

The Hahn-Banach-Lagrange theorem

Abstract. We discuss the Hahn-Banach-Lagrange theorem, a generalized form of the Hahn-Banach theorem. As applications, we derive various results on the existence of linear functionals in functional analysis, on the existence of Lagrange multipliers for convex optimization problems, with an explicit sharp lower bound on the norm of the solutions (multipliers), on finite families of convex functions (leading rapidly to a minimax theorem), on the existence of subgradients of convex functions, and on the Fenchel conjugate of a convex function. We give a complete proof of Rockafellar's version of the Fenchel duality theorem, and an explicit sharp lower bound for the norm of the solutions of the Fenchel duality theorem in terms of elementary geometric concepts.

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