

In this thesis, the aim is to employ some of the advanced probability and calculus techniques to financial mathematics. In the first chapter some major facts from continuous - time probability theory are presented. In the second chapter, one - dimensional stochastic differential equations are introduced, we touch upon the questions of existence and uniqueness of solutions in full generality, construct a weak solution to the Engelbert - Schmidt equation and thoroughly present a known procedure called a Feller's test for explosions. In chapter three, focus is directed to a brief presentation of the well known Dirichlet problem. The problem is also interpreted financially, applied to options valuation and related approximations are implemented. The fourth, final, chapter concentrates on the Cox - Ingersoll - Ross model. Techniques derived in the second and third chapters are employed to thoroughly study the model properties.