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**SECOND SEMESTER 2021-22**

# Course Handout

15-01-2022

*Course No.* :  *BITS F312*

## Course Title : Neural Network and Fuzzy Logic

## Instructor-in-Charge : Dr. Rajesh Kumar Tripathy

1. **Scope and Objective of the Course:**

This course introduces several fundamental concepts of artificial neural networks and fuzzy logic. The objective is to familiarize the students with some basic learning algorithms and techniques and their applications, as well as general questions related to analyzing and handling large data sets. Several software libraries and datasets publicly available will be used to illustrate the application of these algorithms. In this course, the various supervised learning algorithms such as logistic regression, multiclass logistic regression, multilayer perceptron, radial basis function neural network, extreme learning machine, and the deep neural network will be discussed. By the end of this course, students will have a strong understanding of artificial neural network-based techniques for various real-time applications.

**2. Textbooks:**

T1. Simon Haykin, “*Neural Networks – A Comprehensive Foundation”,* Pearson Education, 1999.

T2. H. J. Zimmermann, “*Fuzzy Set Theory and its Applications”,3rd*  Edition, Kluwer Academic, 1996.

**3. Reference books/Materials**

R1: CS229 Lecture notes: Stanford University

R2: CS231 Convolutional neural networks for visual recognition: Stanford University

R3: <http://gyan.iitg.ernet.in/handle/123456789/833>

R4: <https://www.sciencedirect.com/science/article/pii/S0925231206000385>

R5: https://www.springer.com/cda/content/document/cda\_downloaddocument/9783319284354-c2.pdf?SGWID=0-0-45-1545215-p177863021

**4. Course Plan:**

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| **Lecture No.** | **Learning Objectives** | **Topics to be covered** | **Chapter in the Text Book** |
| 1 | Pattern recognition and Machine learning introduction | Introduction to Pattern recognition, machine learning, Supervised, unsupervised and semi-supervised learning, | T1 (ch 2) |
| 2-4 | To understand classification and regression problems and linear regression | Classification and regression problems, Linear regression, gradient descent (Batch gradient descent, mini-batch gradient descent, and stochastic gradient descent) | R1 |
| 5-8 | To understand Binary and Multiclass classifications | Logistic regression, the multiclass extension of logistic regression (One Vs One and One Vs All Multiclass coding schemes) | R1 |
| 9 | To understand measures for classifiers | Performance Measures for Classifiers (binary class and multiclass), Probabilistic classifiers | R3 (2.9.5) |
| 10-11 | To understand neural network | What is a Neural Network?, Human Brain and Biological Neuron, Model of an Artificial Neuron, Activation functions, Neural Network Architectures. | T1 (ch 1) |
| 12-13 | To understand the mathematical model of a single neuron | Single Layer Perceptron, Linear Separability, XOR Problem, Perceptron Learning rules | T1 (ch 3) |
| 14-16 | To understand multilayer perceptron | Multilayer Perceptron, Back-propagation Algorithm and parameters selection, and tuning | T1 (ch 4) |
| 17-19 | To understand kernel machines in machine learning | Radial-Basis Function Networks, various kernel functions used in RBFN, Support Vector Machine (SVM), kernel functions in SVM | T1 (ch 5) and R3 |
| 20-24 | To understand Autoencoder and deep neural network | Autoencoder, Sparse autoencoder, Denoising autoencoder, Deep neural network based on stacking of autoencoders | R1 |
| 25-27 | To understand ELM and its kernel extension | Extreme learning machine (ELM), Kernel ELM | R4 |
| 28-31 | To understand CNN for solving classification problems | Convolutional neural network (CNN), Convolutional Layer**,**Pooling Layer, and Fully-Connected Layers, Convolutional Autoencoder | R2 |
| 32-34 | To introduce the fuzzy world for decision making | Crisp Sets and Crisp relations, Fuzzy sets and Fuzzy relations, Crisp Logic and Fuzzy Logic | T2 (ch 1) |
| 35-37 | To understand fuzzy inference | Membership function, Fuzzification, Fuzzy Inference, Defuzzification Methods | T2 (ch4, ch5, ch9) |
| 38-42 | To understand hybrid neuro-fuzzy networks | Neuro-Fuzzy System, Takagi-Sugeno’s Approach (ANFIS), Fuzzy Backpropagation Networks | R5 |

**5. Evaluation Scheme:**

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| **Component** | **Duration** | **Weightage (%)** | **Marks** | **Date & Time** | **Nature of Component** |
| Mid-Sem Exam | 90 min | 30% | 90 | 11/03 3.30pm to5.00pm | Closed Book |
| Programming Assignments using Python and Google Colab | -------- | 30% | 90 | To be announced | Open Book |
| Comprehensive Exam | 120 min | 40% | 120 | 10/05 AN | Closed Book |

**6. Chamber Consultation Hour:** To be announced in class

**7. Notices:** Notices concerning this course will be on CMS or google classroom.

**8. Make–up Examination:** Make-up will be given on genuine grounds only. The prior application should be made for seeking the make-up examination.

**9. Academic Honesty and Integrity Policy:** Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Rajesh Kumar Tripathy

**INSTRUCTOR-IN-CHARGE**