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

COURSE HANDOUT

Part A: Content Design

Course Title	Machine Learning
Course No(s)	IS ZC464
Credit Units	3
Course Author	VANDANA AGGARWAL
Version No	

Course Objectives

No	Objective
CO1	Machine Learning is an exciting sub-area of Artificial Intelligence which deals with designing machine which can learn and improve their performance from examples/experience. This course introduces the student to the key algorithms and theory that forms the core of machine learning.
CO2	The course will cover the major approaches to learning namely, supervised, and unsupervised.
CO3	The course emphasizes various techniques, which have become feasible with increased computational power. The topics covered in the course include Regression, Decision Trees, Support Vector Machines, Artificial Neural Networks, Bayesian Learning, Genetic Algorithms etc.

Text Book(s)

T1	Tom M. Mitchell, Machine Learning, The McGraw-Hill Companies, Inc. International Edition 1997 **(http://personal.disco.unimib.it/Vanneschi/McGrawHill_-_Machine_Learning_-Tom_Mitchell.pdf)**
T2	Christopher M. Bhisop, Pattern Recognition & Machine Learning, Springer, 2006 **(http://www.rmki.kfki.hu/~banmi/elte/Bishop%20-%20Pattern%20Recognition%20and%20Machine%20Learning.pdf)**

Reference Book(s) & other resources

R1	CHRISTOPHER J.C. BURGES: A Tutorial on Support Vector Machines for Pattern Recognition, Kluwer Academic Publishers, Boston, pp. 1–43.
R2	K. Sastry, D. Goldberg, G. Kendall: Genetic Algorithms.
R3	http://elakiyaelamaran.weebly.com/uploads/2/1/9/2/21924368/genetic_algorithms_in_search_optimization_and_machine_learning.pdf
R4	Julie Main, Tharam Dillon and Simon Shiu: **A Tutorial on Case-Based Reasoning**

Content Structure

1. Introduction
   - 1.1. Objective of the course
   - 1.2. Design a Learning System
   - 1.3. Issues in Machine Learning

2. Mathematical Preliminaries
   - 2.1. Probability theory
   - 2.2. Decision Theory
   - 2.3. Information Theory

3. Bayesian Learning
   - 3.1. MAP Hypothesis
   - 3.2. Minimum Description Length (MDL) principle
   - 3.3. Expectation Maximization (EM) Algorithm
   - 3.4. Bias-variance decomposition

4. Linear models for Regression
   - 4.1. Linear basis function models
   - 4.2. Bayesian linear regression

5. Linear models for classification
   - 5.1. Discriminant Functions
   - 5.2. Probabilistic Generative Classifiers
   - 5.3. Probabilistic Discriminative Classifiers

6. Bayesian Learning Techniques
   - 6.1. Bayes optimal classifier
   - 6.2. Gibbs Algorithm
   - 6.3. Naïve Bayes Classifier

7. Non-linear Models & Model Selection
   - 7.1. Decision Trees
   - 7.2. Neural Networks

8. Instance-based Learning - I
   - 8.1. k-Nearest Neighbor Learning
   - 8.2. Locally Weighted Regression (LWR) Learning

9. Instance-based Learning - II
   9.1. Case-based Reasoning (CBR) Learning

10. Support Vector Machine - I
   10.1. Theory of SVM
   10.2. VC dimension
   10.3. Linearly separable data

11. Support Vector Machine - II
   11.1. Non-linearly separable data

12. Genetic Algorithms - I
   12.1. Properties
   12.2. Solving a problem
   12.3. Operator Selection Methods
   12.4. Basic Genetic Algorithm Operators

13. Genetic Algorithms - II
   13.1. Representing Hypotheses
   13.2. GABIL
   13.3. Hypothesis Search Space
   13.4. Population Evolution
   13.5. Schema theorem

14. Unsupervised Learning
   14.1. Mixture Models
   14.2. K-means Clustering

Learning Outcomes:

No	Learning Outcomes
LO1	Study and analysis of Machine Learning algorithms
LO2	Study of theory of mathematics usable in Machine Learning
LO3	Study and analysis of Supervised learning techniques
LO4	Study and analysis of Unsupervised learning techniques
LO5	Study and analysis of some applications of Machine Learning

Part B: Contact Session Plan

Academic Term	Second Semester 2018-2019
Course Title	Machine Learning

Course No	IS ZC464
Lead Instructor	VANDANA AGGARWAL

Course Contents

Contact Sessions(#)	List of Topic Title (from content structure in Course Handout)	Text/Ref Book/external resource
1	**Introduction** Objective, What is Machine Learning? Application areas of Machine Learning, Why Machine Learning is important? Design a Learning System, Issues in Machine Learning	T1 – Ch1
2	**Mathematical Preliminaries** Probability theory, Bay's Theory, Probability Densities, Gaussian Distribution, Decision Theory, Minimum Misclassification Rate, Information Theory, Measure of Information, Entropy	T2 – Ch2
3	**Bayesian Learning** MAP Hypothesis, Minimum Description Length (MDL) principle, Expectation Maximization (EM) Algorithm, Bias-variance decomposition	T1 - Ch. 6
4	**Linear models for Regression** Linear basis function models, Bayesian linear regression	T2 - Ch. 3
5	**Linear models for classification** Discriminant Functions, Probabilistic Generative Classifiers, Probabilistic Discriminative Classifiers	T2 - Ch. 4
6	**Bayesian Learning Techniques** Bayes optimal classifier, Gibbs Algorithm, Naïve Bayes Classifier	T1 - Ch. 6
7	**Non-linear Models & Model Selection** Decision Trees, Neural Networks	T1 - Ch. 3 T1 - Ch. 4 T2 - Ch. 5
8	Review of Session 1 to 7	Books, Web references and Slides
9	**Instance-based Learning - I** *K*-NN, Case-based Reasoning	T1 - Ch. 8 R4
10	**Instance-based Learning - II** *K*-NN, Case-based Reasoning	T1 - Ch. 8 R4
11	**Support Vector Machine -I** Linearly separable data	R1
12	**Support Vector Machine - II**	R1

	Non-linearly separable data	
13	**Genetic Algorithms - I** Example, properties, How to solve a problem?, Operator Selection Methods, Basic Genetic Algorithm Operators	R2 & R3
14	**Genetic Algorithms - II** Representing Hypotheses, GABIL, Hypothesis Search Space, Population Evolution, Schema theorem	R2 & R3
15	**Unsupervised Learning** Mixture Models, K-means Clustering	T1 - Ch. 6 T2 - Ch. 9
16	Review of Session 9 to 15	Books, Web references and Slides

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/ Assignment-I	Online	-	5%	February 14 to 28, 2019
	Quiz-II	Online	-	5%	March 14 to 28, 2019
	Assignment	Online	-	10%	April 14 to 28, 2019
EC-2	Mid-Semester Test	Closed Book	2 hours	30%	10/03/2019 (FN) 10 AM – 12 Noon
EC-3	Comprehensive Exam	Open Book	3 hours	50%	05/05/2019 (FN) 9 AM – 12 Noon

Note *- Evaluation components can be tailored depending on the proposed model.*

Important Information
Syllabus for Mid-Semester Test (Closed Book): Topics in Weeks 1-7
Syllabus for Comprehensive Exam (Open Book): All topics given in plan of study

Evaluation Guidelines:

1. EC-1 consists of either two Assignments or three Quizzes. Announcements regarding the same will be made in a timely manner.
2. 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.
3. 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.
4. 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.