GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Internet of Things

Subject Code : ME02062111

Subject Name : Optimization Techniques for IoT

w. e. f. Academic Year:	2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Basic knowledge of Linear Algebra, Calculus, Probability, Statistics, Programming Skills in R or Python.
Rationale:	This course covers the fundamental optimization techniques used in Internet of Things including various programming techniques, gradient descent, conjugate gradient, Quasi-Newton methods, stochastic optimization, evolutionary algorithms, convex optimization, unconstrained optimization, and constrained optimization. The course will also cover applications of optimization techniques in IoT.

Course Outcome:

After completion of the Course, Students will be able to:

No	Course Outcomes	RBT Level*
01	Understand the optimization techniques and algorithms.	UN
02	Apply optimization techniques to solve real-world problems.	AP
03	Implement optimization algorithms using programming languages.	AP
04	Analyze optimization techniques and algorithms.	AN
05	Evaluate limitations of optimization techniques and algorithms.	EL

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Teaching and Examination Scheme:

Teaching Scheme			Total Credits	Assessment Pattern and Marks				Total Marks
				Theory		Practical		
L	T	PR	C	ESE (E)	PA(M)	ESE (V)	PA (I)	
03	00	02	04	70	30	30	20	150

Course Content:

Sr No	Course Content	No of Hours	% of Weightage
1	**Introduction to Optimization:** Definition of optimization, types of problems (linear, nonlinear, discrete, continuous), optimization vs. machine learning vs. search algorithms. optimization in reinforcement learning, optimization in natural language processing	8	20
2	**Unconstrained & Constrained Optimization:** Gradient descent methods (batch, mini-batch, stochastic), Newton's method and variants, convergence analysis, stochastic gradient descent. Lagrange multipliers, Karush-Kuhn-Tucker (KKT) conditions, penalty methods, interior point methods Metaheuristic Optimization Techniques: Genetic algorithms (encoding, selection, crossover, mutation), particle swarm optimization, ant colony optimization, simulated annealing, Exploit heterogeneity, Component-based protocol stacks and cross-layer optimization,	10	25
3	**Evolutionary Algorithms and Optimization in Machine Learning:** Evolutionary strategies, genetic programming, differential evolution, Optimization in neural networks (backpropagation, stochastic gradient descent, Adam optimizer), support vector machines (dual and primal optimization) Feature selection, dimensionality reduction (PCA, LDA), hyper parameter tuning (grid search, Bayesian optimization),	10	25
4	**Ethical consideration for Optimization:** Optimization for interpretable AI, fairness and bias reduction in optimization, optimization in federated learning, Bias and fairness issues in optimization algorithms, ethical implications of optimization in IoT	8	20
5	**Optimization applications and case studies in IoT and data science**: Resource Allocation, Recommendation Systems, Energy Optimization, Route Optimization, Supply chain Optimization. Case Studies: Netflix, Amazon, Google, Facebook, Uber, Microsoft	6	10
	TOTAL	**45**	**100**

Reference Book:

1. Chander Mohan, Kusum deep, “Optimization Techniques”
2. Optimization Techniques in Artificial Intelligence and Data Science
3. Jorge Nocedal and Stephen J Wright, “Numerical Optimization”,
4. Stephen Boyd and Lieven Vendenberghe, “Convex Optimization”,

5. Suvrit Sra, Sebastian Nowozin and Stephen j Wright “Optimization for Machine Learning”.

Suggested Course Practical List:

- The practical work will be carried out based on the content covered during the academic sessions.

List of Laboratory/Learning Resources Required:

- Optimization Techniques for AI and Data Science" by IBM on Coursera
- Optimization Methods for Machine Learning" by Stanford University on Stanford Online
- Convex Optimization" by MIT Open Courseware
- Optimization for AI and Data Science by Microsoft Research
- Optimization Techniques for Machine Learning by Google AI
- Convex Optimization by Stanford University

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