Nagarjuna College of Engineering & Technology, Bengaluru

An Autonomous Institute, Affiliated to VTU Belagavi

2022 Batch
Scheme & Syllabus of
VI Semester

As per the NEP 2020 Guidelines,
Choice-Based Credit System
&
Outcome-Based Education

CSE (Data Science)

w.e.f.
Academic Year 2024-2025

Vision

To prepare the next generation practitioners and researcher for data centric world by bringing together interdisciplinary faculty across the globe.

Mission

M1: To provide Skill Based Education to master the students in problem solving and analytical skills to enhance their niche expertise in the field Data Science

M2: To educate the students with latest technologies to update their knowledge in the field of Data Science

M3: To enable students to experience the Content Based Learning with premier quality data science education, research and industrial collaboration

M4: To enable students to become leaders in the Industry and Academia Nationally as well as internationally

M5: To guide students in research on Data Science, with the aim of having an ethical impact on society by tackling societal grand challenges

PROGRAM OUTCOMES (POs): Graduates of the Computer Science and Engineering – Data Science Program will be able to achieve the following **POs:**

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and Computer Science and Engineering principles to the solution of complex problems in Computer Science and Engineering.

PO2: Problem Analysis: Identify, formulate, research literature, and analyses complex Computer Science and Engineering problems reaching substantiated conclusions using first principles of mathematics and engineering sciences.

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

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

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

PO6: The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional Computer Science and Engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional Computer Science and Engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

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

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

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

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

Program Specific Outcome (PSO)

PSO1: Ability to analyse complex computing issues and apply the principlesto achieve related solution.

PSO2: Ability to design, implement and evaluate computing based solutionsto meet range of computing requirements based in the data science.

PSO3: Ability to effectively communicate within diverse work group relatedto professional framework.

Program Educational Objectives (PEOs)

PEO 1: To make students competent for higher studies and employable, to meet industrial requirements.

PEO 2: To develop students having core competence in science, mathematics and fundamentals of Data Science to address ever changing industrial requirements globally.

PEO 3: To create academically conducive environment to learn engineering skills in the domains such as Data Analytics, Data Modelling, Data Visualization and Allied Technologies.

PEO 4: To enrich students with professional ethics, leadership qualities, and entrepreneurial skills.

PEO 5: An ability to engage in lifelong learning for effective adaptation to technological developments.

NAGARJUNA COLLEGE OF ENGINEERING & TECHNOLOGY, BENGALURU

B.E. in CSE (Data Science)

Scheme of Teaching and Examinations 2022

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023-24)

VI SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week					Examination			
					Theory Lecture	Tutorial	Practical / Drawing	Self Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	Credits
					L	T	P	S					
1	IPCC	22CDI61	Big Data Analytics	TD: CD PSB : CD	3	0	2		03	50	50	100	4
2	PCC	22CDT62	Artificial Intelligence & Machine Learning	TD: CD PSB : CD	4	0	0		03	50	50	100	4
3	PEC	22CDT63*	Professional Elective Course	TD: CD PSB : CD	3	0	0		03	50	50	100	3
4	OEC	22CDO64*	Open Elective Course	TD: CD PSB : CD	3	0	0		03	50	50	100	3
5	PROJ	22CDP65	Project Phase I	TD: CD PSB : CD	0	0	4		03	100	--	100	2
6	PCCL	22CDL66	Machine Learning Lab	TD: CD PSB : CD	0	0	2		03	50	50	100	1
7	AEC/ SDC	22CDL67*	Ability Enhancement Course/Skill Development Course V	TD and PSB: Concerned department	If the course is offered as a Theory: 1	0	0		01	50	50	100	1
					If course is offered as a practical: 0	0	2						
8	MC	22NS69	National Service Scheme (NSS)	NSS coordinator	0	0	2			100	--	100	0
		22PE69	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
		22YO69	Yoga	Yoga Teacher									
9	MC	22IKS68	Indian Knowledge System		1	0	0		01	100	--	100	0
									Total	**500**	**300**	**800**	**18**

Professional Elective Course

22CDT631	Natural Language Processing	22CDT633	Blockchain Technology	22CDT635	Data Engineering
22CDT632	Exploratory Data Analysis	22CDT634	Time Series Analysis		

Open Elective Course

22CDO641	Introduction to Data Structures	22CDO643	Mobile Application Development
22CDO642	Fundamentals of Operating Systems	22CDO644	Introduction to PEGAPRPC

Ability Enhancement Course/Skill Development Course-V

22CDL671	Mobile Application Development with Flutter	22CDL673	MLOPS
22CDL672	Introduction to UI/UX	22CDL674	Devops

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S= SDA**: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SXX**: Semester End Evaluation. **K :** The letter in the course code indicates common to al the stream of engineering. **PROJ**: Project /Mini Project. **PEC**: Professional ElectiveCourse. **OEC**: Open Elective Course

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practicals of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governingthe Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), and Yoga(YOG) with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semester to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall

not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

Professional Elective Courses (PEC): A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course. The minimum number of students' strengths for offering a professional elective is 10. However, this conditional shall not be applicable to cases where the admission to the program is less than 10.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled to the open electives offered by their parent Department. However, they can opt for an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor. The minimum numbers of students' strength for offering Open Elective Course is 10. However, this condition shall not be applicable to class where the admission to the program is less than 10.

Project Phase-I: Students have to discuss with the mentor /guide and with their help he/she has to complete the literature survey and prepare the report and finally define the problem statement for the project work.

BIG DATA ANALYTICS

Course Code	**22CDI61**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:2:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40 hours Theory + 8-10 Lab slots**	**Total Marks**	**100**
Credits	**04**	**Exam Hours**	**03**

Course objectives:

1. To learn the core characteristics of big data (volume, variety, velocity) and how it impacts decision-making in modern industries.
2. Gain proficiency in using big data tools (like Hadoop, Hive, and NoSQL databases) and analytics platforms to process and analyze large datasets.
3. To learn techniques to analyze unstructured textual data from web content, applying methods like natural language processing (NLP) to extract valuable insights, trends, and patterns for improving decision-making and content strategies.

Course Description:

This course provides an in-depth understanding of big data concepts, tools, and techniques for analyzing large and complex datasets. Students will explore the characteristics of big data, including volume, variety, and velocity, and learn how to process and analyze data using popular big data technologies such as Hadoop, Spark, and NoSQL databases. The course also covers Text mining, Web usage analytics, and predictive analytics methods, with a focus on real-world applications. Students will gain hands-on experience in data processing, visualization, and decision-making, while also learning about the ethical and privacy concerns associated with big data. By the end of the course, students will be equipped to tackle big data challenges and use data-driven insights to inform business and organizational strategies.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Classification of data, Characteristics, Evolution and definition of Big data, What is Big data, Why Big data, Traditional Business Intelligence Vs Big Data,Typical data warehouse and Hadoop environment.

Big Data Analytics: What is Big data Analytics, Classification of Analytics, Importance of Big Data Analytics, Technologies used in Big data Environments, Few Top Analytical Tools, NoSQL, Hadoop.

08 Hours

Module – II

Introduction to Hadoop: Introducing hadoop, Why hadoop, Why not RDBMS, RDBMS Vs Hadoop, History of Hadoop, Hadoop overview, Use case of Hadoop, HDFS (Hadoop Distributed File System),Processing data with Hadoop, Managing resources and applications with Hadoop YARN(Yet Another Resource Negotiator).

Introduction to Map Reduce Programming: Introduction, Mapper, Reducer, Combiner, Partitioner, Searching, Sorting, Compression.

08 Hours

Module – III

Introduction to MongoDB: What is MongoDB, Why MongoDB, Terms used in RDBMS and MongoDB, Data Types in MongoDB, MongoDB Query Language.

08 Hours

Module – IV

Introduction to Hive: What is Hive, Hive Architecture, Hive data types, Hive file formats, Hive Query Language (HQL), RC File implementation, User Defined Function (UDF).

Introduction to Pig: What is Pig, Anatomy of Pig, Pig on Hadoop, Pig Philosophy, Use case for Pig, Pig Latin Overview, Data types in Pig, Running Pig, Execution Modes of Pig, HDFS Commands, Relational Operators, Eval Function, Complex Data Types, Piggy Bank, User Defined Function, Pig Vs Hive.

08 Hours

Module – V

Spark and Big Data Analytics: Spark, Introduction to Data Analysis with Spark.

Text, Web Content and Link Analytics: Introduction, Text Mining, Web Mining, Web Content and Web Usage Analytics, Page Rank, Structure of Web and Analyzing a Web Graph.

08 Hours

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Write a program using HDFS commands to: a) Create directories in HDFS and manage file permissions (read, write, execute). b) Copy/move files between the local file system and HDFS (both directions).
2	Using MongoDB, perform create, insert, save, and drop operations on a collection.
3	Using Hive, perform static and dynamic partitioning, and demonstrate loading data using a temporary table.
4	Using MongoDB, create a collection named "food" and insert documents containing a fruit array. a) Perform a search operation to find specific elements using indexing. b) Demonstrate the update operation on the fruit array, including pop and pull operations.
5	Using Hive, create a database learning, create a table employee_test, insert data, handle NULL values, and perform drop operations.
6	Using MongoDB, create a collection and perform count, limit, sort, and skip operations. Additionally, perform aggregate functions such as filtering, grouping, and sum.
7	Using Hive, create a bucketed table with fields such as Employee ID, Name, Department, and Hire Date. Load sample employee data into it and demonstrate the concept of clustering.

Course Outcomes:

At the end of the course the student will be able to:

CO1: Identify and list various Big Data concepts, tools and applications.

CO2: Develop programs using HADOOP framework.

CO3: Make use of Hadoop Cluster to deploy Map Reduce jobs, HIVE programs.

CO4: Analyze the given data set and identify deep insights from the data set.

CO5: Demonstrate Text, Web Content and Link Analytics.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	Total 25 Marks : Reduced to 15 Marks	
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
	Total 25 Marks : Reduced to 10 Marks	
Lab Component	Lab Record and execution of programs	**15 Marks**
	Lab Test at the end of 15th week	**10 Marks**
	Total	**25 Marks**
Grand Total of IAT Marks		**50 Marks**
Obtaining 40% of marks in both theory and lab component is essential for appearing for SEE		

Suggested Learning Resources:

Text Books:

1. Seema Acharya and Subhashini Chellappan "Big data and Analytics" Wiley India Publishers, 2nd Edition, 2019.
2. Rajkamal and Preeti Saxena, "Big Data Analytics, Introduction to Hadoop, Spark and Machine Learning", McGraw Hill Publication, 2019.

Reference Books:

1. Adam Shook and Donald Mine, "MapReduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop and Other Systems" - O'Reilly 2012.
2. Tom White, "Hadoop: The Definitive Guide" 4th Edition, O'reilly Media, 2015.
3. Thomas Erl, Wajid Khattak, and Paul Buhler, Big Data Fundamentals: Concepts, Drivers & Techniques, Pearson India Education Service Pvt. Ltd., 1st Edition, 2016
4. John D. Kelleher, Brian Mac Namee, Aoife D'Arcy -Fundamentals of Machine Learning for Predictive Data Analytics: Algorithms, Worked Examples, MIT Press 2020, 2nd Edition

Web links and Video Lectures (e-Resources):

1. https://www.kaggle.com/datasets/grouplens/movielens-20m-dataset
2. https://www.youtube.com/watch?v=bAyrObl7TYE&list=PLEiEAq2VkUUJqp1k-g5W1mo37urJQOdCZ
3. https://www.youtube.com/watch?v=VmO0QgPCbZY&list=PLEiEAq2VkUUJqp1kg5W1mo37urJQOdCZ&index=4
4. https://www.youtube.com/watch?v=GG-VRm6XnNk
5. https://www.youtube.com/watch?v=JglO2Nv_92A

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Course Code	**22CDT62**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**4:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**50**	**Total Marks**	**100**
Credits	**04**	**Exam Hours**	**03**

Course objectives:

- Understands the basics of AI, history of AI and its foundations, basic principles of AI for problem solving.
- Explore the basics of Machine Learning & Machine Learning process, understanding data.
- Understand the Working of Artificial Neural Networks.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Introduction: What is AI, The foundation of Artificial Intelligence, The history of Artificial Intelligence, Intelligent Agents: Agents and Environments, Good Behaviour: The concept of rationality, the nature of Environments, the structure of Agents. Search Strategies: BFS, DFS, A* Algorithm. Game Playing: Minimax Algorithm.

Examples & Applications:

1. AI in Healthcare (Disease Prediction)
2. AI in Finance (Fraud Detection)

Case Study:

IBM Watson in Healthcare: How AI assists doctors in diagnosing diseases. **10 Hours**

Module – II

Fundamentals of Machine Learning

Introduction to Machine Learning: Types (Supervised, Unsupervised, Reinforcement Learning) Regression Models: Linear and Logistic Regression. Univariate and Multivariate. Performance Metrics: Accuracy, Precision, Recall, F1 Score. Overfitting and Underfitting, Bias-Variance Tradeoff

Examples & Applications:

1. Predicting House Prices using Linear Regression
2. Spam Detection in Emails using Logistic Regression

Case Study:

Netflix Recommendation System: How ML personalizes movie recommendations. **10 Hours**

Module – III

Supervised and Unsupervised Learning

Decision Trees, Random Forest, and Support Vector Machines (SVM), k-Nearest Neighbors (k-NN) Algorithm Clustering: K-Means, Hierarchical Clustering, Principal Component Analysis (PCA), Feature Engineering & Feature Selection

Examples & Applications:

1. Customer Segmentation using K-Means
2. Sentiment Analysis using Decision Trees

Case Study:

Facebook Friend Recommendation System: How clustering is used to suggest friends. **10 Hours**

Module – IV

Deep Learning, Reinforcement Learning and Neural Networks

Introduction to Deep Learning: Artificial Neural Networks (ANN), Convolutional Neural Networks (CNN) for Image Processing, Recurrent Neural Networks (RNN) for Sequential Data, Activation Functions (ReLU, Sigmoid, Softmax), Reinforcement Learning: Q-Learning and Deep Q Networks

Examples & Applications:

1. Image Classification using CNN (e.g., Cat vs Dog Classifier)
2. Speech Recognition using RNN

Case Study:

Google DeepMind's AlphaGo: How AI mastered the game of Go. **10 Hours**

Module – V

AI Ethics & Real-World AI

Ethical Issues in AI: Bias, Privacy, Fairness Explainable AI (XAI), AI for Social Good (AI in Climate Change, Education), Future Trends in AI & ML: Generative AI (GANs, Transformers), AI for Edge Computing and IoT, Quantum Machine Learning

Examples & Applications:

1. AI Chatbots (e.g., OpenAI's ChatGPT, Google Bard)
2. AI in Self-Driving Cars (Tesla Autopilot)

Case Study:

AI in Criminal Justice: Examining how AI is used in predictive policing and the ethical concerns involved. **10 Hours**

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

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

CO1: Understand the basics of Artificial Intelligence.

CO2: Apply the suitable search strategy to solve problems.

CO3: Develop similarity-based learning models and regression models for solving classification and prediction tasks.

CO4: Utilize probabilistic learning models & clustering algorithms to identify patterns in data and implement reinforcement learning techniques.

CO5: Build neural network models using perceptrons and multilayer architectures.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. Stuart Russel, Peter Norvig: "Artificial Intelligence A Modern Approach", 3rd Edition, Pearson Education, 2015.
2. S. Sridhar, M Vijayalakshmi "Machine Learning". Oxford University Press, 2021.

Reference:

1. Elaine Rich, Kevin Knight: "Artificial Intelligence", 3rd Edition, Tata McGraw Hill, 2009, ISBN-10: 0070087709
2. Nils J. Nilsson: "Principles of Artificial Intelligence", Elsevier, 1980, ISBN: 978-3-540-11340-9
3. Murty, M. N., and V. S. Ananthanarayana. Machine Learning: Theory and Practice, Universities Press, 2024.

Weblinks and Video Lectures (e-Resources):

1. Problem solving agent:https://www.youtube.com/watch?v=KTPmo-KsOis
2.https://www.youtube.com/watch?v=X_Qt0U66aH0&list=PLwdnzlV3ogoXaceHrrFVZCJKbm_laSH cH
3. https://www.javatpoint.com/history-of-artificial-intelligence
4. https://www.tutorialandexample.com/problem-solving-in-artificial-intelligence
5. https://techvidvan.com/tutorials/ai-heuristic-search/
6. https://www.analyticsvidhya.com/machine-learning/
7. https://www.hackerearth.com/practice/machine-learning/machine-learningalgorithms/mldecision-tree/tutorial/
8. https://www.javatpoint.com/unsupervised-artificial-neural-networks

NATURAL LANGUAGE PROCESSING (PE)

Course Code	**22CDT631**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course objectives:

- Learn the importance of natural language modeling.
- Understand the applications of natural language processing.
- Study spelling, error detection and correction methods and parsing techniques in NLP.
- Illustrate the information retrieval models in natural language processing.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Introduction: What is Natural Language Processing? Origins of NLP, Language and Knowledge, The Challenges of NLP, Language and Grammar, Processing Indian Languages, NLP Applications.
Language Modeling: Statistical Language Model - N-gram model (unigram, bigram), Paninion Framework, Karaka theory.
Textbook 1: Ch. 1, Ch. 2. **08 Hours**

Module – II

Word Level Analysis: Regular Expressions, Finite-State Automata, Morphological Parsing, Spelling Error Detection and Correction, Words and Word Classes, Part-of Speech Tagging.
Syntactic Analysis: Context-Free Grammar, Constituency, Top-down and Bottom-up Parsing, CYK Parsing.
Textbook 1: Ch. 3, Ch. 4. **08 Hours**

Module – III

Naive Bayes, Text Classification and Sentiment: Naive Bayes Classifiers, Training the Naive Bayes Classifier, Worked Example, Optimizing for Sentiment Analysis, Naive Bayes for Other Text Classification Tasks, Naive Bayes as a Language Model.
Textbook 2: Ch. 4. **08 Hours**

Module – IV

Information Retrieval: Design Features of Information Retrieval Systems, Information Retrieval Models - Classical, Non-classical, Alternative Models of Information Retrieval - Custer model, Fuzzy model, LSTM model**,** Major Issues in Information Retrieval.
Lexical Resources: WordNet, FrameNet, Stemmers, Parts-of-Speech Tagger, Research Corpora.

Textbook 1: Ch. 9, Ch. 12. **08 Hours**

Module – V

Machine Translation: Language Divergences and Typology, Machine Translation using Encoder-Decoder, Details of the Encoder-Decoder Model, Translating in Low-Resource Situations, MT Evaluation, Bias and Ethical Issues.

Textbook 2: Ch. 13. **08 Hours**

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

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

CO1: Apply the fundamental concept of NLP, grammar-based language model and statistical-based language model.

CO2: Explain morphological analysis and different parsing approaches.

CO3: Develop the Naïve Bayes classifier and sentiment analysis for Natural language problems and text classifications.

CO4: Apply the concepts of information retrieval, lexical semantics, lexical dictionaries.

CO5: Identify the Machine Translation applications of NLP using Encode and Decoder.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. Tanveer Siddiqui, U.S. Tiwary, "Natural Language Processing and Information Retrieval", Oxford University Press.
2. Daniel Jurafsky, James H. Martin, "Speech and Language Processing, An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education, 2023.

Reference Books:

1. Akshay Kulkarni, Adarsha Shivananda, "Natural Language Processing Recipes - Unlocking Text Data with Machine Learning and Deep Learning using Python", Apress, 2019.
2. T V Geetha, "Understanding Natural Language Processing – Machine Learning and Deep Learning Perspectives", Pearson, 2024.
3. Gerald J. Kowalski and Mark.T. Maybury, "Information Storage and Retrieval systems", Kluwer Academic Publishers.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=M7SWr5xObkA
2. https://youtu.be/02QWRAhGc7g
3. https://www.youtube.com/watch?v=CMrHM8a3hqw
4. https://onlinecourses.nptel.ac.in/noc23_cs45/preview
5. https://archive.nptel.ac.in/courses/106/106/106106211/

EXPLORATORY DATA ANALYSIS (PE)			
Course Code	**22CDT632**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course objectives:

CLO1: To equip students with Python, IPython, and Jupyter for data analysis tasks.
CLO2: To provide a comprehensive understanding of NumPy for scientific computations.
CLO3: To introduce foundational and advanced data manipulation techniques using Pandas
CLO4: To enhance data visualization skills using Matplotlib and Seaborn
CLO5: To introduce Machine Learning concept with practical applications using Scikit-Learn.
CLO6: To promote the practical application of data analysis tools and techniques on real-world datasets

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Introduction to Python and NumPy: Getting Started in IPython and Jupyter, Enhanced Interactive Features, The Basics of NumPy Arrays, Sorted Arrays, Structured Data: NumPy's Structured Arrays.
Textbook: Chapter 2, Chapter 5, Chapter 11, Chapter 12, Chapter 1(Not for CIE/SEE),

08 Hours

Module – II

Data Manipulation with Pandas - I: Introducing Pandas Objects, Handling Missing Data, Hierarchical Indexing, Pivot Tables.
Textbook: Chapter 13, Chapter 16, Chapter 17, Chapter 21

08 Hours

Module – III

Data Manipulation with Pandas - II: Vectorized String Operations, Working with Time Series, High-Performance Pandas: eval and query
Textbook: Chapter 22, Chapter 23, Chapter 24

08 Hours

Module – IV

Data Visualization with MatPlotlib: General Matplotlib Tips, Simple Line Plots, Simple Scatter Plots, Visualization with Seaborn.
Textbook: Chapter 25, Chapter 26, Chapter 27, Chapter 36

08 Hours

Module – V

Introduction to Machine Learning: Machine Learning, Introducing Scikit-Learn, Hyperparameters and
Model Validation.
Textbook: Chapter 37, Chapter 38, Chapter 39

08 Hours

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

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

CO1: Demonstrate the application of the NumPy for performing data analysis tasks.
CO2: Make use of Pandas for various data manipulation tasks.
CO3: Apply advanced data manipulation techniques to real-world datasets.
CO4: Develop data visualizations using Matplotlib and Seaborn to effectively communicate data insights.
CO5: Explain the fundamental concepts of machine learning and validation models using Scikit-Learn.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. Jake VanderPlas - Python Data Science Handbook: Essential Tools for Working with Data, Oreilly 2nd edition, 2022.

Reference Books:

1. https://python4csip.com/files/download/Data%20Visualization.pdfReference books

Web links and Video Lectures (e-Resources):

1. Numpy Tutorial - https://www.w3schools.com/python/numpy/default.asp
2. Pandas Tutorial - https://www.w3schools.com/python/pandas/default.asp
3. Matplotlib Tutorial - https://www.w3schools.com/python/matplotlib_intro.asp
4. Introduction to ML with Scikit Learn - https://scikit-learn.org/1.4/tutorial/basic/tutorial.html

BLOCKCHAIN TECHNOLOGY (PE)			
Course Code	**22CDT633**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course objectives:

1. To Understand Blockchain terminologies with its applications. design
2. To learn working principles of Blockchain and methodologies used in Bitcoin
3. To gain knowledge on Ethereum Network, Wallets, Nodes, Smart contract & DApps
4. To learn blockchain Based Application Architecture using Hyperledger and the Smart Contract Lifecycle

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Distributed systems, CAP theorem, Byzantine Generals problem, Consensus. The history of blockchain, Introduction to blockchain, Various technical definitions of blockchains, Generic elements of a blockchain, Features of a blockchain, Applications of blockchain technology, Tiers of blockchain technology, Consensus in blockchain, CAP theorem and blockchain, Benefits and limitations of blockchain.

Chapter 1 **08 Hours**

Module – II

Decentralization using blockchain, Methods of decentralization, Blockchain and full ecosystem decentralization, Smart contract, Decentralized organizations, Decentralized autonomous organizations, Decentralized autonomous corporations, Decentralized autonomous societies Decentralized applications, Platforms for decentralization.

Cryptographic primitives: Symmetric cryptography, Asymmetric cryptography, Public and private keys, Hash functions: Compression of arbitrary messages into fixed length digest, Easy to compute, Pre-image resistance, Second pre-image resistance, Collision resistance, Message Digest (MD),Secure Hash Algorithms (SHAs), Merkle trees, Patricia trees, Distributed hash tables (DHTs), Digital signatures, Elliptic Curve Digital signature algorithm (ECDSA).

Chapter 2, Chapter 3: pg:56-105 **08 Hours**

Module – III

Bitcoin, Bitcoin definition, Transactions, The transaction life cycle, The transaction structure, Types of transaction, The structure of a block , The structure of a block header, The genesis block, The bitcoin network, Wallets, Smart Contracts-History, Definition, Ricardian contracts, Smart contract templates, Oracles, Smart Oracles, Deploying smart contracts on a blockchain, The DAO.

Chapter 4:pg:111-148, Chapter 6 **08 Hours**

Module – IV

Ethereum 101, Introduction, Ethereum clients and releases, The Ethereum stack, Ethereum blockchain, Currency (ETH and ETC), Forks, Gas, The consensus mechanism, The world state, Transactions, Contract creation transaction, Message call transaction, Elements of the Ethereum blockchain , Ethereum virtual machine (EVM), Accounts, Block, Ether, Messages, Mining, The Ethereum network. Hands-on: Clients and wallets –Geth.

Chapter 7: pg: 210-227, 235-269 **08 Hours**

Module – V

Hyperledger, Hyperledger as a protocol, Fabric, Hyperledger Fabric, Sawtooth lake, Corda.

Chapter 9 **08 Hours**

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

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

CO1: Explain the Blockchain terminologies with its applications. design

CO2: Illustrate the working principles of Blockchain and the Smart Contract Lifecycle

CO3: Demonstrate the principles and methodologies used in Bitcoin

CO4: Develop Ethereum Network, Wallets, Nodes, Smart contract and DApps.

CO5: Make use of Hyperledger in Blockchain Based Application Architecture.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. Imran Bashir. “Mastring BlockChain”, Third Edition, Packt – 2020.

Reference Books:

1. Andreas M. , Mastering Bitcoin: Programming the Open Blockchain – O’rielly – 2017.

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/106104220
2. https://www.geeksforgeeks.org/blockchain/
3. https://www.tutorialspoint.com/blockchain/index.htm

TIME SERIES ANALYSIS (PE)			
Course Code	**22CDT634**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course objectives:

1. Learn the importance of time series analysis on the data.
2. Identify approaches to handle linear stationary and non stationary models.
3. Analyse ways of model building and parameter estimation.
4. Recognize methods to handle multivariate time series data.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Introduction, Five Important Practical Problems, **Autocorrelation Function and Spectrum of Stationary Processes:** Autocorrelation Properties of Stationary Models, Spectral Properties of Stationary Models, **Linear Stationary Models:** General Linear Process, Autoregressive Processes, Moving Average Processes, Mixed Autoregressive—Moving Average Processes.

Ch. 1.1, Ch. 2.1,2.2 Ch. 3.1,3.2,3.3,3.4 **08 Hours**

Module – II

Linear Nonstationary Models: Autoregressive Integrated Moving Average Processes, Three Explicit Forms for the ARIMA Model, Integrated Moving Average Processes.

Forecasting : Minimum Mean Square Error Forecasts and Their Properties, Calculating Forecasts and Probability Limits, Examples of Forecast Functions and Their Updating, Use of State-Space Model Formulation for Exact Forecasting

Ch. 4.1,4.2,4.3, Ch. 5.1,5.2,5.3,5.4,5.5. **08 Hours**

Module – III

Model Identification: Objectives of Identification, Identification Techniques, Initial Estimates for the Parameters, Model Multiplicity.

Parameter Estimation: Study of the Likelihood and Sum-of-Squares Functions, Nonlinear Estimation, Some Estimation Results for Specific Models, Likelihood Function Based on the State-Space Model, Estimation Using Bayes' Theorem

Ch. 6.1,6.2,6.3,6.4 Ch. 7.1,7.2,7.3,7.4,7.5. **08 Hours**

Module – IV

Model Diagnostic Checking: Checking the Stochastic Model, Overfitting, Diagnostic Checks Applied

to Residuals, Use of Residuals to Modify the Model,

Analysis of Seasonal Time Series: Parsimonious Models for Seasonal Time Series, Some Aspects of More General Seasonal ARIMA Models, Structural Component Models and Deterministic Seasonal Components, Regression Models with Time Series Error Terms.

Ch. 8.1,8.2,8.3 Ch. 9.1,9.2,9.3,9.4,9.5 **08 Hours**

Module – V

Multivariate Time Series Analysis: Stationary Multivariate Time Series, Vector Autoregressive Models, Vector Moving Average Models, Vector Autoregressive—Moving Average Models, Forecasting for Vector Autoregressive--Moving Average Processes, State- Space Form of the VARMA Model, Nonstationary and Cointegration

Ch. 14.1,14.2,14.3,14.4,14.5,14.6,14.8 **08 Hours**

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

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

CO1: Apply the fundamental concept of Time series analysis for Autocorrelation Function and spectrum on linear stationary models.

CO2: Develop non-linear stationary models and perform forecasting.

CO3: Identify models and estimate the various parameters.

CO4: Recognize ways to perform model diagnostic checking and analyze the seasonal time series.

CO5: Analyze multivariate time series data.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung, “Time Series Analysis – Forecasting and Control”, Wiley Publications , 2016.

Reference Books:

1. Paul S.P. Cowpertwait and Andrew V. Metcalfe, Introductory Time Series with R, Springer Verlag, New York, 2009.

2. Rob J. Hyndman and George Athanasopoulos, Forecasting: Principles and Practice, One line, Open Access Textbooks.

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/103106123
2. https://www.youtube.com/watch?v=GE3JOFwTWVM
3. https://www.youtube.com/watch?v=tepxdcepTbY
4. https://www.youtube.com/watch?v=rDwczdWBlTA

DATA ENGINEERING (PE)			
Course Code	**22CDT635**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course Objectives:

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

1. Learn the concepts of data engineering and its fundamentals that maps the data science domain.
2. Understand the data modeling techniques, data governance and compliance.
3. Apply the knowledge of the data engineering in various applications.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

INTRODUCTION TO DATA ENGINEERING: Overview of Data Engineering, Role of a Data Engineer, Data Engineering vs. Data Science, Data Lifecycle Management, Data Architecture and Infrastructure, Introduction to Big Data, Characteristics of Big Data, Tools and Technologies in Data Engineering.

Text Book 1: Chapter 1

Self Study: Explore the latest trends and advancements shaping the field of data engineering, including technological innovations, industry practices, and evolving roles and responsibilities.

08 Hours

Module – II

DATA MODELING AND DATABASE DESIGN: Data Modeling Concepts, Dimensional Modeling, SQL and NoSQL Databases, Relational Database Management Systems (RDBMS), Document Stores, Key-Value Stores, Column-Family Stores, Graph Databases, Normalization and Denormalization, Indexing and Query Optimization.

Text Book 2: Chapter 4,7

Case Study: Design a dimensional model for an online retail company aiming to optimize its business operations and customer experience. Discuss the normalization and demoralization strategies, indexing techniques, and database technology choices, considering scalability and performance requirements. Evaluate the potential use of graph databases for analyzing customer-product relationships.

08 Hours

Module – III

DATA WAREHOUSING AND ETL PROCESSES: Data Warehousing Concepts, OLAP vs. OLTP, Data Warehouse Architecture, ETL (Extract, Transform, Load) Processes, ETL Tools and Techniques, Data Cleansing and Transformation, Data Lakes.

Text Book 3: Chapter 2,3

08 Hours

Module – IV

DATA INTEGRATION AND WORKFLOW MANAGEMENT: Data Integration Techniques, APIs, Webhooks, Data Connectors, Workflow Orchestration, Apache Airflow, Luigi, Prefect, Data Quality Management, Data Profiling, Data Quality Dimension.

Text Book 2: Chapter 11

08 Hours

Module – V

DATA GOVERNANCE AND COMPLIANCE: Data Governance Fundamentals, principles of Data Governance, Data Stewardship and Ownership, Regulatory Compliance, GDPR, CCPA, and Other Data Privacy Regulations, Industry-specific Compliance Requirements (e.g., HIPAA for Healthcare), Data Security and Encryption, Encryption Techniques and Best Practices, Secure Data Transmission and Storage, Auditing and Monitoring, Ethical Considerations.

Text Book 3: Chapter 1

08 Hours

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course outcomes:

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

CO1: Understand core data engineering concepts and technologies in Data Engineering and data governance fundamentals stewardship, ownership, and adherence to regulatory compliance such as GDPR, CCPA.

CO2: Demonstrate the data modeling techniques and database design principles to create optimized database schemas for various applications.

CO3: Apply ETL processes to ensure data integrity and quality in data warehousing environments.

CO4: Examine data workflows using modern orchestration tools, ensuring data integration and quality across sources.

CO5: Analyze the concepts of data security, focusing on encryption techniques, monitoring and ethical considerations in data management.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. Joe Reis , Matt Housley , Fundamentals of Data Engineering: Plan and Build Robust Data Systems (Grayscale Indian Edition) – 27 June 2022, ISBN-13, 978-9355421548.
2. Hector Garcia-Molina Jeffrey D. Ullman Jennifer Widom, DATABASE SYSTEMS, The Complete Book Second Edition 2019, ISBN-13, **978-0131873254.**
3. Mayank Malhotra, Ultimate Data Engineering with Databricks: Develop Scalable Data Pipelines Using Data Engineering's Core Tenets Such as Delta Tables, Ingestion, Transformation, Security, and Scalability – Import, 14 February 2024, ISBN-13, **978-8196994785.**

Reference Books:

1. Roberto Zagni, Data Engineering with dbt: A practical guide to building a cloud-based,

pragmatic, and dependable data platform with SQL,Second Edition,2023, ISBN-13978-1803246284.

Web links and Video Lectures (e-Resources):

1. https://www.datacamp.com/category/data-engineering
2. https://www.udemy.com/topic/data-engineering/
3. https://www.youtube.com/watch?v=hf2go3E2m8g
4. https://www.youtube.com/watch?v=ZRz-7E-7X7c

INTRODUCTION TO DATA STRUCTURES (OE)

Course Code	**22CDO641**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course objectives:

1. Introduce primitive and non-primitive data structures
2. Understand the various types of data structure along their operations
3. Study various searching and sorting algorithms
4. Assess appropriate data structures during program development / problem solving

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Arrays: Introduction, One-Dimensional Arrays, Two-Dimensional Arrays, Initializing Two-Dimensional Arrays, Multidimensional arrays.

Pointers: Introduction, Pointer Concepts, Accessing Variables through Pointers, Pointer Applications, Dynamic Memory Allocation Functions.

Structures and Unions: Introduction, Declaring Structures, Giving Values to Members, Structure Initialization, Comparison of Structure Variables, Arrays of Structures, Arrays within Structures, Nested Structures, Unions, Size of Structures.

Textbook 1: Ch. 8.1 to 8.5, Ch. 12.1 to 12.8, 12.10, 12.11.

Textbook 2: Ch. 2.1 to 2.3, 2.5, 2.9. **08 Hours**

Module – II

Stacks: Introduction, Stack Operations, Stack Implementation using Arrays, Applications of Stacks.

Queues: Introduction, Queue Operations, Queue Implementation using Arrays, Different Types of Queues: Circular Queues, Double-Ended Queues, Priority Queues, Applications of Queues.

Textbook 2: Ch. 6.1 to 6.3, Ch. 8.1 to 8.2. **08 Hours**

Module – III

Linked Lists: Introduction, Singly Linked List, Self-Referential Structures, Operations on Singly Linked Lists: Insert-Delete-Display, Implementation of Stacks and Queues using Linked List, Concatenate two Lists, Reverse a List without Creating a New Node, Static Allocation Vs Linked Allocation.

Circular Singly Linked List: Introduction, Operations: Insert-Delete-Display.

Textbook 2: Ch. 9.1 to 9.2, 9.3 (Only 9.3.1 to 9.3.5, 9.3.11 to 9.3.12), 9.4 to 9.5. **08 Hours**

Module – IV

Trees: Introduction, Basic Concepts, Representation of Binary Trees, Operations on Binary Trees: Insertion-Traversals-Searching-Copying a Tree, Binary Search Trees, Operations on Binary Search Trees: Insertion-Searching-Find Maximum and Minimum Value-Count Nodes, Expression Trees.
Textbook 2: Ch. 10.1 to 10.4, 10.5 (Only 10.5.1, 10.5.2, 10.5.3.1, 10.5.3.2, 10.5.3.4), 10.6.3. **08 Hours**

Module – V

Sorting: Introduction, Bubble Sort, Selection Sort, Insertion Sort.
Searching: Introduction, Linear Search, Binary Search.
Textbook 1: Ch. 17.1, 17.2.6, 17.3.2.
Textbook 2: Ch. 11.1 to 11.3, 11.10.1. **08 Hours**

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

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

CO1: Develop C programs utilizing fundamental concepts such as arrays, pointers and structures.
CO2: Apply data structures like stacks and queues to solve problems.
CO3: Develop C programs using linked lists and their various types.
CO4: Explain the fundamental concepts of trees and their practical applications.
CO5: Demonstrate different sorting and searching algorithms and determine their algorithmic complexities.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. E Balagurusamy, "C Programming and Data Structures", 4th Edition, McGraw-Hill, 2007.
2. A M Padma Reddy, "Systematic Approach to Data Structures using C", 9th Revised Edition, Sri Nandi Publications, 2009.

Reference Books:

1. Ellis Horowitz and Sartaj Sahni, "Fundamentals of Data Structures in C", 2nd Edition, Universities Press, 2014.
2. Seymour Lipschutz, "Data Structures Schaum's Outlines", Revised 1st Edition, McGraw-Hill, 2014.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=DFpWCl_49i0
2. https://www.youtube.com/watch?v=x7t_-ULoAZM
3. https://www.youtube.com/watch?v=I37kGX-nZEI
4. https://www.youtube.com/watch?v=XuCbpw6Bj1U
5. https://www.youtube.com/watch?v=R9PTBwOzceo
6. https://www.youtube.com/watch?v=qH6yxkw0u78
7. https://archive.nptel.ac.in/courses/106/105/106105085/
8. https://onlinecourses.swayam2.ac.in/cec19_cs04/preview

FUNDAMENTALS OF OPERATING SYSTEMS (OE)			
Course Code	**22CDO642**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course objectives:

1. To demonstrate the need and different types of OS.
2. To discuss suitable techniques for management of different resources
3. To analyse different memory, storage, and file system management strategies.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Introduction: What operating systems do; Computer System organization; Computer System Organization, Computer System architecture; Operating System operations; Resource Management

Operating System Structures: Operating System Servies, User and Operating System interface; System calls, Application Program Interface, Types of system calls.

Textbook 1: Chapter 1: 1.1, 1.2, 1.3,1.4, 1.5 Chapter 2: 2.1, 2.2 (2.2.1, 2.2.2), 2.3 (2.3.2, 2.3.3)

08 Hours

Module – II

Process Management: Process concept; Process scheduling; Operations on processes; Interprocess Communication

Multi-threaded Programming: Overview; Multithreading models, Thread Libraries

Textbook 1: Chapter 3: 3.1-3.4, Chapter 4: 4.1, 4.3 5, 4.4 **08 Hours**

Module – III

CPU Scheduling: Basic Concepts, Scheduling criteria, Scheduling algorithms, Thread Scheduling**.**

Process Synchronization: Synchronization: The critical section problem; Peterson's solution; Semaphores; Classical problems of synchronization;

Textbook 1: Chapter 5: 5.1, 5.2,5.3.1, 5.3.2, 5.3.3, 5.3.4, 5.4 Chapter 6: 6.1, 6.2.,6.3, 6.6 **08 Hours**

Module – IV

Deadlocks: System model; Deadlock characterization; Methods for handling deadlocks; Deadlock prevention; Deadlock avoidance; Deadlock detection and recovery from deadlock.

Memory Management: Background; Contiguous memory allocation; Paging; Structure of page table.

Textbook 1: Chapter 8: 8.1-8.8 Textbook 1: Chapter 9: 9.1-9.4 (9.4.1, 9.4.2) **08 Hours**

Module – V

Virtual Memory Management: Background; Demand paging; Copy-on-write; Page replacement.
File System Interface: File concept; Access methods; Directory Structure, Protection, File System Implementation: File System Structure, File System Operations,
File System Internals: File Systems, File System Mounting; Partition and Mounting, File sharing;
Textbook 1: Chapter 10: 10.1-10.3, 10.4 (10.4.1, 10.4.2, 10.4.4.) Chapter 13: 13.1, 13.2, 13.3 (13.3.1, 13.3.2, 13.3.3), 13.4 (13.4.1, 13.4.2) Chapter 15: 15.1-15.4 **08 Hours**

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

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

CO1: Explain the fundamentals of operating systems.
CO2: Apply appropriate CPU scheduling algorithm for the given scenarios.
CO3: Analyse the various techniques for process synchronization and deadlock handling.
CO4: Apply the various techniques for memory management.
CO5: Analyse the importance of File System Mounting and File Sharing.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Principles 10th edition, Wiley-India, 2015.

Reference Books:

1. Ann McHoes Ida M Fylnn, Understanding Operating System, Cengage Learning, 6th Edition, 2010.
2. D.M Dhamdhere, Operating Systems: A Concept Based Approach 3rd Ed, McGraw- Hill, 2013, P.C.P. Bhatt, An Introduction to Operating Systems: Concepts and Practice 4th Edition, PHI(EEE), 2014.
3. William Stallings Operating Systems: Internals and Design Principles, 6th Edition, Pearson, 2008.

1. Akshay Kulkarni, Adarsha Shivananda, "Natural Language Processing Recipes - Unlocking Text Data with Machine Learning and Deep Learning using Python", Apress, 2019.
2. T V Geetha, "Understanding Natural Language Processing – Machine Learning and Deep Learning Perspectives", Pearson, 2024.
3. Gerald J. Kowalski and Mark.T. Maybury, "Information Storage and Retrieval systems",Kluwer Academic Publishers.

Web links and Video Lectures (e-Resources):

1.https://archive.nptel.ac.in/courses/106/105/106105214/
2.https://archive.nptel.ac.in/courses/106/102/106102132/

MOBILE APPLICATION DEVELOPMENT (OE)			
Course Code	**22CDO643**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

Course objectives:

1. Create, test and debug Android application by setting up Android development environment.
2. Implement adaptive, responsive user interfaces that work across a wide range of devices.
3. Infer long running tasks and background work in Android applications
4. Demonstrate methods in storing, sharing and retrieving data in Android applications.
5. Analyze performance of android applications
6. Describe the steps involved in publishing Android application to share with the world.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Introduction to Android OS: Android Description – Open Handset Alliance – Android. Ecosystem – Android versions – Android Activity – Features of Android – Android Architecture Stack Linux Kernel. Configuration of Android Environment: Operating System – Java JDK Android SDK – Android Development Tools (ADT) – Android Virtual Devices (AVDs) – Emulators Dalvik Virtual Machine – Differences between JVM and DVM – Steps to Install and Configure Eclipse and SDK.

(Chapters 1 & 2) **08 Hours**

Module – II

Create the first android application: Directory Structure. Android User Interface: Understanding the Components of a screen‑ Linear Layout ‑ Absolute Layout ‑ Frame. Layout Relative Layout ‑ Table Layout.

(Chapters 3 & 4) **08 Hours**

Module – III

Designing User Interface with View ‑ Text View ‑ Button ‑ Image Button ‑ Edit Text Check Box ‑ Toggle Button ‑ Radio Button and Radio Group ‑ Progress Bar ‑ Auto complete Text View ‑ Spinner ‑ List View ‑ Grid View ‑ Image View - Scroll View ‑ Custom Toast ‑ Alert ‑ Time and Date Picker.

(Chapter 5) **08 Hours**

Module – IV

Activity: Introduction ‑ Intent ‑ Intent filter ‑ Activity life cycle ‑ Broadcast life cycle Service. Multimedia: Android System Architecture ‑ Play Audio and Video ‑ Text to Speech.

(Chapters 6 & 7) **08 Hours**

Module – V

SQLite Database in Android: SQLite Database – Creation and Connection of the database – Transactions. Case Study: SMS Telephony and Location Based Services.
(Chapters 8, 9, & 10) **08 Hours**

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

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

CO1: Explain Mobile Application Ecosystem like concepts, architecture, and lifecycle of mobile applications on Android.

CO2: Identify the key components of mobile application frameworks and development tools.

CO3: Apply design principles to create intuitive and responsive user interfaces using appropriate UI/UX tools.

CO4: Develop Functional Mobile Applications -Integrate core functionalities such as layouts, event handling, navigation, and multimedia support into applications.

CO5: Implement local data storage mechanisms (SQLite, Shared Preferences) and external databases (Firebase, APIs) for mobile applications.

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. Prasanna Kumar Dixit, "Android", Vikas Publishing House Private Ltd., Noida, 2014.

Reference Books:

1. Reto Meier and Wrox Wiley, “Professional Android 4 Application Development”, 2012.
2. ZiguradMednieks, LaridDornin, G.BlakeMeike, Masumi Nakamura, “Programming Andriod”, O’Reilly,2013.
3. Robert Green, Mario Zechner, “Beginning Android 4 Games Development”, Apress Media LLC, New York, 2011.

Web links and Video Lectures (e-Resources):

1. https://www.geeksforgeeks.org/android-tutorial/
2. https://developer.android.com/
3. https://www.tutorialspoint.com/android
4. https://www.w3schools.blog/android-tutorial

Introduction To PEGAPRPC (OE)			
Course Code	**22CDO644**	**CIE Marks**	**50**
Teaching Hours/Week (L:T:P: S)	**3:0:0:0**	**SEE Marks**	**50**
Total Hours of Pedagogy	**40**	**Total Marks**	**100**
Credits	**03**	**Exam Hours**	**03**

PEGA PRPC (Pega Rules Process Commander) is a Business Process Management (BPM) tool developed by Pega Systems. It enables enterprises to build scalable, agile applications for automating business processes, improving decision-making, and enhancing customer engagement. PEGA is a low-code platform that allows users to create applications with minimal coding using a model-driven approach.

Prerequisites: Basic C & Java Programming

Course objectives

1. To introduce the concept of **Business Process Management (BPM)** and explain how **PEGA PRPC** is used to automate business processes.
2. To explain the fundamental concepts of **Case Management** and how **process flows** are structured in PEGA.
3. To introduce the **UI design concepts** in PEGA and how user interaction is structured.
4. To explain how **data is managed and structured** within PEGA applications
5. To provide knowledge about **troubleshooting errors, application deployment, and best practices** in PEGA.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) need not to be only a traditional lecture method, but alternative effective teaching methods could be adopted to attain the outcomes.
2. Use of Video/Animation to explain functioning of various concepts.
3. Encourage collaborative (Group Learning) Learning in the class.
4. Ask at least three HOT (Higher order Thinking) questions in the class, which promotes critical thinking.
5. Adopt Problem Based Learning (PBL), which fosters students‟ Analytical skills, develop design thinking skills such as the ability to design, evaluate, generalize, and analyze information rather than simply recall it.
6. Introduce Topics in manifold representations.
7. Show the different ways to solve the same problem with different circuits/logic and encourage the students to come up with their own creative ways to solve them.
8. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.

Module – I

Introduction to PEGA and Business Process Management (BPM): What is BPM? Importance of BPM in organizations, **List of BPM Technologies Overview of PEGA PRPC** (Pega Rules Process Commander),Features and **Advantages of PEGA** over traditional programming, **PEGA Architecture** and its components, **Role of Rules and Rule-Based Development,** PEGA Enterprise Edition vs. PEGA Personal Edition.

08 Hours

Module – II

PEGA PRPC Software development Life cycle, PEGA Agile Development Methodology **Pega Certifications, Roles of Pega PRPC, Creation of new application in PEGA PRPC, PEGA Studios, Properties, Data Type,** Framework Application vs. Implementation Application**.**

08 Hours

Module – III

User Interface (UI) Concepts in PEGA

Overview of UI in PEGA: Components and Importance, **Basic Elements of UI:** Sections, **Types of Layouts and Controls. UI-Section, Flow Action-Preprocessing and post Processing Action Flow-Process, Diagrams Cases and data, Paragraph, Declare Expression, Validations.**

08 Hours

Module – IV

Introduction to Data Pages, Reports, Pega Alert Id's: Data transform and its methods and parameters, Activity and its methods and parameters, Declare Onchange, DCO (Direct capturing objects), Integration rules-SOAP,REST. **08 Hours**

Module – V

Debugging, Deployment & Best Practices

Common Errors in PEGA and Debugging Techniques, **Introduction to Tracer and Clipboard Tools (Conceptual Overview Only)**, **Importance of Performance, Optimization in PEGA Applications**, **Deployment Models and Basic Cloud Concepts in PEGA**, **Industry Best Practices for PEGA Development.**

08 Hours

Teaching-Learning Process for all modules	Chalk and board, Active Learning, PPT Based presentation, Video

Course Outcomes

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

CO1: PEGA simplifies business process automation using a rule-based approach.
CO2: Case management helps in structuring workflows and improving process automation.
CO3: PEGA's UI components help in designing interactive and user-friendly applications.
CO4: PEGA handles data storage, retrieval, and structuring for efficient processing.
CO5: The importance of debugging, optimizing, and deploying PEGA applications efficiently

Assessment Details (both IAT and SEE)

Theory Component	IAT-1 after completion 45 to 50% Syllabus	25 Marks
	IAT-2 after completion 95 to 100% Syllabus	25 Marks
	Average of two IATs	**25 Marks**
	CCE-1	25 Marks
	CCE-2	25 Marks
	Average of two CCEs	**25 Marks**
Grand Total of IAT Marks (min marks 20 / 50)		**50 Marks**
SEE conducted for 100 and scaled down to 50 **(min marks 18/50)**		**50 Marks**
IAT + SEE (min marks 40)		**100 Marks**

Suggested Learning Resources:

Text Books:

1. **PEGA Certified System Architect (CSA) Study Guide "Author**: **Pega Systems Inc. Publisher**: **Pega Academy Description**: Covers fundamental PEGA concepts, including case management, UI design, data modeling, and rule-based development. Suitable for beginners.
2. **Business Process Management: Concepts, Languages, Architectures "Author**: **Mathias Weske Publisher**: **Springer Description**: Provides an in-depth understanding of **Business Process Management (BPM)**, essential for learning PEGA's role in process automation.

Reference Books:

1. **"Low-Code Application Development with Pega"Authors**: **Gareth Vaughan & Richard Marshall Publisher**: **Packt Publishing Description**: Discusses how **PEGA enables low-code enterprise application development**, focusing on case management and workflow automation.
2. **"The Complete Guide to Business Process Management"Author**: **Tom Debevoise & James Taylor Publisher**: **Future Strategies Inc. Description**: Covers BPM fundamentals, process automation, and decision-making, which are relevant to PEGA-based workflows.
3. **"PEGA Decisioning and Case Management: A Practical Guide"Author**: **Anthony**

AbdelnourPublisher: **Independently Published Description**: Provides insights into **decision rules and case management concepts in PEGA applications**.

Online Learning Resources:

1. **Pega Academy** – https://academy.pega.com/
    a. Offers official training and study materials for PEGA concepts.
2. **PEGA Documentation** – https://community.pega.com/
    a. Contains up-to-date PEGA platform guides, case studies, and best practices.

MACHINE LEARNING LAB

Course Code	**22CDL66**	**CIE Marks**	**50**
Teaching Hours /Week(L:T:P)	**(0:0:2)**	**SEE Marks**	**50**
Total Hours of Pedagogy	**12 Lab slots**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course objectives:

As a student will be able to:

1. To become familiar with data and visualize univariate, bivariate, and multivariate data using statistical techniques and dimensionality reduction.
2. To understand various machine learning algorithms such as similarity-based learning, regression, decision trees, and clustering.
3. To familiarize with learning theories, probability-based models and developing the skills required for decision-making in dynamic environments.

LIST OF LABORATORY PROGRAMS – PART A

1.	Develop a program to create histograms for all numerical features and analyze the distribution of each feature. Generate box plots for all numerical features and identify any outliers. Use California Housing dataset. **Book 1: Chapter 2**
2.	Develop a program to Compute the correlation matrix to understand the relationships between pairs of features. Visualize the correlation matrix using a heatmap to know which variables have strong positive/negative correlations. Create a pair plot to visualize pairwise relationships between features. Use California Housing dataset. **Book 1: Chapter 2**
3.	Develop a program to implement Principal Component Analysis (PCA) for reducing the dimensionality of the Iris dataset from 4 features to 2. **Book 1: Chapter 2**
4.	For a given set of training data examples stored in a .CSV file, implement and demonstrate the Find-S algorithm to output a description of the set of all hypotheses consistent with the training examples. **Book 1: Chapter 3**
5.	Develop a program to implement k-Nearest Neighbour algorithm to classify the randomly generated 100 values of x in the range of [0,1]. Perform the following based on dataset generated. 1. Label the first 50 points $\{x_1,\ldots\ldots,x_{50}\}$ as follows: if $(xi \leq 0.5)$, then $x_i \in Class_1$, else $x_i \in Class_1$ 2. Classify the remaining points, $x_{51},\ldots\ldots,x_{100}$ using KNN. Perform this for $k=1,2,3,4,5,20,30$ **Book 2: Chapter – 2**
6.	Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. Select appropriate data set for your experiment and draw graphs. **Book 1: Chapter – 4**
7.	Develop a program to demonstrate the working of Linear Regression and Polynomial Regression. Use Boston Housing Dataset for Linear Regression and Auto MPG Dataset (for vehicle fuel efficiency prediction) for Polynomial Regression. **Book 1: Chapter – 5**
8.	Develop a program to demonstrate the working of the decision tree algorithm. Use Breast Cancer Data set for building the decision tree and apply this knowledge to classify a new sample. **Book 2: Chapter – 3**
9.	Develop a program to implement the Naive Bayesian classifier considering Olivetti Face Data set for training. Compute the accuracy of the classifier, considering a few test data sets. **Book 2: Chapter – 4**
10.	Develop a program to implement k-means clustering using Wisconsin Breast Cancer data set and visualize the clustering result. **Book 2: Chapter – 4**

Case Study- PART B

1. **IBM Watson in Healthcare:** How AI assists doctors in diagnosing diseases.
2. **Netflix Recommendation System:** How ML personalizes movie recommendations.
3. **Facebook Friend Recommendation System:** How clustering is used to suggest friends.
4. **Google DeepMind's AlphaGo:** How AI mastered the game of Go.
5. **AI in Criminal Justice:** Examining how AI is used in predictive policing and the ethical concerns involved

Course Outcomes:

At the end of the course the student will be able to :

CO1: Illustrate the principles of multivariate data and apply dimensionality reduction techniques.

CO2: Demonstrate similarity-based learning methods and perform regression analysis.

CO3: Develop decision trees for classification and regression problems, and Bayesian models for probabilistic learning.

CO4: Implement the clustering algorithms to share computing resources.

Text Books:

1. S Sridhar and M Vijayalakshmi, "Machine Learning", Oxford University Press, 2021.
2. M N Murty and Ananthanarayana V S, "Machine Learning: Theory and Practice", Universities Press (India) Pvt. Limited, 2024.

Web links and Video Lectures (e-Resources):

1. https://www.drssridhar.com/?page_id=1053
2. https://www.universitiespress.com/resources?id=9789393330697
3. https://onlinecourses.nptel.ac.in/noc23_cs18/preview

Assessment Details(both IAT and SEE)

Continuous Internal Assessment of Laboratory/Practical Courses		
Lab Test 1	Lab Test 2	Lab Records
15 marks	15 marks	20 marks
Semester End Examination(SEE)		50 marks

Conduct of Practical Examination:

Experiment distribution :

For laboratories having only one part: Students are allowed to pick one experiment from the lot with equal opportunity.

For laboratories having PART A and PART B: Students are allowed to pick one experiment from PART A and case study presentation from PART B, with equal opportunity.

- Change of experiment is allowed only once and marks allotted for procedure to be made zero of the changed part only.
- Marks Distribution (Need to change in accordance with university regulations)

a) For laboratories having only one part → Procedure + Execution + Viva-Voce:
15+70+15 = 100 Marks

b) For laboratories having PART A and PART B

i. Part A – Procedure + Execution + Viva =10 + 30 + 10 =50 Marks

ii. Part B – Report + Presentation + Viva = 10 + 30 + 10 = 50 Marks

MOBILE APPLICATION DEVELOPMENT WITH FLUTTER

Course Code	**22CDL671**	**CIE Marks**	**50**
Teaching Hours /Week(L:T:P)	**(0:0:2)**	**SEE Marks**	**50**
Total Hours of Pedagogy	**12 Lab slots**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course objectives:

As a student will be able to:

1. To introduce basics of Flutter platform for progressive app development
2. To gain knowledge on user interface support in Flutter.
3. To learn various programming elements required for app development.
4. To develop progressive applications with flutter.

LIST OF LABORATORY PROGRAMS

1.	Develop an application using Flutter to print “Hello world and Hello Flutter”.
2.	Develop an application using Flutter to Increment and Decrement Numbers (Counter App).
3.	Develop Login Screen Application.
4.	Develop a “To-do List” Application.
5.	Develop Calculator Application.
6.	Develop an application to Check the Weather in Countries Across the world (Weather app).
7.	Develop a “Stopwatch” application using Flutter.
8.	Develop an application that Navigate from one Screen to another (Seamless navigation).
9.	Develop Basic E-commerce UI Application.
10.	Develop an application to implement Animates Logo.
11.	Develop an application that tracks our daily Expenses and get a report chart.
12.	Develop an application to Play Quiz and get the Score Board.

Course Outcomes:

At the end of the course the student will be able to :

CO1: Demonstrate basics elements Flutter platform for progressive app development.

CO2: Develop user interface designs for applications.

CO3: Experiment with different programming elements of app development.

CO4: Develop progressive applications for real-world problems.

Suggested Learning Resources:

1. https://flutter.dev/
2. https://developers.google.com/learn/pathways/intro-to-flutter
3. https://github.com/flutter/flutter
4. https://www.geeksforgeeks.org/flutter-tutorial/
5. https://www.tutorialspoint.com/flutter/index.htm

Assessment Details(both IAT and SEE)

Continuous Internal Assessment of Laboratory/Practical Courses		
Lab Test 1	Lab Test 2	Lab Records
15 marks	15 marks	20 marks
Semester End Examination(SEE)		50 marks

Conduct of Practical Examination:

Experiment distribution :

For laboratories having only one part: Students are allowed to pick one experiment from the lot with equal opportunity.

For laboratories having PART A and PART B: Students are allowed to pick one experiment from PART A and one experiment from PART B, with equal opportunity.

- Change of experiment is allowed only once and marks allotted for procedure to be made zero of the changed part only.
- Marks Distribution (Need to change in accordance with university regulations)

a) For laboratories having only one part → Procedure + Execution + Viva-Voce:
15+70+15 = 100 Marks

b) For laboratories having PART A and PART B

i. Part A – Procedure + Execution + Viva = 6 + 28 + 6 = 40 Marks

ii. Part B – Procedure + Execution + Viva = 9 + 42 + 9 = 60 Marks

INTRODUCTION TO UI/UX

Course Code	**22CDL672**	**CIE Marks**	**50**
Teaching Hours /Week(L:T:P)	**(0:0:2)**	**SEE Marks**	**50**
Total Hours of Pedagogy	**12 Lab slots**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course objectives:

As a student will be able to:

1. To explore and understand the nuances of User Experience and User Interface.
2. To gain mastery over the usage of Figma for designing and prototyping UI/UX.
3. To understand user requirement and translate it into UI/UX protype.
4. To analyse apps and websites and understand how they can be continually improved.
5. To understand the UI components and interactions being used in different apps and websites.

Experiments (Designing and Prototyping using Figma)

NOTE: Wire frames can be hand-drawn and recorded by the students. Designing and Prototyping can be done using Figma.

1.	Chat App Redesign: Create a Wireframe and redesign any popular chat app.
2.	Food App: Create a wireframe, Design and Prototype the UI Pages for the food application.
3.	Social Media App: Create a wireframe, Design and Prototype social media photo sharing app.
4.	Product Website: Design and prototype a product website page. Create web pages and rollovers for the web pages.
5.	Travel Agency Website: Create a wireframe, Design and prototype the UI for the website including design for Home Page with search bar, Activities page, Client Testimonial Page, Image Gallery.
6.	UI/UX Designer Portfolio Design: Create a wireframe, Design and prototype a UI for a portfolio including design for About page, Work showcase page, Blog page, contact page.
7.	Dashboard Design: Create a wireframe, Design and Prototype Dashboard UI page, add some Dashboard details, statistics and graphs, Add dropdown options for some dashboard details.
8.	E-Commerce Website: Create a wireframe, Design and prototype Web pages including product category pages (example: mobiles, gaming consoles, Speakers), product pages in each category, buynow page, add to cart page.
9.	Educational Website: Create a wireframe, Design and Prototype the UI for an educational website – Include a Homepage with footer, About Us Page, Programs page, Instructors page, Pricing page, Payments page with radial buttons. Design dropdowns for programs button.
10.	Music Player App: Create a wireframe, Design and prototype the pages with a background and a Rollover button, and Song selection Page with a Home Rollover button. The third page may include animated play and pause button, play music animation, timer animation.

Course Outcomes:

At the end of the course the student will be able to :

CO1: Apply the basics of wireframing in designing apps and Websites.

CO2: Make use of Figma for designing and prototyping UI/UX for different types of apps and Websites.

CO3: Analyse user requirements and translate the requirements to design prototypes.

CO4: Demonstrate the UI/UX concepts applied when designing the prototype of apps and Websites.

CO5: Develop (redesign) the existing apps & Websites with customized design.

Suggested Learning Resources:

1. https://www.figma.com/
2. UX Programming for Beginners, August, 2022
3. https://www.udemy.com/course/learn-figma-web-design
4. https://www.udemy.com/course/figma-2023-master-class-realtime-uiux-web-projects

Assessment Details(both IAT and SEE)

Continuous Internal Assessment of Laboratory/Practical Courses		
Lab Test 1	Lab Test 2	Lab Records
15 marks	15 marks	20 marks
Semester End Examination(SEE)		50 marks

Conduct of Practical Examination:

Experiment distribution :

For laboratories having only one part: Students are allowed to pick one experiment from the lot with equal opportunity.

For laboratories having PART A and PART B: Students are allowed to pick one experiment from PART A and one experiment from PART B, with equal opportunity.

- Change of experiment is allowed only once and marks allotted for procedure to be made zero of the changed part only.
- Marks Distribution (Need to change in accordance with university regulations)

a) For laboratories having only one part → Procedure + Execution + Viva-Voce:
15+70+15 = 100 Marks

b) For laboratories having PART A and PART B

i. Part A – Procedure + Execution + Viva = 6 + 28 + 6 = 40 Marks

ii. Part B – Procedure + Execution + Viva = 9 + 42 + 9 = 60 Marks

MLOPS			
Course Code	**22CDL673**	**CIE Marks**	**50**
Teaching Hours /Week(L:T:P)	**(0:0:2)**	**SEE Marks**	**50**
Total Hours of Pedagogy	**12 Lab slots**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course Overview

This 8-week course (16 hours total) covers the fundamentals and practical aspects of Machine Learning Operations (MLOps). The course is divided into theory and hands-on practical sessions to provide a comprehensive understanding of MLOps, from model development to deployment and monitoring.

Week 1: Introduction to MLOps

Topics Covered:

Definition and Importance of MLOps
MLOps vs DevOps vs DataOps
MLOps Lifecycle and Workflow
Setting up the Environment (Python, Jupyter, Docker, Git)

Hands-on: Install necessary tools and setup environment

Resources:

Book: 'Machine Learning Engineering' by Andriy Burkov
Article: 'What is MLOps?' by Google Cloud
Tool: Docker & Git Documentation

Week 2: Version Control and Experiment Tracking

Topics Covered:

Version Control for Machine Learning Models
Data and Model Versioning
Experiment Tracking using MLflow/DVC

Hands-on: Implement experiment tracking with MLflow

Resources:

Book: 'Introducing MLOps' by Mark Treveil
MLflow Documentation: https://mlflow.org/docs/latest/index.html
DVC Documentation: https://dvc.org/doc

Week 3: Automated Model Training & CI/CD Pipelines

Topics Covered:

Automation in Model Training
Continuous Integration and Deployment (CI/CD) for ML
Tools: Jenkins, GitHub Actions, Kubeflow Pipelines

Hands-on: Create a simple CI/CD pipeline for ML

Resources:

Article: 'CI/CD for Machine Learning' by AWS
GitHub Actions Documentation
Kubeflow Pipelines Docs: https://www.kubeflow.org/docs/components/pipelines/

Week 4: Model Deployment Strategies

Topics Covered:

Batch vs Real-time Inference
Deploying Models using Flask/FastAPI
Serving Models with TensorFlow Serving & TorchServe

Hands-on: Deploy a model using FastAPI

Resources:

Book: 'Building Machine Learning Powered Applications' by Emmanuel Ameisen
FastAPI Documentation: https://fastapi.tiangolo.com/
Tensor Flow Serving Guide

Week 5: Model Monitoring and Logging
Topics Covered:
Why Monitoring is Important
Monitoring Model Drift and Data Drift
Tools: Prometheus, Grafana, Seldon Core
Hands-on: Implement basic model monitoring
Resources:
Article: 'Monitoring ML Models in Production' by Google
Prometheus & Grafana Documentation
Seldon Core Documentation

Week 6: Scaling and Optimization
Topics Covered:
Scaling ML Workflows with Kubernetes
Distributed Model Training (Horovod, Ray)
Optimizing ML Pipelines
Hands-on: Run ML workloads on Kubernetes
Resources:
Book: 'Kubeflow for Machine Learning' by Trevor Grant
Horovod Documentation: https://horovod.ai/
Kubernetes Documentation

Week 7: Security and Compliance in MLOps
Topics Covered:
Security Risks in MLOps
Data Privacy and Compliance (GDPR, HIPAA)
Model Explainability and Fairness
Hands-on: Implement basic security best practices
Resources:
Article: 'AI Security and Compliance' by IBM
Book: 'Responsible Machine Learning' by Patrick Hall
Fairness Indicators Guide

Week 8: Case Studies and Capstone Project
Topics Covered:
Industry Case Studies on MLOps
End-to-End ML Pipeline Implementation
Capstone Project: Deploy and monitor an ML model
Hands-on: Implement a full ML pipeline
Resources:
Google MLOps Case Studies
Book: 'Practical MLOps' by Noah Gift
Kaggle ML Projects

Week 9: Onwards Mini Project

Assessment Details(both IAT and SEE)

Continuous Internal Assessment of Laboratory/Practical Courses		
Lab Test 1	Lab Test 2	Lab Records
15 marks	15 marks	20 marks
Semester End Examination(SEE)		50 marks

Conduct of Practical Examination:

Experiment distribution :

For laboratories having only one part: Students are allowed to pick one experiment from the lot with equal opportunity.

For laboratories having PART A and PART B: Students are allowed to pick one experiment from PART A and one experiment from PART B, with equal opportunity.

- Change of experiment is allowed only once and marks allotted for procedure to be made zero of the

changed part only.

- Marks Distribution (Need to change in accordance with university regulations)
  a) For laboratories having only one part → Procedure + Execution + Viva-Voce:
  15+70+15 = 100 Marks
  b) For laboratories having PART A and PART B
    i. Part A – Procedure + Execution + Viva = 6 + 28 + 6 = 40 Marks
    ii. Part B – Procedure + Execution + Viva = 9 + 42 + 9 = 60 Marks

DEVOPS			
Course Code	**22CDL674**	**CIE Marks**	**50**
Teaching Hours /Week(L:T:P)	**(0:0:2)**	**SEE Marks**	**50**
Total Hours of Pedagogy	**12 Lab slots**	**Total Marks**	**100**
Credits	**01**	**Exam Hours**	**03**

Course objectives:

As a student will be able to:

1. To introduce DevOps terminology, definition & concepts
2. To understand the different Version control tools like Git, Mercurial
3. To understand the concepts of Continuous Integration/ Continuous Testing/ Continuous Deployment)
4. To understand Configuration management using Ansible
5. Illustrate the benefits and drive the adoption of cloud-based Devops tools to solve real world problems

Sl. No	Experiments
1.	**Introduction to Maven and Gradle:** Overview of Build Automation Tools, Key Differences Between Maven and Gradle, Installation and Setup
2.	**Working with Maven:** Creating a Maven Project, Understanding the POM File, Dependency Management and Plugins
3.	**Working with Gradle:** Setting Up a Gradle Project, Understanding Build Scripts (Groovy and Kotlin DSL), Dependency Management and Task Automation
4.	**Practical Exercise:** Build and Run a Java Application with Maven**,** Migrate the Same Application to Gradle
5.	**Introduction to Jenkins:** What is Jenkins?, Installing Jenkins on Local or Cloud Environment, Configuring Jenkins for First Use
6.	**Continuous Integration with Jenkins:** Setting Up a CI Pipeline**,** Integrating Jenkins with Maven/Gradle**,** Running Automated Builds and Tests
7.	**Configuration Management with Ansible:** Basics of Ansible: Inventory, Playbooks, and Modules, Automating Server Configurations with Playbooks, Hands-On: Writing and Running a Basic Playbook
8.	**Practical Exercise:** Set Up a Jenkins CI Pipeline for a Maven Project, Use Ansible to Deploy Artifacts Generated by Jenkins
9.	**Introduction to Azure DevOps:** Overview of Azure DevOps Services, Setting Up an Azure DevOps Account and Project
10.	**Creating Build Pipelines:** Building a Maven/Gradle Project with Azure Pipelines, Integrating Code Repositories (e.g., GitHub, Azure Repos), Running Unit Tests and Generating Reports
11.	**Creating Release Pipelines:** Deploying Applications to Azure App Services, Managing Secrets and Configuration with Azure Key Vault, Hands-On: Continuous Deployment with Azure Pipelines
12.	**Practical Exercise and Wrap-Up:** Build and Deploy a Complete DevOps Pipeline, Discussion on Best Practices and Q&A

Course Outcomes:

At the end of the course the student will be able to:

CO1: Demonstrate different actions performed through Version control tools like Git.

CO2: Perform Continuous Integration and Continuous Testing and Continuous Deployment using Jenkins by building and automating test cases using Maven & Gradle.

CO3: Experiment with configuration management using Ansible.

CO4: Demonstrate Cloud-based DevOps tools using Azure DevOps.

Suggested Learning Resources:

1. https://www.geeksforgeeks.org/devops-tutorial/
2. https://www.javatpoint.com/devops
3. https://www.youtube.com/watch?v=2N-59wUIPVI
4. https://www.youtube.com/watch?v=87ZqwoFeO88

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  ii. Part B – Procedure + Execution + Viva = 9 + 42 + 9 = 60 Marks

INDIAN KNOWLEDGE SYSTEM (IKS)			
Course Code	**22IKS68**	**CIE Marks**	**100**
Teaching Hours/Week (L:T:P: S)	**1:0:0:0**	**SEE Marks**	**-**
Total Hours of Pedagogy	**20**	**Total Marks**	**100**
Credits	**0**	**Exam Hours**	**-**

Module – I

Introduction to Indian Knowledge System (IKS)

- Definition and Scope of IKS
- Importance of IKS in Modern Education
- Contributions of Ancient India to Science, Technology, and Arts
- IKS and Sustainable Development

Module – II

Science and Engineering in Ancient India

- Contributions of Indian Mathematicians (Aryabhata, Brahmagupta, Bhaskara)
- Astronomy and Timekeeping (Surya Siddhanta, Siddhantic Astronomy)
- Metallurgy and Civil Engineering (Iron Pillar, Stepwells, Vastu Shastra)
- Concepts of Fluid Mechanics, Materials Science, and Shipbuilding

Module – III

Ayurveda, Medicine, and Well-being

- Fundamentals of Ayurveda (Tridosha, Panchamahabhuta)
- Contributions of Charaka and Sushruta
- Yoga and its Scientific Basis (Patanjali Yoga Sutras)
- Siddha and Unani Medicine

Module – IV

Indian Philosophy, Ethics, and Governance

- Six Schools of Indian Philosophy (Nyaya, Vaisheshika, Samkhya, Yoga, Mimamsa, Vedanta)
- Dharma, Ethics, and Social Systems in Ancient India
- Arthashastra and Chanakya's Contributions to Governance
- Justice Systems in Ancient India

Module – V

Linguistics, Literature, and Arts in IKS

- Evolution of Sanskrit and Other Indian Languages
- Classical Literature (Vedas, Upanishads, Mahabharata, Ramayana)
- Performing Arts (Natya Shastra, Bharatanatyam, Kathakali)

- Temple Architecture and Sculpture

Module – VI

Indian Knowledge and Modern Science

- Integration of IKS with Modern Science
- Influence of Indian Mathematics on the World (Decimal System, Zero, Algebra)
- Ancient Environmental Practices and Sustainability
- Relevance of IKS in Artificial Intelligence and Data Science

Suggested Learning Resources:

Suggested Textbooks & References

- "Science in Samskrit" – C.K. Raju
- "History of Indian Science and Technology" – D.P. Agrawal
- "Indian Knowledge System" – Kapil Kapoor