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

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Curriculum & Syllabus

(2024-2025 Admitted Students Onwards)

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

Course Category	I	II	III	IV	V	VI	VII	VIII	No. of Credits
Minor Courses	-	-	-	-	6	6	6	-	18

Minor Courses						
ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING						
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**
1	24AM501	Python Programming for Artificial Intelligence	3	0	0	3
2	24AM502	Machine Learning for Engineering Applications	3	0	0	3
3	24AM601	Computer Vision and Intelligent Sensing Systems	3	0	0	3
4	24AM602	Industrial AI, Digital Twin and Predictive Analytics	3	0	0	3
5	24AM701	Generative AI, Large Language Models and AI Assistants	3	0	0	3
6	24AM702	AI Applications in Smart Engineering Systems	3	0	0	3

Course Code:	**24AM501**	**Course Title:**	**PYTHON PROGRAMMING FOR ARTIFICIAL INTELLIGENCE**
Credits:	**3**	**L – T – P**	**3 -0 -0**
Prerequisites:		Basic Computer Fundamentals	

Course objectives:

The course enables the students to:

1. Understand Python programming concepts and develop structured programs for solving engineering and AI-related problems.
2. Apply Python libraries such as NumPy, Pandas, and Matplotlib for numerical computation, data manipulation, and visualization.
3. Perform data preprocessing techniques to prepare engineering datasets for Artificial Intelligence and Machine Learning applications.
4. Develop Python programs to analyze real-world engineering datasets and automate decision-making processes.
5. Design AI-ready data analysis solutions using Python programming tools for industrial and multidisciplinary engineering applications.

Teaching-Learning Process:

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

- Interactive Lectures with Industry Case Studies
- Live Coding Sessions using Jupyter Notebook and Google Colab
- Project-Based Learning
- Problem-Based Learning
- Think–Pair–Share Activities
- Flipped Classroom
- Peer Programming
- Case Study Discussions
- Mini Projects using Real Engineering Datasets
- Continuous Hands-on Laboratory Practice

UNIT I – PYTHON FUNDAMENTALS FOR ENGINEERING	[9 hours]
Introduction to Python – Features and applications of Python in Artificial Intelligence and Engineering – Installing Python and Anaconda – Python IDEs (Jupyter Notebook, Google Colab, VS Code) – Variables, identifiers and keywords – Data types and type conversion – Input and output statements – Operators and expressions – Conditional statements – Iterative statements – Functions (built-in and user-defined) – Lambda functions – Modules and packages – File handling (text and CSV files) – Exception handling – Engineering applications using Python – Simple automation programs for engineering calculations.	

UNIT II – NUMPY FOR SCIENTIFIC COMPUTING	[9 hours]
Introduction to NumPy – Creating one-dimensional and multi-dimensional arrays – Array indexing, slicing and iteration – Array attributes and data types – Mathematical and statistical operations – Universal functions (ufuncs) – Broadcasting – Reshaping, flattening, stacking and splitting arrays – Random number generation – Linear algebra operations – Matrix multiplication – Eigenvalues and eigenvectors – Numerical methods using NumPy – Engineering computations involving vectors, matrices and sensor data.	

UNIT III – PANDAS FOR DATA ANALYSIS	[9 hours]
Introduction to Pandas – Series and DataFrame – Importing datasets from CSV and Excel files – Data inspection and exploration – Selecting, filtering and sorting data – Indexing and slicing – Handling missing values and duplicate records – Data cleaning and formatting – String operations – Data aggregation using GroupBy – Merging, joining and concatenating datasets – Pivot tables – Descriptive statistics – Correlation analysis – Exploratory Data Analysis (EDA) using engineering datasets.	

UNIT IV – DATA VISUALIZATION USING MATPLOTLIB	[9 hours]
Importance of data visualization in Artificial Intelligence – Introduction to Matplotlib – Plot customization – Line charts – Scatter plots – Bar charts – Pie charts – Histograms – Box plots – Error bar plots – Multiple plots and subplots – Annotations and legends – Visualization of time-series data – Engineering dashboards – Visualization of manufacturing, healthcare, agricultural and infrastructure datasets – Interpretation of graphical results for engineering decision making.	

UNIT V – DATA PREPROCESSING FOR ARTIFICIAL INTELLIGENCE	[9 hours]
Introduction to data preprocessing – Data quality issues – Handling missing values – Detecting and removing duplicate data – Outlier detection and treatment – Noise reduction techniques – Data transformation – Feature engineering – Encoding categorical variables – Label Encoding and One-Hot Encoding – Feature scaling – Normalization and Standardization – Data discretization – Train-test data splitting – Introduction to cross-validation – Preparing engineering datasets for Machine Learning applications – Case studies on predictive maintenance, smart agriculture, healthcare analytics and energy management.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Develop Python programs using fundamental programming constructs to solve engineering and industrial problems.
CO2	Apply NumPy arrays and mathematical operations for scientific computing and numerical analysis.
CO3	Analyze engineering datasets using Pandas for data cleaning, transformation, aggregation, and exploratory analysis.
CO4	Create meaningful visualizations using Matplotlib to support engineering decision-making and AI model development.
CO5	Build AI-ready data preprocessing pipelines to prepare real-world datasets for Machine Learning applications.

COs and POs Mapping:

COs	POs										
	1	2	3	4	5	6	7	8	9	10	11
CO1	3	2	1	-	2	-	-	-	-	-	-
CO2	3	3	1	1	3	-	-	-	-	-	-
CO3	3	3	2	2	3	-	-	-	-	1	-

CO4	2	**3**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**2**	**-**
CO5	3	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**1**	**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. Allen B. Downey, *Think Python: How to Think Like a Computer Scientist*, 3rd Edition, O'Reilly Media, 2024.
2. Wes McKinney, *Python for Data Analysis*, 3rd Edition, O'Reilly Media, 2022.
3. Jake VanderPlas, *Python Data Science Handbook*, 2nd Edition, O'Reilly Media, 2023.

Reference Books

1. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow*, 3rd Edition, O'Reilly Media, 2023.
2. Charles R. Severance, *Python for Everybody*, University of Michigan, 2023.
3. Joel Grus, *Data Science from Scratch*, 2nd Edition, O'Reilly Media, 2019.

4. Fabio Nelli, *Python Data Analytics*, 3rd Edition, Apress, 2024.
5. Reema Thareja, *Python Programming: Using Problem Solving Approach*, Oxford University Press, 2023.

Web Links and Video Lectures (E-Resources):

1. https://greenteapress.com/wp/think-python-3rd-edition/
2. https://wesmckinney.com/book/
3. https://jakevdp.github.io/PythonDataScienceHandbook/

Suggested Skill Activities:

Students shall complete the following skill-based activities using Python and Jupyter Notebook.

1. Develop Python programs for engineering calculations and automation.
2. Perform numerical computations using NumPy arrays and matrix operations.
3. Analyze manufacturing, energy, or healthcare datasets using Pandas.
4. Create interactive visualizations for engineering datasets using Matplotlib.
5. Clean and preprocess real-world datasets for AI applications.
6. Build a data preprocessing pipeline for predictive maintenance datasets.
7. Perform exploratory data analysis on agricultural or biomedical datasets.
8. Develop a mini project using Python to solve an engineering problem.
9. Create a dashboard visualizing engineering performance indicators.
10. Present findings through technical reports and code documentation using GitHub.

Course Code:	**24AM502**	**Course Title:**	**MACHINE LEARNING FOR ENGINEERING APPLICATIONS**
Credits:	**3**	**L – T – P**	**3-0-0**
Prerequisite	**-**		

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:	**24AM601**	**Course Title:**	**COMPUTER VISION AND INTELLIGENT SENSING SYSTEMS**
Credits:	**3**	**L – T – P**	**3 -0 -0**
Prerequisites:		Python Programming for Artificial Intelligence	

Course objectives:

The course enables the students to:

1. Understand the fundamentals of computer vision, digital image processing, and intelligent sensing technologies for engineering applications.
2. Apply image processing techniques using OpenCV to acquire, enhance, and analyze visual data.
3. Develop computer vision models for object detection, image classification, and defect identification using deep learning techniques.
4. Integrate intelligent sensors, cameras, and edge AI devices for real-time monitoring and automation in engineering systems.
5. Design AI-enabled vision solutions to solve real-world industrial problems in manufacturing, civil infrastructure, healthcare, agriculture, and energy systems.

Teaching-Learning Process:

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

- Interactive Lectures with Industry Case Studies
- Live Coding Sessions using Jupyter Notebook and Google Colab
- Project-Based Learning
- Problem-Based Learning
- Think–Pair–Share Activities
- Flipped Classroom
- Peer Programming
- Case Study Discussions
- Mini Projects using Real Engineering Datasets
- Continuous Hands-on Laboratory Practice

UNIT I – FUNDAMENTALS OF COMPUTER VISION AND DIGITAL IMAGING	**[9 hours]**
Introduction to Artificial Intelligence in Vision Systems – Human Vision versus Computer Vision – Applications of Computer Vision in Engineering – Digital Image Formation – Image Acquisition Systems – Cameras and Image Sensors – Image Representation – Pixels, Resolution and Color Spaces (RGB, HSV, Grayscale) – Image File Formats – Image Enhancement Techniques – Histogram Processing – Filtering Techniques – Introduction to OpenCV – Engineering applications in manufacturing, healthcare, agriculture and infrastructure.	

UNIT II – IMAGE PROCESSING USING OPENCV	**[9 hours]**
Introduction to OpenCV – Reading, Displaying and Saving Images – Image Transformations – Image Resizing, Rotation and Cropping – Thresholding Techniques – Edge Detection – Morphological Operations – Contour Detection – Feature Detection and Matching – Template Matching – Image Segmentation – Motion Detection – Video Processing – Industrial applications including surface inspection, crack detection and quality monitoring.	

UNIT III – DEEP LEARNING FOR COMPUTER VISION	**[9 hours]**
Introduction to Deep Learning for Vision – Image Classification – Convolutional Neural Networks (CNN) – Transfer Learning – Data Augmentation – Object Detection Fundamentals – YOLO Architecture – SSD and Faster R-CNN Concepts – Semantic Segmentation – Instance Segmentation – Model Performance Metrics – Deployment of Vision Models using TensorFlow and PyTorch – Engineering applications in defect detection, medical diagnosis and autonomous inspection.	

UNIT IV – INTELLIGENT SENSING SYSTEMS AND EDGE AI	**[9 hours]**
Introduction to Intelligent Sensors – Optical Sensors – Infrared Sensors – Thermal Cameras – LiDAR – Ultrasonic Sensors – Radar Sensors – Depth Cameras – Sensor Calibration – Sensor Fusion – Edge AI Devices – Embedded Vision Systems – IoT-enabled Vision Systems – Real-Time Image Processing – Smart Monitoring Systems – Applications in robotics, autonomous systems, industrial automation and smart cities.	

UNIT V – COMPUTER VISION APPLICATIONS IN SMART ENGINEERING SYSTEMS	[9 hours]
AI-Based Quality Inspection – Surface Defect Detection in Manufacturing – Structural Crack Detection in Civil Engineering – Smart Traffic Monitoring – Medical Image Analysis – Crop Disease Identification – Precision Agriculture – Transformer and Power Line Inspection – Autonomous Drone Vision – Vision-based Predictive Maintenance – Explainable AI in Computer Vision – Ethical Issues in Vision Systems – Case Studies on Industry 5.0 Applications.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Acquire and process digital images using computer vision techniques for engineering applications.
CO2	Apply OpenCV-based image processing methods for feature extraction, segmentation, and object recognition.
CO3	Develop deep learning-based computer vision models for image classification and object detection..
CO4	Integrate intelligent sensing systems with computer vision for real-time monitoring and decision-making.
CO5	Design AI-based vision solutions for solving industrial problems in smart manufacturing, infrastructure monitoring, biomedical imaging, and precision agriculture.

COs and POs Mapping:

COs	**POs**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
CO1	3	**2**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	3	**3**	**2**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	3	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	2	**3**	**3**	**3**	**3**	**1**	**1**	**-**	**2**	**2**	**-**

CO5	3	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**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. Richard Szeliski, **Computer Vision: Algorithms and Applications**, 2nd Edition, Springer, 2022.
2. Jan Erik Solem, **Programming Computer Vision with Python**, O'Reilly Media, 2023.
3. Adrian Rosebrock, **Practical Python and OpenCV**, PyImageSearch, Latest Edition.

Reference Books

1. Rafael C. Gonzalez and Richard E. Woods, **Digital Image Processing**, 5th Edition, Pearson, 2023.
2. Simon J.D. Prince, **Computer Vision: Models, Learning and Inference**, Cambridge University Press, 2024.

3. Aurélien Géron, **Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow**, 3rd Edition, O'Reilly Media, 2023.
4. Joseph Howse, **OpenCV 4 with Python Blueprints**, Packt Publishing, Latest Edition.
5. David Forsyth and Jean Ponce, **Computer Vision: A Modern Approach**, 3rd Edition, Pearson.

Web Links and Video Lectures (E-Resources):

1. https://greenteapress.com/wp/think-python-3rd-edition/
2. https://wesmckinney.com/book/
3. https://jakevdp.github.io/PythonDataScienceHandbook/

Suggested Skill Activities:

Students shall complete the following skill-based activities using Python and Jupyter Notebook.

1. Develop image processing programs using Python and OpenCV.
2. Build image enhancement and edge detection applications.
3. Detect objects using OpenCV and pre-trained deep learning models.
4. Develop CNN models for image classification using TensorFlow.
5. Implement YOLO-based object detection for industrial inspection.
6. Integrate webcam and intelligent sensors for real-time monitoring.
7. Analyze thermal or drone images for infrastructure inspection.
8. Develop a smart agriculture vision system for crop disease detection.
9. Create a biomedical image classification application.
10. Complete a mini project on AI-enabled intelligent sensing for an engineering application.

Course Code:	**24AM602**	**Course Title:**	**INDUSTRIAL AI, DIGITAL TWIN AND PREDICTIVE ANALYTICS**
Credits:	**3**	**L – T – P**	**3 -0 -0**
Prerequisites:		Python Programming for Artificial Intelligence	

Course objectives:

The course enables the students to:

1. Understand the concepts of Industrial Artificial Intelligence, Industry 4.0/5.0, Digital Twin, and Predictive Analytics for smart engineering systems.
2. Apply Artificial Intelligence and Machine Learning techniques to analyze industrial data for predictive maintenance, quality improvement, and process optimization.
3. Develop Digital Twin models for monitoring, simulation, and optimization of engineering assets and industrial processes.
4. Utilize Industrial IoT (IIoT), cloud platforms, and data visualization tools for real-time industrial decision-making.
5. Design AI-driven predictive analytics solutions to address real-world challenges in manufacturing, energy, infrastructure, healthcare, and agriculture.

Teaching-Learning Process:

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

- Interactive Lectures with Industry 4.0 and Industry 5.0 Case Studies
- Live Demonstrations using Python, Power BI, and Cloud Platforms
- Project-Based Learning
- Problem-Based Learning
- Flipped Classroom
- Industrial Data Analysis Workshops
- Hands-on Laboratory Sessions
- Team-Based Mini Projects
- Expert Talks from Industry
- Simulation-Based Learning

UNIT I – INDUSTRIAL AI AND INDUSTRY 5.0 FUNDAMENTALS	[9 hours]
Introduction to Artificial Intelligence in Industry – Evolution from Industry 4.0 to Industry 5.0 – Smart Manufacturing – Intelligent Automation – Human-Centric Manufacturing – AI for Industrial Decision Support – Industrial Data Sources – Industrial Cyber-Physical Systems (CPS) – Industrial Internet of Things (IIoT) – Industrial Communication Protocols – AI applications in manufacturing, power systems, civil infrastructure, healthcare, and agriculture.	

UNIT II – PREDICTIVE ANALYTICS FOR ENGINEERING SYSTEMS	[9 hours]
Introduction to Predictive Analytics – Industrial Data Collection – Time-Series Data Analysis – Feature Engineering – Data Preprocessing for Industrial Data – Regression and Classification Models – Anomaly Detection – Remaining Useful Life (RUL) Prediction – Predictive Maintenance Strategies – Failure Prediction – Production Quality Prediction – AI-based Demand Forecasting – Engineering case studies using manufacturing, energy, and infrastructure datasets	

UNIT III – DIGITAL TWIN FOR SMART ENGINEERING	[9 hours]
Introduction to Digital Twin – Physical Asset, Digital Model, and Digital Twin – Digital Thread – Digital Shadow – Digital Twin Architecture – Data Acquisition and Integration – Real-Time Monitoring – Simulation and Virtual Commissioning – AI-Driven Digital Twin – Digital Twin for Smart Factories – Smart Buildings – Smart Grids – Healthcare Systems – Precision Agriculture – Performance Optimization and Asset Lifecycle Management..	

UNIT IV – INDUSTRIAL IoT, CLOUD ANALYTICS AND VISUALIZATION	[9 hours]
Industrial IoT Architecture – Intelligent Sensors – Edge Devices – IoT Gateways – Cloud Computing for Industrial AI – Cloud Platforms – Data Storage and Processing – MQTT and OPC-UA Concepts – Dashboard Development – Industrial Visualization using Power BI and Grafana – Real-Time Monitoring – Key Performance Indicators (KPIs) – AI-enabled Industrial Decision Support Systems – Introduction to Edge AI.	

UNIT V – AI APPLICATIONS IN SMART INDUSTRIAL SYSTEMS	[9 hours]
AI for Predictive Maintenance – AI-Based Quality Inspection – Intelligent Energy Management – Smart Grid Analytics – Structural Health Monitoring – Smart Transportation Systems – AI in	

Biomedical Equipment Monitoring – Precision Agriculture Analytics – Supply Chain and Inventory Optimization – Explainable AI (XAI) in Industrial Systems – Responsible AI – Industrial Case Studies – Mini Project on AI-enabled Predictive Analytics and Digital Twin.

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Apply Industrial AI concepts to improve operational efficiency and intelligent decision-making in engineering systems
CO2	Develop predictive analytics models for fault prediction, predictive maintenance, and process optimization using industrial datasets.
CO3	Design Digital Twin models for real-time monitoring, simulation, and performance evaluation of engineering assets.
CO4	Integrate Industrial IoT devices, cloud platforms, and dashboards for AI-enabled monitoring and visualization.
CO5	Develop AI-powered industrial solutions for smart manufacturing, energy systems, civil infrastructure, healthcare, and precision agriculture.

COs and POs Mapping:

COs	**POs**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	**3**	**2**	**2**	**3**	**1**	**1**	**-**	**1**	**1**	**-**	**2**
CO2	3	**3**	**3**	**3**	**3**	**1**	**1**	**-**	**1**	**1**	**-**	**2**
CO3	3	**3**	**3**	**3**	**3**	**2**	**2**	**-**	**2**	**2**	**1**	**2**
CO4	2	**3**	**3**	**3**	**3**	**2**	**2**	**-**	**2**	**2**	**1**	**2**
CO5	3	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**3**

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. Alasdair Gilchrist, **Industry 4.0: The Industrial Internet of Things**, 2nd Edition, Apress, 2024.
2. Michael Grieves and John Vickers, **Digital Twin: Mitigating Unpredictable, Undesirable Emergent Behavior in Complex Systems**, Springer, Latest Edition.
3. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, **The Elements of Statistical Learning**, 2nd Edition, Springer.

Reference Books

1. Jay Lee, Hung-An Kao, and Shanhu Yang, **Service Innovation and Smart Analytics for Industry 4.0 and Big Data Environment**, Springer.
2. Mark Asch, Marc Bocquet, and Maëlle Nodet, **Data Assimilation: Methods, Algorithms and Applications**, SIAM.

3. Aurélien Géron, **Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow**, 3rd Edition, O'Reilly Media, 2023.
4. Ovidiu Vermesan and Peter Friess, **Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems**, River Publishers.
5. Klaus Schwab, **The Fourth Industrial Revolution**, World Economic Forum.

Web Links and Video Lectures (E-Resources):

1. https://link.springer.com/book/10.1007/9781484220474?utm_source=chatgpt.com
2. https://link.springer.com/book/10.1007/978-0-387-84858-7?utm_source=chatgpt.com
3. https://link.springer.com/search?query=Digital+Twin+Michael+Grieves&utm_source=chatgpt.com

Suggested Skill Activities:

1. Analyze industrial datasets using Python for predictive analytics.
2. Develop predictive maintenance models for rotating machinery or manufacturing equipment.
3. Create dashboards for industrial KPIs using Power BI or Grafana.
4. Simulate a Digital Twin for an engineering asset using Python or cloud-based tools.
5. Perform anomaly detection on sensor data from industrial equipment.
6. Build a Remaining Useful Life (RUL) prediction model using machine learning.
7. Integrate IoT sensor data with cloud platforms for real-time monitoring.
8. Analyze energy consumption data for intelligent energy management.
9. Develop a mini project on AI-based quality inspection or smart infrastructure monitoring.
10. Present an industrial AI solution addressing a real-world engineering problem.

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Course Code:	**24AM701**	**Course Title:**	**GENERATIVE AI, LARGE LANGUAGE MODELS AND AI ASSISTANTS**
Credits:	**3**	**L – T – P**	**3 -0 -0**
Prerequisites:		Python Programming for Artificial Intelligence	

Course objectives:

The course enables the students to:

1. Understand the principles of Generative Artificial Intelligence, Foundation Models, Large Language Models (LLMs), and AI Assistants for engineering applications.
2. Apply prompt engineering techniques and generative AI tools to automate engineering tasks, technical documentation, content generation, and problem solving.
3. Develop AI-powered applications using Large Language Models, Retrieval-Augmented Generation (RAG), AI Agents, and multimodal AI techniques.
4. Integrate Generative AI with engineering workflows for intelligent decision support, design optimization, predictive maintenance, and knowledge management.
5. Design responsible, secure, and ethical AI solutions using enterprise-grade Generative AI technologies to solve real-world industrial problems.

Teaching-Learning Process:

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

- Interactive Lectures with Industry Case Studies
- Demonstration of Commercial and Open-Source Generative AI Tools
- Prompt Engineering Workshops
- Project-Based Learning
- Problem-Based Learning
- Flipped Classroom
- Hands-on AI Application Development
- Collaborative Learning
- Industry Expert Sessions
- Mini Project and Technical Presentation

UNIT I – INTRODUCTION TO GENERATIVE AI AND LARGE LANGUAGE	**[9 hours]**

MODELS	
Introduction to Artificial Intelligence, Machine Learning and Deep Learning – Evolution of Generative AI – Foundation Models – Generative AI Ecosystem – Large Language Models (LLMs) – Transformers and Attention Mechanism (Concepts) – Tokens and Embeddings – Text Generation – Multimodal AI – Open-source and Commercial LLMs – Applications of Generative AI in engineering, manufacturing, healthcare, agriculture, and infrastructure.	

UNIT II – PROMPT ENGINEERING AND AI PRODUCTIVITY TOOLS	[9 hours]
Principles of Prompt Engineering – Zero-shot, One-shot and Few-shot Prompting – Chain-of-Thought Prompting – Prompt Chaining – Role-based Prompting – Structured Output Generation – AI-assisted Coding – AI for Technical Report Writing – AI for Design Documentation – AI-assisted Data Analysis – AI Productivity Tools for Engineers – Engineering use cases in maintenance, design optimization, quality inspection, project management, and decision support.	

UNIT III – RETRIEVAL-AUGMENTED GENERATION (RAG) AND AI AGENTS	[9 hours]
Knowledge Retrieval in Generative AI – Retrieval-Augmented Generation (RAG) Architecture – Document Loading and Text Chunking – Embeddings and Vector Databases (Concepts) – Semantic Search – AI Agents – Workflow Automation – Tool Calling – Function Calling – Engineering Knowledge Assistants – Enterprise AI Assistants – AI for Standard Operating Procedures (SOPs), technical manuals, and maintenance support.	

UNIT IV – MULTIMODAL AI AND GENERATIVE AI APPLICATION DEVELOPMENT	[9 hours]
Multimodal AI Fundamentals – Text, Image, Audio and Video Generation – Vision-Language Models – AI-powered Image Understanding – Document Intelligence – AI Chatbots – Low-code and No-code AI Application Development – API-based Integration of LLMs – Engineering Application Development using Generative AI – AI-assisted Quality Inspection – Smart Healthcare – Smart Agriculture – Digital Engineering Assistants.	

UNIT V – RESPONSIBLE GENERATIVE AI AND INDUSTRIAL APPLICATIONS	[9 hours]
Responsible AI Principles – AI Ethics – Explainable AI – Bias and Fairness – Hallucination in LLMs – Privacy and Security – AI Governance – Enterprise Generative AI – AI Deployment Considerations – Generative AI for Smart Manufacturing – Predictive Maintenance Support – Digital Twin Integration – Energy Management – Infrastructure Monitoring – Biomedical Applications – Precision Agriculture – Future Trends in Generative AI.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Apply Generative AI models and Large Language Models to solve engineering and industrial problems.
CO2	Develop effective prompts and workflows for technical documentation, engineering design support, and intelligent automation.
CO3	Build AI-powered applications using Retrieval-Augmented Generation (RAG), AI agents, and multimodal AI technologies.
CO4	Integrate Generative AI tools with engineering data sources and enterprise workflows to enhance productivity and decision-making.
CO5	Design responsible, secure, and explainable Generative AI solutions for smart manufacturing, healthcare, infrastructure, energy, and agriculture.

COs and POs Mapping:

COs	**POs**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	**3**	**2**	**2**	**3**	**1**	**-**	**1**	**1**	**1**	**-**	**2**
CO2	2	**3**	**3**	**2**	**3**	**-**	**-**	**1**	**2**	**3**	**1**	**2**
CO3	3	**3**	**3**	**3**	**3**	**1**	**1**	**1**	**2**	**2**	**1**	**2**
CO4	2	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**2**

CO5	3	**3**	**3**	**3**	**3**	**2**	**2**	**3**	**2**	**2**	**2**	**3**

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. **Mohit Sewak**, *Generative AI with Python and PyTorch*, Springer, 2024.
2. **Noah Gift**, *Practical Generative AI with Python*, O'Reilly Media, 2025.
3. **B.M. Harwani**, *Generative AI with Python*, Apress, 2024.

Reference Books

1. **Chip Huyen**, *AI Engineering: Building Applications with Foundation Models*, O'Reilly Media, 2025.
2. **Christopher D. Manning, Prabhakar Raghavan, and Hinrich Schütze**, *Introduction to Information Retrieval*, Cambridge University Press.

3. **Aurélien Géron**, *Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow*, 3rd Edition, O'Reilly Media, 2023.
4. **Lewis Tunstall, Leandro von Werra, and Thomas Wolf**, *Natural Language Processing with Transformers*, O'Reilly Media, 2022.
5. **Delip Rao and Brian McMahan**, *Natural Language Processing with PyTorch*, O'Reilly Media, 2019.

Web Links and Video Lectures (E-Resources):

1. https://link.springer.com/search?query=Generative+AI+with+Python+and+PyTorch+Mohit+Sewak&utm_source=chatgpt.com
2. https://link.springer.com/search?query=Generative+AI+with+Python+B.M.+Harwani&utm_source=chatgpt.com
3. https://link.springer.com/search?query=Generative+AI+with+Python+B.M.+Harwani&utm_source=chatgpt.com

Suggested Skill Activities:

1. Design effective prompts for engineering problem-solving using Generative AI tools.
2. Generate technical reports, maintenance manuals, and engineering documentation using LLMs.
3. Develop AI-powered chatbots for engineering knowledge assistance.
4. Build a Retrieval-Augmented Generation (RAG) application using engineering documents.
5. Create AI assistants for equipment troubleshooting and maintenance support.
6. Develop multimodal AI applications combining text and image inputs.
7. Integrate Generative AI APIs into engineering applications.
8. Analyze AI-generated outputs for accuracy, bias, and reliability.
9. Develop a domain-specific AI assistant for manufacturing, healthcare, energy, or agriculture.
10. Complete a mini project demonstrating the application of Generative AI to solve an industrial engineering problem.

Course Code:	**24AM702**	**Course Title:**	**AI APPLICATIONS IN SMART ENGINEERING SYSTEMS**
Credits:	**3**	**L – T – P**	**3 -0 -0**
Prerequisites:		Python Programming for Artificial Intelligence	

Course objectives:

The course enables the students to:

1. Apply Artificial Intelligence, Machine Learning, Computer Vision, and Generative AI techniques to solve multidisciplinary engineering problems.
2. Design intelligent engineering solutions using AI for smart manufacturing, energy systems, infrastructure, healthcare, agriculture, and industrial automation.
3. Develop AI-enabled decision support systems by integrating sensor data, Industrial IoT, cloud platforms, and predictive analytics.
4. Build and deploy AI-based prototypes that address real-time industrial and societal challenges using modern AI tools and engineering datasets.
5. Demonstrate professional competencies through team-based projects, technical presentations, and deployment of AI solutions aligned with Industry 5.0.

Teaching-Learning Process:

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

- Project-Based Learning
- Design Thinking Approach
- Challenge-Based Learning
- Hands-on Laboratory Sessions
- Industry Case Studies
- Hackathons and Innovation Challenges
- Collaborative Team Projects
- Industry Expert Talks
- Demonstration-Based Learning
- Continuous Project Review and Technical Presentation

UNIT I – AI FOR SMART MANUFACTURING AND INDUSTRIAL AUTOMATION	**[9 hours]**
Introduction to Smart Manufacturing – Industry 5.0 – Artificial Intelligence in Manufacturing – Industrial IoT and Intelligent Sensors – AI for Process Monitoring – Predictive Maintenance – Machine Health Monitoring – AI-Based Quality Inspection – Computer Vision for Defect Detection – Intelligent Robotics – Digital Production Systems – Case Studies on Smart Factories.	

UNIT II – AI FOR SMART ENERGY, ELECTRICAL AND CIVIL INFRASTRUCTURE	**[9 hours]**
Artificial Intelligence in Smart Grids – Load Forecasting – Renewable Energy Forecasting – Transformer Health Monitoring – Energy Management Systems – AI for Structural Health Monitoring – Crack Detection using Computer Vision – Smart Buildings – Intelligent Transportation Systems – Traffic Flow Prediction – Disaster Monitoring – Infrastructure Asset Management – AI Applications in Sustainable Engineering.	

UNIT III – AI FOR BIOMEDICAL AND PRECISION AGRICULTURE	**[9 hours]**
Artificial Intelligence in Healthcare – Medical Image Analysis – Disease Prediction – Wearable Healthcare Systems – Intelligent Biomedical Devices – AI in Telemedicine – Precision Agriculture – Crop Disease Detection – Smart Irrigation – Yield Prediction – Soil Health Monitoring – Drone-Based Agricultural Monitoring – AI for Food Supply Chain Optimization.	

UNIT IV – GENERATIVE AI, DIGITAL TWIN AND INTELLIGENT DECISION SUPPORT	**[9 hours]**
Generative AI for Engineering Design – AI Assistants for Technical Documentation – Retrieval-Augmented Generation (RAG) for Engineering Knowledge Systems – AI Agents for Industrial Automation – Digital Twin Concepts – AI-Based Simulation and Optimization – Cloud AI Platforms – Explainable AI – Responsible AI – AI-Based Decision Support Systems – Industrial Case Studies.	

UNIT V – CAPSTONE PROJECT: AI SOLUTIONS FOR SMART ENGINEERING SYSTEMS	[9 hours]
Problem Identification – Literature Review – Requirement Analysis – Data Collection – Data Preprocessing – AI Model Selection – Model Development – Validation and Performance Evaluation – Prototype Development – Dashboard Design – Deployment Strategies – Project Documentation – Technical Presentation – Demonstration of AI-enabled Engineering Solution.	

Course outcomes:

On completion of the course, the student will have the ability to:

CO1	Analyze engineering problems and identify suitable Artificial Intelligence techniques for intelligent decision-making.
CO2	Develop AI models using machine learning, computer vision, and predictive analytics to solve engineering applications.
CO3	Design AI-enabled systems by integrating intelligent sensors, Industrial IoT, cloud services, and engineering data.
CO4	Develop domain-specific AI applications for manufacturing, civil infrastructure, healthcare, energy, agriculture, and transportation.
CO5	Build, evaluate, and present an industry-oriented AI project that demonstrates innovation, technical competency, and real-world applicability.

COs and POs Mapping:

COs	**POs**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	3	**3**	**2**	**2**	**2**	**1**	**-**	**-**	**1**	**1**	**-**	**2**
CO2	3	**3**	**3**	**3**	**3**	**1**	**1**	**-**	**1**	**1**	**-**	**2**
CO3	3	**3**	**3**	**3**	**3**	**2**	**2**	**-**	**2**	**2**	**1**	**2**
CO4	3	**3**	**3**	**3**	**3**	**2**	**3**	**1**	**2**	**2**	**1**	**3**

CO5	3	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**3**

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>
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<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" align="right">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. Stuart Russell and Peter Norvig, **Artificial Intelligence: A Modern Approach**, 4th Edition, Pearson, 2021.
2. Aurélien Géron, **Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow**, 3rd Edition, O'Reilly Media, 2023.
3. Alasdair Gilchrist, **Industry 4.0: The Industrial Internet of Things**, 2nd Edition, Apress, 2024.

Reference Books

1. Jay Lee, Hung-An Kao, and Shanhu Yang, **Service Innovation and Smart Analytics for Industry 4.0 and Big Data Environment**, Springer.

2. Richard Szeliski, **Computer Vision: Algorithms and Applications**, 2nd Edition, Springer, 2022.
3. Chip Huyen, **AI Engineering: Building Applications with Foundation Models**, O'Reilly Media, 2025.
4. Michael Grieves and John Vickers, **Digital Twin: Mitigating Unpredictable, Undesirable Emergent Behavior in Complex Systems**, Springer.
5. Klaus Schwab, **The Fourth Industrial Revolution**, World Economic Forum.

Web Links and Video Lectures (E-Resources):

1. https://www.pearson.com/en-us/subject-catalog/p/artificial-intelligence-a-modern-approach/P200000003500?utm_source=chatgpt.com
2. https://www.oreilly.com/library/view/hands-on-machine-learning/9781098125967/?utm_source=chatgpt.com
3. https://mitpress.mit.edu/9780262046824/probabilistic-machine-learning/?utm_source=chatgpt.com

Suggested Skill Activities:

1. Develop an AI model for predictive maintenance of industrial equipment.
2. Build a computer vision application for surface defect or crack detection.
3. Design a smart energy consumption prediction system.
4. Develop a crop disease detection model using image datasets.
5. Create an AI-based healthcare diagnosis support application.
6. Build an AI assistant for technical document generation.
7. Develop an Industrial IoT dashboard for monitoring engineering systems.
8. Implement an intelligent decision support system using engineering datasets.
9. Present a technical seminar on emerging AI applications in engineering.
10. Publish project documentation using GitHub.

CAPSTONE PROJECT DOMAINS

Students shall undertake projects in any one of the following domains.

Mechanical Engineering

- Predictive Maintenance of Rotating Machinery
- AI-Based CNC Tool Condition Monitoring
- Automated Visual Quality Inspection
- Smart Production Monitoring

Civil Engineering

- Structural Health Monitoring
- Concrete Crack Detection
- Smart Traffic Management
- Construction Site Safety Monitoring

Electrical and Electronics Engineering

- Smart Grid Analytics
- Transformer Fault Prediction
- Renewable Energy Forecasting
- Intelligent Energy Management

Biomedical Engineering

- Medical Image Classification
- Wearable Health Monitoring
- Disease Risk Prediction
- AI-Assisted Clinical Decision Support

Agricultural Engineering

- Precision Irrigation
- Crop Disease Detection
- Yield Prediction
- Smart Greenhouse Monitoring

Multidisciplinary Projects

- Smart Campus Management
- AI-Based Waste Management
- Smart Water Distribution System
- Environmental Monitoring
- Autonomous Drone Monitoring
- AI-Powered Disaster Response Systems