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| **21DS601 Optimization Techniques for Data Science L-T-P-C: 2-1-0-3** |

**Course Objectives**

* The course will lay down the basic concepts and techniques of optimization theory needed for subsequent study.
* The course provides a thorough understanding of how optimization problems are solved, and some experience in solving them.
* The course will provide the background required to use the methods in research work and/or applications.

**Course Outcomes**

After completing this course, the students will be able to

* **CO1:** Understand the importance of optimization for data science and apply basic concepts of mathematics to formulate and understand optimization problem.
* **CO2:** Understand the analytical methods for solving constrained optimization problems and unconstrained optimization problems.
* **CO3:** Understand various applications arising in different scientific domains such as control, signal processing, machine learning and communications.

**CO-PO Mapping**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **PO/PSO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
| **CO** |
| **CO1** | 1 | 2 | 3 | 3 | 3 | 3 | 3 | - | - | - |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | - | 2 | - |
| **CO3** | 2 | 3 | 3 | 3 | 3 | 3 | - | - | 3 | 3 |

**Syllabus**

Introduction - mathematical optimization, least-squares and linear programming, convex and nonlinear optimization. convex sets, Convex optimization problems - optimization problem in standard form, convex optimization problems, quasi-convex optimization, linear optimization, quadratic optimization, generalized inequality constraints, semi definite programming, vector optimization. Duality, approximation and fitting, statistical estimation, geometric problems, Unconstrained minimization- gradient descent method, steepest descent method, Newton's method. Equality constrained minimization - equality constrained minimization, eliminating equality constraints, Newton's method with equality constraints, infeasible start Newton method, and implementation. Interior-point methods -inequality constrained minimization, logarithmic barrier function and central path, barrier method, L1 Norm optimization methods. Introduction to Neural Networks - Alternating direction method of multipliers (ADMM) and applications (16 applications mentioned by Prof. Stephen Boyd)

**Textbook / References**

*Kalyanmoy, Deb. Optimization for engineering design: Algorithms and examples. Prentice-Hall of India Pvt. Limited, 2012.*

*Chong, Edwin KP, and Stanislaw H. Zak. An introduction to optimization. John Wiley & Sons, 2004.*

*Bhatti, M. Asghar. Practical Optimization Methods: With Mathematica® Applications. Springer Science & Business Media, 2012.*

*Stephen P. Boyd, and Lieven Vandenberghe. Convex optimization. Cambridge university press, 2004.*

*Lecture notes on optimization*

**Evaluation Pattern**

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| **Assessment component** | **Type of Assessment** | **Minimum Number of Assessments** | **Weightage (%)** |
| Internal | Quizzes, Assignments, Presentations | 8 (each worth 10%) | 80 |
| External | Term Project | 1 | 20 |