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Advanced Courses in Mathematics – CRM Barcelona (ACM)

Edited by

Enric Ventura, Universitat Politècnica de Catalunya

Since 1995 the Centre de Recerca Matemàtica (CRM) has organised a number of Advanced Courses at the post-doctoral or advanced graduate level on forefront research topics in Barcelona. The books in this series contain revised and expanded versions of the material presented by the authors in their lectures.

■ **Bolsinov, A. / Morales-Ruiz, J. / Zung, N.,** Geometry and Dynamics of Integrable Systems (2016)
ISBN 978-3-319-33502-5
These lecture notes address three major aspects of integrable systems: obstructions to integrability from differential Galois theory; the description of singularities of integrable systems on the basis of their relation to bi-Hamiltonian systems; and the generalization of integrable systems to the non-Hamiltonian settings. All three sections were written by top experts in their respective fields.
Native to actual problem-solving challenges in mechanics, the topic of integrable systems is currently at the crossroads of several disciplines in pure and applied mathematics, and also has important interactions with physics. The study of integrable systems also actively employs methods from differential geometry. Moreover, it is extremely important in symplectic geometry and Hamiltonian dynamics, and has strong correlations with mathematical physics, Lie theory and algebraic geometry (including mirror symmetry). As such, the book will appeal to experts with a wide range of backgrounds.

■ **Bally, V. / Caramellino, L. / Cont, R.,** Stochastic Integration by Parts and Functional Itô Calculus (2016).
ISBN 978-3-319-27127-9
This volume contains lecture notes from the courses given by Vlad Bally and Rama Cont at the Barcelona Summer School on Stochastic Analysis (July 2012). The notes of the course by Vlad Bally, co-authored with Lucia Caramellino, develop integration by parts formulas in an abstract setting, extending Malliavin's work on abstract Wiener spaces. The results are applied to prove absolute continuity and regularity results of the density for a broad class of random processes. Rama Cont's notes provide an introduction to the Functional Itô Calculus, a nonanticipative functional calculus that extends the classical Itô calculus to path-dependent functionals of stochastic processes. This calculus leads to a new class of path-dependent partial differential equations, termed Functional Kolmogorov Equations, which arise in the study of martingales and forward-backward stochastic differential equations. This book will appeal to both young and senior researchers in probability and stochastic processes, as well as to practitioners in mathematical finance.

■ **Hacking, P. / Laza, R. / Oprea, D.,** Compactifying Moduli Spaces (2015).
ISBN 978-3-0348-0920-7
This book focusses on a large class of objects in moduli theory and provides different perspectives from which compactifications of moduli spaces may be investigated.
Three contributions give an insight on particular aspects of moduli problems. In the first of them, various ways to construct and compactify moduli spaces are presented. In the second, some questions on the boundary of moduli spaces of surfaces are addressed. Finally, the theory of stable quotients is explained, which yields meaningful compactifications of moduli spaces of maps.
Both advanced graduate students and researchers in algebraic geometry will find this book a valuable read.

■ **Llibre, J. / Moeckel, R. / Simó, C.,** Central Configurations, Periodic Orbits, and Hamiltonian Systems (2015).
ISBN 978-3-0348-0932-0
The notes of this book originate from three series of lectures given at the Centre de Recerca Matemàtica (CRM) in Barcelona. The first one is dedicated to the study of periodic solutions of autonomous differential systems in R^n via the Averaging Theory and was delivered by Jaume Llibre. The second one, given by Richard Moeckel, focusses on methods for studying Central Configurations. The last one, by Carles Simó, describes the main mechanisms leading to a fairly global description of the dynamics in conservative systems. The book is directed towards graduate students and researchers interested in dynamical systems, in particular in the conservative case, and aims at facilitating the understanding of dynamics of specific models. The results presented and the tools introduced in this book include a large range of applications.

■ **Alexeev, V.,** Moduli of Weighted Hyperplane Arrangements (2015).
ISBN 978-3-0348-0914-6