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**FIRST SEMESTER 2022-23**

# Course Handout

29.08.2022

In addition to Part I (General Handout for all courses appended to the timetable), this portion gives further specific details regarding the course.

Course No. : **BITS F312**

## Course Title : **Neural Network and Fuzzy Logic**

## Instructor-in-Charge : **K. Srinivasa Raju**

Chamber No. : **D-107**

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

The aim of this course is twofold: **1**. Provide a thorough understanding of the basics; **2.** Bring the students face-to-face with an application in Fuzzy Logic and Neural Networks and related approaches. In addition, every student is required to work on a project, as part of the course, involving an application of Fuzzy Logic and Neural Networks. Further, the project work provides an opportunity to learn about the latest developments in this upcoming field. The unified approach will enable students to tackle real-life problems in a more comprehensive manner and provide a broader view of the subject.

**Course Level Outcomes:** After successful completion of this course, the student will be able to:

1. Explain the philosophy behind neural networks and allied fields
2. Explain the mechanism behind fuzzy logic
3. Understand the role of fuzzy logic and neural networks in the decision making
4. Understand adaptive fuzzy and neural control systems
5. Analyze fuzzy logic and neural networks from a programming perspective
6. **Text Book:**

**T1**. T.J. Ross Fuzzy Sets and Fuzzy Logic with Engineering Applications, Wiley, 2021

**3. Reference books**

**R1.** Vinod Chandra SS, S Anand Hareendran (2021) Machine Learning: A Practitioner’s Approach, PHI Learning Private Limited

**R2.** Rajasekaran S, Pai GAP (2012) Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, PHI Learning Private Limited

**R3**. Sivanandam SN, S Sumathi, SN Deepa (2006) Introduction to Neural Networks using Matlab 6.0, McGraw-Hill

**R4**. Hagan MT (2008) Neural Network Design, Cengage Learning

**R5**. Raju KS, Nagesh Kumar D (2014) Multicriterion Analysis in Engineering and Management, PHI Learning Private Limited.

**4. Course Plan:**

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| **Lecture No.** | **Learning Objectives** | **Topics to be covered** | **Chapter in the Text Book** |
| 1-2 | The necessity of Neural Networks and their background | Introduction to Neural networks, Neural Dynamics | Ch-9 (R1) |
| 3-4 | Understanding various learning rules and different architectures | Unsupervised and supervised learning rules, Neural Network Architectures, Single layer, multi-layer, Recurrent Networks | Ch-4 (R1) |
| 5 | Importance of activation function and different ways of understanding activation function | Different types of activation functions | Ch-9 (R1) |
| 6-7 | Understanding the mathematical philosophy behind BPN | Back Propagation Networks (BPN) | Ch-9 (R1) |
| 8 | Importance of parameters in BPN and fine-tuning of the same | Back Propagation Learning, Selection of Parameters in BPN, Tuning of Parameters | Ch-9 (R1) |
| 9-10 | Understanding different variations of BPN algorithms and case studies related to Neural Networks | Variation of Standard Back Propagation Algorithms, Case Studies | Ch-9 (R1) |
| 11-12 | Understanding the difference between crisp and fuzzy logic, shapes of membership functions | Crisp set theory, fuzzy set theory, Linear, Triangular, Trapezoidal, Hyperbolic, and Exponential Membership function | Ch-2 (T1) &  Supplementary material |
| 13-14 | Basics of Crisp and Fuzzy relations | Properties of Crisp and Fuzzy relations, Value Assignments | Ch-3 (T1) |
| 15-16 | Fuzzification and defuzzification | Approaches for fuzzification and defuzzification | Ch-4 (T1) |
| 17-19 | Fuzzy logic and reasoning | Various types of reasoning, Linguistic Hedges, Fuzzy Rule based systems | Ch-5 (T1) |
| 20-24 | Decision-making with fuzzy information | Similarity Analysis, TOPSIS, VIKOR, Analytical Hierarchy Process, Group Decision Making, Fuzzy Extensions | Supplementary material |
| 25-27 | Classification | Equivalence Relations, K-Means, Fuzzy C-Means, Cluster Validity Indices, Principal Component Analysis | Ch-7 (T1) &  Supplementary material |
| 28-29 | Various Approaches to Fuzzy Logic | Fuzzy Optimization, Fuzzy Cognitive Mapping, Artificial Intelligence/ Expert Systems, Case Studies | Ch-11 (T1) &  Supplementary material |
| 30 | Understanding basic definitions of control theory | Concepts in control systems, stability, state variable, controllability, Control system design problem, Simple fuzzy logic controllers | Ch-6 (T1) |
| 31-33 | Mathematical philosophy behind control theory | Fuzzy Engineering Process control, Classical feedback control, classical PID control, Fuzzy control, MIMO control systems | Ch-6 (T1) |
| 34-35 | Understanding ANFIS combination of ANN and Fuzzy Inference system | Adaptive Neuro-Fuzzy Inference System (ANFIS) | Supplementary material |
| 36-37 | Understanding the potentiality of Deep Learning with selected algorithms | Deep Learning, RNN, LSTM, CNN, TensorFlow | Ch-10 (R1) |
| 38-39 | Understanding the potentiality of Boosting Algorithms | Ensemble Classifier, Algorithms based on bagging and boosting, Quantification of classification | Ch-12 (R1) |
| 40 | Analyzing selected nature-based optimization algorithms | Introduction to Bio-inspired optimization algorithms | Supplementary material |

**\*Supplementary material/sources will be provided wherever required.**

**5. Evaluation Scheme:**

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| **Component** | **Duration** | **Weightage (%)** | **Marks** | **Date & Time** | **Nature of Component** |
| Mid-Semester Examination | 90 min | 30 | 90 | 02/11 9.00 - 10.30AM | Closed Book |
| Course related Project | -------- | 30 | 90 |  | Open Book |
| Comprehensive Examination | 180 min | 40 | 120 | 22/12 FN | Closed Book |

1. **Chamber Consultation Hour: MONDAY 5-6 P.M**
2. **Notices:** Notices concerning this course will be uploaded on Google Classroom Page for this course.
3. **Make-up Policy:** Make-ups will not be granted under any circumstances.
4. **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.

**INSTRUCTOR-IN-CHARGE**

**BITS F312**