This course will focus on fundamental subjects in (deterministic) optimization, connected through the themes of convexity, Lagrange multipliers, and duality.

The aim is to develop the core analytical issues of continuous optimization, duality, and saddle point theory using a handful of unifying principles that can be easily visualized and readily understood.

The mathematical theory of convex sets and functions will be central, and will allow an intuitive, highly visual, geometrical approach to the subject. This theory will be developed in detail and in parallel with the optimization topics.


2. **Convexity and Optimization (4 lectures):** Global and local minima. Directions of recession and existence of optimal solutions. Hyperplanes. Elementary form of duality. Saddle points and minimax theory.


5. **Conjugate Convex Functions (1 lecture):** Conjugate functions. The Fenchel duality theorem. Exact penalty functions.


7. **The Fenchel Duality Theorem - Semidefinite Programming (2 lectures):** Primal and dual Fenchel duality theorems. Cone programming. Semidefinite programming and applications.


This course places emphasis on proofs as well as geometric intuition. It is more sophisticated than Linear Programming, and Nonlinear Programming (6.251, 6.252), and has some but not much overlap with these two courses.


**Prerequisites:** A course in linear algebra and a course in real analysis, such as 18.06 and 18.100.