Penalty functions for control systems with constraints: necessary conditions of optimality

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In this course, we derive necessary conditions of optimality for different optimal control problems with "passive" and "active" constraints. By passive constraints, we mean state and mixed constraints and by active constraints, we mean problems with control systems involving the normal cone to a set of admissible states. Active constraints appear in sweeping processes and in rigid multibody systems subject to frictionless unilateral constraints. We approximate the constraints in all these problems by penalty functions and deduce necessary conditions of optimality by passing to the limit in the necessary conditions for the approximating systems. We intentionally consider a smooth case and the simplest boundary conditions; we consider global minimum and assume that the set of trajectories of the control system is compact. The aim is not to obtain the most general results but to present proofs as simple as possible.