GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: PG

Branch: Applied Instrumentation

Course / Subject Code :ME01067021

Subject Name : Intelligent systems and control

w. e. f. Academic Year:	2024-25
Semester:	1st
Category of the Course:	PCC-02

Prerequisite:	**Control theory, Soft computing and Control**
Rationale:	This course provides an overview and fundamentals of intelligent systems (Neural Networks and Fuzzy logic)), which includes a wide range of real time engineering applications. Also covers intelligent auto tuning of controller with evolutionary techniques, Fuzzy-PID controls, hybrid systems.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Understand the structure of Neural Networks and learning algorithms.	
02	Implement ANN based Intelligent systemfor realtime engineering application.	
03	Understand and implement the structure of a fuzzy PID controller and its components.	
04	Understand how the concepts of Fuzzification and Defuzzification are used in a fuzzy PID controller.	
05	Understand how to create a PID controller using genetic algorithms concepts.	

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	INTRODUCTION: Motivation, Neural Networks,Rationale for Using NN in Engineering, Fuzzy Logic Control, Rationale for Using FL in Engineering, Evolutionary Computation, Hybrid Systems	4	2%
2.	FUNDAMENTALS OF NEURAL NETWORKS: Introduction, Basic Structure of a Neuron, Model of Biological Neurons, Elements of Neural Networks, Weighting Factors, Threshold, Activation Function, ADALINE, Linear Separable Patterns, Single Layer Perceptron,	5	8%

	General Architecture, Linear Classification. Perceptron Algorithm, Multi-Layer Perceptron, General Architecture, Input-Output Mapping, XOR Realization		
3.	NEURAL NETWORK ARCHITECTURES: Introduction , NN Classifications, Feedforward and feedback networks, Supervised and Unsupervised Learning Networks, Back Propagation Algorithm, Delta Training Rule, Radial Basis Function Network (RBFN), Training of the Kohonen Network, Examples of Self-Organization, Hopfield Network	6	15%
4.	INTRODUCTION TO FUZZY SETS: BASIC DEFINITIONS AND RELATIONS Introduction, Classical Sets, Classical Set Operations, Properties of Classical Sets, Fuzzy Sets, Fuzzy Membership Functions, Fuzzy Set Operations, Properties of Fuzzy Sets, Alpha-Cut Fuzzy Sets, Extension Principle, Classical Relations vs. Fuzzy Relations	5	10%
5.	INTRODUCTION TO FUZZY LOGIC: Introduction, Predicate Logic, Tautologies, Contradictions, Deductive Inferences, Fuzzy Logic, Approximate Reasoning	4	10%
6.	UZZY CONTROL AND STABILITY: Introduction, Basic Definitions, Inference Engine, Defuzzification, Fuzzy Control Design, Analysis of Fuzzy Control Systems, Stability of Fuzzy Control Systems, Lyapunov Stability, Stability via Interval Matrix Method	6	15%
7.	INTELLIGENT AUTO TUNING OF PID CONTROLLLER: Process Reaction Curve and Relay Methods Identification and PID Tuning, Introduction, Developing Simple Models from the Process Reaction , Identification Algorithm for Oscillatory Step Responses, Identification Algorithm for Non-Oscillatory Responses Without Overshoot , Developing Simple Models from a Relay Feedback Experiment, On-line Identification of FOPDT Models , On-line Identification of SOPDT Models , Examples for the On-line Relay Feedback Procedure , Off-line Identification , An Inverse Process Model-Based Design Procedure for PID Control , Inverse Process Model-Based Controller Principles , PI/PID Controller Synthesis , Auto tuning of PID Controllers, Assessment of PI/PID Control Performance, Achievable Minimal IAE Cost and Rise Time, Assessment of PI/PID Controllers	6	25%
	FUZZY LOGIC AND GENETIC ALGORITHM METHODS IN PID TUNING: Introduction, Fuzzy PID Controller Design , Fuzzy PI Controller Design, Fuzzy D Controller Design , Fuzzy PID Controller Design, Fuzzification, Fuzzy Control Rules, Defuzzification, A Control Example, Multi-Objective Optimised Genetic Algorithm Fuzzy PID Control , Genetic Algorithm Methods Explained , Case study A: MultiObjective Genetic Algorithm Fuzzy PID Control of a Nonlinear Plant, Case study B: Control of Solar Plant	6	15%
	Total		**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
20	**20**	**10**	**20**	**20**	**10**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Intelligent Control Systems Using Soft Computing Methodologies by Ali Zilouchian and Mo Jamshidi, CRC Press.
2. Principles ofSoft Computing by S.N.Sivanandam, S.N.Deepa , 2e, Wiley India Pvt.Ltd.
3. PID Control New Identification and Design Methods by Michael A. Johnson and Mohammad H. Moradi, Springer
4. Artificial Intelligence and Intelligent Systems by N.P.Padhi, Oxford University Press.
5. PID controllers: theory, design, and tuning by Karl J. Astrom and Tore Hagglund Instrument Society of America (ISA)
6. NEURAL NETWORKS, FUZZY LOGIC AND GENETIC ALGORITHM: SYNTHESIS AND APPLICATIONS by S. RAJASEKARAN, G. A. VIJAYALAKSHMI PAI, PHI Learning Pvt. Ltd

(b) Open source software and website:

1. https://www.scilab.org/

Suggested Course Practical List: If any

List of Laboratory/Learning Resources Required:

Suggested Project List:

Suggested Activities for Students:

Student has to prepare computer programs and simulations for various intelligent soft computing techniques covered in this course with any computing tools (C, C++, Java, MatLab, Scilab, etc...). Prepare research paper and submit report by using intelligent soft computing techniques covered in this course for any engineering problems

1. Design and implementation of intelligent system for industrial process control and Industrial drives control application.

2. Design and implementation of intelligent system for Research Activity in Medicine and Biological Sciences.

3. Design and implementation of intelligent system in Cancer Research

4. Design and implementation of intelligent system for Biosignal Detection, processing Correction.

5. Design and implementation of intelligent system for Decision-making in Medical Treatment Strategies.

6. Design and implementation of intelligent system for image processing in vision control.

7. Design and implementation of intelligent system for data communication and networking

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