Course Handout

1	**Course details**	
	Faculty name	Mr. Pratyush Kumar Deka
	Programme	B.Tech CSE
	Semester	V
	Section	CSE Elec Sec7
	Course code	BCSE3066
	Course title	Machine Learning
2	**Vision of School of Computing Science and Engineering**	
	To be known globally as a premier department of Computer Science and Engineering for value-based education, multidisciplinary research and innovation.	
3	**Mission of School of Computing Science and Engineering**	
	MD1:	Create a strong foundation on the fundamentals of Computer Science and Engineering through Outcome Based Teaching -Learning Process.
	MD2:	Establish state-of-the-art facilities for Analysis, Design and Implementation to develop sustainable ethical solutions
	MD3:	Conduct multidisciplinary research for developing innovative solutions
	MD4:	Involve the students in group activity including that of professional bodies to develop leadership and communication skills
4	**Programme educational objectives(PEOs)**	
	PEO1	Graduates of Computer Science and Engineering will be globally competent and provide sustainable solutions for interdisciplinary problems as team players.
	PEO2	Graduates of Computer Science and Engineering will engage in professional activities with ethical practices in the field of Computer Science and Engineering to enhance their own stature to contribute towards society.
	PEO3	Graduates of Computer Science and Engineering will acquire specialized knowledge in engineering technologies for research, innovation and product development.
5	**Programme outcomes**	
	PO1	**Engineering Knowledge**: Apply knowledge of mathematics and science, with fundamentals of Computer Science & Engineering to be able to solve complex engineering problems related to CSE.
	PO2	**Problem Analysis**: Identify, Formulate, review research literature and analyze complex engineering problems related to CSE and reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
	PO3	**Design/Development of solutions**: Design solutions for complex engineering problems related to CSE 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.
	PO4	**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.
	PO5	**Modern Tool Usage**: Create, Select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to computer science related complex engineering activities with an understanding of the limitations.
	PO6	**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 CSE professional Engineering practice.
	PO7	**Environment and Sustainability**: Understand the impact of the CSE professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development
	PO8	**Ethics**: Apply Ethical Principles and commit to professional ethics and responsibilities and norms of the engineering practice
	PO9	**Individual and Team Work**: 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 able to comprehend and with 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 management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.
	PO12	**Life-Long Learning**: Recognize the need for and have the preparation and ability to engage in independent and life-long learning the broadest context of technological change.
6	**Programme specifics outcome(PSO) (if any)**	
	PSO1	Able to analyse, design and implement sustainable and ethical solutions in the field of computer science.
	PSO2	Able to use problem solving skills to develop efficient algorithmic solutions.
7	Course outcomes (COs)	
	CO1	Understand basic concepts and applications of Machine Learning Algorithms
	CO2	Apply supervised learning algorithms in different domains.
	CO3	Apply unsupervised learning algorithms in different domains.
	CO4	Understand the basic concepts of Neural Networks and its applications in Deep Learning.

	CO5	Understand the recommendation systems and reinforcement learning algorithms and its applications.				
8	Evaluation Component	Duration	Marks (50)	Date &Time	Nature of Component	Evaluation Component
	CAT-1	90 mins	50 (15)		Closed Book	
	CAT-2	90 mins	50 (15)		Closed Book	
	Quiz-1	15 mins	5		LMS/Closed Book	
	Quiz-2	15 mins	5		LMS/Closed Book	
	Quiz-3	15mins	5		Closed Book	
	Assignment(s)			Any time throughout the semester	-	
9	List of teaching-learning pedagogy: chalk/talk, PowerPoint presentation, flipped classes, videos, demonstration					
10	Open Hours: Thursday 01:00 PM to 03:00PM					
11	Link address for course materials https://gu.mastersofterp.in/rfcampusgu					
12	Recommended list of e-books. 1. Ng A. CS229 Lecture notes. 2000;1(1):1-3.					
13	Recommended list of online courses like SWAYYAM/NPTEL/MOOCS: 1. Machine Leaning by Andrew Ng (Coursera). 2. Data Analysis using Python by IBM (Coursera). 3. INTRODUCTION TO MACHINE LEARNING by Balaraman Ravindran (swayam)					
14	Recommended list of mini projects / projects/ technical training etc. 1. House price prediction. 2. CAR-Selling price prediction.					
15	Students' Presentation					
16	List of e-books 1. Müller, A.C. and Guido, S., 2016. Introduction to machine learning with Python: a guide for data scientists. " O'Reilly Media, Inc.". 2. Stanford Machine Learning http://www.holehouse.org/mlclass/ 3. Master Machine Learning Algorithms https://machinelearningmastery.com/master-machine-learning-algorithms/					
17	List of NPTEL/MOOCS/SWAYAM/Courses/Video 1. INTRODUCTION TO MACHINE LEARNING by Balaraman Ravindran (swayam). 2. MACHINE LEARNING, ML by Carl Gustaf Jansson (swayam).					

18	Content beyond Syllabus 1. Data Preprocessing using Python package. 2. Implementation of Learning algorithms in Python
19	List of mini projects/projects: 1. SPAM Classification 2. Credit-Card Fraud Detection 3. CHATBOT Etc.

Lesson Plan

Lecture No.	Date	Learning Objectives	Topics to be covered	Teaching Pedagogy	Course Module	Total Lectures	Reference
1	06 Aug 2019	Understand basic concepts and applications of Machine Learning Algorithms.	Introduction of Machine Learning.	Black Board/ Interaction	1	6	T1, R1, R2
2	07 Aug		Types of Machine Learning and Applications of ML	Black Board/ Interaction			
3	09 Aug		Understanding of Datasets: Feature selection, Preprocessing of data	Black Board/ Interaction			
4	13 Aug		Basics Mathematics: Matrix Operations	Flipped Class			
5	14 Aug		Differential Equation, Gradient Descent.	Flipped Class			
6	16 Aug		Graphs: Linear and Non-linear, Contour graph, Sigmoid Function.	Flipped Class			
5	20 Aug	Apply supervised learning algorithms in	Decision Tree Classification	Black Board/ Interactio	2	11	T1, R1, R2, R4

		different domains.		n			
6	21 Aug		Decision TreeClassification	Black Board/ Problem Solving			
7	23 Aug		Regression: Linear Regression	Black Board/ Problem Solving			
8	27 Aug		Cost Function, Gradient Descent for Linear Regression	Black Board/ Interaction			
9	28 Aug		Linear Regression with Multiple variables: Multiple Features	BB/PPT			
10	30 Aug		Gradient Descent for multiple variables	Black Board/ Interaction			
11	03 Sep		Polynomial Regression,	Black Board/ Problem Solving			
12	04 Sep		Normal Equation. Overfitting and Underfitting	Black Board/ Interaction			
13	06 Sep		Naive Bayes Classifiers	Black Board/ Interaction			
14	10 Sep		k-Nearest Neighbor and Support Vector Machines	Black Board/			

				Interaction			
15				Black Board/ Interaction			
CAT –I							
16	11 Sep	Apply unsupervised learning algorithms in different domains.	Unsupervised learning	Black Board/ Group Discussion	3	10	T1, R1, R2
17	13 Sep		Clustering Algorithms	Black Board/ Interaction			
18	17 Sep		k-Means clustering,	Black Board/ Interaction			
19	18 Sep		k-Means clustering	Black Board/ Problem Solving			
20	20 Sep		Hierarchical Clustering	Black Board/ Interaction			
21	24 Sep		Hierarchical Clustering	Black Board/ Problem Solving			
22	25 Sep		Probabilistic Clustering	Black			

				Board/ Problem Solving			
23	27 Sep		Dimensionality Reduction	Black Board/ Interaction			
24	01 Oct		Feature Extraction	Black Board/ Interaction			
25	02 Oct		Manifold Learning	Black Board/ Interaction			
26	04 Oct	Understand the basic concepts of Neural Networks and Its applications in Deep Learning.	Neural Networks: Representation, Artificial Neural Networks(ANN)	Black Board/ Interaction	4	9	T1, R3
27	08 Oct		Deep Neural Network	Black Board/ Interaction			
28	09 Oct		Activation Function: Sigmoid Activation Function, tanh, ReLU and Leaky ReLU.	Black Board/ Problem Solving			
29	11 Oct		Distribution of data for improving accuracy. Bias and Variance.	Black Board/ Interaction			
30	15 Oct		Forward and Backward propagation.	Black Board/			

				Problem Solving			
32	16 Oct		Regularization for Neural Networks, Data Augmentation	Black Board/ Interaction			
33	18 Oct		Normalization of Datasets	Black Board/ Interaction			
34	22 Oct		Convolutional Neural Networks(CNN)	Flipped Class			
35	23 Oct		Recurrent Neural Networks(RNN), Sequence Models	Flipped Class			
CAT-II							
36	25 Oct	Understand the recommendation systems and reinforcement learning algorithms and its applications	Reinforcement learning, Positive Reinforcement, Negative Reinforcement and Applications	Flipped Class	5	4	T1, Internet Souces
37	29 Oct		Recommendation system: Content-based methods and Collaborative Filtering Methods	Flipped Class			
38	30 Oct		Case studies of Recommendation Systems	Case Study			
39	01 Nov		Case studies of Recommendation Systems	Case Study			

Course Description:
Machine learning uses interdisciplinary techniques such as statistics, linear algebra, optimization, and computer science to create automated systems that can sift through large volumes of data at high speed to make predictions or decisions without human intervention. Machine learning as a field is now incredibly pervasive, with applications spanning from business intelligence to homeland security, from analyzing biochemical interactions to structural monitoring of aging bridges, and from emissions to astrophysics, etc. This class will familiarize students with a broad cross-section of models and algorithms for machine learning and prepare students for research or industry application of machine learning techniques.

Scope & Objective:

The objective of this course is to make the students able to understand, compare and select appropriate machine learning algorithm for a given problem that would help the students to develop real life applications based on Machine Learning.

Course Objectives

The objective of this course is to:

1. Introduce students to machine learning and data science and its applications.
2. Develop the ability to understand, apply and implement different machine learning algorithms.
3. Introduce students to deep learning and Neural Networks concepts and its application.
4. Able to choose machine learning and deep learning algorithms to develop a particular application.

Course Outcomes

At the end of the course student will be able to:

1. Understand basic concepts and applications of Machine Learning Algorithms.
2. Apply supervised learning algorithms in different domains.
3. Apply unsupervised learning algorithms in defferent domains.
4. Understand the basic concepts of Neural Networks and Its applications in Deep Learning.
5. Understand the recommendation systems and reinforcement learning algorithms and its applications.

Text Books

1. Alpaydin, Ethem. Introduction to machine learning. MIT press, 2009.

Reference Books

1. R1: Müller AC, Guido S. Introduction to machine learning with Python: a guide for data scientists. " O'Reilly Media, Inc."; 2016 Sep 26.
2. R2: Ng A. CS229 Lecture notes. 2000;1(1):1-3.
3. R3: Goodfellow I, Bengio Y, Courville A, Bengio Y. Deep learning. Cambridge: MIT press; 2016 Nov 18.
4. R4: M.Gopal, Applied Machine Learning, TMH.

Course Content

Unit I: Introduction **6 lecture hours**

Introduction of Machine Learning. Types of Machine Learning: Supervised, Semi-supervised and Unsupervised Machine Learning. Applications of ML. Uderstanding of Datasets: Features selection, Traing and Test Datasets. Basics Mathematics: Matrix Operations, Differential Equation, Gradient Descent. Graphs: Linear and Non-linear, Contour graph, Sigmoid Function.

Module II: Supervised Learning Algorithms **11 lecture hours**

Classification: Logistics Classification, Decision trees, Naive Bayes Classifiers, k-Nearest Neighbor, Support Vector Machines. Regression: Linear Regression, Cost Function, Gradient Descent for Linear Regression, Linear Regression with Multiple variables: Multiple Features, Gradient Descent for multiple variables, Polynomial Regression, Normal Equation. Overfitting and Underfitting.

Module III: Unsupervised Learning Algorithms **10 lecture hours**

Unsupervised learning: Clustering Algorithms: k-Means clustering, Hierarchical Clustering, Probabilistic Clustering, Dimensionality Reduction, Feature Extraction and Manifold Learning.

Module IV: Neural Networks **9 lecture hours**

Neural Networks:Representation, Artificial Neural Networks(ANN), Deep Neural Network, Bias, Activation Function: Sigmoid Activation Function, tanh, ReLU and Leaky ReLU. Distribution of data for improving accuracy. Bias and Variance. Forward and Backward propogation. Regularization for Neural Networks, Data Augmentation. Normalization of Datasets. Convolutional Neural Networks(CNN). Recurrent Neural Networks(RNN), Sequence Models.

Module V: Reinforcement learning and Recommendation System **4 lecture hours**

Reinforcement learning: Positive Reinforcemen, Negative Reinforcement, Applications.
Reommendation system: Content-based methods and Collaborative Filtering Methods. Case studies of Recommendation Systems: Google Search, Amazon, Netflix, IMDb, YouTube and etc.