INDIAN INSTITUTE OF INFORMATION TECHNOLOGY
DESIGN AND MANUFACTURING (IIITD&M) KANCHEEPURAM

<table>
<tr><td>Course Title</td><td>Pattern Recognition</td><td>Course No</td><td colspan="3">To be allotted later on by the office</td></tr>
<tr><td>Specialization</td><td>Computer Science Engineering and Electronics Engineering</td><td>Structure (IPC)</td><td></td><td></td><td></td></tr>
<tr><td>Offered for</td><td>B.Tech and Dual Degree Students (CSE and Electronics), PG and PhD</td><td>Status</td><td colspan="2">Core ☐</td><td>Elective</td></tr>
<tr><td>Pre-requisite</td><td>An undergraduate level understanding of probability, statistics and linear algebra is assumed. A basic knowledge of Matlab will be useful.</td><td>To take effect from</td><td colspan="3"></td></tr>
<tr><td>Objectives</td><td colspan="5">This course covers the techniques and gain proficiency of pattern recognition that are fundamental to a wide variety of application areas such as medical research, biometrics, computer vision, etc.</td></tr>
<tr><td>Course Outcomes</td><td colspan="5">• A good knowledge of Bayesian decision theory and Bayesian learning.
• Fundamental understanding of classifiers such as linear discriminant function, quadratic discriminant function, nearest neighbor rule, neural network and SVM.
• A good understanding of feature selection algorithms.
• Ability to evaluate the performance of various classifiers on real-world datasets.</td></tr>
<tr><td>Contents of the course

(With approximate break up of hours)</td><td colspan="5">1) Basics of Probability, Random Processes and Linear Algebra (recap): Probability: independence of events, conditional and joint probability, Bayes theorem Random Processes: Stationary and non-stationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra. (6)
2) Bayes Decision Theory: Minimum-error-rate classification. Classifiers, Discriminant functions, Decision surfaces. Normal density and discriminant functions. Discrete features.(4)
3) Parameter Estimation Methods: Maximum-Likelihood estimation: Gaussian case. Maximum 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 Neighbour method.(11)
4) Dimensionality reduction: Principal component analysis - it relationship to Eigen analysis. Fisher discriminant analysis - Generalized Eigen analysis. Eigen vectors/Singular vectors as dictionaries. Factor Analysis, Total variability space - a dictionary learning methods. Non negative matrix factorization - a dictionary learning method.(8)
5) Linear discriminant functions: Gradient descent procedures, Perceptron, Support vector machines - a brief introduction. (4)
6) Artificial neural networks: Multilayer perceptron – feed forward neural network. A brief introduction to deep neural networks, convolutional neural networks, recurrent neural networks.(4)
7) Non-metric methods for pattern classification: Non-numeric data or nominal data. Decision trees: Classification and Regression Trees (CART). (3)
8) Application(s): Face recognition - preprocessing, face detection algorithms, selection of representative patterns, classification algorithms, results and discussion. (4)</td></tr>
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Text and References	Textbook 1) O.Duda, P.E.Hart and D.G.Stork, *Pattern Classification*, John Wiley, 2001 2) S.Theodoridis and K.Koutroumbas, *Pattern Recognition*, 4th Ed., Academic Press, 2009 References 3) C.M.Bishop, *Pattern Recognition and Machine Learning*, Springer, 2006 4) P.A Devijver and J. Kittler, *Pattern Recognition: A Statistical Approach*, Prentice-Hall International, Englewood Cliffs, NJ, 1980. 5) K. Fukunaga, *Introduction to Statistical Pattern Recognition, 2nd Ed.* Academic Press, New York, 1990.