SAINT PETERSBURG STATE UNIVERSITY
EULER INTERNATIONAL MATHEMATICAL INSTITUTE

# 2017 CONSTRUCTIVE NONSMOOTH ANALYSIS AND RELATED TOPICS (DEDICATED TO THE MEMORY OF V.F. DEMYANOV) (CNSA)

## CNSA-2017

RUSSIA, SAINT-PETERSBURG,
MAY 22 — 27, 2017

Proceedings
Edited by: L. N. Polyakova

ISBN 978-1-5090-6260-7
IEEE Catalog number CFP17L17-ART

# 2017 Constructive Nonsmooth Analysis and Related Topics (dedicated to the memory of V.F. Demyanov) (CNSA)

## Copyright and Reprint Permission

Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limit of U.S. copyright law for private use of patrons those articles in this volume that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923. For reprint or republication permission, email to IEEE Copyrights Manager at pubs-permissions@ieee.org. All rights reserved.

Copyright © 2017 by IEEE

Xplore Compliant: ISBN 978-1-5090-6260-7
IEEE Catalog number CFP17L17-ART

Copyright © 2017 by IEEE

# 2017 Constructive Nonsmooth Analysis and Related Topics (dedicated to the memory of V.F. Demyanov) (CNSA)

## Technical Program Committee

**Chairman:** Petrosyan L.A. (St. Petersburg State University, Russia)
**Vice-Chairman:** Malozemov V.N. (St. Petersburg State University, Russia)
Polyakova L.N. (St. Petersburg State University, Russia)
**Committee members:**
Egorov N.V. (St. Petersburg State University, Russia)
Lisenkov A.A. (St. Petersburg State Electrotechnical University "LETI", Russia)
Luchinin V.V. (St. Petersburg State Electrotechnical University "LETI", Russia)
Ovsyannikov D.A. (St. Petersburg State University, Russia)
Yankevich V.B. (St. Petersburg State Electrotechnical University "LETI", Russia)

## Organizing Committee

**Chairman:** Kurzhanski A.B. (Lomonosov Moscow State University, Russia)
**Vice-Chairman:** Malozemov V.N. (St. Petersburg State University, Russia)
Polyakova L.N. (St. Petersburg State University, Russia)
**Secretary:** Vinogradova T. (Euler International Mathematical Institute, Russia)
Zalesskaya N. (Euler International Mathematical Institute, Russia)
**Committee members:**
Golovkina A.G. (St. Petersburg State University, Russia)
Karelin V.V. (St. Petersburg State University, Russia)
Tamasyan G.S. (St. Petersburg State University, Russia)

## International Program Committee

**Chairman:** Malozemov V.N. (St. Petersburg State University, Russia)

A.V. Arutyunov (Russia)
A. Bagirov (Australia)
F.L. Chernous'ko (Russia)
S. Dempe (Germany)
G. Di Pillo (Italy)
S.I. Dudov (Russia)
N.V. Egorov (Russia)
Y.G. Evtushenko(Russia)
M. Gaudioso (Italy)
F. Giannessi (Italy)
V.V. Gorokhovik (Belarus)
J. Gwinner (Germany)
A.D. Ioffe (Israel)
M.Yu. Khachai (Russia)
O.V. Khamisov (Russia)
A. Kruger (Australia)
A.B. Kurzhanski (Russia)
S.S.Kutateladze (Russia)
Yu. Ledyaev (USA)
G.A. Leonov (Russia)
M.M. Makela (Finland)
V.V. Mazalov (Russia)
B. Mordukhovich (USA)
Yu. E. Nesterov (Belgium)
D.A. Ovsyannikov (Russia)
D. Pallaschke (Germany)
L.A. Petrosyan (Russia)
E. S. Polovinkin (Russia)
B.T. Polyak (Russia)
P. I. Stetsyuk (Ukraine)
A.S. Strekalovski (Russia)
M. Thera (France)
V.M. Tikhomirov (Russia)
E.I. Veremey (Russia)
A.P. Zhabko (Russia)
V.I. Zorkaltsev (Russia)
V.V. Zhuk (Russia)

# Table of Contents


1 Geometric Conditions of Reduction of Coexhausters
*Abbasov M. E.*

4 Stability Analysis of Hybrid Mechanical Systems with Switched Nonlinear Nonhomogeneous Positional Forces
*Aleksandrov A., Kosov A.*

8 Nonsmooth Problem of Stability for Elastic Rings
*Andryukova V., Tarasov V.*

11 Sufficient Conditions and Evidence-Based Solutions
*Antipin A.*

14 Covering Mappings and Their Applications
*Arutyunov A. V., Zhukovskiy S. E.*

17 Nonsmooth Analysis for Control Problem in the Space of Probabilities
*Averboukh Y.*

20 Error Estimates for Numerical Integration of ODEs in the Minimax Formulation
*Babadzanjanz L. K., Pototskaya I. Y., Pupysheva Y. Y.*

23 Adjoint Extremal Problem for Non-Smooth Functionals
*Baran I., Orlov I.*

27 On the Choosing Problem of PID Controller Parameters for a Quadrocopter
*Baranov O. V., Smirnov N. V., Smirnova T. E.*

30 On the Problem of Control of Continuous-Discrete Systems with Changes in Dimensions of Phase Space and of Control Vector
*Barseghyan V. R.*

33 Software for Pareto Set Reduction
*Baskov O., Noghin V.*

36 Adaptive Mirror Descent for Constrained Optimization
*Bayandina A.*

40 Adaptive Stochastic Mirror Descent for Constrained Optimization
*Bayandina A.*

44 The Influence of Mobile Load on the Carrier Dynamics
*Bilchenko G.*

48 The One-Dimensional and Two-Dimensional Inverse Problems of Heat and Mass Transfer on Hypersonic Aircraft Permeable Surfaces
*Bilchenko G., Bilchenko N.*

52 On the Bijectivity of Controls Pairs and Pairs of Heat and Mass Transfer Local Parameters in the Hypersonic Flow Stagnation Point
*Bilchenko G., Bilchenko N.*

55 Strongly Time-Consistent Core in Multistage Games
*Bulgakova M., Petrosyan L.*

59 The Problem of Elastic-Plastic Bending of Heavy SD-Beams
*Bunin G. V.*

61 Methods of Cluster Analysis for Detection of Homogeneous Groups of Healthcare Time Series
*Bure V., Staroverova K.*

65 Analysis of Color Characteristics of Plants Using Aerial Photography
*Bure V. M., Mitrofanova O. A.*

67 Suboptimal Control in the Stochastic Nonlinear Dynamic Systems
*Butirskiy E., Vasilyev V., Ponkratova K.*

69 Spline-Approximation in the Task Status Estimation of Nonlinear Dynamic Systems
*Butirskiy E., Vasilyev V., Ponkratova K.*

71 Dynamics of a Body with Internal Moving Masses in the Presence of Dry Friction
*Chernousko F.*

75 On Some Properties of Superposition of Optimality Principles on the Space of TU-games
*Chistyakov S., Vasetsov M.*

78 Simulation of Particle Motion In the Given Nonsmooth Speed Fields
*Davydenko A., Starkov V., Stepenko N.*

82 A General Lagrange Multipliers Theorem
*Dmitruk A., Osmolovskii N.*

85 On the Question of Zero-Controllability of Nonstationary Bilinear Systems
*Ekimov A., Balykina Y., Svirkin M.*

88 A Stable Solution of Linear Programming Problems with the Approximate Matrix of Coefficients
*Erokhin V.*

91 Dynamic Stability of the Shapley Value in the Differential Resource Extraction Game
*Ershov D.*

94 Polyhedral Methodology for Conflict Control of Competing Objects in Pursuit Conditions
*Filimonov A., Filimonov N.*

99 Application of the Steepest Descent Method to Solving Differential Inclusions with Either Free or Fixed Right End
*Fominyh A.*

103 An Algorithm for Data Analysis via Polyhedral Optimization
*Gabidullina Z.*

107 Solving of a Projection Problem for Convex Polyhedra Given by a System of Linear Constraints.
*Gabidullina Z.*

110 Analysis of Elastic Systems With Discontinuous Parameters
*Goloskokov D. P., Matrosov A. V.*

114 Characteristics Optimization for Accelerator Driven Cascade Subcritical Reactor
*Golovkina A. G., Kudinovich I. V.*

118 Nonsmooth Mechanical Systems with Impactively Blockable Degrees of Freedom and Active Holonomic Constraints
*Goncharova E., Staritsyn M.*

122 Demyanov-Rubinov Subdifferentials of Real-Valued Functions
*Gorokhovik V.*

126 On the Superadditivity of a Characteristic Function in Cooperative Differential Games With Negative Externalities
*Gromova E., Malakhova A., Marova E.*

130 Evolutionary Behavior of Taxpayers in the Model of Information Dissemination
*Gubar E., Kumacheva S., Zhitkova E., Kurnosykh Z.*

134 Integrability of Nonsmooth One-Variable Functions
*Ivanov G., Alferov G., Efimova P.*

138 Special Matrix Transformations of Essential Nonlinear Control Systems
*Kamachkin A. M., Shamberov V. N., Chitrov G. M.*

141 Online Optimization Algorithms for Multi-Armed Bandit Problem
*Kamalov M., Dobrynin V., Balykina Y.*

144 A Stochastic Model of Rumour Spreading
*Karelin V. V., Bure V. M., Polyakova L. N., Svirkin M. V.*

146 On Boundary Conditions at Infinity for Infinite Horizon Control Problem
*Khlopin D.*

149 Minimizing a Sensitivity Function as Boundary-Value Problem in Terminal Control
*Khoroshilova E.*

152 Investigation of Controllability of Polysystems in Discrete Time Using Their Invariant Measures
*Khryashchev S. M.*

156 Two-Component Immunization
*Kolesin I.*

158 Properties of Solutions of Nonlinear Equations of Mechanics Control Systems
*Korolev V.*

163 Stochastic Model of the Universe Matter
*Korolev V., Novoselov V.*

167 On the Control Problem of a Switched Mechanical System
*Kosov A.*

169 Optimization of Dispersive and Dissipative Characteristics of Finite-Difference Schemes for Advection Equation
*Krivovichev G. V., Marnopolskaya E. S.*

173 Non-Smooth Resource Allocation Problem
*Krylatov A., Shirokolobova A., Zakharov V., Malygin I.*

175 One Method for Computing the Pareto-Optimal Nash Equilibrium in Bimatrix Game
*Kudryavtsev K., Zhukovskiy V., Stabulit I.*

178 An Irrational Behavior Proof Condition for Multistage Multicriteria Games
*Kuzyutin D., Nikitina M.*

182 Solution of Control Problems for Nonlinear Stationary System Taking Into Account the Non-Stationary Perturbation
*Kvitko A. N., Firulina O. S., Maksina A. M., Chistyakov S. V.*

185 Construction of Nonsmooth Solutions in One Class of Velocity Problems
*Lebebev P. D., Uspenskii A. A., Ushakov V. N.*

189 Multi-objective Optimization in Ship Weather Routing
*Li X. G., Wang H. B., Wu Q.*

193 An Improved A* Algorithm for Fuel-efficient Ship Weather Routing
*Shen Z. H., Wang H. B., Liu H.*

196 A Method to Determine the Local Optimal Path of Ship Navigation for Convex Obstacle
*Li X. Y., Wang H. B., Shen Z. H.*

199 Weakly Convex Sets in Asymmetric Normed Spaces
*Lopushanski M.*

201 Quality Estimation of the Geopolitical Actor Development Strategy
*Malafeyev O. A., Redinskikh N. D.*

203 Analysis of Elastic Systems With Nonsmooth Boundaries
*Matrosov A. V., Goloskokov D. P.*

207 Problems and Optimization Algorithms of Schedules of Parallel-Serial Systems with Undefined Service Routes
*Mezentsev Y., Estraykh I.*

210 Binary Cut-and-Branch Method for Solving Mixed Integer Programming Problems
*Mezentsev Y.*

213 Statistical Evaluation of the Exact Relaxation Method
*Miheev S. E.*

216 Estimates of the Convergence Rate with the Help of Half-derivatives
*Miheev S. E.*

218 Minimax Problem of Simultaneous Optimization of Smooth and Non-Smooth Functionals
*Mizintseva M., Ovsyannikov D.*

222 On the Minimax Approach In a Singularly Perturbed Control Problem
*Myshkov S.*

226 Approximation of Convex Fuzzy Sets
*Noghin V.*

229 Undifferentiated Optimization of Data Sample
*Orekhov A. V.*

232 Sublinear Extension of Algebraic Grothendieck Theory
*Orlov I. V.*

235 Subdifferentials via Sub-Operators
*Orlov I. V.*

239 Stable Cooperation in Oligopoly
*Parilina E., Sedakov A.*

244 An Approximate Solution of Elastic-Plastic Problem of Circular Strength Different (SD) Plates
*Pavilaynen G. V., Yushin R. U.*

247 Elements of Non-Smooth Analysis in the Theory of Waves
*Peregudin S., Peregudina E., Kholodova S.*

249 Methods of Non-Smooth Analysis in Problems of Fluid Dynamic
*Peregudin S., Peregudina E., Kholodova S.*

251 Differential Game of Oil Market with Moving Informational Horizon and Non–Transferable Utility
*Petrosian O., Nastych M., Volf D.*

255 Existence of Strong Nash Equilibrium in Repeated and Multistage Games
*Petrosyan L., Chistyakov S., Pankratova Y.*

258 Synthesis of Optimal Boundary Control of Parabolic Systems With Distributed Parameters on the Graph
*Podval'ny S. L., Provotorov V. V.*

261 Calculation of Subdifferentials for the Difference of Two Convex Functions
*Polovinkin E.*

263 About Constructing a Dual Polyhedral Cone in $R^3$
*Polyakova L., Popova M., Karelin V.*

266 Polyhedral Estimation of the Controllability Region of a Nonlinear System
*Ponomarev A.*

268 Solvability of Nonlinear Initial Boundary Value Problem With Distributed Parameters in a Netlike Domain
*Provotorov V. V.*

272 Generalized Solutions of Bounded p-Variation of Nonlinear Control Systems and Nonsmooth Optimal Impulsive Control Problems
*Samsonyuk O., Staritsyn M.*

276 Optimal Impulsive Control Problems with Hysteresis
*Samsonyuk O., Timoshin S.*

281 A Variant of Mirror Descent Method for Solving Variational Inequalities
*Semenov V. V.*

285 Ambulance Resources Reallocation in St. Petersburg Using Imitation Modelling Approach
*Shavidze G., Balykina Y., Lezhnina E.*

288 On the Coupled Orbit-Attitude Control Motion of a Celestial Body in the Neighborhood of the Collinear Libration Point $L_1$ of the Sun–Earth System
*Shymanchuk D.*

292 Combined Control Synthesis Algorithm
*Smirnov N. V., Smirnov A. N., Smirnov M. N., Smirnova M. A.*

295 Representation of the Compact-Valued Sublinear Operator by Basis Selectors Packet and Sub-Invertibility
*Smirnova S., Orlov I.*

299 Solving one Class of Systems of the Polynomial Volterra Equations of the First Kind by Newton's Method
*Solodusha S.*

304 Transoceanic Routes Optimization using Dynamic Properties of Ship and Weather Conditions
*Sotnikova M. V., Veremey E. I., Korovkin M. V.*

308 On Feedback Maximum Principle for Nonsmooth Optimal Impulsive Control Problems
*Staritsyn M., Sorokin S.*

312 $2d$-Ellipsoid of Optimal Volume and Its Applications
*Stetsyuk P.*

316 Subdifferential Calculus in Abstract Convex Cones
*Stonyakin F. S.*

320 Applications of Subdifferential Calculus to Bochner Integral Theory
*Stonyakin F. S.*

324 On Local Search in d.c. Optimization
*Strekalovsky A., Minarchenko I.*

328 Optimal Impulse Control of Bi-Virus SIR Epidemics with Application to Heterogeneous Internet of Things
*Taynitskiy V., Gubar E., Zhu Q.*

332 Nonsmooth Problems in the Mechanics of Elastic Systems
*Tarasov V.*

335 Impulse Differential Game with Fixed Time and One–dimensional Aim
*Ukhobotov V., Izmest'ev I.*

338 Alpha Sets in Finite-dimensional Euclidean Spaces and Their Properties
*Ushakov V. N., Uspenskii A. A., Ershov A. A.*

342 Metric Problems for Algebraic Manifolds: Analytical Approach
*Uteshev A. Y., Goncharova M. V.*

345 Irregular $H_\infty$-Optimization of Control Laws for Marine Autopilots
*Veremey E.*

349 On the Asymptotic Stability of a Class of Nonlinear Difference Switched Systems
*Voloshin M.*

352 Interval Regularization, Recognizing Functional, and Non-Smooth Optimization Technique
*Vorontsova E.*

357 Ship Weather Routing That Accounts for Ship Stability and Efficient Ship Routing Based on Modified Genetic Algorithm
*Wang Y. H., Wang H. B., Zhu X. M.*

361 Dynamic Shapley Value in the Game with Spanning Forest
*Yin L.*

365 Cutting-Plane Method With Embedding of Epigraphs of Auxiliary Functions
*Zabotin I., Kazaeva K.*

369 The Stability of Difference Systems With Linear Increasing Time-Delay
*Zhabko A., Chizhova O., Zaranik U.*

373 Simplex-like Algorithms for Linear Semidefinite Optimization
*Zhadan V.*

377 On the MATLAB Finite Element Modelling of an Elastic Plane with a Hole under Tension
*Zhao S., Pronina Y.*

381 Coalition Equilibrium in a Three-Person Game
*Zhukovskiy V., Kudryavtsev K.*

385 Algorithms of the Interior Point Method
*Zorkal'tsev V.*

389 Chebyshev, Octahedral and Eucledean Projection of a Point Onto Polyhedron
*Zorkal'tsev V.*

393 **Index of Authors**