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OPTIMAL DESCENT CURVES. A NEW APPROACH TO THE SOLUTION OF AN OLD PROBLEM

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The aim of this work is to develop a new method for the solution of the well-known brachistochrone problem (the determination of the curve of fastest descent), to study the optimality of the descent curves obtained with its help, and to estimate the descent time for the proposed curves and for those obtained by the classical method. The topicality of this aim is substantiated. It is shown that the proposed method may be used in the solution of problems of technical mechanics.

The method is developed based on the study of the first variation of a functional with an autonomous integrand for a fixed-end problem. The function variation at the boundary points is assumed to be nonzero. It is shown that this assumption and the introduction of some other assumptions and limitations allow one to widen the class of functions among which extremal descent curves should be sought for. A procedure is developed for the determination of extremality conditions for this class of functions. It is shown that this procedure is based on two conditions, one of which is the Euler eqation. The new extremality condition is not invariant under the coordinate system. Used together, the two extremality conditions have made it possible to construct two curves that meet the necessary and sufficient extremality conditions when the second functional variation is represented in parametric form. The descent time for the proposed curves is compared with that for the classical extremals, and the former is shown to be shorter than the latter.

Keywords: *first functional variation, joint use of extremality conditions, noninvariance under the coordinate system, parametric form of the second variation, optimal descent curves.*

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