Indian Institute Of Technology Mandi
CS669: Pattern Recognition

1. **Basics of Probability, Random Processes and Linear Algebra (recap)**
   - 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, SVD etc.

2. **Bayes Decision Theory**
   - Minimum-error-rate classification
   - Classifiers, Discriminant functions, Decision surfaces
   - Normal density and discriminant functions
   - Discrete features

3. **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

4. **Nonparametric techniques for density estimation**
   - Parzen-window method
   - K-Nearest Neighbour method

5. **Dimensionality reduction**
   - Principal component analysis – it relationship to eigen analysis
   - Fisher discriminant analysis – Generalised eigen analysis
   - Eigen vectors/Singular vectors as dictionaries.

6. **Linear discriminant functions**
   - Gradient descent procedures
   - Perceptron
   - Support vector machines

7. **Artificial Neural Networks**
   - *Basics of artificial neural networks (ANN)*: Artificial neurons, Computational models of neurons, Structure of neural networks, Functional units of ANN for pattern recognition
   - *Feedforward neural networks:* Pattern classification using perceptron, Multilayer feedforward neural networks (MLFFNNs), Pattern classification using MLFFNNs, Backpropagation learning.

8. **Decision Trees**
   - Decision trees, CART,
   - Bagging and Boosting, Random forest

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:

[4] Some relevant papers/notes will be put up on the moodle from time-to-time.

[5] Simon Haykin, "Neural Networks: A Comprehensive foundation to Neural Networks or Neural Net-works and Learning Machines," any edition will do.