COURSE CONTENT

AI IN STRUCTURAL ENGINEERING								
I Semester: ST								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BSTE08	Elective	3	0	0	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Probability and Statistics								

I. COURSE OVERVIEW:

This course introduces the principles of Artificial Intelligence (AI) and its integration into civil engineering applications. It covers intelligent agents, search techniques, machine learning models, supervised and unsupervised learning methods, with a focus on how these techniques can solve real-world civil engineering problems such as structural health monitoring, construction optimization, transportation systems, and material performance prediction. The course bridges theory and practice, enabling students to apply AI tools for resilient, efficient, and sustainable civil engineering solutions.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamentals, scope, and challenges of AI in civil engineering applications.
II. The problem-solving skills using search algorithms for optimization and planning in civil engineering systems.
III. Supervised and unsupervised learning models and their role in engineering decision-making.
IV. Machine learning techniques for prediction, classification, and clustering in civil engineering domains.

III. COURSE OUTCOMES:

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

CO 1 Explain the fundamental concepts, history, and applications of AI in civil engineering.
CO 2 Identify suitable intelligent agents and search strategies for solving civil engineering optimization problems.
CO 3 Apply supervised learning models such as regression, decision trees, SVM, and neural networks to predict and classify engineering data.
CO 4 Utilize unsupervised learning techniques such as PCA and clustering for analyzing and interpreting civil engineering datasets.
CO 5 Compare different AI models in terms of performance, bias-variance trade-off, and suitability for engineering applications.
CO 6 Analyze case studies of AI applications in structural, geotechnical, transportation, and construction engineering to propose effective solutions.

IV. COURSE CONTENT:

MODULE –I: INTELLIGENT AGENT AND UNINFORMED SEARCH (9)

Introduction - Foundations of AI - History of AI - The state of the art - Risks and Benefits of AI - Intelligent Agents - Nature of Environment - Structure of Agent - Problem Solving Agents - Formulating Problems - Uninformed Search - Breadth First Search - Dijkstra's algorithm or uniform cost search - Depth First Search - Depth Limited Search. Applications: Structural layout optimization, Pathfinding in construction planning, Bridge inspection routing, Preliminary design space exploration.

MODULE -II: PROBLEM SOLVING WITH SEARCH TECHNIQUES (9)

Informed Search - Greedy Best First - A* algorithm - Adversarial Game and Search - Game theory - Optimal decisions in game - Min Max Search algorithm - Alpha-beta pruning. Applications: Optimized design, Decision-making in retrofitting, Construction scheduling.

MODULE -III: LEARNING (9)

Machine Learning: Definitions – Classification - Regression - approaches of machine learning models - Types of learning - Probability - Basics - Linear Algebra – Hypothesis space and inductive bias, Evaluation. Training and test sets, cross validation,

Concept of over fitting, under fitting, Bias and Variance - Regression: Linear Regression - Logistic Regression, Applications: Structural health monitoring, Material strength prediction, Load prediction, perform prediction.

MODULE -IV: SUPERVISED LEARNING (9)

Neural Network: Introduction, Perceptron Networks – Adaline - Back propagation networks - Decision Tree: Entropy – Information gain - Gini Impurity - classification algorithm - Rule based Classification - Naïve Bayesian classification - Support Vector Machines (SVM), applications: Predicting nonlinear stress-strain behavior, Failure mode classification in beams and slabs.

MODULE -V: UNSUPERVISED LEARNING (9)

Unsupervised Learning – Principle Component Analysis - Neural Network: Fixed Weight Competitive Nets - Kohonen Self-Organizing Feature Maps – Clustering: Definition - Types of Clustering – Hierarchical clustering algorithms – k-means algorithm, applications: Grouping buildings, Grouping structural health monitoring, Visualizing patterns in structural damage data.

V. TEXTBOOKS:

1. S. Russell and P. Norvig, "*Artificial Intelligence: A modern approach*", Prentice Hall, Fourth Edition, 2021.
2. S.N. Sivanandam and S.N. Deepa, "*Principles of soft computing*" Wiley India, 3rd edition, 2018.
3. Manuel Duarte Pinheiro, Hugo Rodrigues, "*Machine Learning, Data Science, and Artificial Intelligence Applied to Structural Engineering*", Springer, 2022.
4. Satish Chandra, Mithilesh Kumar, "*Big Data Analytics in Structural Dynamics: Fundamentals and Applications*", CRC Press, 2021.

VI. REFERENCE BOOKS:

1. Tom Mitchell, "*Machine Learning*", McGraw- Hill, 1st Edition 2017.
2. C. Muller and Sarah Alpaydin, Ethem, "*Introduction to machine learning*", MIT press, 2020.

VII. ELECTRONICS RESOURCES:

1. https://nptel.ac.in/courses/106106139
2. https://nptel.ac.in/courses/106102220

VIII. MATERIAL ONLINE:

1. Course Outline Description
2. Tutorial Question Bank
3. Assignments
4. Model Question Paper – I
5. Model Question Paper - II
6. Lecture Notes
7. Early Lecture Readiness Videos
8. Power point presentation