BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
WORK INTEGRATED LEARNING PROGRAMMES
Digital Learning

Part A: Content Design

Course Title	**Applied Machine Learning**
Course No(s)	**SE ZG568 / SS ZG568**
Credit Units	**4**
Course Authors	**Sugata Ghosal**
Version No	**1.0**
Date	**Jan 05, 2021**

Course Objectives

Machine learning is a rapidly growing field at the intersection of computer science and statistics. It is responsible for tremendous advances in technology, from personalized product recommendations to speech recognition in cell phones. The goal of this course is to provide a broad introduction to the key ideas in machine learning. The emphasis will be on intuition and realistic examples rather than theoretical results, though experience with statistics, calculus and linear algebra will be assumed. Through a variety of lecture examples and programming projects, students will learn how to apply powerful machine learning techniques to realistic problems, run evaluations and interpret results, and understand limitations.

No	Course Objective
CO1	Provide a broad background to the key concepts and techniques in machine learning
CO2	Hands on learning to apply contemporary machine learning techniques on realistic problems
CO3	Evaluation and interpretation of results
CO4	Understand limitations of different machine learning techniques
CO5	Gain experience in working with machine learning software pipeline

Text Book(s)

T1	Aurelien Geron, “Hands-On Machine Learning with Scikit-Learn, Keras and Tensorflow”, O’Reilly, 2020
T2	P-N Tan, M. Steinbach, Vipin Kumar, “Introduction to Data Mining”, 2016, Pearson

Reference Book(s) & other resources

R1	Christoph Molner, “Interpretable Machine Learning”, 2020, https://christophm.github.io/interpretable-ml-book/
R2	Pedro Domingos, “A Few Useful Things to Know About Machine Learning”, pp. 78-87, Communications of the ACM, vol. 55 no. 10, October 2012.

Modular Content Structure

No	Title of the Module	References
M1	Introduction to Machine Learning 1.1. What and Why 1.2. Applications of Machine Learning 1.3. Types of Machine Learning 1.4. Challenges in Machine Learning	T1: Chapter 1 R2
M2	Big Picture: End-to-end Machine Learning 2.1. Framing the ML Problem 2.2. Data Types, Pre-processing, Visualization and Analysis	T1: Chapter 2 T2: Chapter 2-3
M3	Big Picture: End-to-end Machine Learning 3.1 Model Selection and Training 3.1.1. Prediction Problem 3.1.2. Classification Problem 3.2 Evaluation 3.2.1. Prediction Problem 3.2.2. Classification Problem 3.3 Machine Learning Pipeline	T1: Chapter 2-3 T2: Chapter 4
M4	Linear Prediction Models 4.1. Linear Regression 4.2. Gradient Descent and Variants 4.3. Regularization 4.4. Bias Vs. Variance	T1: Chapter 4 T2: Appendix D
M5	Classification Models I 5.1. Naïve Bayes 5.2. Logistic Regression 5.3. Support Vector Machines 5.4. Comparative Analysis	T1: Chapter 4, 5 T2: Chapter 5
M6	Classification Models II 6.1. Decision Tree 6.2. Challenges with Decision tree 6.3. Ensembles 6.2.1. Bagging 6.2.2. Boosting 6.4. Random Forest	T1: Chapter 6-7 T2: Chapter 4, 5
M7	Unsupervised Learning 7.1. Dimensionality reduction 7.2 K-means Clustering 7.4 Gaussian Mixture Model	T1: Chapter 8-9 T2: Chapter 8-9
M8	Neural Networks 8.1. Perceptrons and Delta Rule 8.2. Multi-Layer Perceptrons and Backpropagation 8.3. Deep Learning	T1: Chapter 10-11 T2: Chapter 5
M9	Deep Networks 9.1. Convolutional Neural Network 9.2. Recurrent Neural Network 9.3. Applications in Image and Text Processing	T1: Chapter 14, 15

M10	FAccT Machine Learning 10.1. Bias and Fairness 10.2. Interpretability and Transparency	R1

Learning Outcomes:

No	Learning Outcomes
LO1	High-level conceptual understanding of machine learning field and its applicability and limitations
LO2	Ability to frame a machine learning problem and select candidate machine learning models
LO3	Ability to design and implement an end-to-end machine learning based solution using Python and appropriate libraries and do trouble shooting
LO4	Ability to evaluate and interpret the results from a machine learning system

Part B: Learning Plan

Academic Term	Second Semester 2024-2025
Course Title	Applied Machine Learning
Course No	SE ZG568 / SS ZG568
Lead Instructor	HARIKRISHNAN N B

Session No.	Topic Title	Study / HW Resource Reference
1	Introduction to Machine Learning: What and Why, Applications of Machine Learning, Types of Machine Learning, Challenges in Machine Learning	T1: Chapter 1 R2
2	End-to-end Machine Learning: Framing the ML Problem. Data Types, Pre-processing, Visualization and Analysis	T1: Chapter 2 T2: Chapter 2-3
3	End-to-end Machine Learning: Model Selection and Training for Prediction and Classification, Evaluation, Machine Learning Pipeline.	T1: Chapter 2-3 T2: Chapter 2-3
4	Linear Prediction Models: Linear Regression, Gradient Descent and Variants, Regularization, Bias Vs. Variance	T1: Chapter 4
5	Classification Models I: Naïve Bayes classification, Applications in text and image classification	T2: Chapter 5

6	Classification Models I: Logistic Regression, Log Loss error function, Optimization using gradient descent, Feature transformation for nonlinear classification	T1: Chapter 4
7	Classification Models I: Support Vector Machine. Margin maximization. Non-linear SVM. Kernel Function.	T1: Chapter 5 T2: Chapter 5
8	Review of Session 1 to 7	
9	Classification Models II: Decision Tree. Entropy and information gain. Construction algorithm. Challenges with Decision Tree	T1: Chapter 6 T2: Chapter 4
10	Classification Models II: Ensembles techniques. Bagging, boosting, Random Forest	T1: Chapter 7 T2: Chapter 5
11	Unsupervised Machine Learning: Dimensionality reduction and feature extraction, K-means clustering, Gaussian Mixture Model	T1: Chapter 8-9 T2: Chapter 8
12	Artificial Neural Networks: Perceptions, Delta rule, Design for Boolean logic gates and linear classification, Neural networks, Design for nonlinear classification and Boolean functions, Backpropagation algorithm	T1: Chapter 10 T2: Chapter 5
13.	Artificial Neural Networks: Deep Learning, Characteristics, Error Surface, hyperparameters, Regularization, Weight Updates.	T1: Chapter 11
14.	Deep Networks: Convolutional Neural Networks, The Convolution Operation, Pooling, padding, architectures for classification. Recurrent Neural Networks, Architecture, training, bidirectional network, long short-term memory, deep recurrent network. Sequence processing.	T1: Chapter 14-15
15	FAccT Machine Learning. Bias and Fairness, Interpretability and Transparency	R1, Slides
16	Review of session 9 to 15	Books, Slides, Web references

Detailed Plan for Lab work/Design work

Lab No	Lab Objective	Lab Sheet/Capsule Access URL	Content Reference
1	End-to-end ML pipeline for prediction		Module 2
2	End-to-end ML pipeline for classification		Module 3
3	Linear Regression		Module 4
4	Linear Classifiers (Naïve Bayes, Logistic Regression)		Module 5
5	Decision Tree and Random Forest		Module 6
6	Multilayer Perceptrons		Module 8
7	CNN		Module 9
8	RNN		Module 9

Evaluation Scheme:
Legend: EC = Evaluation Component; AN = After Noon Session; FN = Fore Noon Session

No	Name	Type	Duration	Weight	Day, Date, Session, Time
EC-1	Quiz-I	Online	-	5%	February 17-27, 2025
	Programming Assignment I	Offline	-	12%	April 1-10, 2025
	Programming Assignment II	Offline	-	13%	May 1-10, 2025
EC-2	Mid-Semester Test	Closed Book	1.5 hours	30%	22/03/2025 (AN)
EC-3	Comprehensive Exam	Open Book	2.5 hours	40%	24/05/2025 (AN)

Important Information:

Syllabus for Mid-Semester Test (Closed Book): Topics in CS 1-8.
Syllabus for Comprehensive Exam (Open Book): All topics given in plan of study

Evaluation Guidelines:

1. For Closed Book tests: No books or reference material of any kind will be permitted. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
2. For Open Book exams: Use of prescribed and reference text books, in original (not photocopies) is permitted. Class notes/slides as reference material in filed or bound form is permitted. However, loose sheets of paper will not be allowed. Use of calculators is permitted in all exams. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
3. If a student is unable to appear for the Regular Test/Exam due to genuine exigencies, the

student should follow the procedure to apply for the Make-Up Test/Exam. The genuineness of the reason for absence in the Regular Exam shall be assessed prior to giving permission to appear for the Make-up Exam. Make-Up Test/Exam will be conducted only at selected exam centres on the dates to be announced later.

It shall be the responsibility of the individual student to be regular in maintaining the self-study schedule as given in the course handout, attend the lectures, and take all the prescribed evaluation components such as Assignment/Quiz, Mid-Semester Test and Comprehensive Exam according to the evaluation scheme provided in the handout.