COURSE CONTENT

ARTIFICIAL INTELLIGENCE IN MANUFACTURING

III Semester: ME

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P	C	CIA	SEE	Total
2234025	Foundation	3	0	0	3	40	60	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil				Total Classes: 45		

Prerequisites: Nil

Course Overview:

An "Artificial Intelligence in Manufacturing" course overview typically covers how AI and Machine Learning (ML) are applied to optimize production, improve efficiency, and drive innovation in the manufacturing sector. Key topics include predictive maintenance, AI-driven process optimization, digital twins, intelligent robotics, and the integration of AI throughout the Industry 4.0 ecosystem, preparing professionals to implement AI solutions in smart factories

Prerequisite: Production Systems, Fundamentals of Artificial Intelligence

Course Objectives:

1. Tointroducethefundamentalsofartificialintelligenceanditsrelevancein manufacturing.
2. To study AI techniques applicable to production planning, process control, and quality management.
3. Toexploremachinelearningalgorithmsforpredictivemaintenanceandprocessoptimization.
4. To apply AI for real-time monitoring, robotics, and automation in manufacturing environments.
5. Tofamiliarizestudentswithcasestudiesandindustrialapplicationsof AIin manufacturing.

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

1. Understandthebasicconceptsof AIanditsapplicationsinmanufacturingsystems.
2. Applymachinelearningtechniquesformanufacturingprocessoptimization.
3. Analyzemanufacturingdataforpredictiveanalyticsanddecision-making.
4. Implement AI-based solutions in robotics, automation, and process control.
5. Evaluate AI-drivenmanufacturingsystemsforproductivityandqualityimprovement.

UNIT – I: AI and Search Methods

Definition, History, Present State of Artificial Intelligence (AI), Phases of AI, Approaches to AI – Hard or Strong AI, Soft or Weak AI, Applied AI, Cognitive AI, and Application Domains

Focused on Manufacturing. Role of AI in Industrial Revolution 4.0 – Components, Advantages, and Challenges.

Problem Solving Methods:

1. **Uninformed Search:** Depth First Search (DFS), Breadth First Search (BFS), Uniform Cost Search (UCS), Depth Limited Search, Iterative Deepening Depth First Search (IDDFS), and Bidirectional Search.
2. **Informed Search (Heuristic Search):** Greedy Best First Search, A* Search, Memory Bounded Heuristic Search, Learning to Search Better, Simple Problems.

UNIT – II: Neural Networks

Introduction to Perceptron and Neural Networks, Activation and Loss Functions, Single Neuron of Human and Human Brain Modelling.

ANN Architecture: Input Layer, Hidden Layer, and Output Layer.
Types of Neural Networks:

- Single Layer Feed-Forward Network
- Multilayer Feed-Forward Network
- Multi-Layer Perceptron (MLP)
- Recurrent Networks or Feedback ANN, Characteristics of Neural Networks.
  Simple problems on Back Propagation Algorithms to minimize the error.

UNIT – III: Computer Vision and CNNs

Introduction to Convolutional Neural Networks (CNNs) – What is CNN, Common Uses for CNN, CNN Basic Architectures: LeNet, AlexNet, VGGNet, GoogLeNet, ResNet. Introduction to Images, Representation, Image Extraction, Segmentation, and Analysis. Simple demonstrations on image processing using ANN – Face Detection, Fingerprint Recognition, etc.

UNIT – IV: Supervised and Unsupervised Learning

Unsupervised Learning: Definition, Basic Concepts, Applications, K-Means Clustering, Hierarchical Clustering, Dimension Reduction – PCA, Simple Examples.
Supervised Learning: Definition, Basic Concepts, Applications, Linear Regression, Multiple Variable Linear Regression, Logistic Regression, Naive Bayes Classifiers, K-NN Classification, Support Vector Machine (SVM), Simple Examples.

UNIT – V: Reinforcement and Ensemble Learning

Reinforcement Learning: Reinforcement Learning (RL) Framework, Components of RL Framework, Types of RL Systems, Q-Learning, Simple Examples.
Ensemble Learning Techniques: Introduction to Ensemble Methods, Decision Trees, Bagging, Random Forests, Boosting, Simple Examples.

TEXTBOOK:

1. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig, Prentice-Hall, 3rd Edition (2009)
2. Nature-Inspired Optimization in Advanced Manufacturing Processes and Systems, Ganesh M. Kakandikar and Dinesh G. Thakur, CRC press,1stEdition, 2021.

REFERENCES:

1. Artificial Intelligence, Ela Kumar, Wiley‐India,1stEdition,2020.
2. Artificial Intelligence: Concepts and Applications, Lavika Goel, Wiley‐India,1st Edition, 2021.
3. Artificial Intelligence for Robotics and Industrial Applications, Abhishek Arora and Sanjeev Kumar, Wiley India, 1st Edition, 2023.
4. Machine Learning for Manufacturing, Davide Polonio and Paolo Rizzi, Springer,1st Edition, 2022.
5. Deep Learning for Vision Systems, Mohamed Elgendy, Manning Publications, 1stEdition, 2021.
6. Hands-On Artificial Intelligence for Smart Manufacturing, Francesco Carlo Morabito, Springer, 1st Edition, 2023.

ELECTRONIC RESOURCES:

1. https://www.coursera.org/courses?query=ai%20manufacturing
2. https://ai.google/education/
3. https://www.edx.org/learn/artificial-intelligence
4. https://www.youtube.com/results?search_query=ai+in+manufacturing+lecture
5. https://towardsdatascience.com/tagged/manufacturing
6. https://www.ibm.com/topics/artificial-intelligence
7. https://nptel.ac.in/courses?searchQuery=artificial+intelligence

MATERIALS ONLINE:

1. Course template
2. Tech talk and Concept Video topics
3. Assignments
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. E-Learning Readiness Videos (ELRV)