MME 4151: Optimization Techniques

Designed for: B. Tech | Semester: Odd | Year: Fourth
Course: Open elective | Credits:3.0 | Hours:40

Course context and overview:

In an Industry, engineers are always are always ask to lower the production cost to withstand global competition. This ever-increasing demand on engineers encourage them to look for rigorous methods of decision making such as optimization methods, to design and produce products and systems both economically and efficiently. Optimization techniques are being used in a wide spectrum of industries, including aerospace, automotive, chemical, electrical, construction, and manufacturing industries. The objective of this course is to understand the optimization methods developed for solving various types of optimization problems. This course will develop and promote research interest in applying optimization techniques in problems of Engineering and Technology.

Prerequisites Courses: M1

Course Outcomes (COs):

After successful completion of the course, students will be able to	
CO1: Understand the basic principle of optimization and formulate the optimization problems	**Unit 1**
CO2: Understand the classical and traditional optimization techniques	**Unit 2**
CO3: Apply mathematical techniques to solve optimization problems	**Unit 3**
CO4: Develop and formulate optimization problems from the data and description available from the real-life engineering problems	**Unit 4 and Unit 5**

Text Books:

1. Singiresu S. Rao, Engineering Optimization-Theory and Practice, Published by John Wiley & Sons, Inc., Hoboken, New Jersey

2. Kalyanmoy deb, Optimization for Engineering Design: Algorithms and Examples, PHI Learning Pvt. Ltd

Reference books:

1. L. R. Foulds, Optimization Techniques: An Introduction, Springer publication

Additional Resources: NPTEL, MIT Video Lectures, Web resources etc.

UNITS	COURSE TOPIC	Lecture Hours	Student Development
UNIT 1	**Introduction to optimization**	**6**	
	Introduction, Statement of an optimization problems: Design vector, Design constraints and surface, objective function and surface Classification of optimization problems: Based on constraints, nature and permissible values of design variables, physical structure of the problem, nature of equations involved, deterministic nature of variables, separability of functions, number of objective functions.	**2** **4**	**Employability and Skill Development**
UNIT 2	**Classical Optimization Techniques**	**8**	
	Single Variable Optimization, Multivariable Optimization with no Constraints: Semidefinite case, saddle point Multivariable Optimization with Equality Constraints: Solution by direct substitution, method of constrained variation, Method of Lagrange multipliers Multivariable Optimization with Inequality Constraints:	**2** **4** **2**	**Employability and Skill Development**

	Kuhn-Tucker conditions, constraint qualification		
UNIT 3	**Unconstrained and Constrained Optimization Techniques**	**12**	
	One dimensional Minimization methods: Unimodal function, Exhaustive Search, Fibonacci Method, Golden Section method, Interpolation Methods Direct search methods: Random search methods, Pattern and Grid Search Methods, Powell's method. Indirect Search Methods: Steepest descent Methods, Conjugate Gradient Method, Penalty Function Method,	**4** **4** **4**	**Employability and Skill Development**
UNIT 4	**Optimal Control and Optimality Criterion Methods**	**8**	
	Introduction, Calculus of variations: Introduction, Problems of calculus of variations, Lagrange multipliers and constraints Optimal Control Theory: Necessary conditions for optimal control and general problem Optimality criteria methods: With single and multiple displacement constraints	**3** **3** **2**	**Employability and Skill Development**
UNIT 5	**Modern methods of Optimization Techniques**	**6**	
	Introduction to advanced optimization techniques: Genetic Algorithms: Introduction, Representation of design variables, objective function and constraints, Genetic operators Simulated Annealing, Particle swarm optimization, Ant colony optimization, optimization of fuzzy systems, Neural-network-based optimization.	**4** **2**	**Employability and Skill Development**

Evaluation Methods:

Evaluation criteria will be shared by the concerned course instructor.

Prepared By: Dr. Servesh Kumar Agnihotri
Last Update: 19/07/2020