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This book is devoted to real analysis methods for the problem of constructing Markov processes with boundary conditions in probability theory. Analytically, a Markovian particle in a domain of Euclidean space is governed by an integro-differential operator, called the Waldenfels operator, in the interior of the domain, and it obeys a boundary condition, called the Ventcel (Wentzell) boundary condition, on the boundary of the domain. Most likely, a Markovian particle moves both by continuous paths and by jumps in the state space and obeys the Ventcel boundary condition, which consists of six terms corresponding to diffusion along the boundary, an absorption phenomenon, a reflection phenomenon, a sticking (or viscosity) phenomenon, and a jump phenomenon on the boundary and an inward jump phenomenon from the boundary. More precisely, we study a class of first-order Ventcel boundary value problems for second-order elliptic Waldenfels integro-differential operators. By using the Calderón–Zygmund theory of singular integrals, we prove the existence and uniqueness of theorems in the framework of the Sobolev and Besov spaces, which extend earlier theorems due to Bony–Courrège–Priouret to the vanishing mean oscillation (VMO) case. Our proof is based on various maximum principles for second-order elliptic differential operators with discontinuous coefficients in the framework of Sobolev spaces. My approach is distinguished by the extensive use of the ideas and techniques characteristic of recent developments in the theory of singular integral operators due to Calderón and Zygmund. Moreover, we make use of an L_p variant of an estimate for the Green operator of the Neumann problem introduced in the study of Feller semigroups by me. The present book is amply illustrated; 119 figures and 12 tables are provided in such a fashion that a broad spectrum of readers understand our problem and main results.
