



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3171613

PATTERN RECOGNITION

B.E. 7th Semester

Type of course: Elective

Prerequisite: Familiarity with linear algebra, probability, random process, and statistics

Rationale: Pattern recognition techniques are used to design automated systems that improve their own performance through experience. This course covers the methodologies, technologies, and algorithms of statistical pattern recognition from a variety of perspectives.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Syllabus:

Sr. No.	Content	Total Hrs
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.	06
2	Linear Algebra: Inner product, outer product, inverses, eigen values, eigen vectors, singular values, singular vectors.	03
3	Bayes Decision Theory: Minimum-error-rate classification. Classifiers, Discriminant functions, Decision surfaces. Normal density and discriminant functions. Discrete features.	03
4	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, K-Nearest Neighbour method.	12
5	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.	08
6	Linear discriminant functions: Gradient descent procedures, Perceptron, Support vector machines - a brief introduction.	03
7	Artificial neural networks: Multilayer perceptron – feed forward neural network. A brief introduction to deep neural networks, convolutional neural networks, recurrent neural networks.	04
8	Non-metric methods for pattern classification: Non-numeric data or nominal data. Decision trees: Classification and Regression Trees (CART).	03



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Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	25	25	20	15	5

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

- 1) R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001
- 2) S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4/e, Academic Press, 2009
- 3) C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006
- 4) Morton Nadier and Eric Smith P., Pattern Recognition Engineering, John Wiley & Sons, New York, 1993.
- 5) Robert J. Schalkoff, Pattern Recognition: Statistical, Structural and Neural Approaches, John Wiley & Sons Inc., New York, 2007.
- 6) Tom Mitchell, Machine Learning, McGraw-Hill
- 7) Tou and Gonzales, Pattern Recognition Principles, Wesley Publication Company, London, 1974.

Course Outcome:

After learning the course, the students should be able to:

Sr. No.	CO Statement	Marks % Weightage
1	Know the major approaches in statistical and syntactic pattern recognition.	25
2	Understand pattern recognition theories, such as Bayes classifier, linear discriminant analysis	25
3	Become aware of the theoretical issues involved in pattern recognition system design such as the curse of dimensionality.	25
4	Apply pattern recognition techniques in practical problems	25

List of Experiments and Design based Problems (DP)/Open Ended Problem:

Minimum 10 practical's based on the content of the syllabus.

One Design Based/Open Ended Problem to be assigned in a group of 3 students.

List of Open Source Software/learning website:

- <https://nptel.ac.in/courses/117/105/117105101/>
- <https://nptel.ac.in/courses/117/108/117108048/>
- http://videolectures.net/Top/Computer_Science/Machine_Learning/Pattern_Recognition/
- https://www.youtube.com/results?search_query=pattern+recognition