visualization and Decision Making (7–8 Hours)
Principles of Data Visualization: Importance and Types, Tools for Visualization: Excel Charts, Google Sheets, Tableau Public (overview), Creating Bar Charts, Line Charts, Histograms, Pie Charts, Dashboards and Storytelling with Data, Use Cases: Analytics in Retail, Healthcare, Engineering Systems, Ethical Considerations in Data Use: Bias, Privacy, and Transparency.

Text Books:
1. "Data Analytics Made Accessible" by Anil Maheshwari, Amazon Publishing, 2017
2. "Data Science for Business" by Foster Provost and Tom Fawcett, O'Reilly Media, 2013

Reference Books:
1. "Fundamentals of Data Analytics" by Bharti Motwani, Wiley India, 2019
2. "Data Analytics Using Excel" by Seema Acharya, McGraw Hill Education, 2021
3. "Naked Statistics" by Charles Wheelan, W. W. Norton & Company, 2014
4. "Storytelling with Data" by Cole Nussbaumer Knaflic, Wiley, 2015
5. "Python for Data Analysis" by Wes McKinney, O'Reilly Media, 2018
6. "Business Analytics – Data Analysis & Decision Making" by S. Christian Albright and Wayne Winston, Cengage Learning, 2016

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	2	–	–	–	–	–	–	2
CO2	3	3	2	1	3	–	–	–	–	–	–	2
CO3	2	3	2	1	3	–	–	1	–	2	–	3

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SEMESTER: VI

6CS231PC / 6DS231PC / 6KE231PC - ARTIFICIAL INTELLIGENCE

Course Prerequisites: Basic concepts of Data Structures, Algorithms, Programming

Course Objectives
Throughout the course, students will be expected to demonstrate their understanding of Artificial Intelligence by being able to do each of the following:
- To present an overview of Artificial Intelligence (AI) principles and approaches.
- To understand the historical evolution of Artificial Intelligence.
- To learn various searching techniques and identify to address a particular problem).

Course Outcomes
After successful completion of the course, the students will be able to:
1. Explain concepts of Artificial Intelligence and different types of intelligent agents and their architecture.
2. Formulate problems as state space search problem & efficiently solve them.
3. Summarize the various searching techniques, constraint satisfaction problem and example problems -game playing techniques.
4. Apply AI techniques in applications which involve perception, reasoning and learning.
5. Compare the importance of knowledge, types of knowledge, issues related to knowledge acquisition and representation.

SYLLABUS

Unit I: Introduction to AI ((7–8 Hours)
Introduction: What Is AI?, The Foundations of Artificial Intelligence, The History of Artificial Intelligence, The State of the Art, Risks and Benefits of AI, **Intelligent Agents:** Agents and Environments, Good Behavior: The Concept of Rationality, The Nature of Environments, The Structure of Agents

Unit II: Problem Solving Through AI (7–8 Hours)
Introduction, Representation the AI Problems, Production System, Algorithm of Problem Solving, Examples of AI Problems, Nature of AI Problems.

Unit III: Uninformed Search Strategies (7–8 Hours)
Problem-Solving Agents, Example Problems, Search Algorithms, **Uninformed Search Strategies**: Breadth-First Search, Uniform-Cost Search, Depth First Search, Bi-directional Search, Depth Limited Search, Iterative Deepening Depth-First Search.

Unit IV: Informed Search Strategies (7–8 Hours)
Basic Concept of Heuristic Search and Knowledge, Designing of Heuristic Function, **Heuristic Search Strategies:** Generate-And-Test, Best-First Search, Problem Reduction, Hill Climbing, Constraint Satisfaction, Means- Ends-Analysis.

Unit V: Adversarial Search & Games (7–8 Hours)
Game Theory, Optimal Decisions in Games, Mini-Max Search, Alpha Beta Pruning, Additional Refinements, Monte Carlo Tree Search, Stochastic Games, Partially Observable Games, Limitations of Game Search Algorithms.

Unit VI: Introduction to Knowledge (7–8 Hours)
Hrs Introduction, Types of Knowledge, Knowledge Representation, Knowledge Storage, Knowledge Acquisition, Knowledge Organization and Management, Basic Concepts of Knowledge Engineering.

Text Books:

1. Artificial Intelligence: A Modern Approach by Stuart Russell & Peter Norvig (Pearson - 4th Ed.)
2. Artificial Intelligence by Ela Kumar (IK International Publishing House Pvt. Ltd.)

Reference Book:

1. Artificial Intelligence by Elaine Rich and Kevin Knight (Tata McGraw Hill - 3rd Ed.)
2. A First Course in Artificial Intelligence by Deepak Khemani (Tata McGraw Hill - 1st Ed.)
3. Artificial Intelligence and Expert Systems by Patterson (PHI)
4. Introduction to Artificial Intelligence by Rajendra Akerkar (PHI Learning Pvt. Ltd.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6AD231PC - DATA ANALYTICS

Course Prerequisites: Database Management System

Course Objectives:
After completing this course/unit, students will be able to:
- To introduce the concepts and components of Business Intelligence (BI)
- To evaluate the technologies that make up BI (data warehousing, OLAP)
- To identify the technological architecture of BI systems·
- To explain different data preprocessing techniques
- To identify machine learning model as per business need
- To understand the BI applications in marketing, logistics, finance and telecommunication sector

Course Outcomes (COs)*:*
After successful completion of the course, students will be able to:
1. Differentiate the concepts of Decision Support System & Business Intelligence
2. Use Data Warehouse & Business Architecture to design a BI system.
3. Build graphical reports
4. Apply different data preprocessing techniques on dataset
5. Implement machine learning algorithms as per business needs
6. Identify role of BI in marketing, logistics, and finance and telecommunication sector

SYLLABUS

Unit I: Foundations of Data Analytics & Analytics Lifecycle *(8 Hours)*
Definition and scope of Data Analytics, Types of analytics: Descriptive, Diagnostic, Predictive, Prescriptive, Business Intelligence vs Data Science vs Big Data, Big Data characteristics (Volume, Variety, Velocity, Veracity, Value), Analytics Lifecycle (Discovery → Data Preparation → Model Planning → Model Building → Communicating Results → Operationalizing), CRISP-DM framework, Roles in Data Analytics ecosystem, Data ethics, privacy, and responsible analytics.

Unit II: Data Preparation and Data Management *(7 Hours)*

Data types and measurement scales, Data collection from multiple sources, Data integration techniques, Data quality issues, Handling missing values and outliers, Data transformation and aggregation, Introduction to relational databases, SQL fundamentals for analytics, Advanced SQL for analytical queries (GROUP BY, JOIN, Subqueries, Window functions), Introduction to Data Warehousing (Star & Snowflake schema), ETL vs ELT concepts.

Unit III: Descriptive and Diagnostic Analytics *(7 Hours)*
Descriptive statistics and summary measures, Key Performance Indicators (KPIs), Exploratory Data Analysis (EDA), Correlation and covariance, Trend and pattern analysis, Segmentation techniques, Root cause analysis, Hypothesis testing (conceptual), Introduction to regression analysis, Case studies in business analytics.

Unit IV: Data Visualization and Analytics Communication *(7 Hours)*
Foundations of Visualization:Importance of Data Visualization in Business Intelligence, Data abstraction: data types, dataset types, attribute types, Task abstraction, Four levels of validation, Pre-attentive attributes and visual perception principles, Ethical and misleading visualizations. Visualization Techniques:Scalar and point visualizations, Multidimensional visualizations, Heatmaps and cluster visualization, Treemaps and Sunburst charts, Network/graph visualizations (conceptual).Visualization Tools:Introduction to Matplotlib and Seaborn, Basic and advanced plots,Dashboard design principles,Overview of Tableau and Power BI, Storytelling with data.

Unit V: Big Data Analytics Tools & Emerging Technologies *(8 Hours)*
Python for Data Analytics: NumPy arrays and vectorized computation, Pandas Data Structures, Data loading and file formats, Data cleaning and transformation, String manipulation, Handling missing data, Computing descriptive statistics, Data visualization using Matplotlib, Excel for Data Analytics:Data cleaning and preparation, Sorting and filtering, Lookup functions, Pivot tables, Conditional formatting, Analysis Toolpak: Descriptive statistics, Correlation, Regression, ANOVA, Moving averages, Exponential smoothing

Unit VI: BI Applications *(7 Hours)*
Big Data storage concepts, Hadoop ecosystem overview, HDFS and MapReduce (conceptual), Limitations of MapReduce, Introduction to Apache Spark, Spark vs Hadoop comparison, NoSQL systems (Key-value, Document, Column-family, Graph databases), Basics of Graph Analytics (degree, centrality, shortest path – conceptual), Big Data visualization challenges (Volume, Variety, Velocity), Cloud-based analytics overview (AWS, Azure, GCP – conceptual)

Text Books:
1. Seema Acharya & Subhashini Chellappan – Big Data Analytics, Wiley India
2. EMC Education Services Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data
3. Python Data Analytics: With Pandas, NumPy and Matplotlib, Author: Fabio Nelli, Publisher: Apress

Reference Books:
1. Hands-On Data Visualization: Interactive Storytelling from Spreadsheets to Code, Jack Dougherty and Ilya Ilyankou
2. Business Analytics with R and Python, David L. Olson, Desheng Dash Wu, Cuicui Luo, Majid Nabavi
3. Python for Business Analytics: Unlocking Data Insights for Strategic Decision-Making, Mahadi Hasan Miraz, Narishah Mohamed Salleh, Hwang Ha Jin
4. Designing Data-Intensive Applications , Martin Kleppmann (Not a traditional analytics book but excellent for understanding data architectures, data storage, NoSQL, distributed systems, and scalability — aligning with your Big Data tools and NoSQL sections.)
5. SQL Queries for Mere Mortals, John Viescas, (A practical SQL reference that helps learners master SQL fundamentals and advanced queries.)

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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~~6CS231PC / 6DS231PC / 6KE231PC - Security Policy & Governance~~

~~Course Prerequisites~~
~~Data Communication and Networking~~

~~Course Objectives~~
- ~~To understand the legal and regulatory environment and its relationship with information security~~

- ~~To understand fundamental concepts of information security, leadership, and management~~
- ~~To examine the role of information security governance and strategic planning within organizations~~
- ~~To develop, implement, and maintain various types of information security policies~~
- ~~To understand risk management processes and risk control classification in organizations~~

~~Course Outcomes~~

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

6. ~~Explain the key characteristics of information security, leadership, and management~~
7. ~~Differentiate between law and ethics in the context of information security~~
8. ~~Explain the importance of ethical codes of conduct in information security~~
9. ~~Discuss the importance, benefits, and outcomes of information security governance~~
10. ~~Describe the process of developing, implementing, and maintaining information security policies~~
11. ~~Define risk management and explain its role in organizational security~~

~~SYLLABUS~~

~~Unit I: Introduction to Information Security Management (6 Lectures, 10 Marks)~~

~~Introduction to security management, basic concepts of information security, threats and attacks, management and leadership concepts, principles of information security management.~~

~~Unit II: Compliance, Law and Ethics (6 Lectures, 10 Marks)~~

~~Introduction to law and ethics, ethics in information security, professional organizations and codes of conduct, information security and law, organizational liability, management of digital forensics.~~

~~Unit III: Governance and Strategic Planning for Security (6 Lectures, 10 Marks)~~

~~Role of planning in security, strategic planning processes, information security governance framework, planning for information security implementation.~~

~~Unit IV: Information Security Policy (6 Lectures, 10 Marks)~~

~~Security policy concepts, enterprise information security policy, issue-specific security policy, system-specific security policy, guidelines for effective policy development and implementation.~~

~~Unit V: Risk Management – Assessing Risk (6 Lectures, 10 Marks)~~

~~Introduction to risk management in information security, risk assessment concepts, risk identification and analysis, risk management process.~~

~~Unit VI: Risk Management – Treating Risk (6 Lectures, 10 Marks)~~

~~Introduction to risk treatment, risk mitigation strategies, managing and monitoring risk, alternative risk management methodologies.~~

~~Text Book~~

~~Michael E. Whitman, Herbert J. Mattord, *Management of Information Security*, Sixth Edition, Cengage Learning, 2016.~~

~~Reference Books~~

1. ~~D. G. Harkut, K. N. Kasat, *Security Policy and Governance: Forging Resilience*, Notion Press, 2023.~~
2. ~~Robert F. Smallwood, *Information Governance for Business Documents and Records*, Wiley, 2014.~~
3. ~~Michael E. Whitman, Herbert J. Mattord, *Principles of Information Security*, Sixth Edition, Cengage Learning, 2018.~~
4. ~~Krag Brotby, *Information Security Governance: A Practical Development and Implementation Approach*, John Wiley & Sons, 2009.~~
5. ~~Brijendra Singh, *Network Security and Management*, Second Edition, PHI.~~
6. ~~Alan Calder, Steve Watkins, *IT Governance: An International Guide to Data Security and ISO27001/ISO27002*, Kogan Page, 2015.~~
7. ~~Evan Wheeler, *Security Risk Management: Building an Information Security Risk Management Program from the Ground Up*, Syngress, 2011.~~
8. ~~Mike Chapple, James Michael Stewart, Darril Gibson, *CISSP® Official Study Guide*, Eighth Edition, John Wiley & Sons, 2018.~~

~~Tentative CO-PO Mapping:~~

~~**(Mapping Scale:** 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)~~

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

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6CS232PC / 6DS232PC / 6KE232PC / 6AD232PC - DESIGN & ANALYSIS OF ALGORITHM

Course Prerequisites: Any programming language, Discrete Mathematics and Data Structures

Course Objectives

- To understand asymptotic analysis and performance evaluation of algorithms
- To apply appropriate algorithmic strategies for problem solving
- To analyze time and space complexity of algorithms
- To gain familiarity with classical and contemporary algorithms
- To develop the ability to design efficient algorithms

Course Outcomes

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

1. Analyze algorithms with respect to time and space complexity
2. Apply algorithm design principles to solve computational problems
3. Differentiate and apply various algorithmic design strategies
4. Evaluate efficiency of algorithms using asymptotic notations
5. Implement and analyze standard searching and sorting algorithms

SYLLABUS

Unit I: Algorithm Analysis & Iterative Design (6 Lectures, 10 Marks)

Introduction to algorithms, use of loops, efficiency of algorithms, estimating and specifying execution times, order notations including Big-O, Big-Ω and Big-Θ, algorithmic strategies overview, algorithm design using recursion.

Unit II: Divide and Conquer (6 Lectures, 10 Marks)

Introduction to divide and conquer strategy, multiplication algorithms and analysis, triangulation problem, convex hull problem, drawbacks of divide and conquer approach, timing analysis of divide and conquer algorithms.

Unit III: Greedy Methods (6 Lectures, 10 Marks)

Introduction to greedy strategy, knapsack problem, job sequencing with deadlines, minimum spanning trees, Prim's algorithm, Kruskal's algorithm, Dijkstra's shortest path algorithm.

Unit IV: Dynamic Programming (6 Lectures, 10 Marks)

Introduction to dynamic programming, multistage graphs, traveling salesman problem, matrix chain multiplication, longest common subsequence, optimal polygon triangulation, single source shortest path using dynamic programming concepts.

Unit V: Backtracking (6 Lectures, 10 Marks)

Combinatorial search techniques, search and traversal methods, backtracking strategy, backtracking framework, typical state space trees and applications.

Unit VI: Algorithm Efficiency & Complexity Classes (6 Lectures, 10 Marks)

Polynomial time and non-polynomial time algorithms, worst-case and average-case analysis, time analysis of algorithms, efficiency of recursion, complexity analysis, complexity calculation for sorting algorithms, time–space trade-off concepts and applications in algorithm research.

Text Book: Dave and Dave, *Design and Analysis of Algorithms*, Pearson Education.

Reference Books:

1. A. V. Aho, J. E. Hopcroft, J. D. Ullman, *The Design and Analysis of Computer Algorithms*, Addison-Wesley.
2. G. Brassard, P. Bratley, *Fundamentals of Algorithmics*, PHI.
3. E. Horowitz, S. Sahni, *Fundamentals of Algorithms*, Galgotia Publications.
4. T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, *Introduction to Algorithms*, McGraw-Hill.

Tentative CO-PO Mapping:

(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6CS233PC / 6DS233PC / 6KE233PC / 6AD233PC - CLOUD COMPUTING

Course Prerequisites: Data Communication and Networks

Course Objectives
- To understand the fundamentals, principles, and motivations of cloud computing
- To study cloud architectures, deployment models, service models, and tools used in real-life scenarios
- To understand virtualization, storage, and networking concepts in cloud environments
- To explore commercial cloud platforms and cloud-driven applications
- To understand security, compliance, and management issues in cloud computing

Course Outcomes
After successful completion of the course, the students will be able to:
1. Explain the concepts, architecture, and applications of cloud computing
2. Analyze cloud deployment and service models and their associated challenges
3. Explain virtualization concepts and their role in cloud infrastructure
4. Compare major cloud service providers and their offerings
5. Analyze security, privacy, and compliance issues in cloud environments

SYLLABUS

Unit I: Cloud Computing Fundamentals, Architecture and Management (6 Lectures, 10 Marks)
Computing paradigms and types of computing, fundamentals of cloud computing, motivation and need for cloud computing, definition and principles of cloud computing, requirements of cloud services, cloud applications, benefits and drawbacks, cloud computing architecture, network connectivity in cloud computing, applications on the cloud, cloud management, migration of applications to the cloud.

Unit II: Cloud Deployment and Service Models (6 Lectures, 10 Marks)
Cloud deployment models including private cloud, public cloud, community cloud and hybrid cloud, cloud service models including infrastructure as a service, platform as a service, software as a service, overview of other cloud service models.

Unit III: Operating Systems and Virtualization (6 Lectures, 10 Marks)
Types of operating systems, role of operating systems in cloud computing, features of cloud operating systems, application development environments, cloud application development platforms and APIs, introduction to virtualization, virtualization opportunities, approaches to virtualization, hypervisors, role of virtualization in cloud computing.

Unit IV: Cloud Software Development and Networking (6 Lectures, 10 Marks)
Software development in cloud environments, perspectives on SaaS development, challenges in cloud-aware software development, cloud application development using PaaS technologies, networking for cloud computing, data center environments, networking issues in data centers, transport layer issues in data center networks.

Unit V: Cloud Service Providers (6 Lectures, 10 Marks)
Overview of cloud service providers, EMC cloud toolkit, Google cloud platform and services, Amazon Web Services including EC2, S3 and SQS, Microsoft Azure services, IBM cloud models and smart cloud, SAP HANA cloud platform, Salesforce cloud services, Rackspace and VMware cloud offerings.

Unit VI: Open-Source Cloud Platforms and Cloud Security (6 Lectures, 10 Marks)
Open-source support for cloud computing, open-source tools for IaaS, PaaS and SaaS, open-source tools for research and distributed system management, introduction to cloud security, data, virtualization and network security issues, security issues in SaaS, PaaS and IaaS models, audit and compliance, disaster recovery, privacy and data integrity.

Text Book: K. Chandrasekaran, *Essentials of Cloud Computing*, CRC Press, Taylor & Francis Group.

Reference Books

1. A. Srinivasan, J. Suresh, *Cloud Computing: A Practical Approach for Learning and Implementation*, Pearson.
2. M. N. Rao, *Cloud Computing*, PHI Learning Pvt. Ltd., 2015.
3. Kumar Saurabh, *Cloud Computing*, Second Edition, Wiley India, 2012.
4. Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, *Cloud Computing: Principles and Paradigms*, John Wiley & Sons, 2011.
5. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, *Cloud Computing: A Practical Approach*, Tata McGraw-Hill, 2010.
6. Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Halper, *Cloud Computing for Dummies*, Wiley Publishing, 2010.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6CS234PE1 / 6DS234PE1 / 6KE234PE1 / 6AD234PE1 - NATURAL LANGUAGE PROCESSING

Course Prerequisites
Fundamentals of Artificial Intelligence

Course Objectives
- To understand the fundamentals, models, and algorithms of natural language processing
- To study morphological, lexical, syntactic, and semantic analysis of natural language
- To understand the role of context-free grammars and probabilistic grammars in NLP
- To explore statistical and machine learning approaches for language processing
- To gain knowledge of information extraction and text classification techniques

Course Outcomes
After successful completion of the course, the students will be able to:
1. Tag and annotate text with basic linguistic features such as morphology and part-of-speech
2. Design and implement applications using core NLP components
3. Implement rule-based and statistical approaches for morphology and syntax analysis
4. Design appropriate tag sets for statistical processing in real-time NLP applications
5. Compare and apply different statistical and machine learning approaches for NLP tasks

SYLLABUS

Unit I: Overview and Morphology (6 Lectures, 10 Marks)
Introduction to natural language processing, NLP models and algorithms, regular expressions and basic regular expression patterns, finite state automata, morphology concepts, inflectional morphology, derivational morphology, finite-state morphological parsing.

Unit II: Word-Level Analysis (6 Lectures, 10 Marks)
Role of language models, simple n-gram models, parameter estimation and smoothing techniques, evaluation of language models, part-of-speech tagging and sequence labeling, lexical syntax, hidden Markov models, maximum entropy models.

Unit III: Syntactic Analysis (6 Lectures, 10 Marks)
Context-free grammars, grammar rules for English, treebanks, normal forms for grammars, dependency grammar, syntactic parsing, ambiguity in parsing, probabilistic context-free grammars, probabilistic lexicalized context-free grammars.

Unit IV: Semantic Analysis (6 Lectures, 10 Marks)
Representing meaning, meaning structures of languages, first-order predicate calculus, syntax-driven semantic analysis, semantic attachments, syntax-driven analyzers, robust semantic analysis, relations among lexemes and their senses, word sense disambiguation.

Unit V: Learning to Classify Text (6 Lectures, 10 Marks)
Supervised classification concepts, examples of supervised classification, evaluation of classifiers, decision trees, naïve Bayes classifiers, modeling linguistic patterns.

Unit VI: Information Extraction from Text (6 Lectures, 10 Marks)
Information extraction concepts, chunking techniques, development and evaluation of chunks, recursion in linguistic structures, named entity recognition, relation extraction.

Text Books
1. Daniel Jurafsky, James H. Martin, *Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech*, Pearson, 2014.
2. Steven Bird, Ewan Klein, Edward Loper, *Natural Language Processing with Python*, First Edition, O'Reilly Media, 2009.
3. Christopher D. Manning, Hinrich Schütze, *Foundations of Statistical Natural Language Processing*, MIT Press, 1999.

Reference Books
1. Breck Baldwin, *Language Processing with Java and LingPipe Cookbook*, Atlantic Publishers, 2015.
2. Richard M. Reese, *Natural Language Processing with Java*, O'Reilly Media, 2015.
3. Nitin Indurkhya, Fred J. Damerau, *Handbook of Natural Language Processing*, Second Edition, Chapman and Hall/CRC, 2010.
4. Roland R. Hausser, *Foundations of Computational Linguistics: Human–Computer Communication in Natural Language*, MIT Press, 2011.
5. Tanveer Siddiqui, U. S. Tiwary, *Natural Language Processing and Information Retrieval*, Oxford University Press, 2008.
6. Daniel Jurafsky, James H. Martin, *Speech and Language Processing*, Second Edition, Prentice Hall, 2008.
7. Charu C. Aggarwal, *Machine Learning for Text*, Springer, 2018.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	–	–	–	–	–	–	–	2

CO2	3	3	3	–	–	–	–	–	1	1	–	2
CO3	3	3	2	–	–	–	–	–	–	–	–	2
CO4	2	2	2	–	–	–	–	–	–	–	–	2
CO5	3	3	2	–	–	–	–	–	–	–	–	3

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6CS234PE2 / 6DS234PE2 / 6KE234PE2 - BIG DATA ANALYTICS

Course Prerequisites
Knowledge of basic computer science principles and skills, basic knowledge of Linear Algebra and Probability Theory, basic knowledge of Database Management Systems

Course Objectives
- To understand the fundamental concepts of big data and analytics
- To explore tools, platforms, and practices for working with big data
- To apply data analytics techniques for large-scale datasets
- To understand machine learning methods used in big data analytics
- To study NoSQL databases and graph-based analytics for big data

Course Outcomes
After successful completion of the course, the students will be able to:
1. Apply big data tools and analytics techniques on large datasets
2. Analyze data using clustering and classification algorithms
3. Implement regression, recommendation, and analytics algorithms for big data
4. Perform analytics on streaming and time-series data
5. Use NoSQL and graph databases for big data management and analysis

SYLLABUS

Unit I: Big Data Analytics and Lifecycle (6 Lectures, 10 Marks)
Big data overview, state of practice in analytics, key roles in the big data ecosystem, examples of big data analytics, data analytics lifecycle overview, discovery phase, data preparation phase, model planning phase, model building phase, communicating results, operationalizing analytics, case study on global innovation network and analysis.

Unit II: Data Analytics Methods, Clustering and Association Rules (6 Lectures, 10 Marks)
Exploratory data analysis, statistical methods for evaluation including hypothesis testing, difference of means, Wilcoxon rank-sum test, type I and type II errors, ANOVA, overview of clustering techniques, k-means clustering including use cases and diagnostics, overview of association rule mining, Apriori algorithm, candidate rule evaluation, applications of association rules, frequent itemset generation, rule generation, validation, testing and diagnostics.

Unit III: Regression and Classification Techniques (6 Lectures, 10 Marks)
Linear regression models, logistic regression models, model description and diagnostics, decision trees and decision tree algorithms, evaluation of decision trees, Naïve Bayes classifier, Bayes theorem, smoothing techniques, diagnostics of classifiers, overview of additional regression and classification methods.

Unit IV: Time Series and Text Analytics (6 Lectures, 10 Marks)
Overview of time series analysis, Box–Jenkins methodology, autoregressive and moving average models, ARMA and ARIMA models, autocorrelation function, building and evaluating ARIMA models, text analytics process, text collection and representation, term frequency–inverse document frequency, topic categorization, sentiment analysis, extracting insights from textual data.

Unit V: Big Data Tools and Techniques – Hadoop and MapReduce (6 Lectures, 10 Marks)
Big data storage and high-performance architectures, Hadoop distributed file system, MapReduce programming model, YARN, Hadoop ecosystem components including ZooKeeper, HBase, Hive, Pig and Mahout, parallelism in big data applications, developing MapReduce applications, execution model, analytics for unstructured data, overview of NoSQL in Hadoop ecosystem.

Unit VI: Database Analytics, NoSQL and Graph Analytics (6 Lectures, 10 Marks)
SQL essentials and advanced SQL, in-database text analytics, NoSQL data management concepts, schemaless data models, key-value stores, document stores, column-oriented stores, object data stores, graph databases, graph models and triples, graph analytics use cases, graph algorithms, features of graph analytics platforms, basics of data visualization, operationalizing analytics projects.

Text Books:
1. EMC Education Services, *Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data*, John Wiley & Sons, 2015.
2. David Loshin, *Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph*, First Edition, Morgan Kaufmann/Elsevier, 2013.

Reference Books
1. Bart Baesens, *Analytics in a Big Data World: The Essential Guide to Data Science and Its Applications*, First Edition, Wiley, 2014.
2. Mohammad Guller, *Big Data Analytics with Spark: A Practitioner's Guide*, First Edition, Apress, 2015.

3. Arshdeep Bahga, Vijay Madisetti, *Big Data Science and Analytics: A Hands-On Approach*, First Edition, 2019.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6CS234PE3 – CRYPTOGRAPHY

Course Prerequisites:
Discrete Structure and Graph Theory, Data Communication and Networking, Introduction to Cyber Security

Course Objectives
- To understand fundamental security concepts and cryptographic principles
- To study classical and modern symmetric encryption techniques
- To understand public key cryptography and digital signature mechanisms
- To study message authentication, hash functions, and integrity mechanisms
- To understand network and Internet security protocols and authentication mechanisms

Course Outcomes
After successful completion of the course, the students will be able to:
1. Classify and explain symmetric encryption techniques and their applications
2. Explain public key cryptographic techniques and digital signature mechanisms
3. Analyze authentication mechanisms and cryptographic hash algorithms
4. Explain Internet security protocols and their use in secure communications
5. Understand system-level security concepts and user authentication mechanisms

SYLLABUS

Unit I: Cryptography Concepts and Techniques (6 Lectures, 10 Marks)
Cryptography concepts and techniques, plaintext and ciphertext, substitution techniques, transposition techniques, encryption and decryption processes, symmetric and asymmetric key cryptography, steganography, key range and key size, types of cryptographic attacks.

Unit II: Symmetric Key Algorithms and AES (6 Lectures, 10 Marks)
Introduction to symmetric key cryptography, algorithm types and modes of operation, data encryption standard, international data encryption algorithm, RC4 and RC5 algorithms, advanced encryption standard and its structure.

Unit III: Asymmetric Key Cryptography and Digital Signatures (6 Lectures, 10 Marks)
Introduction to asymmetric key cryptography, history and overview, RSA algorithm, comparison of symmetric and asymmetric cryptography, digital signature concepts and applications.

Unit IV: Digital Certificates and Public Key Infrastructure (6 Lectures, 10 Marks)
Introduction to digital certificates, certificate formats, private key management, public key infrastructure concepts, PKIX model, public key cryptography standards, XML security, PKI and security integration, creation of digital certificates.

Unit V: Internet Security Protocols (6 Lectures, 10 Marks)
Introduction to Internet security protocols, secure socket layer, transport layer security, secure hypertext transfer protocol, time stamping protocol, secure electronic transaction, comparison of SSL and SET, electronic money concepts, email security mechanisms.

Unit VI: User Authentication Mechanisms (6 Lectures, 10 Marks)
Introduction to user authentication, authentication basics, password-based authentication, authentication tokens, certificate-based authentication, biometric authentication techniques.

Text Book: Atul Kahate, *Cryptography and Network Security*, Second Edition, McGraw-Hill.

Reference Books
1. William Stallings, *Cryptography and Network Security: Principles and Practice*, Fourth Edition, PHI.
2. Behrouz A. Forouzan, Debdeep Mukhopadhyay, *Cryptography and Network Security*, Second Edition, McGraw-Hill.
3. Matt Bishop, *Computer Security: Art and Science*, Pearson Education.
4. Douglas R. Stinson, *Cryptography: Theory and Practice*, CRC Press.

5. Keith M. Martin, *Everyday Cryptography: Fundamental Principles and Applications*, Second Edition, Oxford University Press.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6KE234PE3 - CRYPTOGRAPHY & SECURITY

Course Prerequisites
- Discrete Structures & Graph Theory
- Data Communication and Networking
- Introduction to Cyber Security

Course Objectives:
- To understand fundamental principles of cryptography and information security
- To study classical and modern cryptographic algorithms and their applications
- To understand public key cryptography, digital signatures, and authentication mechanisms
- To analyze security protocols used in network and Internet communications
- To develop the ability to evaluate security mechanisms and cryptographic solutions

Course Outcomes (COs)*:*
After successful completion of the course, students will be able to:
1. Explain core concepts of cryptography, security services, and threat models
2. Apply symmetric and asymmetric cryptographic algorithms for secure communication
3. Analyze hash functions, message authentication, and digital signature mechanisms
4. Explain Internet security protocols and authentication frameworks
5. Evaluate system-level security mechanisms and security architectures

SYLLABUS

Unit I: Introduction to Cryptography & Security Concepts *(7 Hours)*
Security goals and services, cryptography concepts and terminology, plaintext and ciphertext, encryption and decryption processes, symmetric and asymmetric key cryptography, steganography, cryptographic primitives, key management issues, cryptographic attacks including brute force, cryptanalysis, man-in-the-middle, replay and side-channel attacks

Unit II: Classical & Symmetric Key Cryptography *(7 Hours)*
Classical ciphers including substitution and transposition techniques, block and stream ciphers, data encryption standard, triple DES, advanced encryption standard structure and rounds, modes of operation including ECB, CBC, CFB and OFB, RC4 and RC5 overview, performance and security comparison of symmetric algorithms

Unit III: Public Key Cryptography & Digital Signatures *(7 Hours)*
Public key cryptography principles, RSA algorithm, Diffie-Hellman key exchange, elliptic curve cryptography overview, comparison of symmetric and asymmetric cryptography, digital signature concepts, digital signature algorithms, applications of digital signatures, key management challenges

Unit IV: Hash Functions, Authentication & PKI *(7 Hours)*
Cryptographic hash functions, properties and design principles, MD5, SHA-1, SHA-2 and SHA-3 overview, message authentication codes, HMAC, authentication protocols, digital certificates, certificate authorities, public key infrastructure architecture, PKI standards and applications

Unit V: Network & Internet Security Protocols *(7 Hours)*
Security at different network layers, secure socket layer and transport layer security, HTTPS, secure electronic transaction, IP security architecture, email security mechanisms including PGP and S/MIME, electronic payment security, timestamping and key distribution mechanisms

Unit VI: System Security & Emerging Trends *(7 Hours)*
User authentication mechanisms, password-based, token-based and biometric authentication, access control models, operating system security basics, database security concepts, cloud security overview, blockchain and cryptography, post-quantum cryptography overview, current trends and challenges in cryptographic security

Text Book: Atul Kahate, *Cryptography and Network Security*, Second Edition, McGraw-Hill Education

Reference Books

1. William Stallings, *Cryptography and Network Security: Principles and Practice*, PHI
2. Behrouz A. Forouzan, Debdeep Mukhopadhyay, *Cryptography and Network Security*, McGraw-Hill
3. Matt Bishop, *Computer Security: Art and Science*, Pearson Education
4. Douglas R. Stinson, *Cryptography: Theory and Practice*, CRC Press
5. Keith M. Martin, *Everyday Cryptography*, Oxford University Press

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6AD234PE2 - DIGITAL FORENSICS

Course Prerequisites
Operating Systems, Data Communication & Networking, Introduction to Cyber Security

Course Objectives:
After completing this course/unit, students will be able to:

- To introduce students to the principles, scope, investigation lifecycle, legal framework, and types of cybercrimes and digital evidence involved in digital forensic investigations.
- To develop understanding of digital evidence acquisition methods, storage structures, imaging techniques, hashing, and integrity verification processes.
- To provide knowledge of forensic analysis techniques including metadata examination, deleted file recovery, log analysis, and anti-forensic detection mechanisms.
- To familiarize students with network forensic techniques, cyber-attack investigation, email and web artifact analysis, and social media/OSINT-based investigations.
- To introduce investigation approaches for multimedia manipulation, financial cybercrimes, cryptocurrency basics, dark web activities, and emerging digital threats.
- To develop understanding of mobile, cloud, and IoT forensic challenges along with AI applications, legal considerations, and forensic reporting practices.

Course Outcomes (COs)*:*
After successful completion of the course, students will be able to:

1. Explain digital forensic concepts, types of cybercrimes, evidence categories, investigation processes, and applicable legal frameworks.
2. Perform basic digital evidence acquisition, disk imaging, hashing, and integrity validation using standard forensic tools.
3. Analyze digital evidence through metadata examination, deleted data recovery, log analysis, and identify anti-forensic techniques.
4. Investigate network traffic, email headers, browser artifacts, and assess social media evidence including fake content indicators.
5. Evaluate digital evidence related to multimedia manipulation, financial cyber fraud, cryptocurrency traces, and emerging cybercrime scenarios.
6. Apply mobile and cloud forensic techniques, recognize AI-assisted forensic applications, and prepare structured forensic investigation reports following legal and ethical standards.

SYLLABUS

Unit I: Introduction to Digital Forensics *(7 Hours)*
Introduction to Digital Forensics: Need, scope, and evolution, Types of cyber crimes (financial fraud, cyber terrorism, CSAM, ransomware, identity theft), Types of digital evidence (volatile & non-volatile), Digital forensic investigation lifecycle, Chain of custody and legal admissibility, Forensic workstations and lab setup, Overview of cyber laws (IT Act 2000 & amendments in India).

Unit II: Digital Evidence Acquisition *(7 Hours)*
Storage devices and disk architecture, File systems (FAT, NTFS, EXT basics), Disk imaging, cloning, and hashing (MD5, SHA), Live vs dead acquisition, RAID acquisition basics, Remote acquisition techniques, Integrity verification and validation, Overview of acquisition tools (FTK Imager, Autopsy).

Unit III: Digital Evidence Processing and Analysis *(7 Hours)*
File system analysis, Metadata and timestamp analysis, Deleted file recovery, Log file analysis, Introduction to anti-forensics (data wiping, steganography, encryption misuse), Validation of forensic findings, Virtual machine forensics, Live memory forensics basics.

Unit IV: Network, Internet & Social Media Forensics *(7 Hours)*
Network forensic fundamentals, Types of cyber attacks (DoS, phishing, malware), Packet capture and traffic analysis, Email header analysis, Web browser artifact analysis, Social media forensics, Fake news detection basics, Fake reviews & bot activity identification, Introduction to OSINT (Open-Source Intelligence).

Unit V: Multimedia, Financial & Emerging Crime Forensics *(7 Hours)*
Image and video forensics fundamentals, Fake photo detection (morphing, manipulation), Deepfake basics and detection concepts, Financial cybercrime investigation, Online banking fraud, UPI fraud patterns, Cryptocurrency forensic basics, Dark web investigation overview, Terrorist digital footprint analysis basics, Child exploitation digital evidence handling protocols (legal awareness level).

Unit VI: Mobile, Cloud & AI in Digital Forensics *(7 Hours)*
Mobile device forensics (Android & iOS overview), SIM & memory card analysis, IoT device forensics, Cloud computing basics and forensic challenges, Cloud data acquisition overview, AI applications in digital forensics (anomaly detection, pattern recognition), Legal, ethical, and privacy considerations, Forensic report writing and courtroom presentation.

Text Books:
1. Nelson B., Phillips A., Steuart C., "Guide to Computer Forensics and Investigations", 6th Ed., Cengage Learning.
2. Digital Forensics Explained (2nd Edition), Greg Gogolin, CRC Press (an imprint of Taylor & Francis Group), 2021.
3. Digital Forensics and Cyber Crime Investigation: Recent Advances and Future Directions, Ahmed A. Abd El-Latif, Lo'ai Tawalbeh, Manoranjan Mohanty, Brij B. Gupta & Konstantinos E. Psannis, CRC Press (Taylor & Francis Group), 2025.

Reference Books:
1. John Sammons, The Basics of Digital Forensics, Elsevier, 1st Edition 2015.
2. Davidoff, Sherri, Network forensics: Tracking hackers through cyberspace, Pearson education India Private limited, 2017.
3. Gaytri Gupta, Cyber Forensic Analytics, Wiley India.
4. Warren G. Kruse II & Jay G. Heiser, Addision-Wesley Professional.
5. Akashdeep Bhardwaj, Practical Digital Forensics, BPB Publications (India).

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

6CS235PE1 - DATA WAREHOUSING & MINING

Course Prerequisites: Basic knowledge of Database Management Systems

Course Objectives
- To introduce the fundamentals of data mining, data types, and similarity and dissimilarity measures
- To explain association rules, frequent pattern mining, and related algorithms
- To understand mathematical and statistical foundations of data mining techniques
- To identify the scope, need, and applications of data warehousing and data mining
- To apply appropriate data mining techniques for decision making and analytics
- To motivate research interest in advanced areas of data mining

Course Outcomes
After successful completion of the course, the students will be able to:
1. Explain fundamental concepts and techniques of data mining
2. Analyze similarity and dissimilarity measures among datasets
3. Apply data preprocessing techniques for data mining applications
4. Explain data warehouse concepts and data mining principles
5. Perform multidimensional data analysis using data cubes
6. Analyze and evaluate frequent patterns, association rules, and correlations

SYLLABUS

Unit I: Introduction to Data Mining (6 Lectures, 10 Marks)
Need for data mining, definition of data mining, types of data that can be mined, types of patterns that can be mined, technologies used in data mining, target applications of data mining, major issues and challenges in data mining.

Unit II: Getting to Know Your Data (6 Lectures, 10 Marks)
Data objects and attribute types, basic statistical descriptions of data, data visualization techniques, measuring data similarity and dissimilarity.

Unit III: Data Preprocessing (6 Lectures, 10 Marks)
Overview of data preprocessing, data cleaning techniques, data integration methods, data reduction strategies, data transformation, data discretization.

Unit IV: Data Warehousing and OLAP (6 Lectures, 10 Marks)
Data warehouse concepts, data warehouse modeling, data cube and OLAP operations, data warehouse design and usage, data warehouse implementation, introduction to data lake and data ocean concepts.

Unit V: Data Cube Technology (6 Lectures, 10 Marks)
Preliminary concepts of data cube computation, data cube computation methods, processing advanced queries using cube technology, multidimensional data analysis in cube space.

Unit VI: Mining Frequent Patterns, Associations and Correlations (6 Lectures, 10 Marks)
Basic concepts of frequent pattern mining, frequent itemset mining methods, association rule generation, pattern evaluation methods, interestingness measures for patterns.

Text Book: Jiawei Han, Micheline Kamber, *Data Mining: Concepts and Techniques*, Third Edition, Morgan Kaufmann, Elsevier.

Reference Books
1. Arun K. Pujari, *Data Mining Techniques*, Third Edition, Orient Blackswan / Universities Press, 2013.
2. Paulraj Ponnaiah, *Data Warehousing Fundamentals*, John Wiley & Sons, 2001.
3. Pang-Ning Tan, Michael Steinbach, Vipin Kumar, *Introduction to Data Mining*, Pearson Education, 2007.
4. K. P. Soman, Shyam Diwakar, V. Ajay, *Insight into Data Mining: Theory and Practice*, PHI, 2006.
5. G. K. Gupta, *Introduction to Data Mining with Case Studies*, PHI, 2006.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6CS235PE2 - IMAGE PROCESSING

Course Prerequisites: Calculus, Linear Algebra, Differential Equations

Course Objectives
- To introduce the fundamental concepts and applications of digital image processing
- To understand basic image processing operations in spatial and frequency domains
- To study various image transform techniques and their properties
- To analyze image enhancement and restoration techniques
- To understand image segmentation and morphological processing methods

Course Outcomes
After successful completion of the course, the students will be able to:
1. Explain the fundamental steps and components involved in digital image processing
2. Compare different image transform techniques and analyze their properties
3. Apply spatial domain techniques for image enhancement
4. Analyze and apply frequency domain techniques for image enhancement
5. Perform image segmentation and identify meaningful image components
6. Apply morphological operations to improve and analyze image quality

SYLLABUS

Unit I: Introduction to Image processing: (6 Lectures, 10 Marks)
Fundamental steps in image processing, Components of image processing system, Pixels, coordinate conventions, Imaging Geometry, Spatial Domain, Frequency Domain, sampling and quantization, Basic relationship between pixels, Applications of Image Processing.

Unit II : Image transforms and its properties: (6 Lectures, 10 Marks)
Unitary transform, Fourier Transform & it's properties, Discrete Fourier Transform & it's properties, Discrete Cosine Transform, Walsh Transform, Hadamard Transform.

Unit III: Image Enhancement in spatial domain: (6 Lectures, 10 Marks)
Basic Gray Level Transformation functions – Image Negatives, Log Transformations, Power- Law Transformations. Piecewise-Linear Transformation Functions: Contrast Stretching, Gray Level Slicing, Bit Plane Slicing, Histogram Processing–Equalization, Specification. Basics of Spatial Filtering – Smoothing: Smoothing Linear Filters, Ordered Statistic Filters, Sharpening: Laplacian, Unsharp Masking and High Boost Filtering.

Unit IV: Image Enhancement in Frequency Domain: (6 Lectures, 10 Marks)
Basics of Filtering in Frequency Domain, Filters -Smoothing Frequency Domain Filters : Ideal Low Pass Filter, Gaussian Low Pass Filter, Butterworth Low Pass Filter, Sharpening Frequency Domain Filters: Ideal High Pass Filter, Gaussian High Pass Filter, Butterworth High Pass Filter, Homomorphic Filtering.

Unit V: Image Segmentation: (6 Lectures, 10 Marks)
Pixel-Based Approach- Multi-Level Thresholding, Local Thresholding, Threshold Detection Method, Region-Based Approach- Region Growing Based Segmentation, Region Splitting, Region Merging, Split and Merge, Edge Detection - Edge Operators, Line Detection, Corner Detection.

Unit VI: Video Processing: (6 Lectures, 10 Marks)
Analog video, Digital video, Time varying image formation model, Geometric image formation, formation, sampling of video signal

Text Books:
1. A. K. Jain, *Fundamentals of Digital Image Processing*, Prentice Hall of India, 1989.
2. Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing*, Third Edition, Pearson India, 2013.

Reference Books:
1. Al Bovik, *The Essential Guide to Image Processing*, Academic Press, 2009.
2. Milan Sonka, Vaclav Hlavac, Roger Boyle, *Image Processing, Analysis, and Machine Vision*, Thomson Learning, 2008.
3. S. Jayaraman, S. Esakkirajan, T. Veerakumar, *Digital Image Processing*, McGraw-Hill Education, 2009.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6CS235PE3 / 6KE235PE3 - DIGITAL FORENSICS

Course Prerequisites: Data Communication and Networking, Introduction to Cyber Security, Cryptography

Course Objectives
- To understand the fundamentals of digital forensics and forensic investigation processes
- To learn techniques for identification, acquisition, preservation, and analysis of digital evidence
- To understand forensic investigation of computers, mobile devices, and networks
- To study the role of email, social media, and cloud platforms in digital investigations
- To gain exposure to commonly used digital forensic tools and methodologies

Course Outcomes
After successful completion of the course, the students will be able to:
1. Explain digital forensics concepts, investigation preparation, and procedures
2. Apply appropriate data acquisition and validation techniques for digital evidence
3. Analyze digital evidence from systems, networks, email, and social media sources
4. Explain forensic analysis techniques including validation and live forensics
5. Discuss cloud forensics challenges, tools, and investigation approaches

SYLLABUS

Unit I: Introduction to Digital Forensics (6 Lectures, 10 Marks): Overview of digital forensics, preparation for digital investigations, planning digital forensic investigations, procedures for private sector high-tech investigations, understanding data recovery workstations and forensic software, conducting digital investigations.

Unit II: Data Acquisition (6 Lectures, 10 Marks)
Storage formats for digital evidence, selection of appropriate acquisition methods, contingency planning for image acquisition, acquisition tools, validation of data acquisition, RAID data acquisition, remote network acquisition tools, other forensic acquisition tools.

Unit III: Processing Crime and Incident Scenes (6 Lectures, 10 Marks)
Identification of digital evidence, evidence collection in private sector scenes, processing law enforcement crime scenes, preparation for search, securing a digital incident or crime scene, seizing digital evidence, storage of digital evidence, obtaining and verifying digital hash values.

Unit IV: Digital Forensic Analysis and Validation (6 Lectures, 10 Marks)
Types of data to collect and analyze, forensic data validation techniques, addressing data hiding and obfuscation techniques, virtual machine forensics, live acquisition techniques, network forensics.

Unit V: Email and Social Media Forensics (6 Lectures, 10 Marks)
Role of email in digital investigations, email client and server architecture, investigation of email crimes and policy violations, email servers, specialized email forensic tools, forensic analysis of social media communications.

Unit VI: Cloud Forensics (6 Lectures, 10 Marks)
Cloud computing concepts, legal challenges in cloud forensics, technical challenges in cloud forensics, data acquisition in cloud environments, conducting cloud-based investigations, tools and platforms for cloud forensics.

Text Book:
Nelson, B., Phillips, A., Stuart, C., *Guide to Computer Forensics and Investigations*, Sixth Edition, Cengage Learning.

Reference Books

1. Warren G. Kruse II, Jay G. Heiser, *Computer Forensics: Incident Response Essentials*, Addison-Wesley, 2002.
2. Sherri Davidoff, Jonathan Ham, *Network Forensics: Tracking Hackers through Cyberspace*, Prentice Hall, 2012.
3. Michael G. Solomon, K. Rudolph, Ed Tittel, Neil Broom, Diane Barrett, *Computer Forensics JumpStart*, Wiley Publishing, 2011.
4. Albert J. Marcella, *Cyber Forensics: A Field Manual for Collecting, Examining, and Preserving Evidence of Computer Crimes*, Auerbach Publications, 2008.
5. John Sammons, *The Basics of Digital Forensics*, Elsevier, First Edition, 2015.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6DS235PE1 - MACHINE LEARNING

Course Prerequisites: Artificial Intelligence

Course Objectives

- To understand the fundamental concepts and paradigms of machine learning
- To study mathematical and statistical foundations required for machine learning
- To understand and apply optimization techniques used in learning models
- To differentiate among various machine learning techniques such as regression, classification, and clustering
- To design predictive and analytical models using machine learning approaches

Course Outcomes

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

1. Explain the fundamentals and workflow of machine learning
2. Apply mathematical techniques such as linear algebra and probability in machine learning
3. Use optimization techniques for model training and prediction
4. Implement regression models for real-world problems
5. Apply and evaluate classification techniques
6. Design predictive models using clustering techniques

SYLLABUS

Unit I: Introduction to Machine Learning (6 Lectures, 10 Marks)

Machine learning concepts, motivation for machine learning, history of machine learning, fundamentals of machine learning, data requirements for learning, overview of machine learning techniques, validation techniques including cross-validation, supervised learning, unsupervised learning, reinforcement learning.

Unit II: Mathematics for Machine Learning (6 Lectures, 10 Marks)

Linear algebra fundamentals, matrix decomposition algorithms, singular value decomposition properties and applications, low-rank approximations, feature reduction and dimensionality reduction, principal component analysis, eigenvalues and eigenvectors, orthogonality concepts.

Unit III: Optimization Techniques (6 Lectures, 10 Marks)

Unconstrained and constrained optimization, numerical optimization techniques, Newton's method, steepest descent method, penalty function method.

Unit IV: Regression Techniques (6 Lectures, 10 Marks)

Introduction to regression, linear regression with one variable, covariance and correlation, model evaluation in regression, evaluation metrics for regression models, gradient descent for linear regression, multiple linear regression, non-linear regression, hypothesis testing of regression models.

Unit V: Classification Techniques (6 Lectures, 10 Marks)

Naïve Bayes classifier, k-nearest neighbors algorithm, support vector machines for classification and regression, decision trees and tree construction, ensemble methods, performance measures, error analysis, confusion matrix, receiver operating characteristic curve.

Unit VI: Clustering Techniques (6 Lectures, 10 Marks)

Clustering concepts, distance measures, clustering methods including distance-based, density-based and hierarchical clustering, iterative distance-based clustering, handling continuous and categorical data in k-means, hierarchical clustering construction, Gaussian mixture models, expectation-maximization algorithm for Gaussian mixtures.

Text Book: Tom M. Mitchell, *Machine Learning*, McGraw-Hill, 1997.

Reference Books:

1. R. O. Duda, P. E. Hart, D. G. Stork, *Pattern Classification*, Second Edition, Wiley-Blackwell, 2000.
2. Shai Shalev-Shwartz, Shai Ben-David, *Understanding Machine Learning: From Theory to Algorithms*, Cambridge University Press, 2014.
3. Christopher M. Bishop, *Pattern Recognition and Machine Learning*, Springer, 2006.
4. Ethem Alpaydin, *Introduction to Machine Learning*, PHI.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6DS235PE2 - WIRELESS SENSOR NETWORK

Course Prerequisites: Computer Networks, Internet of Things, Sensors and Actuators

Course Objectives

- To understand the fundamentals, architecture, and applications of wireless sensor networks
- To study protocols across different layers of sensor networks and their differences from traditional networks
- To analyze challenges related to energy efficiency, scalability, and reliability in sensor networks
- To understand power management, synchronization, localization, and security issues in WSNs
- To examine real-time and mission-critical applications of wireless sensor networks

Course Outcomes

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

1. Explain the architecture and functioning of wireless sensor node networks

2. Describe sensor node architecture and physical layer characteristics
3. Analyze medium access control mechanisms and their properties in sensor networks
4. Compare routing protocols and algorithms used at different layers of WSNs
5. Evaluate power management techniques and synchronization challenges
6. Explain localization techniques and security mechanisms in wireless sensor networks

SYLLABUS

Unit I: Wireless Sensor Networks Overview and Applications (6 Lectures, 10 Marks)
Definitions and background of wireless sensor networks, sensing concepts and sensor types, characteristics of wireless sensor networks, challenges and constraints including energy efficiency, self-management, wireless networking, decentralized management, design constraints, security challenges, applications such as structural health monitoring, traffic control, healthcare systems, pipeline monitoring, precision agriculture, active volcano monitoring and underground mining.

Unit II: Sensor Node Architecture and Physical Layer (6 Lectures, 10 Marks)
Sensor node architecture, sensing subsystem, processor subsystem, communication interfaces, sensor node prototypes, physical layer components, source encoding, channel encoding, modulation techniques, signal propagation.

Unit III: Medium Access Control Protocols (6 Lectures, 10 Marks)
Medium access control concepts, contention-free medium access, contention-based medium access, wireless MAC protocols, characteristics of MAC protocols in sensor networks, contention-free MAC protocols, contention-based MAC protocols, hybrid MAC protocols.

Unit IV: Network Layer Protocols (6 Lectures, 10 Marks)
Routing metrics, flooding and gossiping techniques, data-centric routing, proactive routing, on-demand routing, hierarchical routing, location-based routing, quality-of-service based routing protocols.

Unit V: Power Management and Time Synchronization (6 Lectures, 10 Marks)
Local power management aspects, dynamic power management techniques, conceptual power management architecture, clock concepts, synchronization problems, time synchronization basics, time synchronization protocols in wireless sensor networks.

Unit VI: Localization and Security in WSNs (6 Lectures, 10 Marks)
Localization techniques, ranging techniques, range-based and range-free localization, event-driven localization, fundamentals of network security, security challenges in wireless sensor networks, security attacks in sensor networks, security protocols and mechanisms, IEEE 802.15.4 and ZigBee security.

Text Book
Waltenegus Dargie, Christian Poellabauer, *Fundamentals of Wireless Sensor Networks: Theory and Practice*, John Wiley & Sons, 2010.

Reference Books
1. Kazem Sohraby, Daniel Minoli, Taieb Znati, *Wireless Sensor Networks: Technology, Protocols, and Applications*, John Wiley & Sons, 2007.
2. Anna Hac, *Wireless Sensor Network Designs*, John Wiley & Sons.
3. Ian F. Akyildiz, Mehmet Can Vuran, *Wireless Sensor Networks*, John Wiley & Sons, 2010.
4. Feng Zhao, Leonidas J. Guibas, *Wireless Sensor Networks: An Information Processing Approach*, Morgan Kaufmann.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6KE235PE1 - WIRELESS TECHNOLOGY AND 5G

Course Prerequisites
- Data Communication and Networking
- Signals and Systems (basic concepts)
- Probability and Random Processes (introductory level)

Course Objectives
- To understand the fundamentals and evolution of wireless communication systems
- To study radio propagation, wireless channel characteristics, and multiple access techniques
- To understand cellular communication concepts and modern wireless standards

- To explore 4G LTE and 5G New Radio architectures, technologies, and use cases
- To analyze challenges, performance metrics, and future trends in wireless and 5G systems

Course Outcomes (COs)
After successful completion of the course, students will be able to:

1. Explain fundamental concepts of wireless communication and radio propagation
2. Analyze wireless channel behavior and multiple access techniques
3. Describe cellular system design principles and mobility management
4. Explain 4G LTE and 5G architectures, protocols, and key technologies
5. Evaluate 5G use cases, performance requirements, and future wireless trends

SYLLABUS

Unit I: Introduction to Wireless Communication Systems *(7 Hours)*
Evolution of wireless communication, basic elements of a wireless communication system, frequency spectrum and spectrum allocation, electromagnetic spectrum, advantages and challenges of wireless communication, applications of wireless systems, overview of wireless standards and generations from 1G to 5G

Unit II: Radio Propagation and Wireless Channels *(7 Hours)*
Radio wave propagation mechanisms including reflection, diffraction and scattering, large-scale path loss models, free space propagation model, shadowing effects, small-scale fading, multipath propagation, Doppler effect, delay spread and coherence bandwidth, channel capacity and Shannon limit

Unit III: Multiple Access and Cellular Concepts *(7 Hours)*
Multiple access techniques including FDMA, TDMA, CDMA, OFDMA and SC-FDMA, cellular system concepts, cell structure and frequency reuse, handoff and roaming, power control, interference management, capacity enhancement techniques, introduction to MIMO systems

Unit IV: 4G LTE Architecture and Technologies *(7 Hours)*
Overview of 4G LTE evolution, LTE network architecture including E-UTRAN and EPC, LTE protocol stack, radio resource management, modulation and coding schemes, OFDM principles, LTE frame structure, mobility and quality of service in LTE networks

Unit V: 5G New Radio and Network Architecture *(7 Hours)*
Motivation for 5G, 5G use case categories including eMBB, URLLC and mMTC, 5G architecture and core network, 5G NR protocol stack, spectrum for 5G including sub-6 GHz and mmWave, massive MIMO, beamforming, network slicing, edge computing integration

Unit VI: 5G Performance, Applications and Future Trends *(7 Hours)*
Performance requirements of 5G including latency, throughput and reliability, 5G applications in smart cities, healthcare, autonomous vehicles and Industry 4.0, security challenges in wireless and 5G networks, standardization bodies, evolution beyond 5G and introduction to 6G concepts

Text Book: Theodore S. Rappaport, *Wireless Communications: Principles and Practice*, 2nd Edition, Pearson Education

Reference Books:

1. Andreas F. Molisch, *Wireless Communications*, Second Edition, Wiley
2. David Tse, Pramod Viswanath, *Fundamentals of Wireless Communication*, Cambridge University Press
3. Erik Dahlman, Stefan Parkvall, Johan Sköld, *5G NR: The Next Generation Wireless Access Technology*, Academic Press
4. Mischa Dohler, *5G Mobile Communications*, Springer
5. Clint Smith, Daniel Collins, *5G Wireless Networks*, McGraw-Hill

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6KE235PE2 - COMPUTER VISION

Course Prerequisites
- Linear Algebra and Probability (basic concepts)
- Programming in Python / C++
- Fundamentals of Artificial Intelligence or Image Processing (preferred)

Course Objectives
- To understand the fundamentals and scope of computer vision systems
- To study image formation, feature extraction, and representation techniques
- To apply classical and learning-based methods for image and video analysis
- To understand object detection, recognition, and motion analysis techniques
- To explore real-world applications of computer vision in engineering domains

Course Outcomes (COs)
After successful completion of the course, students will be able to:
1. Explain the fundamentals, challenges, and components of computer vision systems
2. Apply image processing and feature extraction techniques for vision tasks
3. Analyze and implement object detection and recognition methods
4. Apply machine learning and deep learning techniques for vision applications
5. Evaluate computer vision solutions for real-world problems

SYLLABUS

Unit I: Introduction to Computer Vision and Image Formation *(7 Hours)*
Introduction to computer vision, human vision versus computer vision, applications of computer vision, components of a vision system, image formation process, pinhole camera model, camera geometry, perspective projection, camera calibration basics, image acquisition and digitization

Unit II: Image Processing and Feature Extraction *(7 Hours)*
Image preprocessing techniques including filtering and smoothing, edge detection techniques such as Sobel, Prewitt and Canny, corner detection including Harris and Shi–Tomasi, feature descriptors such as SIFT, SURF and ORB, feature matching techniques

Unit III: Object Detection and Recognition *(7 Hours)*
Object detection fundamentals, template matching, sliding window approach, histogram-based methods, object recognition concepts, shape-based and appearance-based recognition, face detection using Viola–Jones algorithm, feature-based classification approaches

Unit IV: Motion Analysis and Video Processing *(7 Hours)*
Video representation and formats, background subtraction techniques, optical flow concepts and methods, motion estimation and tracking, Kalman filter and particle filter basics, object tracking applications, activity recognition overview

Unit V: Machine Learning and Deep Learning for Computer Vision *(7 Hours)*
Role of machine learning in computer vision, supervised and unsupervised learning for vision tasks, convolutional neural networks architecture, popular CNN models overview, transfer learning concepts, object detection using deep learning approaches such as YOLO and SSD, semantic segmentation overview

Unit VI: Applications and Advanced Topics in Computer Vision *(7 Hours)*
Computer vision applications in autonomous vehicles, healthcare and medical imaging, surveillance and security, biometrics, industrial inspection, augmented and virtual reality integration, ethical issues and challenges in computer vision, future trends and research directions.

Text Book: Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer

Reference Books (Numbered):

1. Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing*, Pearson
2. Milan Sonka, Vaclav Hlavac, Roger Boyle, *Image Processing, Analysis and Machine Vision*, Cengage
3. Simon J. D. Prince, *Computer Vision: Models, Learning, and Inference*, Cambridge University Press
4. Ian Goodfellow, Yoshua Bengio, Aaron Courville, *Deep Learning*, MIT Press
5. Adrian Rosebrock, *Deep Learning for Computer Vision with Python*, PyImageSearch

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	–	–	–	–	–	–	–	–	2
CO2	3	3	2	2	2	–	–	–	–	–	–	2
CO3	2	3	3	2	2	–	–	–	–	–	–	2

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

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6AD235PE1 - BLOCKCHAIN TECHNOLOGY

Course Prerequisites
Basic knowledge of Computer Networks, Distributed Systems, Cryptography and Information Security.

Course Objectives:
After completing this course/unit, students will be able to:
- To introduce the architecture, principles, and working mechanisms of blockchain and distributed ledger technologies.
- To understand cryptographic foundations and mathematical principles enabling blockchain security.
- To analyze consensus mechanisms, blockchain security challenges, and system-level trade-offs.
- To design and develop smart contracts and decentralized applications using blockchain platforms.
- To evaluate blockchain platforms and applications considering scalability, regulatory, sustainability, and ethical implications.

Course Outcomes (COs)*:*
After successful completion of the course, students will be able to:
1. Explain blockchain architecture, distributed ledger principles, and system components.
2. Apply cryptographic primitives and mathematical foundations in blockchain systems.
3. Analyse, compare, and evaluate consensus mechanisms and blockchain security models.
4. Design, develop, test, and deploy secure smart contracts and decentralized applications.
5. Evaluate blockchain platforms and real-world applications considering scalability, regulation, sustainability, and ethical issues.

SYLLABUS

Unit I: Blockchain Architecture & Distributed Systems (6 Hours)
Evolution and need for blockchain, blockchain vs traditional databases, distributed ledger technology concepts, core properties of blockchain (decentralization, immutability, transparency, auditability), blockchain architecture including blocks, transactions, block header, Merkle tree concept, node types and peer-to-peer network model, types of blockchain (public, private, consortium), transaction lifecycle, CAP theorem overview and blockchain limitations such as scalability, latency, and storage constraints.

Unit II: Cryptographic Foundations (6 Hours)
Cryptography fundamentals in blockchain, symmetric and asymmetric cryptography overview, hash functions and properties, SHA-256 and Keccak overview, Merkle trees and verification concepts, digital signatures and ECDSA, public-private key cryptography and ownership, wallet concepts and key management basics, role of cryptography in ensuring authentication, integrity, and non-repudiation, overview of elliptic curve cryptography and zero-knowledge proof concepts.

Unit III: Consensus Mechanisms & Blockchain Security (6 Hours)
Need for consensus and Byzantine Generals Problem, overview of consensus mechanisms, Proof-of-Work, Proof-of-Stake, Delegated Proof-of-Stake, PBFT (conceptual), comparison of consensus mechanisms based on performance, energy efficiency, and scalability, blockchain forks (hard and soft), common blockchain attacks including 51% attack, Sybil attack, double spending, and basic blockchain security considerations.

Unit IV: Cryptocurrency & Blockchain Platforms (6 Hours)
Bitcoin architecture and UTXO model, transaction lifecycle overview, Ethereum architecture and account-based model, Ethereum Virtual Machine and gas concept, overview of smart contract execution, introduction to Hyperledger Fabric architecture and permissioned blockchain concepts, comparison of major blockchain platforms and node roles.

Unit V: Smart Contracts & Decentralized Applications (6 Hours)
Smart contracts concepts and lifecycle, introduction to Solidity programming structure, development using Remix IDE (conceptual exposure), deployment on test networks, ERC-20 token concept, basics of decentralized application architecture, interaction using Web3 libraries (conceptual), common smart contract vulnerabilities (reentrancy, overflow, denial of service), secure coding practices, introduction to IPFS for decentralized storage.

Unit VI: Scalability, Regulation & Emerging Trends (6 Hours)
Blockchain scalability challenges and scalability trilemma, overview of Layer-2 solutions (state channels and rollups), interoperability concepts, privacy considerations in blockchain systems, global and Indian regulatory overview, concept of Central Bank Digital Currency (CBDC), environmental and sustainability concerns, emerging trends including DeFi, NFTs, DAOs, Web3 ecosystem, and ethical implications of decentralized technologies.

Text Books:

1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction. Princeton University Press.
2. Antonopoulos, A. M. (2017). Mastering Bitcoin: Programming the Open Blockchain (2nd ed.). O'Reilly Media.

Reference Books:

1. Antonopoulos, A. M., & Wood, G. (2018). Mastering Ethereum: Building Smart Contracts and DApps. O'Reilly Media.
2. Imran Bashir, Mastering Blockchain, Packet Publishing
3. Andreas M. Antonopoulos, Mastering Bitcoin, O’Reilly
4. Mastering Bitcoin: Unlocking Digital Crypto currencies, by Andreas Antonopoulos, O’Reilly publisher
5. Blockchain Blueprint for a New Economy by Melanie Swan, O’Reilly
6. Narayanan, Arvind, et al. Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction. Princeton University Press, 2016.
7. Antonopoulos, Andreas M. Mastering Bitcoin: Programming the Open Blockchain. O’Reilly Media, Inc., 2017
8. Antonopoulos, Andreas M. and Wood, Gavin. Mastering Ethereum. O’Reilly Media, Inc., 2018. (Free draft available at https://github.com/ethereumbook/ethereumbook)
9. Ethereum project documentation. Online: http://www.ethdocs.org/en/latest/
10. Zero to Blockchain - An IBM Redbooks course, by Bob Dill, David Smits- https://www.redbooks.ibm.com/Redbooks.nsf/RedbookAbstracts/ crse0401.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6AD235PE2 - DATA VISUALIZATION TECHNIQUES

Course Prerequisites: Fundamental Statistics and Math

Course Objectives:
After completing this course/unit, students will be able to:

- To learn different statistical methods for Data visualization.
- To learn Visualization Techniques
- To efficiently acquire, manage, clean, transform, and analyze structured data using NumPy and pandas.
- To understand the usage of the Matplotlib, Seaborn Packages
- To Learn about Excel and various operations using Excel
- To Visualize Big Data hierarchies with treemaps

Course Outcomes (COs)*:*
After successful completion of the course, students will be able to:

1. Apply statistical methods for Data visualization on Various Datasets.
2. Understand different Visualization Techniques.
3. Gain knowledge on various visualization techniques using Python.
4. Understand usage of various packages in Python..
5. Understand the concept of Excel, Visualization using Excel.
6. Apply techniques for complex Big Data: Visualize structures, spot high- volume patterns, design Tableau/Power BI dashboards for variety/velocity, and ethically analyze trends via Treemaps/Sunburst Charts.

SYLLABUS

Unit I: *(6 Hours)*
Introduction to Data Visualization, Key factors of Data Visualization, Importance of Data Visualization in Business Intelligence, Data Visualization tools and types of data, Data Abstraction: data types, dataset types, Attribute types, Task Abstraction, Four Levels for Validation.

Unit II: *(6 Hours)*
Visualization Techniques: Scalar and point visualizations, – vector visualizations – multidimensional visualizations – Cluster Visualizations – matrix visualization in Bayesian data analysis.

Unit III: *(8 Hours)*
Getting Started with Pandas: Arrays and vectorized computation, Introduction to pandas Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics. Data Loading, Storage and File Formats. Reading and

Writing Data in Text Format, Web Scraping, Binary Data Formats, Interacting with Web APIs, Interacting with Databases Data Cleaning and Preparation. Handling Missing Data, Data Transformation, String Manipulation.

Unit IV: *(6 Hours)*
Data Visualization Tools in Python- Introduction to Matplotlib, Basic plots Using matplotlib, Specialized Visualization Tools using Matplotlib, Advanced Visualization Tools using Matplotlib Waffle Charts, Word Clouds.

Unit V: *(8 Hours)*
Introduction: Data Analysis, Excel Data analysis. Working with range names. Tables Cleaning Data. Conditional formatting, Sorting, Advanced Filtering, Lookup functions, Pivot tables, Data Visualization, Data Validation. Understanding Analysis tool pack: Anova, correlation, covariance, moving average, descriptive statistics, exponential smoothing, fourier Analysis, Random number generation, sampling, ttest, f-test, and regression.

Unit VI: *(6 Hours)*
Addresses techniques for visualizing Big Data (considering Volume, Variety, Velocity), interactive visualizations like Treemaps and Sunburst Charts, and introduces visualization tools such as Tableau and Power BI.

Text Books:

1. Core Python Programming - Second Edition, R. NageswaraRao, DreamtechPress.
2. A to Z of MS EXCEL: A Book for Learners & Trainers (MS Excel Comprehensive Guide by RinkooJainn.
3. Data Analysis with Excel by Manish Nigam. Bpb Publications.

Reference Books;

1. KNIME Essentials, by GáborBakos, 2013.
2. Data Science Tools by Christopher Greco, 2020.
3. Introduction to Data Science a Python approach to concepts, Techniques and Applications, Igual, L;Seghi', S. Springer, ISBN:978-3-319-50016-4.
4. ALL-IN-ONE-EXCEL 2022 Bible for Dummies by Bryant Shelton.
5. Excel® 2019 BIBLE BY Michael Alexander, Dick Kusleika.
6. Python for Data Analysis by William McKinney, Second Edition, O'Reilly MediaInc.
7. The Visual Display of Quantitative Information, by Edward Tufte for design principles.
8. Data Visualization: A Practical Introduction, by Kieran Healy for Big Data applications.
9. Learning Power BI, by Ethan Knight for tool-specific depth.

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

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6CS236PC / 6DS236PC / 6KE236PC / 6AD236PC - DESIGN & ANALYSIS OF ALGORITHM LAB

Course Prerequisite: Any programming language, Discrete Mathematics and Data Structures

Course Objectives:
Throughout the course, students will be expected to demonstrate their understanding of Design and Analysis of Algorithms by being able to do each of the following:

- To understand asymptotic analysis of algorithms.
- To apply algorithmic strategies while solving problems.
- Ability to analyze time and space complexity.
- Demonstrate a familiarity with major algorithms.

Course Outcomes (Expected Outcome):
On completion of the course, the students will be able to:

1. Carry out the analysis of various Algorithms for mainly Time complexity.
2. Apply design principles and concepts to algorithm design.
3. Understand different algorithmic design strategies.
4. Analyze the efficiency of algorithms using time complexity.
5. Apply the standard sorting algorithms.

List of Experiments:
This is the sample list of Experiments; minimum 12 experiments are to be performed covering the entire syllabus. At least two experiments should be beyond syllabi based on learning of syllabi

List of Experiments based on Syllabus: (Maximum 20)

1. Implement C programs to perform recursive calls using the following searching algorithms.
   a. Linear Search when the list is given.
   b. Binary Search when the given list is not sorted.
2. Study and analyze to sort an array of integers using merge sort.
3. Implement and analyze to sort an array of integers using quicksort.
4. Write a program to implement the Closest Pair of Points problem using the divide and conquer strategy.
5. Study and Implement the Divide and Conquer strategy using the Merge sort Algorithm and determine the complexity of an algorithm. DATA- {23, 12, 3, 5, 89, 1, 24}
6. Write a C program for Implementing (n X n) matrix multiplication using the Strassen matrix multiplication algorithm.
7. Explain the knapsack algorithm to find an optimal solution of getting maximum profit and implement using the program.
8. Find Minimum Cost Spanning Tree of a given undirected graph using Kruskal's algorithm and implement using C.
9. Implement programs to find minimum cost spanning trees from a given graph using Prim's algorithm.
10. Implement Prim's algorithm to find the Minimum Cost Spanning Tree of an undirected graph using the program.
11. Develop a program to implement Floyd's algorithm which will produce the shortest distance between all vertex pairs of a weighted graph.
12. Implement programs to find the shortest path in a given graph using Dijkstra's algorithm.
13. Implement programs factorial knapsack problem.
14. Develop a program to implement Strassen's matrix multiplication algorithm.
15. Implement programs to implement LCS problems using Dynamic Programming.
16. Develop a program to implement matrix chain multiplication problems using dynamic programming.
17. Explain Breadth-First Search and Implement BFS to print all the nodes reachable from a given starting node in a digraph.
18. Develop a program to Print all the nodes reachable from a given starting node in a digraph using Depth First Search.
19. Study an algorithm Tower of Hanoi where the aim is to move the entire stack to another rod for n=3 and understand the concept of recursion.
20. Implement C programs N Queen's problem using Back Tracking.

List of Experiments beyond Syllabus: (Maximum 05)

1. Implement the Work Function Algorithm and the Greedy Algorithm for the k-Server problem on graph metrics.
2. Design and Implement Boyer Moore Algorithm for Pattern Searching.
3. Design and Implement Topological Sort of a graph using departure time of vertex.
4. Implement programs to find an s-t cut of minimum capacity. Minimum Cut Problem s 2 3 4 5 6 7 t 15 5 30 15 10 8 15 9 6 10 15 4 4 A Capacity = 10 + 8 + 10 = 28
5. Implement programs to s-t flow of maximum value. Maximum Flow Problem 10 9 9 14 4 10 4 8 9 1 0 0 0 14 capacity flow s 2 3 4 5 6 7 t 15 5 30 15 10 8 15 9 6 10 15 4 4 0 Value = 28

Text Book: Dave and Dave: "Design and Analysis of Algorithms" Pearson Education.

Reference Books:

1. Aho,Hopcroft & Ullman "The Design & Analysis of Computer Algorithms", Addison-Wesley
2. G. Brassard, P.Bratley: "Fundamentals of Algorithmics" , PHI
3. Horowitz & Sahani: " Fundamental Algorithms" , Galgotia.
4. Cormen, T.H, Lierson & Rivest: " Introduction to Algorithms", Mc Graw-Hill.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6CS237PC / 6DS237PC / 6KE237PC / 6AD237PC - CLOUD COMPUTING LAB

Course Prerequisite: Data Communication and Networks

Course Objectives:
After completion of this laboratory course, students will be able to:

- Gain hands-on exposure to fundamental concepts, architectures, and service models of Cloud Computing.

- Implement and experiment with virtualization, cloud services, and deployment models using real cloud platforms and tools.
- Develop and deploy cloud-based applications using IaaS, PaaS, and SaaS environments.
- Understand and apply cloud security, storage, and networking concepts through practical exercises.

Course Outcomes (Expected Outcome):
On successful completion of the course, students will be able to:
1. Demonstrate the use of cloud architectures, deployment models, and service models using practical tools.
2. Configure and manage virtual machines, storage, and networking resources in cloud environments.
3. Deploy applications on cloud platforms using IaaS and PaaS services.
4. Analyze cloud security issues and apply basic security mechanisms in cloud service models.
5. Compare and evaluate major cloud service providers based on services, performance, and use cases.

List of Experiments:

Part A: Cloud Fundamentals & Virtualization
1. Study and comparison of Cloud Computing deployment and service models.
2. Installation and configuration of VirtualBox / VMware Workstation.
3. Creation and management of Virtual Machines (VMs).
4. Study of Hypervisors (Type-1 & Type-2).
5. VM snapshot creation, cloning, and resource allocation.

Part B: Infrastructure as a Service (IaaS)
1. Launching and managing EC2 instances on AWS (or equivalent).
2. Configuring cloud storage services (Amazon S3 / Azure Blob / Google Cloud Storage).
3. Setting up Elastic IPs and security groups.
4. Monitoring cloud resources using CloudWatch / Azure Monitor.
5. Study and implementation of VM migration to cloud.

Part C: Platform as a Service (PaaS)
1. Deployment of a web application using PaaS (Google App Engine / Azure App Service).
2. Developing and deploying a cloud-native application.
3. Using Docker containers for application deployment.
4. Introduction to Kubernetes (basic deployment).
5. Using cloud APIs for application integration.

Part D: Software as a Service (SaaS)
1. Study of popular SaaS platforms (Google Workspace, Salesforce, Office 365).
2. Hands-on usage of Salesforce Sales Cloud / Service Cloud.
3. Access control and user management in SaaS applications.

Part E: Cloud Networking, Security & Open Source
1. Study of cloud networking components (VPC, subnets, routing).
2. Implementing basic firewall and security rules.
3. Study of IAM (Identity and Access Management).
4. Installation and use of OpenStack (introductory level).
5. Using Open-source cloud tools (OpenNebula / Eucalyptus – demo).
6. Study of cloud backup, disaster recovery and fault tolerance.
7. Mini Project: Deploy a complete cloud-based application using IaaS/PaaS.

Text Book: K. Chandrasekaran, *Essentials of Cloud Computing*, CRC Press, Taylor & Francis.

Reference Books:

1. A. Shrinivasan, J. Suresh – Cloud Computing: A Practical Approach, Pearson.
2. M. N. Rao – Cloud Computing, PHI Learning Pvt. Ltd.
3. Kumar Saurabh – Cloud Computing, Wiley India.
4. Rajkumar Buyya et al. – Cloud Computing: Principles and Paradigms, Wiley.
5. Anthony T. Velte et al. – Cloud Computing: A Practical Approach, Tata McGraw-Hill.
6. Judith Hurwitz et al. – Cloud Computing for Dummies, Wiley.

Tentative CO-PO Mapping:
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CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	2	2	–	–	–	–	–	–	1
CO2	2	3	2	2	3	–	–	–	–	–	–	1
CO3	2	2	3	2	3	–	–	–	–	–	–	1

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

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6CS238PE/6DS238PE/6KE238PE/6AD238PE - PROGRAMME ELECTIVE COURSE II LAB –

NATURAL LANGUAGE PROCESSING

Course Prerequisite: Fundamentals of Artificial Intelligence

Course Objectives:
After completion of this laboratory course, students will be able to:
- Acquire hands-on experience with core NLP techniques such as tokenization, tagging, parsing, and semantic analysis.
- Implement rule-based and statistical NLP models using standard NLP libraries and datasets.
- Design and evaluate text classification and information extraction systems.
- Apply NLP concepts to real-world language processing applications.

Course Outcomes (Expected Outcome):
On successful completion of the course, students will be able to:
1. Implement language preprocessing techniques including tokenization, stemming, lemmatization, and POS tagging.
2. Construct and evaluate statistical NLP models such as N-grams, HMMs, and Naïve Bayes classifiers.
3. Develop syntactic and semantic analyzers using CFG/PCFG and parsing techniques.
4. Design NLP-based applications for classification, named entity recognition, and information extraction.
5. Compare different NLP approaches (rule-based vs statistical vs ML-based) for specific problem domains.

List of Experiments:

Part A: NLP Basics & Text Preprocessing
1. Installation and familiarization with NLTK, spaCy, Gensim libraries.
2. Text preprocessing: tokenization, normalization, stop-word removal.
3. Implementation of stemming and lemmatization techniques.
4. Regular expression based pattern matching for text processing.
5. Construction of Finite State Automata (FSA) for simple morphological parsing.

Part B: Word-Level & Statistical Language Models
1. Implementation of Unigram, Bigram, and Trigram language models.
2. Smoothing techniques (Laplace, Good-Turing – demo).
3. Evaluation of language models using perplexity.
4. Implementation of Part-of-Speech tagging using NLTK/spaCy.
5. POS tagging using Hidden Markov Models (HMM).

Part C: Syntax & Parsing
1. Design of Context-Free Grammar (CFG) for simple English sentences.
2. Implementation of Parse Trees using NLTK.
3. Study and implementation of Probabilistic CFG (PCFG).
4. Dependency parsing using spaCy.
5. Ambiguity resolution using parsing strategies.

Part D: Semantic Analysis
1. Implementation of Word Sense Disambiguation (WSD) techniques.
2. Representation of meaning using First Order Predicate Logic (FOPL).
3. Semantic role labeling (introductory).
4. Lexical semantics: Synsets, hypernyms, hyponyms using WordNet.

Part E: Text Classification & Information Extraction
1. Implementation of Naïve Bayes text classifier.
2. Decision Tree based text classification (demo).
3. Named Entity Recognition (NER) using rule-based and statistical models.
4. Chunking and shallow parsing.
5. Information extraction from unstructured text.
6. **Mini Project**: End-to-end NLP application (e.g., sentiment analysis / chatbot / IE system).

Text Books:

1. Jurafsky & Martin – Speech and Language Processing, Pearson.
2. Steven Bird et al. – Natural Language Processing with Python, O’Reilly.
3. Manning & Schuetze – Foundations of Statistical NLP, MIT Press.

Reference Books:

1. Breck Baldwin – Language Processing with Java and LingPipe Cookbook.

2. Richard M. Reese – NLP with Java, O'Reilly.
3. Nitin Indurkhya & Fred Damerau – Handbook of NLP, CRC Press.
4. Charu C. Aggarwal – Machine Learning for Text, Springer.
5. Tanveer Siddiqui & U.S. Tiwary – NLP and Information Retrieval, Oxford.

Tentative CO-PO Mapping:
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CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	–	2	3	–	–	–	–	–	–	1
CO2	2	3	2	2	3	–	–	–	–	–	–	1
CO3	2	3	2	2	2	–	–	–	–	–	–	1
CO4	2	3	3	2	3	–	–	–	–	–	–	1
CO5	2	3	2	2	2	–	–	–	–	–	–	2

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6CS238PE/6DS238PE/6KE238PE - PROGRAMME ELECTIVE COURSE II LAB –

BIG DATA ANALYTICS

Course Prerequisite:
- Basic Computer Science concepts
- Linear Algebra & Probability (introductory level)
- Database Management Systems

Course Objectives:
After completion of this laboratory course, students will be able to:
- Gain hands-on experience with big data tools, frameworks, and analytics techniques.
- Implement clustering, classification, regression, and association rule mining algorithms on large datasets.
- Perform time-series, text, and stream analytics using scalable data processing tools.
- Work with distributed storage systems, Hadoop ecosystem, NoSQL, and graph databases.

Course Outcomes (Expected Outcome):
On successful completion of the course, students will be able to:
1. Use big data platforms such as Hadoop, Spark, and NoSQL databases for data analytics.
2. Analyze large datasets using clustering, classification, regression, and recommendation techniques.
3. Apply analytics on structured, semi-structured, and unstructured data including text and time series.
4. Perform data stream and batch analytics using scalable frameworks.
5. Design and implement analytics solutions using NoSQL and graph-based data models.

List of Experiments:

Part A: Big Data Fundamentals & Analytics Lifecycle
1. Study of Big Data characteristics (5Vs) and analytics lifecycle.
2. Dataset understanding, ingestion, and data preprocessing.
3. Exploratory Data Analysis (EDA) using Python/R on large datasets.
4. Statistical analysis: Hypothesis testing, ANOVA, error types.
5. Case study analysis on Global Innovation Network Analytics (GINA).

Part B: Clustering & Association Rule Mining
1. Implementation of K-Means clustering on large datasets.
2. Determining optimal clusters using Elbow & Silhouette methods.
3. Implementation of Hierarchical clustering (demo).
4. Mining frequent itemsets using Apriori algorithm.
5. Visualization and evaluation of association rules.

Part C: Regression & Classification Analytics
1. Implementation of Linear Regression on large datasets.
2. Implementation of Logistic Regression for classification problems.
3. Decision Tree construction and evaluation.
4. Implementation of Naïve Bayes classifier with smoothing.
5. Model diagnostics: Accuracy, Precision, Recall, ROC-AUC.

Part D: Time Series & Text Analytics
1. Time series modeling using ARIMA.
2. Forecast evaluation and error metrics.
3. Text preprocessing & TF-IDF vectorization.
4. Sentiment analysis on large text datasets.
5. Topic modeling using LDA (demo).

Part E: Hadoop, MapReduce & NoSQL
1. Installation & configuration of Hadoop (pseudo-distributed mode).
2. Implementation of MapReduce programs (Word Count, Log Analysis).
3. Working with Hive & Pig for data querying.
4. NoSQL database operations using HBase / MongoDB.
5. **Mini Project**: End-to-end Big Data analytics solution using Hadoop/Spark.

Text Books:
1. EMC Education Services – Data Science and Big Data Analytics, Wiley.
2. David Loshin – Big Data Analytics, Morgan Kaufmann.

Reference Books:
1. Bart Baesens – Analytics in a Big Data World, Wiley.
2. Mohammad Guller – Big Data Analytics with Spark, Apress.
3. Arshdeep Bahga & Vijay Madisetti – Big Data Science & Analytics, Hands-On Approach.

Tentative CO-PO Mapping:
(**Mapping Scale:** 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6CS238PE - PROGRAMME ELECTIVE COURSE II LAB – CRYPTOGRAPHY

Course Prerequisite:
- Discrete Structures & Graph Theory
- Data Communication and Networking
- Introduction to Cyber Security

Course Objectives:
After completion of this laboratory course, students will be able to:
- Gain hands-on understanding of cryptographic principles and security concepts.
- Implement and analyze symmetric and asymmetric encryption algorithms.
- Apply hash functions, digital signatures, and authentication mechanisms in secure communication.
- Experiment with network and system-level security protocols used in real-world applications.

Course Outcomes (Expected Outcome):
On successful completion of the course, students will be able to:
1. Implement and compare symmetric encryption algorithms for secure data transmission.
2. Design and evaluate public key cryptographic mechanisms including RSA and digital signatures.
3. Apply hash functions and message authentication techniques to ensure data integrity.
4. Demonstrate the working of internet security protocols such as SSL/TLS and secure email.
5. Analyze authentication mechanisms and basic intrusion scenarios from a security perspective.

List of Experiments:

Part A: Cryptography Fundamentals
1. Study of cryptographic concepts, threats, and attack models.
2. Implementation of substitution ciphers (Caesar, Monoalphabetic).
3. Implementation of transposition ciphers.
4. Implementation of Vigenère cipher and cryptanalysis (demo).
5. Study of key space, key size, and brute-force attacks.

Part B: Symmetric Key Cryptography
1. Implementation of DES encryption and decryption.
2. Implementation of AES encryption and decryption.
3. Performance comparison of DES vs AES.
4. Implementation of RC4 stream cipher.
5. Study of block cipher modes of operation (ECB, CBC, CFB – demo).

Part C: Asymmetric Key Cryptography & Digital Signatures
1. Implementation of RSA key generation, encryption, and decryption.
2. Implementation of RSA-based digital signature scheme.
3. Comparison of symmetric vs asymmetric encryption.

4. Secure file transfer using public key cryptography.
5. Digital signature verification and integrity check.

Part D: Hashing, Authentication & PKI
1. Implementation of hash algorithms (MD5, SHA-1, SHA-256).
2. Message authentication using hash and HMAC.
3. Study and implementation of digital certificates.
4. Creation and validation of X.509 certificates (OpenSSL).
5. Study of Public Key Infrastructure (PKI) and PKCS standards.

Part E: Network Security & Authentication
1. Study of SSL/TLS handshake process (simulation/demo).
2. Secure communication using HTTPS and SSL/TLS.
3. Secure email using PGP/S-MIME (demo).
4. Study of authentication mechanisms (password, token, certificate-based).
5. Mini Project: Secure communication system using cryptographic techniques.

Text Book: Atul Kahate – Cryptography and Network Security, McGraw Hill, Second Edition.

Reference Books:
1. William Stallings – Cryptography and Network Security: Principles and Practice, PHI.
2. Behrouz A. Forouzan & Debdeep Mukhopadhyay – Cryptography and Network Security, McGraw Hill.
3. Matt Bishop – Computer Security: Art and Science, Pearson.
4. Douglas R. Stinson – Cryptography: Theory and Practice, CRC Press.
5. Keith M. Martin – Everyday Cryptography, Oxford University Press.

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(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

6KE238PE3 - CRYPTOGRAPHY & SECURITY - LAB

Course Prerequisites
- Discrete Structures and Graph Theory
- Data Communication and Networking
- Introduction to Cyber Security
- Basic Programming Skills (Python / C / Java)

Course Objectives ***(Bulleted – 4–5)***
- To provide hands-on understanding of cryptographic algorithms and security mechanisms
- To implement symmetric and asymmetric encryption techniques in practical scenarios
- To apply hashing, digital signatures, and authentication techniques for secure communication
- To analyze network and system security protocols through experimentation
- To develop secure applications using cryptographic primitives

Course Outcomes (COs) ***(Numbered – 4–5)***
After successful completion of the course, students will be able to:
1. Implement and analyze symmetric and asymmetric cryptographic algorithms
2. Apply hashing and message authentication techniques to ensure data integrity
3. Demonstrate digital signatures and public key infrastructure mechanisms
4. Implement secure communication using Internet security protocols
5. Analyze authentication mechanisms and basic security attack scenarios

LIST OF EXPERIMENTS

Part A: Cryptography Fundamentals
1. Study of cryptographic concepts, security services, threats, and attack models
2. Implementation of substitution ciphers such as Caesar cipher and monoalphabetic cipher
3. Implementation of transposition cipher techniques
4. Implementation of Vigenère cipher and basic cryptanalysis
5. Study of key space, key size, brute-force attacks, and security strength

Part B: Symmetric Key Cryptography

6. Implementation of DES encryption and decryption
7. Implementation of AES encryption and decryption
8. Performance comparison of DES and AES algorithms
9. Implementation of RC4 stream cipher
10. Study and demonstration of block cipher modes of operation such as ECB, CBC, and CFB

Part C: Asymmetric Cryptography & Digital Signatures

11. Implementation of RSA key generation, encryption, and decryption
12. Implementation of RSA-based digital signature scheme
13. Comparison of symmetric and asymmetric encryption techniques
14. Secure file transfer using public key cryptography
15. Digital signature verification and integrity checking

Part D: Hashing, Authentication & PKI

16. Implementation of hash algorithms such as MD5, SHA-1, and SHA-256
17. Message authentication using hash functions and HMAC
18. Study and implementation of digital certificates
19. Creation and validation of X.509 certificates using OpenSSL
20. Study of Public Key Infrastructure (PKI) and PKCS standards

Part E: Network Security & Mini Project

21. Study and demonstration of SSL/TLS handshake process
22. Secure communication using HTTPS and SSL/TLS
23. Study of secure email mechanisms such as PGP and S/MIME
24. Study of authentication mechanisms including password, token, and certificate-based systems
25. **Mini Project:** Design and implementation of a secure communication or secure storage system using cryptographic techniques

Text Book: Atul Kahate, *Cryptography and Network Security*, Second Edition, McGraw-Hill

Reference Books *(Numbered)*

1. William Stallings, *Cryptography and Network Security: Principles and Practice*, PHI
2. Behrouz A. Forouzan, Debdeep Mukhopadhyay, *Cryptography and Network Security*, McGraw-Hill
3. Matt Bishop, *Computer Security: Art and Science*, Pearson
4. Douglas R. Stinson, *Cryptography: Theory and Practice*, CRC Press
5. Keith M. Martin, *Everyday Cryptography*, Oxford University Press

Tentative CO-PO Mapping:

(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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6AD238PE - PROGRAMME ELECTIVE COURSE II LAB

DIGITAL FORENSICS LAB

Type: Practical | **Credits**: 1

Prerequisite:

Working knowledge of Operating Systems, Computer Networks, Fundamentals of Cyber Security, file systems and databases.

Course Objectives:

- Provide hands-on experience in digital forensic investigation techniques
- Familiarize students with commonly used digital forensic tools and environments
- Enable students to acquire, preserve, and analyze digital evidence
- Develop skills for interpreting forensic findings
- Train students in documentation and forensic report preparation

Course Outcomes (COs):

1. **CO1:** Perform forensic acquisition of digital evidence using standard tools.

2. **CO2:** Analyze file systems and recover deleted or hidden data.
3. **CO3:** Investigate basic mobile and cloud-based forensic scenarios.

Tentative List of Practicals (Any 8–10):

1. Study of Digital Forensic Environment and Tools
2. Disk Imaging and Data Acquisition
3. File System and Deleted File Analysis
4. Basic Operating System Forensics
5. Introduction to Memory Analysis
6. Network Traffic Capture
7. Email and Browser Forensics
8. Mobile Device Forensics
9. Cloud Forensics Case Study
10. Digital Forensic Report Preparation.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	3	–	–	2	–	–	–	2
CO2	3	3	2	2	3	–	–	2	–	–	–	2
CO3	2	3	2	2	3	–	–	2	–	–	–	2

6CS239MD - CLOUD COMPUTING & VIRTUALIZATION

Type: Theory | **Credits**: 2 **Total Contact Hours**: 22–25 hours

Prerequisite: Basics of computer networks and operating systems.

Course Objectives:

- To introduce the fundamental concepts of cloud computing and service models.
- To understand virtualization technologies used to enable cloud environments.
- To analyze and evaluate different cloud platforms and deployment models.
- To explore real-world applications and use cases of cloud computing.

Course Outcomes (COs):

1. **CO1**: Explain cloud computing paradigms and deployment models. *(Unit 1)*
2. **CO2**: Understand the role of virtualization in enabling cloud environments. *(Unit 2)*
3. **CO3**: Compare and contrast different cloud service providers and applications. *(Unit 3)*

SYLLABUS:

Unit 1: Cloud Computing Foundations (7–8 hrs)
Introduction to Cloud Computing: Characteristics, Benefits, Limitations, Service Models: IaaS, PaaS, SaaS, Deployment Models: Public, Private, Hybrid, Community, Use Cases in Academia, Industry, and Government.

Unit 2: Virtualization Technologies (7–8 hrs)
Concept of Virtual Machines and Hypervisors, Types of Virtualization: OS, Server, Storage, and Network Virtualization, Tools and Platforms: VMware, VirtualBox, Docker (Basics), Resource Allocation, Load Balancing, and Scalability.

Unit 3: Cloud Platforms and Real-world Applications (7–8 hrs)
Overview of Leading Cloud Platforms: AWS, Microsoft Azure, Google Cloud, Basic Cloud Services: Compute, Storage, Database, Networking, Introduction to Serverless Computing and Containers, Application Areas: E-commerce, Education, Smart Cities, IoT, Startups.

Textbook: Rajkumar Buyya, James Broberg, Andrén Goscinski, "Cloud Computing: Principles and Paradigms," Wiley, 2011.

Reference Books:

1. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, "Cloud Computing: A Practical Approach," McGraw Hill, 2010.
2. Thomas Erl, "Cloud Computing: Concepts, Technology & Architecture," Pearson, 2013.
3. Judith Hurwitz, R. Bloor, M. Kaufman, F. Halper, "Cloud Computing for Dummies," Wiley, 2010.
4. Arshdeep Bahga, Vijay Madisetti, "Cloud Computing: A Hands-On Approach," Universities Press, 2014.
5. Barrie Sosinsky, "Cloud Computing Bible," Wiley, 2011.
6. Gautam Shroff, "Enterprise Cloud Computing," Cambridge University Press, 2010.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

6DS239MD - APPLIED MACHINE LEARNING FOR ENGINEERS

Subject Code: 6DS239MD **Subject Title**: Applied Machine Learning for Engineers
Type: Theory | **Credits**: 2 **Total Contact Hours**: 22–25 hours

Prerequisite:

- Fundamentals of programming in Python
- Basics of Data Science & Statistics
- Familiarity with linear algebra and probability

Course Objectives:

- To introduce the core concepts and workflows of machine learning.
- To expose students to supervised and unsupervised learning algorithms.
- To demonstrate practical implementation of ML models using Python.
- To equip students with model evaluation, tuning, and interpretation skills.

Course Outcomes (COs):

1. **CO1**: Understand the basic principles and categories of machine learning algorithms. (Unit 1)
2. **CO2**: Apply supervised and unsupervised learning methods to real-world datasets. (Unit 2)
3. **CO3**: Evaluate and improve ML models using standard metrics and techniques. (Unit 3)

SYLLABUS:

Unit 1: Introduction to Machine Learning (7 hrs)
What is Machine Learning?, Types of ML: Supervised, Unsupervised, and Reinforcement Learning
ML Pipeline: Data Preprocessing, Training, Evaluation, Deployment, Tools & Libraries: scikit-learn, Pandas, Numpy.

Unit 2: Supervised and Unsupervised Learning (8 hrs)
Linear Regression, Logistic Regression, Decision Trees, K-Nearest Neighbors (KNN), Naive Bayes
Clustering: K-Means, Hierarchical Clustering, Feature Scaling, Feature Selection.

Unit 3: Model Evaluation and Tuning (7 hrs)
Train/Test Split, Cross-Validation, Evaluation Metrics: Accuracy, Precision, Recall, F1-Score, ROC-AUC, Hyperparameter Tuning (Grid Search, Random Search), Avoiding Overfitting: Regularization, Cross-validation, Ensemble Models.

Textbook(s):

Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow," 2nd Ed., O'Reilly Media, 2019.

Reference Books:

1. Tom Mitchell, "Machine Learning," McGraw-Hill Education, 1997.
2. Ethem Alpaydin, "Introduction to Machine Learning," MIT Press, 4th Ed., 2020.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning," Springer, 2nd Ed., 2009.
4. Andriy Burkov, "The Hundred-Page Machine Learning Book," 2019.
5. Sebastian Raschka, Vahid Mirjalili, "Python Machine Learning," Packt Publishing, 3rd Ed., 2020.
6. Yuxi Liu, "Python Machine Learning by Example," Packt Publishing, 2nd Ed., 2019.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO10	PO12
CO1	3	2					1

CO2	2	3	3	2	2	2	2
CO3		3	2	3	3	2	2

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6KE239MD - DEVOPS & SOFTWARE DEPLOYMENT PRACTICES

Type: Theory | **Credits**: 2 | **Total Contact Hours**: 22–25 hours

Prerequisite: Basic knowledge of software engineering principles, programming, and version control systems.

Course Objectives:

- To introduce the fundamentals of DevOps culture, principles, and practices.
- To provide an understanding of continuous integration (CI), continuous delivery (CD), and infrastructure automation.
- To equip students with skills to deploy and monitor software using modern DevOps tools.
- To develop a foundational understanding of collaboration between development and operations for agile delivery.

Course Outcomes (COs):

1. **CO1**: Understand core DevOps concepts and the software delivery lifecycle. *(Unit 1)*
2. **CO2**: Apply CI/CD pipelines for automated testing and deployment. *(Unit 2)*
3. **CO3**: Utilize modern DevOps tools for configuration management and monitoring. *(Unit 3)*

SYLLABUS:

Unit 1: Introduction to DevOps & Agile Culture *(7 hrs)*
Evolution from Traditional Software Development to DevOps, DevOps Lifecycle: Plan, Develop, Build, Test, Release, Deploy, Operate, Monitor, Agile vs DevOps, DevOps Roles & Responsibilities, Benefits and Challenges in DevOps Implementation, Overview of tools used in DevOps: Git, Jenkins, Docker, Kubernetes, Ansible.

Unit 2: Continuous Integration & Deployment (CI/CD) *(8 hrs)*
Principles of Continuous Integration and Delivery, Building CI/CD Pipelines: Concepts and Workflow, Introduction to Jenkins, GitHub Actions, and GitLab CI, Deployment Strategies: Rolling, Blue-Green, Canary, Case Study: Implementing CI/CD pipeline using GitHub & Jenkins.

Unit 3: Infrastructure Automation, Monitoring & Logging *(7 hrs)*
Infrastructure as Code (IaC): Introduction to Docker and Kubernetes, Configuration Management using Ansible or Terraform (overview), System Monitoring and Logging: Prometheus, Grafana, ELK Stack, DevOps Security and Compliance Basics, Future Trends: DevSecOps, GitOps, AI in DevOps.

Text Books:

1. **Ernest Mueller, James Wickett, Karthik Gaekwad, and Peco Karayanev**, *DevOps Handbook: How to Create World-Class Agility, Reliability, & Security in Technology Organizations*, IT Revolution Press, 2016.
2. **Gene Kim, Jez Humble, Patrick Debois, and John Willis**, *The Phoenix Project: A Novel about IT, DevOps, and Helping Your Business Win*, IT Revolution, 2018.

Reference Books & Resources:

1. Kelsey Hightower, Kubernetes: Up and Running, O'Reilly Media, 2021.
2. Jenkins User Documentation – https://www.jenkins.io/doc/
3. Docker Official Documentation – https://docs.docker.com
4. Terraform by HashiCorp – https://developer.hashicorp.com/terraform
5. GitLab CI/CD Docs – https://docs.gitlab.com/ee/ci/
6. Ansible Documentation – https://docs.ansible.com

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO10	PO12
CO1	3	2				1		1
CO2	2	3	3	2	3		2	2
CO3	2		2	3	3	2	2	3

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6AD239MD - DEEP LEARNING FOUNDATIONS

Type: Theory | **Credits**: 2 | **Total Contact Hours**: 22–25 hours

Prerequisite:
Basics of machine learning, linear algebra, and programming in Python.

Course Objectives:
- To introduce the core principles and building blocks of deep learning.
- To provide mathematical understanding and implementation strategies for neural networks.
- To explore deep learning architectures and their applications across domains.

Course Outcomes (COs):
1. **CO1**: Understand neural network architectures and training processes. (Unit 1)
2. **CO2**: Apply forward and backward propagation in basic deep learning models. (Unit 2)
3. **CO3**: Analyze the applications and performance of CNNs, RNNs, and optimization techniques. (Unit 3)

Unit-wise Syllabus:

Unit 1: Neural Network Basics (7 hrs)
Introduction to Deep Learning and Neural Networks, Biological Neuron vs Artificial Neuron, Perceptron and Multilayer Perceptrons (MLP), Activation Functions (ReLU, Sigmoid, Tanh), Loss Functions and Evaluation Metrics.

Unit 2: Training Deep Neural Networks (8 hrs)
Forward Propagation and Backward Propagation, Gradient Descent and its Variants (SGD, Adam, RMSprop), Regularization Techniques: Dropout, Batch Normalization, Overfitting, Underfitting, and Generalization, Practical Tips for Training Deep Networks.

Unit 3: Deep Learning Architectures and Applications (7 hrs)
Convolutional Neural Networks (CNNs): Filters, Pooling, Applications, Recurrent Neural Networks (RNNs): Sequence Modelling Basics, Applications in Vision, NLP, Healthcare, and Autonomous Systems, Introduction to Frameworks: TensorFlow and PyTorch, Current Trends and Ethics in Deep Learning.

Text Book: Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep Learning," MIT Press, 2016.

Reference Books:

1. Michael Nielsen, "Neural Networks and Deep Learning," Determination Press, 2015.
2. Francois Chollet, "Deep Learning with Python," Manning Publications, 2021.
3. Charu C. Aggarwal, "Neural Networks and Deep Learning," Springer, 2018.
4. Nikhil Buduma, "Fundamentals of Deep Learning," O'Reilly Media, 2017.
5. Josh Patterson and Adam Gibson, "Deep Learning: A Practitioner's Approach," O'Reilly Media, 2017.
6. Aurelien Geron, "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow," O'Reilly Media, 2022.

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO10	PO12
CO1	3	2						1
CO2	2	3	2	2	3		2	2
CO3		2	3	2	3	3	3	2

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6CS240VS / 6DS240VS / 6AD240VS / 6KE240VS - COMPUTING SKILL # 2 (VSEC IV)

Type: Theory + Practical | **Credits:** 2 | **Teaching Load / Week:** Theory – 1 Hr | Practical – 2 Hrs

Course Prerequisite
Basic Python programming, fundamentals of databases, familiarity with Computing Skill #1 LAB.

Course Objectives:
- To strengthen advanced Python programming skills for data processing and automation
- To introduce RESTful APIs, web services, and backend integration
- To apply database connectivity, ORM concepts, and data handling techniques
- To develop cloud-ready, secure, and scalable applications
- To build industry-oriented mini projects integrating programming, data, and deployment

Course Outcomes:
1. Apply advanced Python features for real-world data processing and automation tasks
2. Develop RESTful APIs and backend services using Python frameworks
3. Implement database-driven applications using SQL/NoSQL and ORM tools
4. Integrate authentication, security, and logging mechanisms in applications
5. Design, deploy, and demonstrate a cloud-ready mini application

Syllabus Contents:
Advanced Python programming concepts, exception handling and decorators, file and directory automation, data handling using NumPy and Pandas, REST API concepts, HTTP methods and JSON handling, backend development using Flask or Django REST Framework, database connectivity using SQLite/MySQL/PostgreSQL, ORM concepts and CRUD operations, authentication and authorization basics, JWT and session management, API testing using Postman, logging and debugging, cloud deployment basics, containerization overview, mini project development and deployment.

List of Experiments

Part A: Advanced Python & Data Handling
1. Python exception handling, custom exceptions, decorators, and generators
2. File system automation using Python (os, shutil, pathlib)
3. Data manipulation using NumPy arrays and Pandas DataFrames
4. Data cleaning, transformation, and visualization using Pandas and Matplotlib

Part B: Backend Development & APIs
5. Designing RESTful APIs using Flask / Django REST Framework
6. Implementation of CRUD operations using REST APIs
7. JSON handling, request validation, and response formatting
8. API testing and debugging using Postman

Part C: Database & ORM Integration
9. Database connectivity using SQLite/MySQL/PostgreSQL
10. ORM concepts using SQLAlchemy / Django ORM
11. Secure database operations and role-based access control

Part D: Security, Deployment & Cloud Basics
12. Authentication and authorization using JWT / session-based login
13. Logging, exception tracking, and debugging techniques
14. Cloud deployment basics using GitHub + Render / Railway / AWS EC2 (Demo)

Part E: Mini Project (Compulsory)
15. Mini Project: Full-stack Python application (API + DB + UI / client) with deployment

Suggested Mini Project Domains:
Student Management System, Secure REST API for Analytics, IoT Data Backend Service, Cyber Incident Reporting System, Data Visualization Dashboard, E-commerce Backend Service.

Text Books:
1. Miguel Grinberg, *Flask Web Development*, O'Reilly Media
2. William S. Vincent, *Django for APIs*, WelcomeToCode

Reference Books:
1. Wes McKinney, *Python for Data Analysis*, O'Reilly Media
2. Luciano Ramalho, *Fluent Python*, O'Reilly Media
3. Leonard Richardson, Mike Amundsen, *RESTful Web APIs*, O'Reilly
4. Eric Matthes, *Python Crash Course*, No Starch Press
5. Docker Documentation & Flask/Django Official Docs

Tentative CO-PO Mapping:
(Mapping Scale: 3 → High correlation, 2 → Medium correlation 1 → Low correlation, – → No correlation)

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

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