GANPAT UNIVERSITY

FACULTY OF ENGINEERING AND TECHNOLOGY

Programme	Master of Technology	Branch	Mechanical Engineering (Specialization in Additive Manufacturing)
Semester	II	Version	1.0.0.0
Effective from Academic Year	**2025-26**	Effective for the batch Admitted in	**July 2025**
Subject code	**3ME2120**	Subject Name	**Soft Computing Techniques**

Teaching scheme								
(Per week)	Lecture(DT)		Practical(Lab.)		Total		CE	SEE	Total

	L	TU	P	TW			CE	SEE	Total
Credit	2	0	2	0	4	Theory	40	60	100
Hours	2	0	4	0	6	Practical	60	40	100

Pre-requisites:

Basic knowledge of mathematics, statistics, optimization techniques, fundamentals of additive manufacturing processes, and introductory programming (MATLAB / Python).

Course Learning Outcomes:

The course content shall be taught and implemented to develop analytical, computational, and decision-making skills leading to the following learning outcomes:

CO1: Explain the fundamentals of soft computing techniques and their relevance to engineering optimization problems.

CO2: Apply fuzzy logic and artificial neural networks to model and predict AM process behavior.

CO3: Analyze evolutionary algorithms for single and multi-objective optimization in AM processes.

CO4: Develop hybrid soft computing models for process parameter optimization and quality improvement in AM.

CO5: Evaluate real-world case studies involving AI-driven decision-making in additive manufacturing systems.

Course Content		
Name of UNIT	**Content**	**Hrs**
UNIT – I: Introduction to Soft Computing and Its Role in Additive Manufacturing	Concept of soft computing; hard computing vs soft computing; components of soft computing: fuzzy logic, artificial neural networks, evolutionary algorithms, and probabilistic reasoning; uncertainty, imprecision, and approximation; need for soft computing in AM; overview of optimization and prediction challenges in AM processes; soft computing workflow for AM applications.	**6**
UNIT – II: Fuzzy Logic Systems for AM Process Modeling	Fuzzy sets and membership functions; linguistic variables; fuzzification and defuzzification; fuzzy rule base and inference systems; Mamdani and Sugeno models; fuzzy modeling of AM process parameters (layer thickness, speed, temperature); decision-making under uncertainty in AM; case studies on fuzzy-based quality prediction.	**6**
UNIT – III: Artificial Neural Networks for Additive Manufacturing	Biological neuron and artificial neuron models; neural network architectures; feedforward and recurrent neural networks; backpropagation algorithm; training, testing, and validation; overfitting and generalization; ANN-based modeling of mechanical properties, surface roughness, dimensional accuracy, and defects in AM; comparison with regression models.	**5**

UNIT – IV: Evolutionary Optimization Techniques	Genetic Algorithms: encoding, selection, crossover, mutation, fitness functions; multi-objective optimization concepts; NSGA-II fundamentals; particle swarm optimization (PSO); grey wolf optimizer (GWO) overview; application of evolutionary algorithms for AM process optimization, energy minimization, and performance enhancement..	**6**
UNIT – V: Hybrid Soft Computing and Advanced Applications in AM	Hybrid models: ANN–GA, ANN–PSO, Fuzzy–ANN systems; surrogate modeling and meta-modeling; integration of soft computing with simulation tools (ANSYS, Digimat, AM process simulators); AI-driven digital twins for AM; future trends: explainable AI, real-time optimization, and Industry 4.0 integration.	**5**

List of Practical
The practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate course learning outcomes.

No.	Unit	Name of Practical
1	1	Introduction to MATLAB/Python environment for soft computing
2	2	Development of a fuzzy logic model for AM parameter decision-making
3	3	ANN-based prediction of mechanical properties of AM parts
4	3	Training and validation of neural network models using experimental AM data
5	4	Genetic Algorithm-based optimization of AM process parameters
6	5	Case study: Multi-objective optimization of AM using NSGA-II

List of Instruments / Equipment / Trainer Board

1	High-performance computing systems
2	MATLAB / Python with soft computing toolboxes
3	AM experimental datasets (polymer/metal AM)
4	Optimization and simulation software.
5	CAD and AM process planning tools

List of Reference Books

No.	Title	Authors	Publisher
1	Neural Networks and Fuzzy Systems	Bart Kosko	Prentice Hall
2	Genetic Algorithms in Search, Optimization, and Machine Learning	David E. Goldberg	Addison-Wesley
3	Fuzzy Logic with Engineering Applications	Timothy J. Ross	Wiley
4	Soft Computing and Intelligent Systems	Madan Gupta	Elsevier
5	Artificial Intelligence in Additive Manufacturing	Various Authors	Springer