Institute/ School Name	School of Engineering and Technology		
Department Name	Department of Computer Science & Engineering		
Program Name	Bachelor of Engineering (Computer Science & Engineering): B.E (CSE)		
Course Code	23CS006	Course Name	Machine Learning Systems for Real World
L-T-P (Per Week)	2-0-2	Course Credits	03
Academic Year	2025-2026	Semester/Batch	4th/2024-2028
Pre-requisites (if any)	None		
NHEQF Level	5	SDGs	4,9
Course Coordinator	Dr. Ramamani Tripathy		

1. Scope and Objective of the Course:

This course provides a comprehensive foundation in Machine Learning (ML), covering supervised, unsupervised, and reinforcement learning techniques. It emphasizes the development of skills in data preprocessing, model development, evaluation, and optimization using Python-based machine learning tools. The objective of the course is to enable learners to understand core ML concepts, build practical skills in implementing and evaluating learning algorithms, and apply machine learning techniques effectively to real-world problems.

2. Programme Outcomes (POs):

At the end of the programme, students will be able to:	
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO 6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

3. Course Learning Outcomes (CLO):

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

CLO1: Understand fundamental machine learning concepts, algorithms, and workflows.

CLO2: Analyze data-driven engineering problems and select appropriate machine learning techniques to derive meaningful and substantiated solutions.

CLO3: Evaluate the performance and limitations of machine learning models using appropriate validation strategies and performance metrics.

CLO4: Acquire skills to implement and optimize machine learning algorithms using modern programming environments, libraries, and computational tools.

CLO5: Develop skills to design machine learning solutions that consider ethical,. societal, environmental, and sustainability aspects, and demonstrate preparedness for independent and lifelong learning.

4. CLO-PO Mapping Matrix:

Course Learning Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	NHEQF Level Descriptor
CLO1	H	L	-	-	-	-	-	-	-	-	-	L	Q1
CLO2	M	H	L	-	-	-	-	-	-	-	-	-	Q2, Q3
CLO3	L	M	-	H	M	-	-	-	-	-	-	-	Q4
CLO4	M	L	-	-	H	-	-	-	-	-	-	M	Q2
CLO5	-	-	H	-	-	-	-	M	-	L	-	H	Q2

5. ERISE Grid Mapping:

Feature Enablement	Level (1-5, 5 being highest)
Entrepreneurship	1
Research/Innovation	4
Skills	5
Employability	3

6. Recommended Books (Reference Books/Textbooks):

B01: Fenner, M., Machine learning with Python for everyone (1st Edition). Addison-Wesley Professional.

B02: Chollet, F., & Chollet, F., Deep learning with Python (2nd Edition). Simon and Schuster.

B03: Alpaydin, E., Introduction to machine learning (4th Edition). MIT press.

B04: Burkov, A., Machine learning engineering (Vol. 1). True Positive Incorporated.

B05: Géron, A., Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow (2nd Edition). O'Reilly.

B06: Zhang, A., Lipton, Z. C., Li, M., & Smola, A. J., Dive into deep learning (1st Edition). Cambridge University Press.

7. Other readings and relevant websites:

Resources	Link of Journals, Magazines, Websites and Research Papers
R1	https://www.udemy.com/course/python-for-data-science-and-machine-learning-bootcamp
R2	https://nptel.ac.in/courses/106106139
R3	https://www.youtube.com/watch?v=bYM09nTVbk0
R4	https://www.analyticsvidhya.com/blog/2018/05/24-ultimate-data-science-projects-to-boost-your-knowledge-and-skills/
R5	https://developers.google.com/machine-learning
R6	Barongo, R. I., & Mbelwa, J. T. (2024). Using machine learning for detecting liquidity risk in banks. Machine Learning with Applications, 15, 100511.

R7	https://onlinelibrary.wiley.com/doi/abs/10.1002/masy.202100286
Resources	**Link of Audio-Video resources**
V1	https://nptel.ac.in/courses/106105152
V2	https://www.youtube.com/channel/UCNU_lfiiWBdtULKOw6X0Dig
V3	https://onlinecourses.swayam2.ac.in/imb25_mg56/preview
V4	https://onlinecourses.nptel.ac.in/noc25_cs46/preview

8. Recommended Tools and Platforms:

- Google Colab, Jupyter Notebook, VS Code, PyCharm.

9. Course Plan:

Lecture Number	Topics	Weightage in ETE (%)	Instructional Resources
1-2	Introduction to machine learning (ML), artificial intelligence (AI), and deep learning (DL), and Applications.	40	B01, B04, V2, R1
3-4	Practice Problem: Introduction to Integrated Development Environments (IDEs) and Python Libraries.		
5-6	Types of ML: Supervised learning, Unsupervised learning, Reinforcement learning.		
7-8	Practice Problem: Practice Problems on Python Libraries.		
9-10	Supervised Learning: Introduction and example, labelled data, data preprocessing, feature selection, and extraction.		B01, B03, R2, R5
11-12	Generalization, overfitting, and underfitting; Evaluation metrics: accuracy, precision, recall, F1-score, confusion matrix, and ROC curve.		
13-14	Practice Problem: Dataset selection and exploration using Python ML frameworks; train–test data splitting.		
15-18	Classification algorithms: k-nearest neighbors (KNN), decision trees, support vector machines (SVM), Naïve Bayes.		B02, B04, V1
19-20	Practice Problem: Implementation of k-nearest neighbors (KNN), decision tree, and SVM.		
21-22	Logistic regression and Ensemble methods		
23-24	Practice Problem: Implementation of Logistic regression, ensemble methods		
25-26	Regression algorithms: Linear regression, multiple regression, polynomial regression, and regularization techniques.		
27-28	Practice Problem: Implementation of Linear and Polynomial Regression.		
29-30	Evaluation metrics: mean squared error (MSE), mean absolute error (MAE), R^2 score.	40	B01, B03, V2
31-32	Practice Problem: Implementation of Regularization Techniques (Ridge, Lasso).		
33-35	Unsupervised Learning: Types of unsupervised learning, challenges, evaluation considerations, and dimensionality reduction using Principal Component Analysis (PCA).		B02, B04, V2, R3
36-37	Practice Problem: PCA for dimensionality reduction.		
38-39	Clustering: K-means clustering, hierarchical clustering, distance measures, cluster evaluation techniques.		
40-41	Practice Problem: Implementation of the K-means algorithm.		
42-43	Reinforcement Learning: Reinforcement learning concepts, agent, environment, state, action, reward, policy, exploration, and exploitation.		
44	Markov Decision Process (MDP), basic reinforcement learning algorithms such as Q-learning and SARSA.		

45-46	Practice Problems: • Implement Q-learning for a simple grid-world environment. • Implement SARSA for a simple grid-world environment.		
47-50	Neural Networks and Deep Learning: Perceptron and multilayer perceptron (MLP) architectures, activation functions (sigmoid, tanh, ReLU), forward and backward propagation.	20	B01, B02, V2, R2, R4, R6
51-52	Practice Problem: Train MLP; forward/backward propagation verification.		B03, V3, B05, R5, B01, B04, B06, R7
53-56	Convolutional neural networks (CNN), recurrent neural networks (RNN), and long short-term memory (LSTM).		
57-58	Practice Problem: CNN implementation for the image dataset.		
59-60	Overfitting and Cross-Validation		
61-62	Practice Problem: RNN/LSTM implementation on a sequential dataset.		

10. Industry Interventions:

Industry curated course "Explore Machine Learning using Python" at the link below:

- https://infyspringboard.onwingspan.com/web/en/app/toc/lex_auth_01260040079074918423 7_shared/overview

11. Innovative Pedagogies:

- Flipped classroom (Annexure-I)

12. Action plan for different types of learners

Slow Learners	Average Learners	Advanced Learners
Remedial Classes	Practice Assignment (Annexure -II)	Draft of a Research Article

13. Evaluation Scheme & Components:

Evaluation Component	Type of Component	No. of Assessments	Weightage of Component	Mode of Assessment (Offline/Online)
Internal Component 1	Formative Assessment (FA)	01	20%	Offline
Internal Component 2	Sessional Tests (STs)	02*	30%	Offline
External Component	End Term Examination	01	50%	Offline
Total		**100%**		

* Average of the STs shall be used to determine the final marks.

14. Details of Evaluation Components:

Evaluation Component	Description	Syllabus Covered (%)	Timeline of Examination	Weightage (%)
Internal Component 1	FA	• Industry Certification • Lab Assessments	Will be intimated in due course	20%
Internal Component 2	ST 01	Up to 40% (Lectures 1-25)		30%
	ST 02	41% - 80% (Lectures 26-51)		
External Component	End Term Examination*	100%		50%
Total				100%

* Minimum 75% attendance is required to become eligible for appearing in the End Semester Examination.

15. Format of Evaluation Components:

Type of Assessment	Total Marks	Industry Certification	Hands-on Assessments	1 Mark MCQ	2 Marks	5 Marks	10 Marks
Formative Assessments	20	5	15	-	-	-	-
Sessional Tests	40	-	-	5	5	3	1
End Term Examination	60	-	-	5	5	5	2

16. Revision (if any):

Academic Year of Previous Version	2024-2025	Percentage of Revision	11%

Topics:

- Data collection, preprocessing and analysis techniques, concept of ensemble methods, bagging and boosting overview, Random Forest as an ensemble of decision trees. (Added)
- Naïve Bayes classifier, Bayesian inference, applications of Naïve Bayes in text classification and spam detection. (Added)
- Reinforcement learning concepts, agent, environment, state, action, reward, policy, exploration and exploitation, Markov Decision Process (MDP), basic reinforcement learning algorithms such as Q-learning and SARSA. (Added)
- Simple grid search, NLP, Speech recognition, Tools and frameworks: TensorFlow, Keras, PyTorch, Introduction to GPUs and hardware acceleration for deep learning. (Deleted)

17. This Document

Designation	Name	Signature
Prepared by Course Coordinator	Dr. Ramamani Tripathy	RTripathy
Verified by Assistant Dean	Dr. Hakam Singh	Hsingh
Date	12/01/2026	

Annexure-I

Sr. No	Topics
1	Flipped classroom

Description: The following topics will be delivered using the flipped classroom pedagogy to encourage active learning and engagement.

- Calculation of classification evaluation metrics: Accuracy, Precision, Recall, F1-Score using confusion matrix values.
- Computation of entropy, information gain, and Gini index for decision tree splits.
- Compute Euclidean distances for test points and predict class labels for different values of k (K-NN algorithm)

Annexure-II

Sr. No	Topics
1	Practice Assignment

Description: Assignments will be given to students on various topics to enhance their understanding.
Topics: Logistic Regression, K-Nearest Neighbors (KNN), K-Means Clustering, Principal Component Analysis (PCA), dimensionality reduction, Multilayer perceptrons (MLP) for supervised learning tasks with a focus on numerical data analysis.