

## Approval:10<sup>th</sup> Senate Meeting

Course Name: **Pattern Recognition**

Course Number: **CS669**

Credit: **3-1-0-4**

Prerequisites: **IC**

Students intended for: **MS/Mtech/PhD/3<sup>rd</sup> and 4<sup>th</sup> year BTech**

Elective or Compulsory: **Elective**

Semester: **Odd**

### **Course Modules:**

- 1. Basics of Probability, Random Processes and Linear Algebra (recap) [8 hrs]**
  - Probability: independence of events, conditional and joint probability, Bayes' theorem
  - Random Processes: Stationary and nonstationary processes, Expectation, Autocorrelation, Cross-Correlation, spectra.
  - Linear Algebra: Inner product, outer product, inverses, eigen values, eigen vectors, singular values, singular vectors.

*Programming Assignment 1*
- 2. Bayes Decision Theory [8 hrs]**
  - Minimum-error-rate classification
  - Classifiers, Discriminant functions, Decision surfaces
  - Normal density and discriminant functions
  - Discrete features
- 3. Parameter Estimation Methods [12 hrs]**
  - 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

*Programming Assignment 2*
- 4. Sequential Pattern Recognition [4 hrs]**
  - Discrete Time Warping (DTW)
  - Hidden Markov Models (HMMs)
    - Discrete HMMs
    - Continuous HMMs

*Programming Assignment 3*
- 5. Nonparametric techniques for density estimation [4 hrs]**
  - Parzen-window method
  - K-Nearest Neighbour method
- 6. Dimensionality reduction [4 hrs]**
  - Principal component analysis – its relationship to eigen analysis
  - Fisher discriminant analysis – Generalised eigen analysis
  - Eigen vectors/Singular vectors as dictionaries.

**7. Linear discriminant functions** [8 hrs]

- Gradient descent procedures
- Perceptron
- Support vector machines

**8. Non-metric methods for pattern classification** [4 hrs]

- Non-numeric data or nominal data
- Decision trees: Classification and Regression Trees (CART).

*Programming Assignment 4/Project*

**Text 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, 4th Ed., Academic Press, 2009
- [3] C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006

**References:**

- [1] Some relevant papers/notes will be put up on the website from time-to-time.
- [2] Simon Haykin, "Neural Networks: A Comprehensive foundation to Neural Networks or Neural Net-works and Learning Machines," any edition will do.