**MATEMAATIKA-LOODUSTEADUSKOND**
**MATEMAATIKAINSTITUUT**
**TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2014**

**1. Struktuur**
**Matemaatikainstituut, Department of Mathematics**
**Instituudi direktor Jaan Janno**

- Algebra ja geomeetria õppetool, Chair of Algebra and Geometry, Peeter Puusemp
- Matemaatilise analüüsi õppetool, Chair of Mathematical Analysis, Gert Tamberg
- Rakendusmatemaatika õppetool, Chair of Applied Mathematics, Jaan Janno
- Matemaatilise füüsika õppetool, Chair of Mathematical Physics, Eugen Paal

**2. Teadus- ja arendustegevuse (edaspidi T&A) iseloomustus**
*2.1* Struktuuriüksusesse kuuluvad uurimisgrupid *(kõik uurimisgrupid näidatakse aruandes eraldi, järgides alltoodud ülesehitust).*

**Research group of algebra and geometry** (Peeter Puusemp, Piret Puusemp, Alar Leibak)

− The aim is to develop the endomorphism theory of groups and quasigroups. We are finding some methods for describing these algebraic systems by their endomorphism semigroups.

− *Results in 2014* The endomorphism algebra of idempotent medial quasigroup was introduced and it was proved that each idempotent medial quasigroup is determined by its endomorphism algebra in the class of all idempotent medial quasigroups. (Alar Leibak, Peeter Puusemp). It was proved that each group of order 32 which has a maximal subgroup isomorphic to the direct products $C_4 \times C_2 \times C_2$ or $C_8 \times C_4$ of cyclic groups $C_8$, $C_4$ and $C_2$ is determined by its endomorphism semigroup in the class of all groups. (Piret Puusemp, Peeter Puusemp). It was proved that a multiple wreath product of groups is determined by its endomorphism semigroup in the class of all groups. In particularly, so is every Sylow subgroup of a finite symmetric group. (Peeter Puusemp). A binary operation ♦ was defined on an algebra with involution under which a suitable subset of this algebra is a group. This generalizes a result of Mihailichenko obtained for matrices. (A. Leibak)

− *Main publications*
  o Piret Puusemp, Peeter Puusemp. *On endomorphisms of groups of order 32 with maximal subgroups* $C_4 \times C_2 \times C_2$. Proc. Estonian Academy of Sciences, 2014, **63**, 2, 105-120.
  o Piret Puusemp, Peeter Puusemp. *On endomorphisms of groups of order 32 with maximal subgroups* $C_8 \times C_4$. Proc. Estonian Academy of Sciences, 2014, **63**, 4, 355-371.
  o Alar Leibak, Peeter Puusemp. *On determinability of some classes of medial quasigroups by their endomorphisms.* Journal of Physics: Conference Series. 2014, **532**, 1-9.

**Reasearch group of mathematical analysis**  (Gert Tamberg, Olga Orlova, Olga Meronen)

– We study the generalized Shannon sampling operators that mean the representations of functions in terms of series, where the expansion coefficients are its samples and expansion functions are translates of a certain kernel function. Moreover, we study generalized summability methods that mean the case if the elements of the sequence belong to the Banach space and the elements of the matrix are linear bounded operators.

– *Results in 2014* Sampling operators, defined using an even band-limited kernel function were considered. Approximation properties of generalized sampling operators in Lebesgue spaces were studied. The order of approximation by sampling operators via modules of smoothness was estimated. The Kantorovich-type sampling operators were generalized. Instead of the Steklov means Fejer-type singular integrals were used, which allowed to estimate the order of approximation via a modulus of smoothness of higher order. Norms of generalized Kantorovich-type sampling operators were also estimated and the approximation properties of generalized sampling operators in the case of functions with bounded variation were studied. (G. Tamberg, O. Orlova) The Tauberian remainder theorems in the case of the generalized methods of summability, especially for weighted means method were proved. The Tauberian conditions in the case of the generalized methods of summability were weakened. (O. Meronen)

– *Main publications*
  o Andi Kivinukk, Gert Tamberg. *On window methods in generalized Shannon sampling operators.* In: Schmeisser, G.; Zayed, A. (Ed.). New Perspectives on Approximation and Sampling Theory- Festschrift in honor of Paul Butzer's 85th birthday. Birkhaeuser Verlag, 2014, 63-86.
  o Olga Orlova, Gert Tamberg. *On Approximation properties of Kantorovich-type Sampling Operators.* In: Constructive Functions 2014. Conference and School. Book of Abstracts, Vanderbilt University Press, 2014, 40.
  o Gert Tamberg. *On approximation properties of Shannonn sampling operators with bandlimited kernels*. In: Constructive Functions 2014. Conference and School. Book of Abstracts, Vanderbilt University Press, 2014, 50 – 51.
  o Gert Tamberg. *On Window Methods in Generalized Sampling Operators*. In: FINEST MATH 2014 : Fourth Finnish-Estonian Mathematics Colloquium & Finnish Mathematical Days 2014, Book of Abstracts, University of Helsinki, 2014, 14.
  o Olga Orlova, Gert Tamberg. *On approximation properties of Kantorovich-type sampling operators*. Sampling Theory in Signal and Image Processing, to appear.


**Research group of inverse problems and statistics** (Jaan Janno, Kairi Kasemets, Lassi Päivärinta (since 1.11.2014), Margus Pihlak)

– The main topics are inverse problems, scattering theory and integral equations and methods of mathematical statistics.

– *Results in 2014* A strong positivity principle for generalized time-fractional parabolic equations was proved. Using this principle, uniqueness of an inverse problem to

determine a space-dependent component of the free term was proved. Additional data of the inverse problem comprise an intergal with Bohner measure of the solution of the direct problem over the time. This includes the case of final over-determination, too (J. Janno)    The cooperation continued with the Environmental Technology Institute of Tallinn University of Technology. This was implemented within the framework of nonparametric trend analyzes of Estonian rivers pollution load analysis. Mann-Kendall rank correlation was used primarily to test to investigate the flow of the rivers flowing into Lake Peipsi and the dynamics of the load over the last 40 years. The distributions of asymmetry and kurtosis measures were modeled. On this kind of modeling the central limit theorem was applied. These results will generalize to the multivariate case. Knowing distribution of symmetry and kurtosis measures (even approximate) of the statistical models residuals allows to significantly improves the diagnostic adequacy. (M. Pihlak)

- *Main publications*
    - Kairi Kasemets, Jaan Janno. *A weak inverse problem for a parabolic integro-differential equation containing two kernels*. Electronic Journal of Differential Equations, 2014, Article nr 176, 19 p.
    - Arvo Iital, Marija Klõga, Margus Pihlak, Karin Pachel, Andre Zahharov, Enn Loigu. *Nitrogen content and trends in agricultural catchments in Estonia*. Agriculture, Ecosystems and Environment, 2014, **198**, 44-53.
    - Margus Pihlak. *Modeling of skewness measure distribution*. Statistics in Transiation, 2014, **15**, 1, 145-152.
    - Jaan Janno. *Inverse problem for semilinear fractional parabolic equation with integral over-determination*. PDE's, Inverse Problems and Control Theory, Bologna, 15-19.09.2014. Abstracts, 9.

**Research group of mathematical physics** (Eugen Paal, Olga Bershteyn (until 31.03.2014), Märt Umbleja (master student))

- Currently, the main research topic of the chair of MP is Operads - Deformation - Dynamics. The main aim is the development of the modelling methods for the dynamical operadic systems.

- *Results in 2014* The basis of operadic variational formalism were elaborated which is necessary when modeling the operadic systems. Based on this, the rational (cohomological) variational principle was proposed. (E. Paal) Based on a simple example, it is explained how the homological analysis may be applied for modeling of the electric circuits. The homological branch, mesh and nodal analyses are presented. Geometrical interpretations are given. (E. Paal, M. Umbleja) The operadic Lax representations of the harmonic oscillator were used to construct the quantum counterparts of 3d real Lie algebras in the Bianchi classification. From this it followed that in this model only the discrete values of the spatial coordinates are physically allowed. The basic information about the international QQQ Conference 3Quantum: Algebra Geometry Information (Tallinn, July 2012) were presented and the concise review of the QQQ Proceedings were given.  International seminar Moduli - Operads - Dynamics (MOD II, Tallinn, June 2014)) was organised. 2 conference proceedings were published, with prefaces. (E. Paal)

- *Main publications*

- Eugen Paal. The *operadic modeling of gauge systems of the Yang-Mills type*. Reports on Mathematical Physics, 2014, **74**, 109 - 126.
- Eugen Paal, Märt Umbleja. *Note on homological modeling of the electric circuits*. Journal of Physics: Conference Series, 2014, **532,** 012022.
- Eugen Paal, Jüri Virkepu. *Operadic quantization as a tool for discrete geometry*. Journal of Physics: Conference Series, 2014, **532**, 012023.
- Eugen Paal, Piret Kuusk,  Alexander Stolin, eds. *3Quantum: Algebra Geometry Information* (QQQ Conference 2012, Proceedings). Journal of Physics: Conference Series, 2014 **532.** (conference proceedings)
- Abdenacer Maklouf, Eugen Paal, Sergei Silvestrov, Alexander Stolin, eds. *Algebra, Geometry and Mathematical Physics*. Heidelberg: Springer Verlag, 2014. (conference proceedings)

2.2 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustest.

- puuduvad

2.3 Loetelu struktuuriüksuse töötajatest, kes on välisakadeemiate või muude oluliste T&A- ga seotud välisorganisatsioonide liikmed.

- Gert Tamberg on järgmiste välisorganisatsioonide liige: American Mathematical Society, European Mathematical Society, Society for Industrial and Applied Mathematics (SIAM), Institute of Electrical and Electronics Engineers (IEEE)

- L. Päivärinta on Soome Teaduste Akadeemia (Suomalainen tiedeakatemia)  liige ning matemaatika ja arvutiteaduse sektsiooni juht (chairman of the Section of Mathematics and Computer Science of The Finnish Academy of Science and Letters).

- L. Päivärinta on Soome Pöördülesannete Seltsi (Finnish Inverse Problems Society) asutajaliige.

2.4 Soovi korral esitatakse aruandeaastal saadud T&A-ga seotud tunnustused (va punktis 2.3 toodud tunnustused), ülevaade teaduskorralduslikust tegevusest, teadlasmobiilsusest ning hinnang oma teadustulemustele.

- J. Janno on ajakirjade Mathematical Modelling and Analysis,  Abstract and Applied Analysis ja The Open Acoustics Journal toimetuskolleegiumite liige.

- J. Janno on Eesti Operatsioonianalüüsi Seltsi juhatuse liige.

- J. Janno ja G. Tamberg on Eesti Matemaatika Seltsi juhatuse liikmed.

- J. Janno oli teadusürituse 4th Finnish-Estonian Mathematical Colloquium, 9-10.01.2014, Helsingi, Soome, teaduskomitee liige ja pöördülesannete sektsiooni organisaator.

- J. Janno oli konverentsi 19th International Conference Mathematical Modelling and Analysis (MMA2014), 26 – 29.05.2014, Druskininkai, Leedu, teaduskomitee liige.

- E. Paal oli rahvusvahelise seminari Moduli Operads Dynamics II, 3-6.06.2014, Tallinn, peaorganisaator.

- Matemaatilise füüsika õppetool osaleb rahvusvahelises teadusvõrgustikus AGMP. Peamised rahvusvahelised koostööpartnerid: P. Zusmanovich, N. Jõudu, A. Stolin, S. Silvestrov

- L. Päivärinta on ERC advanced grant nr GA267700 „Inverse Problems" (InvProb) hoidja ja grandiga seotud projekti juht.

- L. Päivärinta on ajakirjade Journal of Inverse and Ill-posed Problems ja Eurasian Journal of Mathematical and Computer Applications toimetuskolleegiumide liige

- A. Leibak viibis teadustööl Šiauliai Ülikoolis, Leedus, 17-28. veebruaril 2014 – eesmärk koostöö Prof. R. Kacinskaitega.

- 9. jaanuar 2014. G. Tambergi ettekanne „On Window Methods in Generalized Shannon Sampling Operators" teadusüritusel 4th Finnish-Estonian Mathematical Colloquium, 9-10.01.2014, Helsingi, Soome.

- 9. jaanuar 2014. G. Tambergi magistrandi O. Orlova ettekanne „On Approximation Properties of Kantorovich-type Sampling Operators" teadusüritusel 4th Finnish-Estonian Mathematical Colloquium, 9-10.01.2014, Helsingi, Soome.

- 29. mai 2014. G. Tambergi ettekanne „On approximation properties of Shannon Sampling operators with bandlimited kernels" konverentsil Constructive Functions 2014, 26-30.05.2014, Vanderbilt University, Nashville, USA

- 29. mai 2014. G. Tambergi magistrandi O. Orlova ettekanne „On Approximation Properties of Kantorovich-type Sampling Operators" konverentsil Constructive Functions 2014, 26-30.05.2014, Vanderbilt University, Nashville, USA.

- 5. juuni 2014. G. Tambergi ettekanne „On approximation properties of Kantorovich-type sampling operators" konverentsil Modern Time-Frequency Analysis, 2-6.06.2014, Strobl, Austria.

- 5. juuni 2014. M. Umbleja ettekanne "Homological modeling of the electric circuits" rahvusvahelisel seminaril Moduli Operads Dynamics II, 3-6.06.2014.

- 13. juuni 2014. M. Pihlaku ettekanne „Modeling of multivariate skewness measure distribution" konverentsil 3rd Stochastic Modeling Techniques and Data Analysis International Conference, 11-14.06.2014, Lissabon, Portugal.

- 17. september 2014. J. Janno ettekanne „Inverse problem for semilinear fractional parabolic equation with integral over-determination" konverentsil PDE's, Inverse Problems and Control Theory, 15-19.09.2014, Bologna, Itaalia.

- 23. oktoober 2014. G. Tambergi doktorandi O. Orlova stendiettekanne "On approximation properties of generalized Kantorovich-type sampling operators" doktorikooli „Computational Harmonic Analysis - with Applications to Signal and Image Processing. 20-24 Oktoober 2014 at CIRM (Marseille, France)" raames.

- 4. detsember 2014. L. Päivärinta plenaarettekanne „Scattering by corners" konverentsil International Conference on Inverse Problems and Optimal Control, 4-6.12.2014, Hong Kong.


Hinnang instituudi teadustööle:  3,5 viiepallises skaalas.