ROHINI
COLLEGE OF ENGINEERING & TECHNOLOGY
(AUTONOMOUS)
Approved By AICTE & Affiliated to Anna University
NBA Accredited for All Eligible B.E/B.Tech Programs | NAAC Accredited with A+ Grade
Near Anjugramam - Kanyakumari Main Road, Palkulam, Variyoor P.O.-629401, Kanyakumari Dist, Tamil Nadu.

MINOR COURSE
Data Science - Curriculum & Syllabus

(2024-2025 Admitted Students Onward)

CREDIT INFO		
Sl.No	**Category**	**Credits**
1	**Minor Courses**	**18**

CREDIT DISTRIBUTION

Sl. No.	Course Category	Credit/Semester								No. of Credits
		I	II	III	IV	V	VI	VII	VIII	
1		-	-	-	-	6	6	6	-	18

Minor Degree Subject

S.no	Course code	Course Title	L	T	P	C
THEORY COURSES						
1	24DS501	Introduction to Data Science and Python Programming	3	0	0	3
2	24DS502	Engineering Statistics and Data Visualization	3	0	0	3
3	24DS601	Database Systems and SQL for Engineers	3	0	0	3
4	24DS602	Machine Learning for Engineering Applications	3	0	0	3
5	24DS701	Industrial IoT, Sensors and Time-Series Analytics	3	0	0	3
6	24DS702	Capstone Project	0	0	6	3
		Total	18	0	0	18

Course Code:	**24DS501**	**Course Title:**	**Introduction to Data Science and Python Programming**
Credits:	**3**	**L – T – P**	**3-0-0**
Prerequisite		24CS331 - Programming for problem solving using python	

Course objectives:

- Understand the fundamentals of data science and its applications in engineering disciplines.
- Develop Python programs using basic programming constructs and data structures.
- Perform data acquisition, preprocessing, and manipulation using Python libraries.
- Analyze engineering datasets through exploratory data analysis and visualization techniques.
- Apply Python programming and data science concepts to solve real-world engineering problems.

Teaching-Learning Process:

The following learner-centric pedagogical methods shall be adopted:

1. Interactive lectures supported by multimedia presentations.
2. Demonstration-based learning using Jupyter Notebook.
3. Hands-on laboratory sessions using Python.
4. Problem-solving exercises.
5. Case study discussions from engineering industries.
6. Collaborative learning through group activities.
7. Project-based learning using real engineering datasets.
8. Flipped classroom for selected topics.
9. Online coding practice using Google Colab.
10. Continuous formative assessment through quizzes and coding assignments.

UNIT I- INTRODUCTION TO DATA SCIENCE AND PYTHON BASICS	[9 hours]
Data Science: Definition, importance, data science lifecycle, applications in engineering and industry.**Data Types and Sources:** Structured, semi-structured and unstructured data; qualitative and quantitative data; primary and secondary data sources; engineering data from sensors, machines, IoT devices, databases and web sources.**Data Acquisition and Preprocessing Concepts:** Data collection methods, data integration, data quality, data cleaning, handling missing values, duplicate removal, data transformation, normalization and feature selection.**Python Environment and Jupyter Notebook:** Installation of Python and Anaconda, IDEs, Jupyter Notebook interface, notebooks, cells, kernels, package installation using pip and conda, introduction to Google Colab.	

UNIT II- PYTHON PROGRAMMING FUNDAMENTALS	[9 hours]
Python Basics: Variables, identifiers, keywords, data types, operators, expressions, type conversion, input and output statements.**Control Flow Statements:** Conditional statements (if, if-else, nested if, elif), looping statements (for and while), break, continue and pass statements.**Functions and Modules:** User-defined functions, function arguments, return values, recursive functions, lambda functions, built-in modules, importing modules and packages.**Python Data Structures:** Strings, lists, tuples, dictionaries and sets; indexing, slicing, updating, common operations and built-in methods.**Exception Handling:** Types of errors, exception handling using try, except, else and finally blocks, raising exceptions.	
UNIT III- NUMERICAL COMPUTING USING NUMPY	**[9 hours]**
Introduction to NumPy: Features, advantages, NumPy arrays, creating arrays from lists and built-in functions.**Array Operations:** Array indexing, slicing, reshaping, concatenation, splitting, broadcasting and vectorized operations.**Mathematical and Statistical Functions:** Arithmetic operations, aggregate functions, statistical measures, cumulative operations and linear algebra functions.**Matrix Operations:** Matrix creation, transpose, inverse, determinant, matrix multiplication and solving simple engineering problems.**Random Number Generation:** Random numbers, sampling techniques and simulation using NumPy.	

UNIT IV- DATA MANIPULATION USING PANDAS	[9 hours]
Introduction to Pandas: Series, DataFrames, creating DataFrames, importing data from CSV, Excel and JSON files.**Data Inspection and Cleaning:** Data exploration, descriptive statistics, identifying duplicates, handling missing values, replacing values and formatting data.**Data Manipulation:** Selecting rows and columns, filtering, sorting, indexing, updating records and data	

transformation.**Grouping and Aggregation:** GroupBy operations, aggregation functions, pivot tables, merging, joining and concatenating datasets.**Engineering Data Analysis:** Analysis of engineering datasets for manufacturing, energy, civil infrastructure, agriculture and healthcare applications.

UNIT V – EXPLORATORY DATA ANALYSIS AND VISUALIZATION	[9 hours]
Exploratory Data Analysis (EDA): Data summarization, descriptive statistics, distribution analysis, correlation analysis and feature relationships.**Data Visualization using Matplotlib:** Line plots, bar charts, scatter plots, histograms, pie charts, box plots and customization of plots.**Data Visualization using Seaborn:** Distribution plots, box plots, violin plots, pair plots, heatmaps and regression plots.**Engineering Case Studies:** Visualization and interpretation of datasets from mechanical, civil, electrical, biomedical and agricultural engineering applications.**Mini Project:** Data acquisition, preprocessing, exploratory data analysis, visualization and presentation of results using a real-world engineering dataset.	

Course outcomes:

After completing the course, the students will be able to:

CO1	Explain the data science lifecycle, data types, and engineering applications.
CO2	Develop Python programs using variables, operators, control structures, functions, and data structures.
CO3	Import, clean, transform, and manipulate engineering datasets using NumPy and Pandas.
CO4	Perform exploratory data analysis and visualize engineering data using appropriate plotting libraries.
CO5	Design simple data-driven solutions for engineering applications using Python.

COs and POs Mapping:

CO's	**PO's**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	**3**	**2**	1	**1**	**1**	-	-	-	-	-	**1**
2	**3**	**2**	**2**	**2**	2	-	-	-	-	-	**1**

3	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
4	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
5	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	**Type of assessment**	**Max Marks**	**Reduced Marks**	**Total**	**Final marks**
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books

1. Joel Grus, **Data Science from Scratch**, 2nd Edition, O'Reilly Media, 2019.
2. Allen B. Downey, **Think Python: How to Think Like a Computer Scientist**, 2nd Edition, O'Reilly Media, 2016.

Reference Books

1. Wes McKinney, **Python for Data Analysis**, 3rd Edition, O'Reilly Media, 2022.
2. Jake VanderPlas, **Python Data Science Handbook**, O'Reilly Media, 2016.
3. Aurélien Géron, **Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow**, 3rd Edition, O'Reilly Media, 2022.
4. Jake VanderPlas, **Essential Math for Data Science**, O'Reilly Media, 2021.
5. Ethem Alpaydin, **Introduction to Machine Learning**, 4th Edition, MIT Press, 2020.

Suggested Skill Activities:

1. Installation and configuration of Python and Jupyter Notebook.
2. Develop Python programs using conditional and looping statements.
3. Create functions for engineering calculations.
4. Implement programs using lists, tuples, dictionaries, and sets.
5. Perform matrix operations using NumPy.
6. Read and analyze CSV datasets using Pandas.
7. Clean datasets by handling missing values.
8. Generate descriptive statistics for engineering data.
9. Create visualizations using Matplotlib.
10. Design dashboards using Seaborn plots.
11. Analyze an engineering dataset using Exploratory Data Analysis.
12. Mini project on real-world engineering data.

Course Code:	24DS502	Course Title:	Engineering Statistics and Data Visualization
Credits:	**3**	**L – T – P**	**3-0-0**
Prerequisite		24MA302-Probability, Statistics and Numerical Methods	

Course objectives:

- Understand the fundamentals of descriptive and inferential statistics used in engineering applications.
- Apply probability distributions and sampling techniques for engineering problem-solving.
- Analyze relationships among engineering variables using correlation, regression, and hypothesis testing.
- Develop meaningful visual representations of engineering data using modern visualization tools.
- Interpret statistical results for decision-making in multidisciplinary engineering domains.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Interactive lectures with real-world engineering datasets
2. Problem-solving sessions
3. Laboratory demonstrations using MS Excel/Google Sheets/Tableau Public/Power BI
4. Case studies from Mechanical, Civil, Electrical, Electronics, Chemical, Agricultural and Biomedical Engineering
5. Mini-projects based on engineering data
6. Group discussions and presentations
7. Industry-oriented assignments

UNIT I- INTRODUCTION TO ENGINEERING STATISTICS	[9 hours]
Engineering statistics: Definition and importance, Engineering data and its characteristics, Types of data (qualitative and quantitative), Data collection methods, Data classification and tabulation, Frequency	

distribution, Measures of central tendency (mean, median, mode), Measures of dispersion (range, variance, standard deviation), Skewness and kurtosis, Applications of statistics in engineering.

UNIT II: PROBABILITY AND STATISTICAL DISTRIBUTIONS	**[9 hours]**
Probability concepts, Sample space and events, Conditional probability and Bayes' theorem, Random variables, Probability distributions (Binomial, Poisson, Normal), Sampling techniques, Central Limit Theorem, Introduction to reliability concepts and engineering applications.	
UNIT III: STATISTICAL INFERENCE AND QUALITY ANALYSIS	**[9 hours]**
Sampling distributions, Estimation of parameters, Confidence intervals, Hypothesis testing, t-test, Chi-square test, One-way ANOVA (introduction), Statistical Quality Control concepts, Control charts, Engineering case studies.	

UNIT IV: CORRELATION, REGRESSION AND PREDICTIVE ANALYTICS	**[9 hours]**
Correlation analysis, Simple linear regression, Multiple regression (introduction), Residual analysis, Trend analysis, Time-series basics, Forecasting concepts, Interpretation of statistical results for engineering decision-making.	

UNIT V: DATA VISUALIZATION	**[9 hours]**
Data visualization: Definition and principles, Visual perception and design basics, Data visualization techniques (bar chart, line chart, histogram, scatter plot, box plot, pie chart, heat map), Dashboard concepts, Interactive visualization, Introduction to Microsoft Excel, Tableau Public and Microsoft Power BI, Visualization of engineering datasets and report generation.	

Course outcomes:

On completion of the course, the student will be able to:

CO1	Apply descriptive statistical techniques to summarize engineering datasets.
CO2	Use probability distributions and sampling methods for engineering decision-making.
CO3	Analyze engineering data using correlation, regression, estimation, and hypothesis testing.
CO4	Develop effective charts, dashboards, and visual analytics using visualization software.

CO5	Interpret statistical findings to solve multidisciplinary engineering problems and communicate results effectively.

COs and POs Mapping:

CO's	PO's										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	**3**	**2**	1	**1**	**1**	-	-	-	-	-	**1**
2	**3**	**2**	**2**	**2**	2	-	-	-	-	-	**1**
3	**3**	**2**	**2**	**2**	**2**	-	-	-	-	-	**1**
4	**3**	**2**	**2**	**2**	**2**	-	-	-	-	-	**1**
5	**3**	**2**	**2**	**2**	**2**	-	-	-	-	-	**1**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

<table>
<tr><th>Component</th><th>Type of assessment</th><th>Max Marks</th><th>Reduced Marks</th><th>Total</th><th>Final marks</th></tr>
<tr><td rowspan="5">Continuous Internal Examination (CIE)</td><td>CIE – I</td><td>100</td><td rowspan="2">50</td><td rowspan="5">100</td><td rowspan="5">40</td></tr>
<tr><td>CIE – II</td><td>100</td></tr>
<tr><td>MCQ</td><td>20</td><td>10</td></tr>
<tr><td>Skill Assessment - I</td><td>40</td><td rowspan="2">40</td></tr>
<tr><td>Skill Assessment - II</td><td>40</td></tr>
<tr><td>End Semester Examination (ESE)</td><td>Theory Exam</td><td>100</td><td>60</td><td>60</td><td>60</td></tr>
<tr><td colspan="5">Total</td><td>100</td></tr>
</table>

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books

1. Douglas C. Montgomery and George C. Runger, *Applied Statistics and Probability for Engineers*, 8th Edition, Wiley, 2020.
2. N. G. Das, *Statistical Methods*, McGraw Hill Education, Revised Edition.

Reference Books:

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying Ye, *Probability and Statistics for Engineers and Scientists*, 9th Edition, Pearson.
2. Andy Kirk, *Data Visualisation: A Handbook for Data Driven Design*, Sage Publications.
3. Cole Nussbaumer Knaflic, *Storytelling with Data*, Wiley.
4. Deborah Rumsey, *Statistics for Dummies*, Wiley.
5. Alberto Cairo, *The Truthful Art: Data, Charts and Maps for Communication*, New Riders

Suggested Skill Activities:

1. Creating frequency tables and descriptive statistics using MS Excel.
2. Visualizing engineering datasets using charts and graphs.
3. Performing correlation and regression analysis.
4. Developing statistical dashboards using Tableau Public or Power BI.
5. Analyzing real-world engineering datasets and presenting findings.

Course Code:	**24DS601**	**Course Title:**	**Database Systems and SQL for Engineers**
Credits:	**3**	**L – T – P**	**3-0-0**

Course objectives:

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

- Understand the concepts and architecture of database management systems and their role in engineering applications.
- Design relational databases using Entity–Relationship (ER) models and normalization techniques.
- Develop SQL queries for creating, manipulating, retrieving, and managing engineering data.
- Apply database concepts to solve real-world engineering problems involving data storage and analysis.
- Develop simple database solutions and reports using SQL for multidisciplinary engineering applications.

Teaching-Learning Process:

1. Interactive lectures with real-world engineering examples
2. Demonstration of database software (MySQL/PostgreSQL/SQLite)
3. Hands-on laboratory sessions
4. Case studies from different engineering disciplines
5. Problem-solving exercises
6. Mini-projects using engineering datasets
7. Group discussions and presentations
8. Industry-oriented assignments

UNIT I: INTRODUCTION TO DATABASE SYSTEMS	**[9 hours]**
Database systems: Definition, characteristics and applications, Data, information and database concepts, Database Management System (DBMS), File system vs DBMS, Types of databases, Database users, Database architecture, Introduction to Relational Database Management Systems (RDBMS).	

UNIT II: RELATIONAL DATA MODEL AND DATABASE DESIGN	[9 hours]
Relational model concepts, Tables, attributes, tuples and domains, Keys (primary, foreign and candidate), Integrity constraints, Entity–Relationship (ER) model, ER diagrams, Mapping ER model to relational schema, Database normalization concepts (First, Second and Third Normal Forms).	
UNIT III: STRUCTURED QUERY LANGUAGE (SQL)	**[9 hours]**
Introduction to SQL, Data Definition Language (DDL), Data Manipulation Language (DML), Data Query Language (DQL), Data Control Language (DCL) and Transaction Control Language (TCL), Creating and modifying tables, Inserting, updating and deleting records, SQL queries using SELECT, WHERE, ORDER BY, GROUP BY, HAVING and DISTINCT.	

UNIT IV: ADVANCED SQL AND DATABASE PROGRAMMING	[9 hours]
SQL operators, Aggregate functions, Built-in functions, Joins (Inner, Left, Right and Full), Subqueries, Views, Indexes, Introduction to Stored Procedures, Triggers and Transactions, Database security and user management concepts.	

UNIT V: ENGINEERING APPLICATIONS OF DATABASES	[9 hours]
Introduction to NoSQL databases, Database connectivity concepts, Database applications in manufacturing, healthcare, civil infrastructure, IoT, energy systems and logistics, Data backup and recovery concepts, Database performance optimization, Case studies using engineering datasets.	

Course outcomes:

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

CO1	Design relational databases for engineering applications using ER modeling and normalization principles.
CO2	Develop SQL statements to create, retrieve, update, and manage engineering data efficiently.
CO3	Apply advanced SQL features such as joins, aggregate functions, subqueries, views, and transactions to solve engineering problems.
CO4	Develop database solutions for multidisciplinary engineering applications involving structured data management.
CO5	Analyze engineering datasets and generate meaningful reports to support engineering decision-making.

COs and POs Mapping:

CO's	PO's										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	**3**	**2**	1	**1**	**1**	-	-	-	-	-	**1**
2	**3**	**2**	**2**	**2**	2	-	-	-	-	-	**1**
3	**3**	**2**	**2**	**2**	**2**	-	-	-	-	-	**1**
4	**3**	**2**	**2**	**2**	**2**	-	-	-	-	-	**1**
5	**3**	**2**	**2**	**2**	**2**	-	-	-	-	-	**1**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	Type of assessment	Max Marks	Reduced Marks	Total	Final marks
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books

1. Real-Time Analytics Techniques to Analyze and Visualize Streaming Dat, by Byron Ellis, Wiley, 2016.
2. 2. Practical Real-Time Data Processing and Analytics, by Shilpi Saxena, Saurabh Gupta, Packt, 2017.

Reference Books:

1. Streaming Data **by Andrew G. Psaltis (Manning):** A practical guide focusing on how to ingest, transport, and analyze streaming data, covering various tools and techniques.
2. Streaming Systems by Tyler Akidau, Slava Chernyak, and Reuven Lax (O'Reilly)

Suggested Skill Activities:

1. Installing and configuring MySQL/PostgreSQL.
2. Creating databases and relational tables.
3. Writing SQL queries using DDL, DML and DQL commands.
4. Performing joins, aggregate functions and subqueries.
5. Designing ER diagrams for engineering applications.
6. Normalizing database tables.
7. Creating views and indexes.
8. Executing transactions and understanding database security.
9. Developing a simple database for an engineering application.
10. Mini project on database design and SQL-based data analysis.

Course Code:	**24DS602**	**Course Title:**	**Machine Learning for Engineering Applications**
Credits:	**3**	**L – T – P**	**3-0-0**
Prerequisite		24AI671-Fundamentals of Data Science	

Course objectives:

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

- Understand the fundamental concepts, workflow, and types of machine learning used in engineering applications.
- Apply data preprocessing and feature engineering techniques to prepare engineering datasets for machine learning.
- Develop and evaluate basic supervised and unsupervised machine learning models using appropriate tools.
- Interpret machine learning results to solve multidisciplinary engineering problems and support engineering decision-making.
- Explore engineering applications of machine learning using real-world case studies and visualization tools.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Interactive lectures with engineering case studies
2. Demonstration of machine learning workflows using Python/Jupyter Notebook
3. Hands-on laboratory sessions using Scikit-learn, Orange Data Mining or Google Colab
4. Problem-based learning with multidisciplinary engineering datasets
5. Mini-projects based on engineering applications
6. Group discussions and presentations
7. Industry-oriented assignments and case studies
8. Visualization and model interpretation exercises

UNIT I- INTRODUCTION TO MACHINE LEARNING	[9 hours]
Machine Learning: Definition, Artificial Intelligence and Machine Learning relationship, Machine learning lifecycle, Types of machine learning (supervised, unsupervised and reinforcement learning), Engineering applications of machine learning, Types of engineering data, Data acquisition concepts, Introduction to Python environment, Google Colab and Jupyter Notebook.	

UNIT II: DATA PREPROCESSING AND FEATURE ENGINEERING	[9 hours]
Engineering datasets, Data cleaning, Handling missing values, Outlier detection, Data transformation, Data normalization and standardization, Feature selection concepts, Feature extraction basics, Training and testing datasets, Introduction to Scikit-learn dataset library.	
UNIT III: SUPERVISED MACHINE LEARNING	**[9 hours]**
Regression and classification concepts, Linear Regression, Logistic Regression, Decision Trees, k-Nearest Neighbors (KNN), Naïve Bayes (concept), Model training, Prediction, Model evaluation metrics (Accuracy, Precision, Recall, F1-score, Mean Squared Error), Engineering prediction applications.	

UNIT IV: UNSUPERVISED MACHINE LEARNING	[9 hours]
Introduction to clustering, K-Means clustering, Hierarchical clustering (concept), Dimensionality reduction concepts, Principal Component Analysis (PCA) overview, Cluster evaluation, Pattern recognition in engineering datasets, Introduction to anomaly detection.	

UNIT V: MACHINE LEARNING APPLICATIONS IN ENGINEERING	[9 hours]
Machine learning applications in manufacturing, predictive maintenance, structural health monitoring, energy systems, transportation, agriculture, biomedical engineering, environmental monitoring and quality control, Model visualization, Ethics in AI and ML, Explainable AI concepts, Mini-project using an engineering dataset.	

Course outcomes:

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

CO1	Apply machine learning workflows to preprocess and analyze engineering datasets.
CO2	Develop supervised machine learning models for prediction and classification in engineering applications.
CO3	Apply unsupervised learning techniques to identify patterns and group engineering data.
CO4	Develop effective charts, dashboards, and visual analytics using visualization software.
CO5	Develop simple machine learning solutions for multidisciplinary engineering applications using appropriate software tools.

COs and POs Mapping:

CO's	**PO's**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	**3**	**2**	1	**1**	**1**	-	-	-	-	-	**1**
2	**3**	**2**	**2**	**2**	2	-	-	-	-	-	**1**
3	**3**	**2**	**2**	**2**	**2**	-	-	-	-	-	**1**
4	**3**	**2**	**2**	**2**	**2**	-	-	-	-	-	**1**
5	**3**	**2**	**2**	**2**	**2**	-	-	-	-	-	**1**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped,
Level 0- Not Mapped

Scheme of Evaluation:

Component	**Type of assessment**	**Max Marks**	**Reduced Marks**	**Total**	**Final marks**
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			

	MCQ	20	10		
	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books

1. Aurélien Géron, **Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow**, 3rd Edition, O'Reilly Media, 2023.
2. Andreas C. Müller and Sarah Guido, **Introduction to Machine Learning with Python**, 2nd Edition, O'Reilly Media.

Reference Books:

1. Ethem Alpaydin, **Introduction to Machine Learning**, 4th Edition, MIT Press.
2. Christopher M. Bishop, **Pattern Recognition and Machine Learning**, Springer.
3. Kevin P. Murphy, **Machine Learning: A Probabilistic Perspective**, MIT Press.
4. Shai Shalev-Shwartz and Shai Ben-David, **Understanding Machine Learning: From Theory to Algorithms**, Cambridge University Press.
5. Sebastian Raschka and Vahid Mirjalili, **Machine Learning with PyTorch and Scikit-Learn**, Packt Publishing.

Suggested Skill Activities:

1. Install and configure Python, Jupyter Notebook or use Google Colab.
2. Load and explore engineering datasets using Pandas.
3. Perform data cleaning and preprocessing.

4. Visualize engineering datasets using Matplotlib and Seaborn.
5. Develop a Linear Regression model for engineering data.
6. Build a Decision Tree or KNN classifier.
7. Perform K-Means clustering on engineering datasets.
8. Evaluate machine learning models using appropriate performance metrics.
9. Compare multiple machine learning algorithms for the same engineering problem.
10. Mini-project: Develop a machine learning solution for applications such as predictive maintenance, energy consumption prediction, crop yield estimation, water quality analysis, equipment failure prediction, traffic analysis, or environmental monitoring.

Course Code:	**24DS701**	**Course Title:**	**Industrial IoT, Sensors and Time-Series Analytics**
Credits:	**3**	**L – T – P**	**3-0-0**
Prerequisite		24EE404-IOT - Sensors and Devices	

Course objectives:

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

- Understand the fundamental concepts, architecture, and applications of Industrial IoT in engineering systems.
- Identify different types of sensors, data acquisition methods, and communication technologies used in industrial applications.
- Apply IoT-based data collection and processing techniques for engineering monitoring systems.
- Analyze time-series sensor data using statistical methods and visualization techniques.
- Develop IoT-based solutions for industrial automation, predictive maintenance, and smart engineering applications.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Interactive lectures with industrial case studies
2. Demonstration of IoT devices, sensors, and communication systems
3. Hands-on laboratory sessions using IoT development platforms
4. Sensor data collection and analysis exercises
5. Time-series visualization activities
6. Problem-based learning using engineering datasets
7. Mini-project development
8. Industry-oriented assignments and presentations

UNIT I: INTRODUCTION TO INDUSTRIAL IOT (IIOT)	[9 hours]
Industrial IoT: Definition, evolution and importance, Internet of Things (IoT) and Industrial IoT comparison, IIoT architecture, Components of IIoT systems, Industry 4.0 concepts, Smart manufacturing, Industrial data flow, Applications of IIoT in engineering domains, Challenges, Security and privacy aspects.	

UNIT II: SENSORS AND DATA ACQUISITION SYSTEMS	[9 hours]
Sensors: Definition, characteristics and classification, Sensor types and applications, Temperature sensors, Pressure sensors, Humidity sensors, Proximity sensors, Light sensors, Vibration sensors, Gas sensors, Sensor selection criteria, Sensor calibration, Signal conditioning, Data acquisition systems, Analog and digital data acquisition.	
UNIT III: IOT COMMUNICATION AND INDUSTRIAL PLATFORMS	**[9 hours]**
Communication technologies for IoT, Wired and wireless communication, Ethernet, Wi-Fi, Bluetooth, ZigBee, LoRaWAN, MQTT protocol, IoT gateways, Edge computing concepts, Cloud-based IoT platforms, Data storage and management, Introduction to Arduino and Raspberry Pi-based IoT systems.	

UNIT IV: TIME-SERIES DATA ANALYTICS	[9 hours]
Time-series data: Definition, characteristics and applications, Sensor data streams, Data preprocessing, Data cleaning, Handling missing values, Data transformation, Sampling and resampling techniques, Trend analysis, Moving averages, Statistical analysis of time-series data, Data visualization techniques, Introduction to Python tools for time-series analytics.	
UNIT V: INDUSTRIAL IOT APPLICATIONS AND PREDICTIVE ANALYTICS	**[9 hours]**
Industrial IoT applications: Smart manufacturing, Predictive maintenance, Energy monitoring, Structural health monitoring, Smart agriculture, Healthcare monitoring, Environmental monitoring, Transportation systems, Introduction to anomaly detection, Condition monitoring, Integration of IoT with Artificial Intelligence and Machine Learning, Case studies and mini-project development.	

Course outcomes:

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

CO1	Identify suitable IoT architectures, sensors, and communication technologies for engineering applications.
CO2	Interface and apply sensors for collecting real-time engineering data.
CO3	Develop IoT-based monitoring systems for industrial and engineering applications.
CO4	Analyze and visualize time-series sensor data to identify trends, patterns, and anomalies.
CO5	Apply IIoT and analytics concepts to develop smart engineering solutions.

COs and POs Mapping:

CO's	**PO's**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	**3**	**2**	1	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**
2	**3**	**2**	**2**	**2**	2	**-**	**-**	**-**	**-**	**-**	**1**
3	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
4	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**
5	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**

Level 3- Highly Mapped, Level 2- Moderately Mapped, Level 1- Low Mapped, Level 0- Not Mapped

Scheme of Evaluation:

Component	**Type of assessment**	**Max Marks**	**Reduced Marks**	**Total**	**Final marks**
Continuous Internal Examination (CIE)	CIE – I	100	50	100	40
	CIE – II	100			
	MCQ	20	10		

	Skill Assessment - I	40	40		
	Skill Assessment - II	40			
End Semester Examination (ESE)	Theory Exam	100	60	60	60
				Total	100

End semester Examination: (QP PATTERN)

- Each unit consists of two 2 marks questions and one 16 marks question (either or).
- All the fifteen questions have to be answered.

Text Books

1. Arshdeep Bahga and Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press.
2. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress.

Reference Books:

1. Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill Education.
2. Olivier Hersent, David Boswarthick and Omar Elloumi, The Internet of Things: Key Applications and Protocols, Wiley.
3. Samuel Greengard, The Internet of Things, MIT Press.
4. John Davies, The Internet of Things: From Data to Insight, Wiley.

Andrew Minteer, Analytics for the Internet of Things (IoT), Packt Publishing.

Suggested Skill Activities:

Students shall complete at least 10 practical activities.

1. Identify different industrial sensors and their applications.
2. Study sensor characteristics and calibration methods.
3. Interface sensors with microcontrollers or IoT platforms.
4. Collect real-time sensor data from IoT devices.
5. Store and visualize sensor data using IoT platforms.

6. Analyze time-series datasets using Excel/Python.
7. Perform data cleaning and preprocessing on sensor data.
8. Create trend analysis and visualization graphs.
9. Develop a simple IoT monitoring dashboard.
10. Mini-project development using IIoT and time-series analytics.

Mini Project Examples:

- Smart energy monitoring system
- Industrial equipment condition monitoring
- Temperature and humidity monitoring system
- Water quality monitoring system
- Predictive maintenance using vibration data
- Smart agriculture monitoring system

Course Code:	**24DS702**	**Course Title:**	**AI and Data Analytics Capstone Project**
Credits:	**3**	**L – T – P**	**3-0-0**

Course objectives:

The objectives of this course are to:

- Develop practical skills in applying artificial intelligence and data analytics techniques to real-world engineering problems.
- Enable students to collect, preprocess, analyze and interpret engineering datasets.
- Provide hands-on experience in developing data-driven models using machine learning and AI tools.
- Develop skills in visualization, reporting, presentation and decision-making based on analytical results.
- Encourage interdisciplinary problem-solving through industry-oriented data analytics projects.

Teaching-Learning Process:

Suggested strategies that teachers may use to effectively achieve the course outcomes:

1. Project-based learning
2. Industry case study discussions
3. Hands-on coding sessions
4. Problem-based learning
5. Collaborative team projects
6. Mentoring and periodic project reviews
7. Demonstration of AI and analytics tools
8. Technical presentations and peer evaluation

UNIT I: PROBLEM IDENTIFICATION AND DATA ACQUISITION	**[9 hours]**
Project Planning: Identification of engineering problems, project objectives, scope definition, literature survey and problem formulation. **Data Sources:** Structured and unstructured data sources, sensor data, IoT data, databases, open datasets and industrial datasets. **Data Acquisition:** Data collection methods,	

data integration, data storage, data quality assessment and data documentation. **Project Tools:** Introduction to Git/GitHub, Google Colab, Jupyter Notebook and cloud-based analytics platforms.

UNIT II: DATA PREPROCESSING AND EXPLORATORY ANALYSIS	[9 hours]
Data Preparation: Data cleaning, handling missing values, duplicate removal, outlier detection and data transformation. **Feature Engineering:** Feature selection, feature extraction, scaling and encoding techniques. **Exploratory Data Analysis:** Descriptive statistics, data distribution, correlation analysis and pattern identification. **Data Visualization:** Graphical representation using Matplotlib, Seaborn and dashboard development tools.	
UNIT III: AI AND MACHINE LEARNING APPLICATIONS	**[9 hours]**
Machine Learning Techniques: Supervised learning, unsupervised learning and model development. **Regression Analysis:** Linear regression, polynomial regression and prediction models. **Classification Techniques:** Decision trees, K-nearest neighbors, support vector machines and performance evaluation. **Clustering Techniques:** K-means clustering, anomaly detection and pattern recognition.**AI Applications:** Predictive analytics, recommendation systems, fault diagnosis and intelligent decision support systems.	

UNIT IV: MODEL DEVELOPMENT AND DEPLOYMENT	[9 hours]
Model Evaluation: Training and testing datasets, validation techniques, accuracy measures, confusion matrix and performance metrics.**Model Improvement:** Hyperparameter tuning, optimization techniques and model comparison.**Data Analytics Platforms:** Python libraries for AI and analytics, Scikit-learn, TensorFlow/Keras basics.**Deployment Concepts:** Introduction to model deployment, dashboards, APIs and cloud-based analytics.	

UNIT V: CAPSTONE PROJECT IMPLEMENTATION AND PRESENTATION	[9 hours]
Project Execution: Implementation of AI and data analytics solutions for engineering applications.**Documentation:** Project report preparation, methodology, results analysis and technical documentation.**Presentation Skills:** Technical presentation, demonstration, project review and viva voce.	

Course outcomes:

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

CO1	Identify suitable AI and data analytics approaches for solving engineering problems.
CO2	Acquire, preprocess and manage real-world engineering datasets.
CO3	Apply statistical analysis, machine learning and AI techniques for data-driven solutions.
CO4	Develop visualization dashboards and interpret analytical results for decision-making.
CO5	Execute an interdisciplinary capstone project and communicate technical outcomes through reports and presentations.

COs and POs Mapping:

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1	3	2	1	1	1	-	-	-	-	-	1
2	3	2	2	2	2	-	-	-	-	-	1
3	3	2	2	2	2	-	-	-	-	-	1
4	3	2	2	2	2	-	-	-	-	-	1
5	3	2	2	2	2	-	-	-	-	-	1

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Text Books

1. Wes McKinney, **Python for Data Analysis**, 3rd Edition, O'Reilly Media, 2022.
2. Aurélien Géron, **Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow**, 3rd Edition, O'Reilly Media, 2022.

Reference Books:

1. Jake VanderPlas, **Python Data Science Handbook**, O'Reilly Media, 2016.
2. Joel Grus, **Data Science from Scratch**, 2nd Edition, O'Reilly Media, 2019.
3. Tom Mitchell, **Machine Learning**, McGraw Hill Education, 2017.
4. Ian Goodfellow, Yoshua Bengio and Aaron Courville, **Deep Learning**, MIT Press, 2016.

Case Studies:

1. Predictive maintenance of industrial machines
2. Smart agriculture analytics
3. Energy consumption forecasting
4. Structural health monitoring
5. Biomedical signal analysis
6. Manufacturing quality prediction
7. Traffic and transportation analytics

Suggested Skill Activities:

Students shall perform the following activities:

1. Identify an engineering problem suitable for data analytics.
2. Collect and prepare real-world datasets.
3. Perform exploratory data analysis.
4. Develop visualization dashboards.
5. Implement AI/ML models.
6. Evaluate model performance.
7. Compare different analytical approaches.
8. Prepare technical documentation.
9. Present project outcomes.
10. Demonstrate the developed solution.