LESSON PLAN

NAME OF SUBJECT TEACHER: DEBANJAN KONAR

NAME OF SUBJECT: MACHINE LEARNING

DEPARTMENT: COMPUTER SCIENCE AND ENGINEERING

SEMESTER (SECTION): ELECTIVE VII

TOTAL NO. OF UNITS: 02

TOTAL NO. OF TOPICS: 08

HOURS ALLOTED PER WEEK: 03

MINIMUM HOURS ALLOTED FOR SEMESTER: 30

CREDITS: 03

SCHEDULE OF CLASSES

Sl . No.	Day	Period/Time
1.		
2.		
3.		

TOTAL WORKING DAYS:

TOTAL WORKING HOURS:

Subject In-charge **HOD/CSE**

PROGRAM OUTCOMES

Engineering Graduates 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 analyze 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 modeling 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 tothe 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 team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	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.
PO 11	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.
PO 12	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.

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Program Specific Outcomes (PSO)

PSO1	Students to have knowledge and expertise in at least one procedural and one object oriented programming language and should be able to analyze and compare algorithms.
PSO2	Students must have the ability to visualize and solve problems using appropriate structures and constraints adhering to existing Software Engineering standards.
PSO3	Students must be able to design and implement database solutions using current technologies.
PSO4	Students should be able to understand, troubleshoot and design computer networks, including distributed networks and wireless networks.
PSO5	Students should be aware of the design principles of Operating Systems specializing on at least one popular Operating System and System Programs. Students should have working knowledge on Advanced Computing techniques for Machine Learning and Computer Intelligence.
PSO6	Students will be able to keep pace with the technological advancement through exposure to recent and emerging trends of Computer Science ranging from Big Data, Cloud Computing, Data Analytics, Social networking, Mobile Robotics, Artificial Intelligence, Internet of Things (IoT), Augmented Reality etc.

COURSE OUTCOME OF CS1741 (MACHINE LEARNING)

On successful completion of this course, students will be able to

CO1	Display sufficient understanding of mathematical and engineering fundamentals in the perspective of machine learning theory.
CO2	Identify machine learning techniques suitable for a complex problem.
CO3	Awake the importance of tolerance of imprecision and uncertainty for design of robust and low-cost intelligent machines.
CO4	Investigate a problem to identify technical issues and solve the problems using various machine learning techniques.
CO5	Design real-life application using machine learning techniques.
CO6	Engineering application of machine learning techniques to solve real-life problems which directly or indirectly benefits to the society.

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PROGRAM INDICATOR (PI)

PI 1.2.1	Apply the knowledge of discrete structures, linear algebra, statistics and numerical techniques to solve problems.
PI 1.2.2	Apply the concepts of probability, statistics and queuing theory in modelling of computer-based system, data and machine learning models.
PI 2.5.1	Evaluate problem statements and identifies objectives.
PI 2.5.2	Identifies processes/modules/algorithms of a computer based system and parameters to solve a problem.
PI 3.5.1	Able to define a precise problem statement with objectives and scope.
PI 3.5.2	Able to identify and document system requirements from stake holders.
PI 3.5.3	Ability to review state of the art literature to synthesize system requirements.
PI 4.4.1	Define a problem for purposes of investigation, its scope and importance.
PI 4.4.2	Ability to choose appropriate procedure/algorithm, data set and test cases.
PI 5.4.1	Identify modern engineering tools, techniques and resources for engineering activities.
PI 5.4.2	Create/adapt/modify/extend tools and techniques to solve engineering problems.
PI 6.3.1	Identify and describe various engineering roles; particularly as pertains to protection of the public and public interest at global, regional and local level

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INTERNAL EXAMINATION DETAILS

Quiz I

	Performance Indicator			Course Outcome		Program Specific Outcome		Bloom's Taxonomy Levels				Program Outcome	
Quality Indicator	PI ( )	PI ( )	PI ( )	CO ( )	CO ( )	PSO ( )	PSO ( )	BL ( )	BL ( )	BL ( )	BL ( )	PO ( )	PO ( )
	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )
Attainment (%)													

Sessional I

	Performance Indicator					Course Outcome			Program Specific Outcome			Bloom's Taxonomy Levels				Program Outcome	
Quality Indicator	PI ( )	PI ( )	PI ( )	PI ( )	PI ( )	CO ( )	CO ( )	CO ( )	PSO ( )	PSO ( )	PSO ( )	BL ( )	BL ( )	BL ( )	BL ( )	PO ( )	PO ( )
	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )
Attainment (%)																	

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Quiz II

	Performance Indicator			Course Outcome		Program Specific Outcome		Bloom's Taxonomy Levels				Program Outcome	
Quality Indicator	PI ( )	PI ( )	PI ( )	CO ( )	CO ( )	PSO ( )	PSO ( )	BL ( )	BL ( )	BL ( )	BL ( )	PO ( )	PO ( )
	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )
Attainment (%)													

Sessional II

	Performance Indicator					Course Outcome			Program Specific Outcome			Bloom's Taxonomy Levels				Program Outcome	
Quality Indicator	PI ( )	PI ( )	PI ( )	PI ( )	PI ( )	CO ( )	CO ( )	CO ( )	PSO ( )	PSO ( )	PSO ( )	BL ( )	BL ( )	BL ( )	BL ( )	PO ( )	PO ( )
	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )	Marks ( )
Attainment (%)																	

BL – Bloom's Taxonomy Levels (1- Remembering, 2- Understanding, 3 – Applying, 4 – Analysing, 5 – Evaluating, 6 - Creating);

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SIKKIM MANIPAL INSTITUTE OF TECHNOLOGY
EVEN SEMESTER, 2020
LESSON PLAN

Subject Code : **CS1741**
Subject Name : **MACHINE LEARNING**
Teacher in-charge : **D. KONAR**

1. **Objective:**
   It reflects recent developments while providing a comprehensive introduction to the fields of pattern recognition and machine learning.

2. **Scope:**
   It is aimed at advanced undergraduates assuming no previous knowledge of pattern recognition or machine learning concepts.

3. **Text Books:**

(a) Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, ISBN-10: 0-387-31073-8 [T1]
(b) David J.C. Mackay, "Information Theory, Inference and Learning Algorithms", Cambridge University Press, 2003, ISBN- 0521642981 [T2]

4. **Reference Books:**

a) Alex Smola and S.V.N. Vishwanathan, "Introduction to Machine Learning", ISBN- 0 521 82583 0 [R1]
b) Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms". ISBN: 978-1-107-05713-5 [R2]

5. Examination rules:

(i) Questions to be set having equal weightage/marks covering the entire syllabus: EIGHT (4 questions each from UNIT I and UNIT II)
(ii) Questions to be answered: FIVE (5) selecting at least TWO from each unit

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6. LECTURE MODULES:

SL. No.	Module	Learning Objectives	Program Outcomes(PO)	Performance Indicator (PI)/ Program Specific Outcomes(PSO)/ Course Outcomes(CO)
1	**INTRODUCTION [03 HOURS]**	Basics concepts of Machine Learning, basics of classifications. Polynomial Curve Fitting, Probability Theory: Expectations and Co-variances, Bayesian probabilities, The Gaussian distribution, Curve fitting re-visited.	PO-1, 2	PI-1.2.1 PSO-3 CO- 1
2	**LINEAR MODELS FOR REGRESSION [04 HOURS]**	Linear Basis Function Models: Maximum likelihood and least squares, Sequential learning, Regularized least squares, The Bias-Variance Decomposition: Bayesian Linear, Regression, Parameter distribution, Predictive distribution.	PO-2, 3	PI-2.5.1, 3.5.2 PSO-2 CO- 1, 2
3	**LINEAR MODELS FOR CLASSIFICATION [04 HOURS]**	Discriminant Functions: Two classes, Multiple classes, Least squares for classification, Probabilistic Generative Models: Continuous inputs, Maximum likelihood solution, Probabilistic Discriminative Models: Fixed basis functions, Logistic regression.	PO-2, 3	PI-2.5.1, 3.5.2 PSO-3 CO- 2
4	**SPARSE KERNEL MACHINES [04 HOURS]**	Maximum Margin Classifiers: Overlapping class distributions, Relation to logistic regression, Multiclass SVMs	PO-2, 3	PI-2.5.1, 3.5.2 PSO-2 CO- 1

5	**KERNEL METHODS [2 HOURS]**	Dual Representations, Constructing Kernels, Radial Basis Function Networks.	PO-2, 3	PI-2.5.1, 3.5.2 PSO-3 CO- 1
6	**NEURAL NETWORKS [06 HOURS]**	Basic concepts: The artificial neuron, The McCulloch- Pitts neural model, The perceptron neural network architectures: Single layer feed forward ANNs, Multi-layer feed forward ANNs, Activation function, Generalized delta rule, The Back propagation Algorithm: Learning, Parameter optimization, Convolutional networks: Auto-sparse encoders.	PO-3	PI-2.5.1, 3.5.2 PSO-3 CO- 1
7	**MIXTURE MODELS AND EM [04 HOURS]**	K-means Clustering, Mixtures of Gaussians, Maximum likelihood, EM for Gaussian mixtures.	PO-2, 3	PI-2.5.1, 3.5.2 PSO-3 CO- 2
8	**SEQUENTIAL DATA [3 HOURS]**	Markov Models, Hidden Markov Models, Maximum likelihood for the HMM, The forward-backward algorithm.	PO-3	PI-2.5.1, 3.5.2 PSO-3 CO- 1

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SYLLABUS PLANNING AND COURSE COVERAGE REPORT

Date of Commencement of Semester:

Last date for completing the syllabus:

Total No. of Remedial classes held:

Any extra classes required to complete the syllabus (Yes/ No):

Module/ Chapter No.	Lecture No.	Topics/ Experiments/ Program Planned	Allotted (in Minutes)	Date / Week No.	Covered (Yes/No)	CO Number Covered	PI	Learning Resources used	Signature of Teacher	Signature of CR	Signature of DAC / HOD
1	1	(a) Polynomial Curve Fitting (b) Probability Theory (c) Probability densities (d) Expectations and covariance									
	2	(a) Bayesian probabilities (b)Bayesian probabilities (c) The Gaussian distribution (d) Curve fitting re-visited									
	3	(a) Bayesian curve fitting (b) Model Selection (c) The Curse of Dimensionality (d) Decision theory									
2	4	(a) Linear Basis Function Models (b) Prediction Problems (c) Example: Polynomial Curve Fitting (d) Maximum Likelihood									

Module/ Chapter No.	Lecture No.	Topics/ Experiments/ Program Planned	Allotted (in Minutes)	Date / Week No.	Covered (Yes/No)	CO Number Covered	PI	Learning Resources used	Signature of Teacher	Signature of CR	Signature of DAC / HOD
		Estimation									
	5	(a) Maximum likelihood and least squares (b) System Equation View of Linear Regression (c) Geometry of least squares (d) Over fitting issue									
	6	(a) Regularized least squares (b) The Bias-Variance Decomposition (c) Sequential learning (d) The Bias Variance Trade off									
	7	(a) Bayesian Linear Regression (b) Parameter distribution (c) Predictive distribution (d) Equivalent kernel									
3	8	(a) Linear Discriminant Functions (b) Two classes (c) Multiple classes (d) Least squares for classification									

Module/ Chapter No.	Lecture No.	Topics/ Experiments/ Program Planned	Allotted (in Minutes)	Date / Week No.	Covered (Yes/No)	CO Number Covered	PI	Learning Resources used	Signature of Teacher	Signature of CR	Signature of DAC / HOD
	9	(a) Probabilistic Generative Models (b) Continuous inputs (c) Maximum likelihood solution (d) Discrete features									
	10	(a) The Perceptron (b) The perceptron criterion (c) The perceptron algorithm (d) Learning by gradient descent									
	11	(a) Perceptron convergence (b) Gaussian Discriminant Analysis (c) Parameter estimation for GDA (d) Logistic Regression									
4	12	(a) Maximum Margin Classifiers (b) Parameter estimation (c) Estimation of the bias (d) Illustrative Synthetic Example									
	13	(a) Overlapping class distributions (b) Overlap in margin (c) Recasting the problem (d) Optimization									

Module/ Chapter No.	Lecture No.	Topics/ Experiments/ Program Planned	Allotted (in Minutes)	Date / Week No.	Covered (Yes/No)	CO Number Covered	PI	Learning Resources used	Signature of Teacher	Signature of CR	Signature of DAC / HOD
	14	(a) Relation to logistic regression (b) Multiclass SVMs (c) SVMs for regression (d) Computational learning theory									
	15	(a) Relevance Vector Machines (b) RVM for regression (c) Analysis of sparsity (d) RVM for classification									
5	16	(a) Dual Representations (b) Constructing Kernels (c) Radial Basis Function Networks (d) Nadaraya-Watson model									
	17	(a) Gaussian Processes (b) Linear regression revisited (c) Gaussian processes for regression (d) Learning the hyper-parameters									

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6	18	(a) Basics of Artificial Neural networks (b) Mculloch-Pitt neural model (c) Feed-forward Network (d) Weight-space symmetries									
	19	(a) Network Training (b) Parameter optimization (c) Local quadratic approximation (d) Use of gradient information									
	20	(a) Error Back-propagation (b) Evaluation of error-function derivatives (c) A simple example (d) Efficiency of back-propagation									
	21	(a) Realize logical AND and logical OR with the help of the same model. (b) Explain the Hebb rule training algorithm used in pattern association. (c) Realize the logical AND function using Hebb learning rule. (d) Consider the following neural network shown in									

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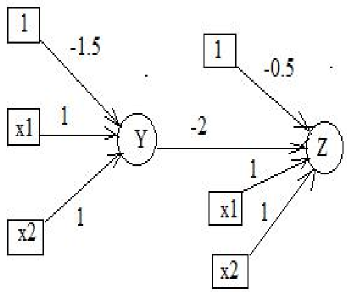
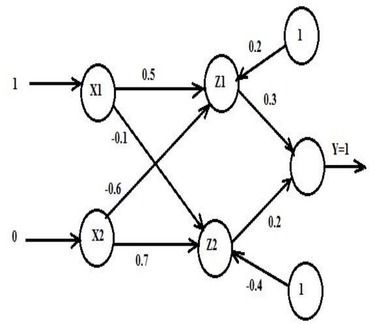
		Figure 1. All the units, except those at the input level, have the activation function f(x) = 1 if x > 0, f(x) = 0 otherwise. What logic function the whole network realizes at the output unit Z assuming inputs are binary?  Figure 1: An artificial neural network									
	22	(a) Supervised learning (b) Realize the logical OR function using Hebb learning rule. (c) Train a neural net using Perceptron learning to realize the logical NAND function. (a) Multilayer feed forward net-structure, Notations,									

Module/ Chapter No.	Lecture No.	Topics/ Experiments/ Program Planned	Allotted (in Minutes)	Date / Week No.	Covered (Yes/No)	CO Number Covered	PI	Learning Resources used	Signature of Teacher	Signature of CR	Signature of DAC / HOD
		Activation function, Generalized delta rule,									
	23	(a) The Back propagation Algorithm: Learning, Parameter choice, Initialization, Stopping criteria, Training set, Data representation, Hidden layers. (b) Using Back-propagation algorithm, find the new weights for the network as shown in Figure 1. The network is presented with input pattern (0, 1) and target output 1. Use learning rate (η) =0.3 and binary sigmoid activation function.  Figure 1: Multi-layer neural network (c) Unsupervised Learning									

Module/ Chapter No.	Lecture No.	Topics/ Experiments/ Program Planned	Allotted (in Minutes)	Date / Week No.	Covered (Yes/No)	CO Number Covered	PI	Learning Resources used	Signature of Teacher	Signature of CR	Signature of DAC / HOD
		Neural Networks (a) Adalin and Madaline									
7	24	(a) Bayesian Networks (b) Example: Polynomial regression (c) Generative models (d) Discrete variables									
	25	(a) Linear-Gaussian models (b) Conditional Independence (c) Three example graphs (d) D-separation									
	26	(a) Markov Random Fields (b) Conditional independence properties (c) Factorization properties (d) Illustration: Image de-noising									
	27	(a) K-means Clustering (b) Image segmentation and compression (c) Mixtures of Gaussians (d) Maximum likelihood									

Module/ Chapter No.	Lecture No.	Topics/ Experiments/ Program Planned	Allotted (in Minutes)	Date / Week No.	Covered (Yes/No)	CO Number Covered	PI	Learning Resources used	Signature of Teacher	Signature of CR	Signature of DAC / HOD
8	28	(a) Markov Random Fields (b) Conditional independence properties (c) Factorization properties (d) Illustration: Image de-noising									
	29	(a) PCA for high-dimensional data (b) Probabilistic PCA (c) Maximum likelihood PCA (d) EM algorithm for PCA									
	30	(a) Bayesian PCA (b) Factor analysis (c) Kernel PCA (d) At what point in the PCA process can we decide to compress the data? What effect does this have?									

REMEDIAL CLASSES

DATE	NO OF STUDENTS ATTENDED	TOPICS COVERED	REMARKS

Detailed discussions (if any):

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ATTENDANCE REGISTER

Name																			

Name																			
