

## TOPICS OF RESEARCH PROJECT

### Algebra and its applications

- **Arithmetical lattices and error-correcting codes.**

*Adviser:* assoc. prof. Alar Leibak

*Literature:*

1. Oggier, F., Viterbo, E., Algebraic number theory and code design for Rayleigh' fading channels, 621.396/O-35
2. Ericson, T., Zinoviev, V., Codes on euclidean spheres, 519/E-68

- **Central simple algebras and their applications in coding theory.**

*Adviser:* assoc. prof. Alar Leibak

*Literature:*

1. Berhuy, G., Oggier, F., An introduction to central simple algebras and their applications to wireless communication, Providence (R. I.): American Mathematical Society, ©2013, 512/B-45
2. Gille, P., Szamuely, T., Central simple algebras and Galois cohomology, CUP 2006, 512/G-45
3. Cohn, P. M., Further algebra and applications, London: Springer, ©2003 512/C-68

- **Conformal mappings on doubly connected domains.**

*Adviser:* assoc. prof. Alar Leibak

*Literature:*

1. Kythe Prem K., Computational conformal mapping., Birkhäuser, ©1998, 512/K-99
2. Gamelin, T., Complex analysis, New York: Springer ©2001 512/G-16

3. Costamagna, E., Di Barba, P., Savini, A., *Conformal mapping of doubly connected domains: an application to the modelling of an electrostatic micromotor*, IET Science, Measurement & Technology, 2009, **3**, pp. 334–342

- **Clifford algebras and their applications.**

*Adviser:* assoc. prof. Alar Leibak

*Literature:*

1. Jagannathan, R., On generalized Clifford algebras and their physical applications.  
[https://arxiv.org/find/math-ph,math/1/au:+Jagannathan\\_R/0/1/0/all/0/1](https://arxiv.org/find/math-ph,math/1/au:+Jagannathan_R/0/1/0/all/0/1)
2. Garling, D. J. H., Clifford algebras : an introduction, CUP 2011 512/G-19
3. De Sabbata, V., Geometric algebra and applications to physics, New York ; London : Taylor & Francis, ©2007, 53/D-46
4. Geometric computing with Clifford algebras : theoretical foundations and applications in computer vision and robotics, Gerald Sommer (ed.), Berlin: Springer, ©2001, 512/G-37
5. Gürlebeck, K., Sprössig, W., Quaternionic and Clifford calculus for physicists and engineers, Chichester : Wiley, ©1997, 517/G-95
6. Lounesto, P., Clifford algebras and spinors., Cambridge University Press, 2001.
7. Porteous, I. R., Clifford algebras and the classical groups, CUP 1995 51/P-85

- **Skew polynomials and their applications.**

*Adviser:* assoc. prof. Alar Leibak

*Literature:*

1. Cohn, P. M., Skew fields : theory of general division rings, CUP, 2003, 512/C-68
2. Cohn, P. M., Further algebra and applications, London: Springer, ©2003 512/C-68

- **Quasigroups and loops.**

*Adviser:* assoc. prof. Alar Leibak

*Literature:*

1. Smith, J. D. H., An introduction to quasigroups and their representations, Chapman & Hall/CRC, ©2007 512/S-68
2. Nagy, P. T., Strambach, K., Loops in group theory and Lie theory, Berlin ; New York : de Gruyter, ©2002 512/N-16

- **P-adic numbers and p-adic analysis.**

*Adviser:* assoc. prof. Alar Leibak

*Literature:*

1. Gouvêa, F. Q. P-adic numbers: an introduction, Springer, 1997.
2. Koblitz, N., P-adic numbers, p-adic analysis, and zeta-functions, New York : Springer-Verlag, 1977 VB-27521
3. Murty, M. R., Introduction to p-adic analytic number theory, AMS : International Press, ©2002 51/M-96
4. Robert, A. M., A course in p-adic analysis, GTM 198, Springer-Verlag 2010
5. Schikhof, W. H., Ultrametric Calculus: An Introduction to P-adic Analysis, CUP 2007

## **Numerical methods**

- **Monte Carlo methods and generation of random variables.**

*Adviser:* prof. Jaan Janno, assoc. prof. Margus Pihlak

*Literature:*

1. Thomopoulos, Nick T., *Essentials of Monte Carlo Simulation : Statistical Methods for Building Simulation Models*. Springer, 2012. e-book of TUT library
2. Fishman, G. S. *Monte Carlo : concepts, algorithms, and applications*. Springer, 1996.

- **Application of Monte Carlo methods in solution of optimization problems.**

*Adviser:* prof. Jaan Janno, assoc. prof. Margus Pihlak

*Literature:*

1. Rubinstein, Reuven Y.; Ridder, Ad; Vaisman, Radislav *Fast Sequential Monte Carlo Methods for Counting and Optimization*. Wiley Series in Probability and Statistics, 2013. e-book of TUT library
2. Rubinstein, Reuven Y, *Simulation and the Monte Carlo Method*. Wiley Series in Probability and Statistics, V. 190, 2009. e-book of TUT library

- **Genetic and other evolutionary algorithms in solution of optimization problems.**

*Adviser:* prof. Jaan Janno

*Literature:*

1. Simon, Dan *Evolutionary Optimization Algorithms*. Wiley, 2013. e-book of TUT library
2. Coello Coello, C., Lamont, G. B, Van Veldhuizen, D. A. *Evolutionary algorithms for solving multi-objective problems*. Springer, 2007.
3. Goldberg, D. E. *Genetic algorithms in search, optimization, and machine learning*. Addison-Wesley Pub. Co., 1989

- **Numerical methods to determine eigenvalues eigenvectors of matrices.**

*Adviser:* prof. Jaan Janno

*Literature:*

1. Börm, Steffen; Mehl, Christian, *Numerical Methods for Eigenvalue Problems*. De Gruyter Textbook, 2012. e-book of TUT library

- **Fractional differentiation and integration and their applications.**

*Adviser:* prof. Jaan Janno

*Literature:*

1. Herrmann, Richard, *Fractional Calculus : An Introduction for Physicists*. World Scientific Publishing Company, 2011. e-book of TUT library
2. Tarasov, V. E. *Fractional dynamics : applications of fractional calculus to dynamics of particles, fields and media*. Springer, 2010.

- **Integral equations.**

*Adviser:* prof. Jaan Janno

*Literature:*

1. Rahman, M., *Integral Equations and their Applications*. WIT Press, 2007. e-book of TUT library

- **Wavelets and their applications.**

*Adviser:* prof. Jaan Janno. sen. researcher Gert Tamberg

*Literature:*

1. Misiti, Michel; Misiti, Yves; Oppenheim, Georges; Poggi, Jean-Michel, *Wavelets and their Applications*. Wiley, 2010. e-book of TUT library
2. Cohen, A. *Numerical Analysis of Wavelet Methods*. Elsevier Science, 2003. e-book of TUT library

- **Inverse problems.**

*Adviser:* prof. Jaan Janno

*Literature:*

1. Fox, C., Nicholls, C. K., Tan, S. M., *An introductions to inverse problems*. Course notes, 2010.

[http://elec.otago.ac.nz/w/images/1/19/ELEC404\\_Inverse\\_Problems.pdf](http://elec.otago.ac.nz/w/images/1/19/ELEC404_Inverse_Problems.pdf)

2. Tarantola, A., *Inverse problem theory and methods for model parameter estimation*. SIAM, 2005.

<http://www.ipgp.fr/~tarantola/Files/Professional/Books/InverseProblemTheory.pdf>

## Statistics

- **Bayesian inference and the parametric bootstrap.**

*Adviser:* assoc. prof. Margus Pihlak

*Literature:*

1. Efron, B. (2012) Bayesian inference and the parametric bootstrap. *The Annals of Applied Statistics*, **6**, Nr. 4, lk. 1971-1997.
2. Chernick, Michael R. *Bootstrap Methods. A Guide for Practitioners and Researchers*. Wiley-Interscience 2008. ISBN 978-0-471-75621-7

- **Using Bayesian statistics on controlling of statistical hypotheses.**

*Adviser:* assoc. prof. Margus Pihlak

*Literature:*

1. Maivali, Ü. (2015) *Interpreting Biomedical Science*, Elsevier. ISBN 978-0-12-418689-7
2. Jaynes, E. T. (2003) *Probability Theory. The Logic of Science*, Cambridge University Press, ISBN 978-0-521-59271-0
3. Sober, E. (2008) *Evidence and Evolution*, Cambridge University Press, ISBN 978-0-521-69274-8

## Approximation theory and its applications

- **Shearlets**

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*Literature:*

1. Shearlets : multiscale analysis for multivariate data, Gitta Kutyniok, Demetrio Labate, editors. New York: Birkhuser, 2012.

- **Wavelets on sphere**

*Advisor:* sen. researcher Gert Tamberg

*Literature:*

1. Pierre Vandergheynst, Yves Wiaux, Wavelets on the Sphere In: Four short courses on harmonic analysis : wavelets, frames, time-frequency methods, and applications to signal and image analysis. Brigitte Forster, Peter Massopust, editors Boston: Birkhuser, 2010, pp 131-174.
2. Volker Michel, Lectures on constructive approximation : fourier, spline, and wavelet methods on the real line, the sphere, and the ball. New York: Springer, 2013

- **Frames**

*Advisor:* sen. researcher Gert Tamberg

*Literature:*

1. Ole Christensen, Frames and bases : an introductory course. Boston: Birkhuser, 2008.

- **B-Spline Generated Frames**

*Advisor:* sen. researcher Gert Tamberg

*Literature:*

1. Ole Christensen, B-Spline Generated Frames” In: „Four short courses on harmonic analysis : wavelets, frames, time-frequency methods, and applications to signal and image analysis. Brigitte Forster, Peter Massopust, editors Boston: Birkhuser, 2010, pp 51-86.

- **Theory of sampling series**

*Advisor:* sen. researcher Gert Tamberg

*Literature:*

1. Antonio G. Garcia, A brief walk through Sampling Theory. Advances in Imaging and Electron Physics, 124: 63-137, 2002.  
[http://gauss.uc3m.es/web/personal\\_web/agarcia/papers/02walk.pdf](http://gauss.uc3m.es/web/personal_web/agarcia/papers/02walk.pdf)

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