Kadi Sarva Vishwavidyalaya

Faculty of Engineering & Technology

Second Year Master of Engineering (Computer Engineering)

(Semester-III)

(With effect from: Academic Year 2018-19)

Subject Code: MECE-303-N-B	**Subject Title:** Pattern Recognition
Pre-requisite	

Teaching Scheme (Credits and Hours)

Teaching Scheme				**Total Credit**	**Evaluation Scheme**					
L	**T**	**P**	**Total**		**Theory**		**Mid Sem Exam**	**CIA**	**Practical**	**Total**
Hours	**Hours**	**Hours**	**Hours**		**Hours**	**Marks**	**Marks**	**Marks**	**Marks**	**Marks**
04	00	02	06	05	03	70	30	20	30	150

Learning Objectives:

- The course provides an overview of the theory, principles and algorithms used in machine learning to construct high performance information processing systems that learn from experience.
- The course discusses main and modern concepts for model selection and parameter estimation in recognition, decision making and statistical learning problems.
- Special emphasis will be given to regression, classification, regularization, feature selection and density estimation in supervised mode of learning.
- Students will be assigned typical machine learning problems to investigate as projects

Outline of the Course:

Sr. No	**Title of the Unit**	**Minimum Hours**
1	Introduction	08
2	Basics of Probability, Random Processes and Linear Algebra	08
3	Representation	10
4	Dimensionality Reduction	08
5	Bayes Classifier	08
6	Linear Discriminant Functions	08
7	Parameter Estimation Methods	08
8	Recent Advances	06
	Total	**64**

Total hours (Theory): 64
Total hours (Lab): 32
Total hours: 96

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Detailed Syllabus:

Sr. No	Topic	Lecture Hours	Weightage (%)
1	**Introduction** Basic concepts of pattern recognition, fundamental problems in pattern recognition system, design concepts and methodologies, example of automatic pattern recognition systems, a simple automatic pattern recognition model, Paradigms for pattern recognition, Statistical and Syntactic pattern recognition, Soft and Hard computing schemes for pattern recognition. Statistical Pattern Recognition- Patterns and classes, Supervised, Semi supervised, and Unsupervised classification	08	13
2	**Basics of Probability, Random Processes and Linear Algebra**: Probability: independence of events, conditional and joint probability, Bayes theorem Random Processes: Stationary and non-stationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra. **Linear Algebra**: Inner product, outer product, inverses, eigen values, eigen vectors, singular values, singular vectors.	08	13
3	**Representation** Vector space representation of patterns and classes, patterns and classes as strings, Tree-based representations, Frequent item sets for representing classes and clusters, Patterns and classes as logical formulas	10	14
4	**Dimensionality Reduction** Feature selection Branch and bound, Sequential feature selection, **Feature extraction:** Fisher's linear discriminant, Principal components as features; **Nearest Neighbor Classifiers**- Nearest neighbor classifier, Soft nearest neighbor classifiers, Efficient algorithms for nearest neighbor classification, K-nearest neighbor classifier, minimal distance classifier, condensed nearest neighbor classifier and its modifications	08	13
5	**Bayes Classifier** Bayes classifier, naïve Bayes classifier, Belief net; **Decision Trees**- Axis-parallel and oblique decision trees, Learning decision trees, Information gain and Impurity measures	08	13
6	**Linear Discriminant Functions** Characterization of the decision boundary, Weight vector and bias, Learning the discriminant function, Perceptron; Support Vector Machines Maximizing the margin, Training support vector machines, Kernel functions	08	13

7	**Parameter Estimation Methods** Maximum-Likelihood estimation: Gaussian case. Maximum a Posteriori estimation. Bayesian estimation: Gaussian case. Unsupervised learning and clustering - Criterion functions for clustering. Algorithms for clustering: K-Means, Hierarchical and other methods. Cluster validation. Gaussian mixture models, Expectation-Maximization method for parameter estimation. Maximum entropy estimation. Sequential Pattern Recognition. Hidden Markov Models (HMMs). Discrete HMMs. Continuous HMMs. Nonparametric techniques for density estimation. Parzen-window method. K-Nearest Neighbor method.	08	13
8	**Recent Advances** Neural network structures for Pattern Recognition – Neural network based Pattern associators – Unsupervised learning in neural Pattern Recognition – Self-organizing networks – Fuzzy logic – Fuzzy pattern classifiers – Pattern classification using Genetic Algorithms.	06	08
	Total	64	100

Instructional Method and Pedagogy:

- At the start of course, the course delivery pattern, prerequisite of the subject will be discussed.
- Lectures will be conducted with the aid of multi-media projector, black board, OHP etc.
- Attendance is compulsory in lecture and laboratory which carries 10 marks in overall evaluation.
- One internal exam will be conducted as a part of internal theory evaluation.
- Assignments based on the course content will be given to the students for each unit and will be evaluated at regular interval evaluation.
- Surprise tests/Quizzes/Seminar/tutorial will be conducted having a share of five marks in the overall internal evaluation.
- The course includes a laboratory, where students have an opportunity to build an appreciation for the concepts being taught in lectures.
- Experiments shall be performed in the laboratory related to course contents.

Learning Outcome:

On successful completion of this course, the student should be able to:

- Understands the fundamental pattern recognition and machine learning theories
- Able to design and implement certain important pattern recognition techniques
- Able to apply the pattern recognition theories to applications of interest.
- Distinguish supervised learning methods from the unsupervised ones.
- Able to apply supervised learning methods (model-based maximum likelihood, k-nearest neighbors) to the classifier design.
- Able to apply k-means clustering algorithm.

Reference Books:

1. Susheela D evi and M. NarasimhaMurty, Pattern Recognition: An Introduction, Universities Press, Hyderabad, 2011.
2. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, John Wiley and Sons, 2000
3. M. NarasimhaMurty and V. Susheela Devi, Pattern Recognition, NPTEL Web Course, 2011 (http://nptel.iitm.ac.in/courses.php?disciplineId=106).
4. Bishop, C. M. Pattern Recognition and Machine Learning. Springer. 2007.
5. Marsland, S. Machine Learning: An Algorithmic Perspective. CRC Press. 2009. (Also uses Python.)
6. Theodoridis, S. and Koutroumbas, K. Pattern Recognition. Edition 4. Academic Press, 2008.
7. Classification, Parameter Estimation and State Estimation - An Engineering Approach Using Matlab, by F. van der Heijden, R.P.W. Duin, D. de Ridder and D.M.J. Tax, 2004.
8. Julus T. Tou ,Rafel C. Gonzalez, Addision, “Pattern Recognition Principles”, 1st Edition, Wesley publishing company.
9. Earl Gose, Richard Johnsonbaugh, “Pattern Recognition and Image Analysis”, 1st Edition, Prentice Hall of India Private limited, 2009.

List of experiments:

Sr. No.	Name of Experiment
1	Implementation Support Vector Machines for Binary Classification
2	Implementation of Face detection and feature extractions
3	Face Detection and Tracking Using CAMShift.
4	Implementation of Digit Classification Using HOG Features
5	Color-based image segmentation using k-means clustering.
6	Detecting moving objects by classifying image pixels in into foreground (white pixels) and background (black pixels) using Gaussian mixture models
7	Implementation of various algorithms of Unsupervised Classification 1.K-means clustering 2.Gaussian mixture models 3.Hidden Markov model
8	Detecting people using support vector machines (SVM) and HOG feature extraction