

Course Handout

Institute/School Name	Chitkara University Institute of Engineering & Technology		
Department Name	Department of Computer Science & Engineering		
Programme Name	Bachelor of Engineering-Computer Science & Engineering (Artificial Intelligence and Machine Learning)		
Course Name	Supervised and Unsupervised Learning	Session	Jan-June, 2026
Course Code	24CAI0203	Semester/Batch	4 th /2024
L-T-P (Per Week)	2-0-4	Course Credits	4
Pre-requisite	Knowledge of statistics, programming (preferably Python)	NHEQF Level	5
Course Coordinator	Dr. Harjeet Singh	SDG Number	4, 9

1. Objectives of the Course

The course *Supervised and Unsupervised Learning* aims to provide a strong foundation in the principles and techniques of machine learning. Students will learn to develop predictive models using supervised learning algorithms such as regression, classification, and ensemble methods, as well as uncover patterns and insights from unlabeled data using unsupervised learning techniques like clustering and dimensionality reduction. The course emphasizes both theoretical understanding and practical implementation, enabling students to preprocess data, select appropriate models, evaluate performance, and apply these methods to real-world problems. By the end of the course, students will be equipped to analyze datasets effectively, solve computational problems, and make informed decisions using machine learning approaches.

The main objectives of the course are to:

- Implement Supervised and Unsupervised Learning algorithms to make predictions.
- Use Regression and Classification algorithms for predicting continuous and discrete values.
- Learn best practices for real world data sets.
- Learn how to use sklearn library for pre-processing the data.
- Understand important concepts which helps to improve model.
- Understand the full product workflow for the machine learning lifecycle.

2. Course Learning Outcomes (CLOs)

On completion of the course, students should be able to:

Course Learning Outcomes	CLOs	Program Outcomes (PO)	NHEQF Level Descriptor	No. of Lectures
CLO1	Analyze fundamental machine learning concepts and tools to determine their practical application across diverse problem domains.	PO1, PO2, PO3, PO4, PO5, PO6	Q1, Q2	4
CLO2	Transform raw datasets into high-quality inputs for machine learning tasks through rigorous preprocessing, missing-value imputation, and feature optimization.	PO1, PO2, PO3, PO4, PO5, PO6	Q3, Q6	10

CLO3	Become proficient in using popular ML libraries and frameworks such as sklearn to build ML models.	PO1, PO2, PO3, PO4, PO5, PO6	Q2, Q3	16
CLO4	Evaluate machine learning model performance using standardized metrics and systematic hyperparameter tuning to ensure optimal model selection.	PO1, PO2, PO3, PO4, PO5, PO6	Q1, Q2	16
CLO5	Assess the societal impact of machine learning by identifying and mitigating issues related to algorithmic bias, privacy, and transparency.	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8, PO9	Q6	14
Total Contact Hours				60

CLO-PO-PSO Mapping grid |Program Outcomes (POs) and Program Specific Outcomes (PSO) are available as a part of Academic Program Guide

CLO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3	Type of Assessment
CLO01	H	M	L	M	L	L						M		M	Formative /Summative
CLO02	H	L	M	M	H	M							M	H	Formative /Summative
CLO03	H	L	L	M	H	M							H	M	Formative /Summative
CLO04	H	M	M	M	H	M						H			Formative /Summative
CLO05	H	H	M	M	M	H	L	H	M			H	L	H	Formative /Summative

*H=High,M=Medium,L=Low

3. Recommended Books:

- B01:** "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien (2nd edition)
- B02:** Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville (2nd edition)
- B03:** Introduction to Machine Learning" by Alpaydin (4th edition)
- B04:** The Elements of Statistical Learning" by Trevor Hastie, Robert Tibshirani (2nd edition)
- B05:** Pattern Classification" by Duda and Hart (2nd edition)

4. Other readings and relevant websites:

S. No.	Link of Journals, Magazines, websites and Research Papers
1	https://www.analyticsvidhya.com/machine-learning/
2	https://towardsdatascience.com/machine-learning/home
3	https://www.geeksforgeeks.org/machine-learning/
4	https://www.javatpoint.com/machine-learning
5	https://medium.com/@randylaosat/a-beginners-guide-to-machine-learning-dfadc19f6caf

5. Recommended Tools and Platforms

Anaconda, Jupyter Notebook, Pycharm, VSCode, Google Colab

6. Course Plan: Theory+Lab

a. Theory Plan

Lect. No.	Topics
1-3	Introduction to Machine Learning: Basic Terminology, Types of Machine Learning, Supervised, Unsupervised, and Semi-Supervised Learning.
4-7	Revision - Python, Numpy, Pandas, Matplotlib (Prerequisite)
8-9	Linear Regression - Linear Regression Ideal, Best Line, Concept, Best Line Metric, Best Line Math Metric
10-12	Linear Regression - Loss functions, Loss function minimize, Square Function, MSE/RMSE, Assumptions of Linear Regression
13-14	Introduction to Gradient Descent, Stochastic Gradient Descent, Mini Batch Gradient Descent.
15-17	Multiple Linear Regression, Polynomial Regression using case studies.
18-20	Classification - Evaluation Metric (Confusion metric, Precision, Recall, F1-Score), Loss function vs Cost Function.
21-24	Classification - Logistic Regression, Step function, Sigmoid function, Loss Function, Optimization technique for loss function
Sessional Test-1 (1-24 lectures)	
25-26	Feature Selection, Bias-Variance Trade offs, Regularization techniques
27-30	Augmentations, K-Fold Cross Validation, Grid Search Cv/Random Search
31-32	Classification and Regression with KNN.
33-36	KNN Complexity and Overfitting vs Underfitting.
37-38	Sklearn Documentation and cross_val_score
39-41	Imbalanced Dataset - Oversampling, Downsampling, Weighting classes
42-45	How to Handle Categorical and Missing Values in a dataset, Feature Importance, Collinearity, Hyper-parameter Tuning
46-47	Dimensionality Reduction - PCA, TSNE
48-50	Dimensionality Reduction - Applications and use case studies
Sessional Test-2 (25-50 lectures)	
51-54	PCA and SVD it's working, Eigen Values, Eigen vectors, Covariance matrix.
55-56	Unsupervised Learning Algorithm - K-Means Clustering, Elbow Method
56-60	Classification and Regression with KNN, SVM, Decision Trees, Random Forest
END-TERM EXAM (FULL SYLLABUS)	

b. Lab Plan:

Lab No.	Experiment
1	Study of Python programming and scientific libraries: NumPy, Pandas, and Matplotlib (Prerequisite)
2	Exploratory Data Analysis (EDA): data loading, cleaning, handling missing values, and visualization
3	Introduction to Machine Learning: basic terminology, types of Machine Learning, and ML workflow
4	Implementation of Simple Linear Regression and visualization of the best-fit line
5	Linear Regression evaluation: loss functions, MSE, RMSE, and assumptions of Linear Regression
6	Implementation and comparison of Gradient Descent, Stochastic Gradient Descent, and Mini-batch Gradient Descent
7	Implementation of Multiple Linear Regression using a real-world case study
8	Implementation of Polynomial Regression and analysis of overfitting and underfitting
9	Study and implementation of classification evaluation metrics: Confusion Matrix, Precision, Recall, and F1-Score
10	Implementation of Logistic Regression: sigmoid function, loss function, and optimization
11	Feature Selection techniques, Bias–Variance trade-off, and Regularization methods
12	Model validation using K-Fold Cross Validation and Hyperparameter Tuning (Grid Search / Random Search)
13	Implementation of K-Nearest Neighbors (KNN) for classification and regression
14	Analysis of KNN complexity and study of Overfitting vs Underfitting
15	Handling imbalanced datasets using Oversampling, Under sampling, and Class Weighting
16	Data preprocessing and feature engineering: categorical encoding, missing values, feature importance, and collinearity
17	Dimensionality Reduction techniques: PCA, t-SNE, and study of PCA using Eigenvalues, Eigenvectors, and SVD
18	Implementation of Unsupervised Learning and ensemble models: K-Means Clustering (Elbow Method), SVM, Decision Tree, and Random Forest
19	Microsoft Power BI Data Analyst (PL300): Preparation of data for analysis, Model data, Design Reports, Manage and Secure Power BI.
Lab Evaluation (1-18 Lab No.)	

7. Delivery/Instructional Resources**Plan (Theory +Lab):**

Lect. No.	Topics	CLO	Book & Chapter	TLM	ALM	PPT URL	Web Reference	Audio-Video Link
1-3	Introduction to Machine Learning: Basic Terminology, Types of Machine Learning, Supervise Learning, Unsupervised Learning, Semi-Supervised Learning.	CLO1	Book1 Ch1	Lecture	Discussion	https://www.slideshare.net/search/slideshow?searchfrom=header&q=introduction+to+machine+learning+ppt	https://www.salesforce.com/eu/blog/2020/06/real-world-examples-of-machine-learning.html	https://www.youtube.com/watch?v=jGwO_UgTS7I
4-7	Revision - Python, Numpy, Pandas, Matplotlib (Pre-requisite)	CLO1	Book2 Ch2	Lecture /Discussion, Lab	Hands-on	https://www.slideshare.net/search/slideshow?searchfrom=header&q=numpy+pandas+matplotlib+ppt	https://towardsdatascience.com/the-data-science-trilogy-numpy-pandas-and-matplotlib-basics-42192b89e26	https://www.youtube.com/watch?v=vmEH_CJofslg
8-9	Linear Regression - Linear Regression Ideal, Best Line, Concept, Best Line Metric, Best Line Math Metric	CLO2	Book1 Ch3	Lecture /Discussion	Numeric-al	https://www.slideshare.net/search/slideshow?searchfrom=header&q=linear+regression+ppt	https://www.analyticsvidhya.com/blog/2021/10/everything-you-need-to-know-about-linear-regression/	https://www.youtube.com/watch?v=ZkjP5RJLQF4
10-12	Linear Regression - Loss functions, Loss function minimize, Square Function, MSE/RMSE, Assumptions of Linear Regression	CLO2	Book1 Ch3	Lecture /Discussion	Problems	https://www.slideshare.net/search/slideshow?searchfrom=header&q=loss+functions+machine+learning+ppt	https://towardsdatascience.com/evaluation-metrics-model-selection-in-linear-regression-73c7573208be	https://www.youtube.com/watch?v=HBi-P5j0Kec
13-14	Introduction to Gradient Descent, Stochastic Gradient Descent, Mini Batch Gradient Descent.	CLO2	Book1 Ch4	Lecture /Discussion	Tracing	https://www.slideshare.net/search/slideshow?searchfrom=header&q=gradient-descent-in-machine-learning	https://www.vatpoint.com/gradient-descent-in-machine-learning	https://www.youtube.com/watch?v=IHZWFWHwa-w

						ppt		
15-17	Classification - Logistic Regression, Step function, Sigmoid function, Loss Function, Optimization technique for loss function	CLO3	Book1 Ch5	Lecture /Discussion	Case Study	https://www.slideshare.net/search/slideshow?searchfrom=header&q=logistic+regression+ppt	https://www.javatpoint.com/logistic-regression-in-machine-learning	https://www.youtube.com/watch?v=yIYKR4sgzI8
18-20	Classification - Evaluation Metric (Confusion metric, Precision, Recall, F1-Score), Loss function vs Cost Function.	CLO3	Book1 Ch6	Lecture /Discussion	Dataset	https://www.slideshare.net/search/slideshow?searchfrom=header&q=confusion+matrix+ppt	https://medium.com/@nandinisekar27/logistic-regression-overview-and-its-error-metrics-8b54512ca39f	https://www.youtube.com/watch?v=Kdsp6soqA7o
21-24	Multiple Linear Regression, Polynomial Regression using case studies.	CLO2	Book1 Ch7	Lecture /Discussion	Analysis	https://www.slideshare.net/search/slideshow?searchfrom=header&q=polynomial+regression+ppt	https://towardsdatascience.com/polynomial-regression-bbe8b9d97491	https://www.youtube.com/watch?v=QptIvDle8Y
25-26	Feature Selection, Bias-Variance Trade offs, Regularization techniques	CLO4	Book1 Ch8	Lecture /Discussion	Comparison	https://www.slideshare.net/search/slideshow?searchfrom=header&q=bias+variance+tradeoff+ppt	https://towardsdatascience.com/regularization-on-the-path-to-bias-variance-trade-off-b7a7088b4577	https://www.youtube.com/watch?v=EuBBz3bI-aA
27-30	Augmentations, K-Fold Cross Validation, Grid Search CV/Random Search	CLO4	Book2 Ch6	Lecture /Discussion	Demo	https://www.slideshare.net/search/slideshow?searchfrom=header&q=k-fold+cross+validation+ppt	https://scikit-learn.org/stable/modules/cross_validation.html	https://www.youtube.com/watch?v=fSytzGwwBVw
31-32	Classification and Regression with KNN.	CLO3	Book1 Ch9	Lecture /Discussion	Visualization	https://www.slideshare.net/search/slideshow?searchfrom=header&q=knn+algorithm+ppt	https://www.javatpoint.com/k-nearest-neighbor-algorithm-for-machine-learning	https://www.youtube.com/watch?v=HVXiime0nQeI

						pt	learning	
33-36	KNN Complexity and Overfitting vs Underfitting.	CLO4	Book1 Ch9	Lecture /Discussion	Graphs	https://www.slideshare.net/search/slideshow?searchfrom=header&q=overfitting+underfitting+ppt	https://www.geeksforgeeks.org/underfitting-and-overfitting-in-machine-learning/	https://www.youtube.com/watch?v=Gx0dV2fCh6M
37-38	Sklearn Documentation and cross_val_score	CLO4	Book2 Ch7	Live Demo	Exploration	https://www.slideshare.net/search/slideshow?searchfrom=header&q=scikit+learn+ppt	https://scikit-learn.org/stable/	https://www.youtube.com/watch?v=0Lt9w-BxKFQ
39-41	Imbalanced Dataset - Oversampling, Down sampling, Weighting classes	CLO5	Book1 Ch10	Lecture /Discussion	Case	https://www.slideshare.net/search/slideshow?searchfrom=header&q=imbalanced+dataset+ppt	https://machelearningmaster.com/random-oversampling-and-undersampling-for-imbalanced-classification/	https://www.youtube.com/watch?v=1KjwOY7XvRk
42-45	How to Handle Categorical and Missing Values in a dataset, Feature Importance, Collinearity, Hyper-parameter Tuning	CLO4	Book2 Ch8	Discussion	Dataset	https://www.slideshare.net/search/slideshow?searchfrom=header&q=feature+engineering+ppt	https://towardsdatascience.com/supervised-machine-learning-feature-engineering-and-hyper-parameter-tuning-a3da583dd7b9	https://www.youtube.com/watch?v=Z_j1Xw2fCkQ
46-47	Dimensionality Reduction - PCA, TSNE	CLO5	Book1 Ch11	Lecture	Visualization	https://www.slideshare.net/search/slideshow?searchfrom=header&q=pca+tsne+ppt	https://www.geeksforgeeks.org/difference-between-pca-vs-t-sne/	https://www.youtube.com/watch?v=FgakZW6K1QQ

48-50	Dimensionality Reduction - Applications and use case studies	CLO5	Book1 Ch11	Lecture /Discussion	Case	https://www.slideshare.net/search/slideshow?searchfrom=header&q=applications+of+PCA+ppt	https://www.geeksforgeeks.org/dimensionality-reduction/	https://www.youtube.com/watch?v=HMOI_lkzW08
51-54	PCA and SVD it's working, Eigen Values, Eigen vectors, Covariance matrix.	CLO5	Book1 Ch12	Lecture	Derivation	https://www.slideshare.net/search/slideshow?searchfrom=header&q=pca+svd+ppt	https://medium.com/@notsokarada/pca-vs-svd-simplified-32c5c753998	https://www.youtube.com/watch?v=HfY8p-g1yqo
55-56	Unsupervised Learning Algorithm - K-Means Clustering, Elbow Method	CLO5	Book1 Ch13	Lecture /Discussion	Clusters	https://www.slideshare.net/search/slideshow?searchfrom=header&q=k+mmeans+clustering+ppt	https://www.analyticsvidhya.com/blog/2019/08/comprehensive-guide-k-means-clustering/	https://www.youtube.com/watch?v=EItIU_EPClzM
56-60	Classification and Regression with KNN, SVM, Decision Trees, Random Forest	CLO6	Book1 Ch14	Lecture /Discussion	Comparison	https://www.slideshare.net/search/slideshow?searchfrom=header&q=svm+random+forest+ppt	https://www.analyticsvidhya.com/blog/2021/06/understanding-random-forest/	https://www.youtube.com/watch?v=yN7ypxC7838

8. Remedial Classes

After every Sessional Test, different types of learners will be identified, and special discussions will be planned and scheduled accordingly for the slow learners.

9. Self-Learning

Assignments to promote self-learning, survey of contents from multiple sources.

S. No.	Topics	CLO	ALM	References/MOOCS
1	Machine Learning Fundamentals: Types of Learning, Linear & Logistic Regression, Evaluation Metrics	CLO01, CLO02, CLO03	Think–Pair–Share	https://www.coursera.org/learn/machine-learning https://developers.google.com/machine-learning/crash-course
2	Model Evaluation, Feature Selection, Cross Validation, and Hyper-parameter Tuning using Scikit-learn	CLO03, CLO04, CLO05	Problem-based Learning	https://scikit-learn.org/stable/tutorial/index.html https://www.kaggle.com/learn/intro-to-machine-learning

10. Delivery Details of Content Beyond Syllabus

Any content delivered beyond the syllabus will be planned for all students, and the schedule will be notified accordingly.

S. No.	Advanced Topics, Additional Reading, Research papers and any	CLO	POs	ALM	References/MOOCs
1	Advanced Regression Techniques: Ridge, Lasso, Elastic Net and Model Interpretability	CLO01, CLO02, CLO05	PO1, PO2, PO3, PO4, PO7, PO11	Think–Pair–Share	https://scikit-learn.org/stable/modules/linear_model.html https://machinelearningmastery.com/elastic-net-regression-in-python/
2	Advanced Classification & Ensemble Learning: SVM, Decision Trees, Random Forest, Boosting	CLO01, CLO03, CLO05	PO1, PO2, PO3, PO5, PO7, PO11	Think–Pair–Share	https://scikit-learn.org/stable/supervised_learning.html https://towardsdatascience.com/ensemble-learning-2c8a1f9e9c3e
3	Dimensionality Reduction for Large-Scale Data: Advanced PCA, Kernel PCA, Autoencoders (Intro)	CLO04, CLO05	PO1, PO2, PO3, PO4, PO7, PO11	Case-based Learning	https://scikit-learn.org/stable/modules/decomposition.html https://www.coursera.org/learn/deep-neural-networks

11. Evaluation Scheme & Components:

Assessment Type	Evaluation Component	Type of Component	No. of Assessments	% Weightage of Component	Max. Marks	Mode of Assessment	CLO
Certification Exam	Component 1	Certification	01	20%	20	Computer Based Test	CLO01, CLO02, CLO03, CLO04, CLO05
Summative	Component2	Sessional Tests (STs)	02*	30%	20	Computer Based Test	CLO01, CLO02, CLO03, CLO04, CLO05
Summative	Component 3	End Term Examination	01**	50%	50	Computer Based Test	CLO01, CLO02, CLO03, CLO04, CLO05
Total			100%				

*Average of the 02 STs will be considered for the evaluation of the STs as final marks.

**To be eligible to appear for the End Term Exam, attendance must be at least 75%.

12. Syllabus of the Course:

Subject: Supervised and Unsupervised Learning			Subject Code:	
S. No.	Topic (s)		No. of	Weightage
1-3	Introduction to Machine Learning: Basic Terminology, Types of Machine		3	10%
4-10	Revision - Python, Numpy, Pandas, Matplotlib (Pre-requisite)		7	5%
11-20	Linear Regression - Loss functions, Loss function minimize, Square Function, MSE/RMSE, Assumptions of Linear Regression,		10	20%
21-30	Multiple Linear Regression, Polynomial Regression using case studies. Feature		10	20%

31-43	Classification and Regression with KNN. KNN Complexity and Over fitting vs Under fitting.	13	20%
44-54	How to Handle Categorical and missing values in a dataset, Feature Importance, Collinearity, Hyper-parameter Tuning,	11	20%
55-60	Unsupervised Learning Algorithm - K-Means Clustering, Elbow Method, Classification and Regression with KNN, SVM, Decision Trees, Random Forest	6	5%

13. Academic Integrity Policy:

Education at Chitkara University builds on the principle that excellence requires freedom where Honesty and integrity are its prerequisites. Academic honesty in the advancement of knowledge requires that all students and Faculty respect the integrity of one another's work and recognize the importance of acknowledging and safeguarding intellectual property. Any breach of the same will be tantamount to severe academic penalties.

This Document is approved by:

Designation	Name	Signature
Course Coordinator	Dr. Harjeet Singh	
Asso. Dean (CSE-AI)	Dr. Vikas Solanki	
Pro-VC (CSE)	Dr. Meenu Khurana	
Date (DD/MM/YYYY)	14/01/2026	