

# Course 1: UMAT-503 - Optimization Techniques

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## Course Objectives

- Introduce the students to the mathematical formulation of optimization.
- Expose the students to a spectrum of optimization techniques and their applicability.

## Course Outcomes

- Apply mathematical skills to model optimization problems.
- Critically analyse theoretical principles and choose the relevant optimization techniques for a specific problem.
- Get exposed to solutions for various types of optimization problems and be enabled to adopt them for the situation at hand.

## Syllabus

Unit	Topic	Contents	Periods
1	Mathematical Review	Lines – Hyperplanes and linear varieties – convex sets – neighbourhoods – polytopes and polyhedra – derivative matrix – level sets and gradients – Taylor's series	8
2	Unconstrained Optimization	Conditions for local minimizers – one-dimensional search methods including golden section, Fibonacci, bisections and Newton's method – Gradient methods including steepest descent methods, Newton's method and its analysis.	12
3	Modelling with Linear Programming	The Simplex method and Sensitivity Analysis, Duality and Post-Optimal Analysis	16
4	Non-Linear Constrained Optimization	Problems with equality constraints – Lagrange condition – second-order condition – minimizing quadratics subject to equality constraints – problems with inequality constraints – Karush-Kuhn-Tucker conditions – second-order conditions.	12
5	Convex Optimization Problems	Convex Functions – Convex Optimization Problems	8
		<b>Total</b>	<b>56</b>

## Key Text(s)

- Edwin K. P. Chong and Stanislaw H. Zak, An Introduction to Optimization, Wiley Inter-Science Publication, John Wiley and Sons Inc., ISBN 978-1-118-27901-4, 4th edition (2013). — Chapters: 4, 5 (5.3–5.6), 6, 7 (7.1–7.5), 8 (8.1–8.2), 9 (9.1–9.2), 20, 21, 22 (22.1–22.3)
- Hamdy A. Taha, Operations Research, Pearson Publication, 9th edition (2014). — Chapters: 2, 3, 4

## Suggested / Additional Readings

- L.R. Foulds, Optimization Techniques, Springer, UTM, 1981.
- Numerical Optimization video lectures: <http://freevideolectures.com/Course/3072/Numerical-Optimization>
- Boyd, Stephen, and Lieven Vandenberghe, Convex Optimization, Cambridge University Press, UK, 2004.