



GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering

Subject Code: 3723118

Semester – II

Subject Name: Artificial Intelligence in Biomedical System

Type of course: Program Elective III

Prerequisite: Mathematics, Object-Oriented Programming, Biostatistics.

Rationale: Artificial intelligence (AI) is an area of computer science, which has been developed since the 1950s, specialized in dealing with problems considered difficult by traditional computer scientists through the use of knowledge and of probabilities and other kinds of uncertainties. AI has the capability of detecting meaningful relationships in a dataset and has been widely used in many clinical situations to diagnose, treat, and predict the results.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Overview of Biomedical Systems and Computational Intelligence Techniques: Early Biomedical Systems, Medical Data, Biological Data, Medical Instrumentation, Medical Systems, Drawbacks of Traditional Approaches, Numerical vs. Symbolic Approaches, The Need for Computational Intelligence in Biomedical Engineering; Bioelectric Signals and Electrode Theory, Signal Processing and Feature Extraction, Unsupervised and Supervised Learning Algorithms, Fuzzy Logic, Evolutionary Algorithms.	5
2	Artificial Neural Networks: Objectives of Neural Networks, Biological Foundations of Neural Networks, Early Neural Models, Precursor to Current Models: Pattern Classification, Classes of Neural Networks: Basic Network Properties, Classification Models, Association Models, Optimization Models, Self-Organization Models, The Adaline (ALC), Perceptron: Structure, Single-Multi Layer Perceptron, Activation Function, The Madaline, Feedforward Network, Back Propagation Network: Algorithm, Modified BP Algorithms, The XOR problem, Problem Solving Applications.	11



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3	<p>Support Vector Machines & Alternative Algorithm: Support Vector Classifier, Support Vector Regression, Training the Support Vector Machine, Genetic Algorithm: Foundations, Representation Schemes, Genetic Operators; Vision: Pattern recognition.</p> <p>Case Study: - Classification of Heart Disease database using Learning Vector Quantization ANN, Access Control by Face Recognition using Backpropagation Neural Network, Analysis of Electromyography Signals, Gait and Movement Pattern Analysis</p>	10
4	<p>Fuzzy Sets and Fuzzy Logic: The Case for Imprecision, The Utility & Limitations of Fuzzy Systems, Statistics and Random Processes, Uncertainty and Information, Fuzzy Sets and Membership, Chance versus Fuzziness, Fuzzy Set Operations, Properties of Fuzzy Sets, Fuzzy Relations: Cardinality of Fuzzy Relations, Operations on Fuzzy Relations, Properties of Fuzzy Relations, Tolerance and Equivalence Relations: Crisp Equivalence & Crisp Tolerance Relations, Fuzzy Tolerance & Equivalence Relations.</p>	8
5	<p>Fuzzy Logic Systems: Properties of Membership Functions, Fuzzification, and Defuzzification: Features of the Membership Function, Various Forms Fuzzification-Defuzzification to Crisp Sets, λ-cuts for Fuzzy Relations, Defuzzification to Scalars.</p> <p>Hybrid Systems: ANFIS: Adaptive Neuro-Fuzzy Inference System, Fuzzy Support Vector Machines.</p>	8

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15%	15%	25%	15%	15%	15%

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Begg, Rezaul, et al. *Computational Intelligence in Biomedical Engineering*. CRC Press, 2008.



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2. Cohen, Maurice, and Donna L. Hudson. *Neural Networks and Artificial Intelligence for Biomedical Engineering*. Edited by Metin Akay (Dartmouth College), IEEE PRESS SERIES IN BIOMEDICAL ENGINEERING, 2000.
3. Suzuki, Kenji, and Yisong Chen, editors. *Artificial Intelligence in Decision Support Systems for Diagnosis in Medical Imaging (Intelligent Systems Reference Library Volume 140)*. Springer, 2018.
4. Heaton, Jeff. *Artificial Intelligence for Human Volume 1: Fundamental Algorithms*. Heaton Research, Inc., 2013.
5. Buckareff, Andrei A. *The Cambridge Handbook of Artificial Intelligence*. Edited by Keith Frankish and William M. Ramsey, Cambridge University Press, 2014.
6. Agah, Arvin. *Medical Applications of Artificial Intelligence*. CRC Press, 2014.
7. Black, Nathanael, and Mast Florian. *Introduction to Artificial Intelligence*. Springer, 2011.
8. Heaton, Jeff. *Artificial Intelligence for Humans, Volume 3: Neural Networks and Deep Learning*. 2015.
9. S Sivanandam, S Sumathi. *Introduction to Neural Networks Using Matlab 6.0* -1 Jul 2017.

Reference Journal:

1. IEEE Transactions on Cybernetics. Impact Factor: 8.803(2017). Journal Homepage: <https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=6221036>.
2. Artificial Intelligence in Medicine, Elsevier. Impact Factor: 2.879(2017). Journal Homepage: www.elsevier.com/locate/artmed.
3. Journal of Healthcare Engineering, Hindawi. Impact Factor: 1.261(2017). Journal Homepage: <https://www.hindawi.com/journals/jhe>.
4. Advances in Fuzzy Systems, Hindawi. Journal Homepage: www.hindawi.com/journals/afs.
5. Advances in Human-Computer Interaction, Hindawi. Journal Homepage: www.hindawi.com/journals/afs.

Course Outcomes:

After completion of the course the student will be able to:



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Sr. No.	CO statement	Marks % weightage
CO-1	Understand the fundamental concepts needed to apply Artificial Intelligence in Medical or Biological domains.	10%
CO-2	Learn training, verification and validation of neural network models	30%
CO-3	Apply the pattern classification techniques, advanced methods of representing information in ANN to understand of current research in the field of Artificial Intelligence in Biomedical System.	20%
CO-4	Apply fuzzy logic concepts in the design of Biomedical System.	25%
CO-5	Apply the concept of Fuzzy logic system and Hybrid System to understand of current research in the field of Biomedical.	15%

At the end of the course, students should be able to decide if a non-trivial problem can be solved effectively using existing Artificial Intelligence methods, and if so, design and possibly implement a prototype system to solve the problem.

List of Experiments:

Sr. No.	Aim of Experiment	Hours
1	Implementation of Fuzzy Operations.	2
2	Implementation of Fuzzy Relations (Max-min Composition).	2
3	Implementation of Fuzzy Controller (Washing Machine).	2
4	Implementation of Simple Neural Network (McCulloh-Pitts model).	2
5	Implementation of Perceptron Learning Algorithm.	2
6	Implementation of Unsupervised Learning Algorithm.	2
7	Implementation of Simple Genetic Application.	2
8	Study of ANFIS Architecture.	2



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9	Implementation of Pattern Recognition algorithm using ANN.	2
10	Implementation of Cardiology and Heart Disease Diagnosis Technique using ANN.	2
11	Case study/implementation of any one journal paper from referred journals.	2

Major Equipment:

Computer Software

1. MATLAB
2. LabVIEW
3. PROLOG

List of Open Source Software/learning website:

1. UC Irvine Machine Learning Repository - <http://archive.ics.uci.edu/ml/>
2. PyTorch – An open source deep learning Platform

Active Learning Assignments: Preparation of PowerPoint slides, which include videos, animations, pictures, graphics for better understanding of theory and practical work. The faculty will assign topics from which students can grasp knowledge about current scenario of the virtual biomedical Instrumentation. The PowerPoint slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.