



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Instrumentation and Control / Automation & Robotics

Subject Code: DI05000261

Subject Name : Artificial Intelligence in Automation

w. e. f. Academic Year:	2026-27
Semester:	5 th
Category of the Course:	PEC - 4

Prerequisite:	Students should have basic knowledge of computer programming (preferably Python), linear algebra, and fundamentals of control systems and industrial automation. Familiarity with sensor data and PLC/SCADA basics will help them understand the integration of intelligent algorithms into industrial hardware.
Rationale:	In the era of Industry 4.0, traditional automation is evolving into "Intelligent Automation." Modern industries require systems that can predict failures, optimize energy consumption, and adapt to changing production needs without human intervention. This course is designed to equip diploma engineers with the skills to implement machine learning, fuzzy logic, and computer vision within industrial frameworks to improve efficiency, safety, and productivity.

COURSE OUTCOME:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
1	Explain fundamental AI concepts and their specific roles in industrial automation.	U
2	Apply machine learning algorithms for predictive maintenance and fault detection.	U, A
3	Implement fuzzy logic and neural network controllers for complex process systems.	A, E
4	Analyze computer vision techniques for industrial quality inspection and sorting.	U, A
5	Evaluate AI-driven optimization strategies for robotics and industrial IoT.	U, E

*Revised Bloom's Taxonomy (RBT): R-Remember; U-Understand; A-Apply; N-Analyze; E-Evaluate; C-Creat

TEACHING AND EXAMINATION SCHEME:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE (E)	PA(M)	PA(I)	ESE (V)	
3	0	2	4	70	30	20	30	150



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COURSE CONTENT:

Unit	Topics and Sub-topics	No. Of Hrs.	% Weightage
Unit-I	Introduction to AI in Industrial Automation 1.1 Overview of AI: Definition and history of AI in manufacturing; Comparison between Conventional Automation vs. AI-based Automation. 1.2 Intelligent Agents: Structure of agents in industrial environments (PLC/SCADA integration); Perception-Action cycle in automated systems. 1.3 AI Search Algorithms: Path planning for AGVs (Automated Guided Vehicles) and AMRs (Autonomous Mobile Robots); Heuristic search basics for optimization.	07	15 %
Unit-II	Machine Learning for Industrial Data 2.1 Data Pre-processing: Handling industrial sensor noise and missing data; Normalization and Feature Extraction from IIoT streams. 2.2 Supervised Learning: Linear and Logistic Regression for sensor calibration; Support Vector Machines (SVM) for equipment state classification. 2.3 Unsupervised Learning: K-means clustering for anomaly detection in process loops; Principal Component Analysis (PCA) for dimensionality reduction.	10	25 %
Unit-III	Neural Networks and Deep Learning 3.1 Artificial Neural Networks (ANN): Biological vs. Artificial Neuron; Multilayer Perceptrons (MLP) and Backpropagation. 3.2 Deep Learning for Automation: Introduction to CNN (Convolutional Neural Networks) for visual inspection; Convolution, Pooling, and Padding layers. 3.3 Time-Series Forecasting:	11	25 %



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	RNN(Recurrent Neural Networks) and LSTM (Long Short-Term Memory) for predicting Remaining Useful Life (RUL) of machinery.		
Unit-IV	Fuzzy Logic and Expert Systems 4.1 Fuzzy Logic Fundamentals: Fuzzy sets and Membership functions; Fuzzification and Defuzzification methods. 4.2 Industrial Fuzzy Control: Design of Fuzzy PID controllers; Rule-based expert systems for industrial troubleshooting. 4.3 Applications: Case studies in temperature and pressure control using fuzzy logic.	10	20 %
Unit-V	AI Implementation and Case Studies 5.1 Hardware for AI: Edge AI vs. Cloud AI in factories; Deployment on Nvidia Jetson, Raspberry Pi, or industrial PCs. 5.2 Industrial Vision Systems: Automated sorting and defect detection using OpenCV library. 5.3 Ethics and Safety: Reliability of AI in safety-critical systems; Human-Robot Collaboration (Cobots).	07	15 %
Total		45 Hrs	100%

SUGGESTED PRACTICAL EXERCISES:

The following practical outcomes (PrOs) that are the sub-components of the COs. *Some of the PrOs marked ‘*’ are compulsory, as they are crucial for that particular CO. These PrOs need to be attained at least at the ‘Precision Level’ of Dave’s Taxonomy related to ‘Psychomotor Domain’.*

Sr. No.	Practical Outcomes (PrOs)	Approx. Hrs. Required
1	Set up Python environment (Anaconda/VS Code) and install ML libraries (Scikit-Learn, TensorFlow, NumPy).	02
2	Perform exploratory data analysis (EDA) and visualization on an industrial sensor dataset.	02



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Sr. No.	Practical Outcomes (PrOs)	Approx. Hrs. Required
3	Implement Linear Regression to predict the output of a temperature sensor based on historical calibration data.	04
4	Develop a classification model (SVM/Logistic Regression) to detect 'Faulty' vs 'Healthy' motor states.	04
5	Apply K-means clustering to group different operating modes of a process plant using sensor data.	02
6	Design and simulate a Fuzzy Logic controller for a liquid level system (MATLAB or Python Scikit-Fuzzy).	04
7	Build a simple Neural Network (ANN) to predict hourly energy consumption in a factory.	04
8	Implement an image classification task to identify defective parts on a conveyor belt using CNN.	04
9	Demonstrate real-time object detection or Edge AI deployment for an automation task.	02
Total		28 Hrs

Note

- More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.
- The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Preparation of AI development environment and library configuration	20
2	Logic development, data cleaning, and Code implementation	30
3	Model training, validation, and accuracy analysis	20
4	Troubleshooting, optimization, and performance tuning	10
5	Interpretation of results and preparation of technical lab report	20
Total		100



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MAJOR EQUIPMENT/ INSTRUMENTS AND SOFTWARE REQUIRED:

These major equipment/instruments and Software required to develop PrOs are given below with broad specifications to facilitate procurement of them by the administrators/management of the institutes. This will ensure conduction of practical in all institutions across the state in proper way so that the desired skills are developed in students.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	High-performance Workstations: i7, 16GB RAM, GPU preferred	All
2	Python Environment: NumPy, Pandas, Scikit-Learn, Keras, TensorFlow	All
3	Simulation Software: MATLAB with Fuzzy/Deep Learning Toolboxes or Open-source Scikit-Fuzzy	6
4	Visual Hardware: USB Webcams for industrial inspection tasks	8, 9
5	Edge Computing (Optional): Nvidia Jetson Nano or Raspberry Pi for deployment demos	9

AFFECTIVE DOMAIN OUTCOMES:

- Follow safety practices while handling industrial hardware and edge devices.
- Practice good data ethics and integrity in reporting model performance.
- Demonstrate collaborative skills during group micro-projects.
- Develop a systematic approach to troubleshooting complex AI models.
- Appreciate the role of "Explainable AI" in ensuring industrial safety.

SUGGESTED STUDENT ACTIVITIES:

- Industry Audit: Visit a local industry to identify processes where AI-based predictive maintenance could prevent downtime.
- Competitive Analysis: Participate in small-scale Kaggle competitions using industrial datasets (e.g., NASA Turbofan).
- Case Study Report: Research and present a report on the use of "Cobots" (Collaborative Robots) in the automotive sector.
- Open-Source Contribution: Explore and experiment with pre-trained models from the TensorFlow Hub or Hugging Face for automation tasks.



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SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any):

- Google Colab Sessions: Use Colab for heavy model training to demonstrate the power of GPU acceleration.
- Visual Demonstrations: Use physical conveyors or miniature sorting systems to show real-time "Defect Detection" logic.
- Virtual Labs: Utilize IIT/NPTEL Virtual Labs for simulations where physical hardware is unavailable.
- Expert Talks: Invite industry experts to discuss "Real-world challenges in AI deployment" to bridge the gap between theory and factory-floor reality.

SUGGESTED MICRO-PROJECTS:

- Smart Energy Monitor: Build an AI model that predicts factory energy usage based on shift timings and machine status.
- Automated Quality Inspector: A vision-based system that sorts parts on a miniature conveyor based on color or size defects.
- Machine Health Predictor: A dashboard that uses vibration sensor data to classify the health of a rotating motor.
- Fuzzy Water-Level Controller: A simulation or hardware model of a tank where the outflow is controlled by a Fuzzy Logic algorithm.

SUGGESTED LEARNING RESOURCES:

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Artificial Intelligence: A Modern Approach	Russell & Norvig	Pearson Education, Upper Saddle River, NJ, USA, 2020 (4th Ed). ISBN: 978-0-13-604259-4
2	The Hundred-Page Machine Learning Book	Andriy Burkov	Andriy Burkov, Quebec City, Canada, 2019.
3	Deep Learning	Goodfellow, et al.	MIT Press, Cambridge, MA, USA, 2016. ISBN: 978-0262035613
4	Fuzzy Logic with Engineering Applications	Timothy J. Ross	John Wiley & Sons Inc., 111 River Street, Hoboken, NJ 07030, USA ISBN: 0-470-86075-8



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Sr. No.	Title of Book	Author	Publication with place, year and ISBN
5	Computer Vision: Algorithms and Applications	Richard Szeliski	Springer Nature, Cham, Switzerland, 2022 (2nd Ed). ISBN: 978-3030343712
6	Edge AI Developer Guide (Nvidia Jetson)	Nvidia Developer	Nvidia Corporation, Santa Clara, CA, USA, 2024. (Continuous Online Update)

SUGGESTED LEARNING WEBSITES:

- NPTEL - Artificial Intelligence Course (<https://nptel.ac.in/courses/106105077>)
- Coursera - Industrial Applications of AI (<https://www.coursera.org/learn/industrial-applications-of-ai>)
- Kaggle - Industrial Datasets for Practice (<https://www.kaggle.com/>)
- Scikit-Learn Documentation (<https://scikit-learn.org/stable/>)
- TensorFlow Tutorials (<https://www.tensorflow.org/>)
- OpenCV Tutorials (<https://opencv.org/>)
- V-Lab: Virtual Labs for Computer Science & Engineering (<https://www.vlab.co.in/broad-area-computer-science-and-engineering>)

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