Birla Institute of Technology & Science, Pilani
Hyderabad Campus

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

2. **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:

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:

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

6. **Chamber Consultation Hour: MONDAY 5-6 P.M**

7. **Notices:** Notices concerning this course will be uploaded on Google Classroom Page for this course.

8. **Make-up Policy:** Make-ups will not be granted under any circumstances.

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.

INSTRUCTOR-IN-CHARGE
BITS F312