

**MEHAANIKATEADUSKOND  
MEHHATROONIKAINSTITUUT  
TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2012**

## **1. Instituudi struktuur**

**Mehhatroonikainstituut, Department of Mechatronics  
Instituudi direktor Mart Tamre**

- Mehhatroonikasüsteemide õppetool, Chair of Mechatronics Systems, Mart Tamre
- Mehhanosüsteemide komponentide õppetool, Chair of Mechanosystem Components, Trieu Minh Vu
- Kvaliteeditehnika ja metroloogia õppetool, Chair of Quality Engineering and Metrology, Andres Kiitam
- Mehhatroonika-, mehhanosüsteemide ja mõõtesüsteemide teadus- ja katselaboratoorium, Laboratory for Mechatronics, Mechano and Measurement Systems

## **2. Instituudi teadus- ja arendustegevuse (edaspidi T&A) iseloomustus**

*(NB! punktid 2.1- 2.6 täidab struktuuriüksus)*

### **2.1 struktuuriüksuse koosseisu kuuluvate uurimisgruppide**

2.1.1 teadustöö kirjeldus *(inglise keeles)*;

#### **Metrology and Quality Engineering**

The main focus of the metrology research is in development of measurement methods for establishment of metrological traceability to SI units with growing and/or emerging needs. Amongst the others, measurement techniques in traceability dissemination of possible redefinition in terms of photons of unit of luminous intensity, the candela have been improved by participation in international as well as in national collaboration. It was found that with the implementation of a special attenuator consisting of ten photodiodes, the uncertainty in calibration of SPAD (Single Photon Avalanche Detector) can be approximately 0,3 %. Another area of research is in development of fully characterized method for electrical conductivity, both in DC and AC methods. It was shown that with the use of equipment of moderate accuracy, the calibration relative uncertainty of samples can be achieved 0,2 %-0,3 %. Also, special coil-type calculable electromagnetic sensors were designed for further studies in covering the gap between measurement accuracy with DC and AC measurement techniques. Study of accurate methods for measurement of electrical conductivity of reference standards has been a focus of the activity too. Instruments designed for conductivity measurements are widely exploited by research and industry. The modern devices operate at frequencies up to 1 MHz with the relative expanded uncertainty of about 1 % of the measured value. Accuracy of the measurement instruments is ensured by use of external measurement standards. In close collaboration with AS Metrosert the methods for traceable measurements of the conductivity standards have been investigated: Van der Pauw method (dc current) and eddy-current method (ac current). Investigations of the eddy-current method for characterization of the conductivity standards at the alternative current have been started. For this purpose a set printed-circuit-board (pcb) planar sensors has been designed. Impedance of the sensors above a conductive medium will be measured by a calibrated impedance meter and substituted to the

mathematical model developed by Dodd, C.V. and Deeds, W.E.

The results have been published in three scientific papers. The EU JRP SIB57 NEWSTAR project “New primary standards and traceability for radiometry” application was accepted for financing starting from 2013.

### **Mechanosystem Components**

The focus in the research is on multibody system dynamics and vibration analysis and monitoring targeted on modeling and optimization of systems and materials behavioral characteristics. People from the chairs of Machine Elements and Machine Mechanics are participating on many projects of which main are Mechatronic and Production Systems Proactivity and Behavioral Models and Advanced multiphase tribo-functional materials and Hard coatings and surface engineering and therefore consolidation of the research into one focus has been difficult.

One focus of the research is to extend the theoretical analysis methods of free vibration of grillages (skeletal structures) that consists of uniform beams with one axis of symmetry and to study the sensitivity of grillages by numerical examples. Main objective in case of thin-walled beams is to study the effect of warping onto the natural frequencies of grillages in two cases: I) when longitudinal members and crossmembers of grillages are adjoined at the nodes in plane and II) when beam members of grillages are adjoined at the nodes on each other. Therefore it is aimed to extend a simplified alternative approach for calculation of forced vibration of grillages under the action of repeated loading in the presence of hysteretic damping and to develop the simplified alternative approach for calculation of natural frequencies and corresponding mode shape of grillages in case, when reinforcing effect of the covering plate cannot be excluded from the dynamic analysis.

The second activity is focused on the friction testing activities and developing consulting services for companies in the areas of strength and reliability of machines.

Third focus is on investigation of nonlinear evolution equation for wave propagation in bubbly liquids, taking into account viscosity and heat transfer, has been derived by Kudryashov and Sinelshchikov. In the case of no dissipation the authors have provided analytical solutions representing undistorted waves. These results are cast into a simpler form and studied in more detail. In addition to the wave profiles the corresponding phase curves are presented. Depending on some parameter the solutions represent solitary or periodic waves. Some of the periodic waves exhibit peaks or cusps. From the periodic waves a new type of “meandering” solutions is constructed.

### **Mechatronics Systems**

The research is focused on proactive smart machine and robotic and production systems, models and optimization for production and service system automation

Activity of is concentrated on two main subfields: Proactive decision support in networked collaborating enterprises of special tooling and machining clusters and modeling and design of proactive autonomous service and technology components and traceability of the production as well as sustainable production models. Intelligent prediction of manufacturing capability in enterprises cluster for preventing management failures enables achieving of near-zero down-time and the best possible quality of a product. Proactive hardware components will be able to react autonomously and flexibly to changing environments and configuration of the networked system structure according to the software control whereby service and industrial system components especially industrial or service robots and their component design are under investigation. Intelligent prediction of manufacturing capability in enterprises cluster for preventing management failures has been

tested utilizing smart grid technology and several production models that enable achieving of greater efficiency. Proactive system behavior has been investigated on the example of the whole production chain of wood product chain where the energy consumption in wide sense and environment impact is used as a driving parameters in a technology process. This kind of tests were performed for whole wood production chain where a subtask was automatic building a sensor network in very beginning of operating materials for production of the artificial objects up to sensor systems at the endproduction, considering time and space separation and distribution of the information and decision/control processes. In parallel reconfigurable robot control algorithms have been investigated in case of modifying sensor network and multy-robot collaboration (UGV and UAV case) where the control optimization and mission planning from the safety critical and energy consumption viewpoint is of interest.

### 2.1.2 aruandeaastal saadud tähtsamad teadustulemused (*inglise keeles*).

## 2.2 Uurimisgrupi kuni 5 olulisemat publikatsiooni läinud aastal.

1. Minh, V.T., Rashid, A.A. (2012). Modeling and model predictive control for hybrid electric vehicles. *International Journal of Automotive Technology*, 13(3), 477 - 485.
2. Gran, Jarle, Kübarsepp, Toomas, et al (2012). Simulations of predictable quantum efficiency detector with PC1D. *Metrologia*, 49, S130 - S134.
3. Põlder, Ahti; Juurma, Märt; Tamre, Mart (2012). Wood products automatic identification based on fingerprint method. *Journal of Vibroengineering*, 14, 477 - 482.
4. Sell, Raivo; Seiler, Sven; Ptasik, Dennis (2012). Embedded System and Robotic Education in a Blended Learning Environment Utilizing Remote and Virtual Labs in the Cloud, Accompanied by 'Robotic HomeLab Kit'. *International Journal of Emerging Technologies in Learning (iJET)*, 7(4), 26 - 33.
5. Aleksandrov, D.; Penkov, I. (2012). Fluid flow optimization on semiautomatic code marker base. *Journal of Energy and Power Engineering*, 6, 916 - 920.

## 2.3 Loetelu struktuuriüksuse töötajate rahvusvahelistest tunnustustest.

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

Prof. M.Tamre - 2012 - ... IEEE liige; 2011 - ... ASME liige; 2010 - ... TTÜ esindaja Rootics Industries Association organisatsioonis; 2005 - ... AUVSI liige.

Prof. T.M.Vu - Membership of Professional Societies:

- Member of Institute of Electrical and Electronics Engineering – Control System Society (IEEE-CSS).
- Member of Asian Control Association (ACA).
- Member of review Committee of Asian Journal of Control (AJC).
- Member of review Committee of International Symposium on Neutral Networks (ISNN).

Dots. G.Arjassov - 2010 - ... Masina-, Metall- ja Aparaaditööstuse Kutsenõukogu liige; Sankt-Peterburi Teaduste Maja ehitismehaanika ja tugevusõpetuse teadusseltsi auliige ning toimetuskolleegiumi liigerahvusvaheliste konverentside orgkomitee liige.

## 2.5 Aruandeaasta tähtsamad T&A finantseerimise allikad.

**T113B**, Mehhatroonika- ja tootmissüsteemide proaktiivsus ja käitumismudelid, Tamre Mart ja baasfinantseerimine **B04**, Metroloogia kaasaegsetes teadustes, Toomas Kübarsepp.

**2.6** Soovi korral lisada aruandeaastal saadud T&A-ga seotud tunnustusi (va punktis 2.3 toodud tunnustused), ülevaate teaduskorralduslikust tegevusest, teadlasmobiilsusest ning anda hinnang oma teadustulemustele.

## 2.7 Instituudi teadus- ja arendustegevuse teemade ja projektide nimetused (*Eesti Teadusinfosüsteemi, edaspidi ETIS, andmetel*)

- Haridus- ja Teadusministeerium
  - sihtfinantseeritavad teemad:  
T113B, Mehhatroonika- ja tootmissüsteemide proaktiivsus ja käitumismudelid, Tamre Mart (2008 – 2013)
  - baasfinantseerimise toetusfondist rahastatud projektid (sh TTÜ tippkeskused):  
B04, Metroloogia kaasaegsetes teadustes, Toomas Kübarsepp (2011 – 2013)
  - riiklikud programmid:
    - Teiste ministeeriumide poolt rahastatavad riiklikud programmid:
    - Uuriija-professori rahastamine:
    - SA Eesti Teadusfond/Eesti Teadusagentuur
      - grandid:  
ETF8652, Mudelitel baseeruv manussüsteemide projekteerimine ja autonoomne navigatsioon, Sell Raivo (2011 – 2014)
      - ühisgrandid välisriigiga:
      - järel doktorite grandid (SA ETF ja Mobilitas):
      - tippteadlase grandid (Mobilitas):
        - Ettevõtluse Arendamise SA
          - eeluuringud:
          - arendustoetused:
            - SA Archimedesega sõlmitud lepingud
              - infrastruktuur (nn „mini-infra“, „asutuse infra“):
              - Eesti tippkeskused:
              - riiklikud programmid:
              - muud T&A lepingud:
            - SA Keskkonnainvesteeringute Keskusega sõlmitud lepingud:
            - Siseriiklikud lepingud:  
Lep12068, Raamatute väljastusautomaadi projekteerimine, Põlder Ahti (12.04.2012 - 4.05.2012)

Lep12089, Metroloogia ja mõõtetehnika valdkonna terminoloogia arendamine., Laaneots Rein (18.05.2012 - 31.12.2012)

Lep12158, Vanapaberi automaatne sorteerimine, Põlder Ahti (6.08.2012 - 31.10.2012)

- EL Raamprogrammi projektid:
- Välisriiklikud lepingud:

*Ekomisjoni õppe-arendusprojektid*

*VERT532, Virtuaalakadeemia platvorm, Sell Raivo (1.10.2011 - 30.09.2013)*

*VY517, Mehhatroonika teadvuse tõstmine Türgi VKE-de ja kutsekoolide hulgas, Sell Raivo (1.12.2010 - 30.11.2012)*

**2.8** Struktuuriüksuse töötajate poolt avaldatud eelretsenseeritavad teaduspublikatsioonid (*ETIS klassifikaatori alusel 1.1, 1.2, 1.3, 2.1, 2.2, 3.1, 3.2, 3.3, 4.1 ja 5.1*).

### 1.1

Minh, T. V. (2012). Clutch control and vibration reduction for a hybrid electric vehicle. Proceedings of the Institution of Mechanical Engineers, Part I: Journal of Systems and Control Engin, 226(7), 867 - 874.

Surzhenkov, A.; Põdra, P.; Sergejev, F.; Saarna, M.; Adoberg, E.; Mikli, V.; Viljus, M.; Kulu, P. (2012). Comparative Study of the PVD Coatings on the Plasma Nitrided Steel. Materials Science (Medžiagotyra), 18(1), 40 - 44.

Minh V. T., Hashim F. B. Mohd, Awang M. (2012). Development of a real-time clutch transition strategy for a parallel hybrid electric vehicle. Proceedings of the Institution of Mechanical Engineers, Part I: Journal of Systems and Control Engin, 226(12), 188 - 203.

Minh, V.T., Rashid, A.A. (2012). Modeling and model predictive control for hybrid electric vehicles. International Journal of Automotive Technology, 13(3), 477 - 485.

Gran, Jarle, Kübarsepp, Toomas, et al (2012). Simulations of predictable quantum efficiency detector with PC1D. Metrologia, 49, S130 - S134.

Põlder, Ahti; Juurma, Märt; Tamre, Mart (2012). Wood products automatic identification based on fingerprint method. Journal of Vibroengineering, 14, 477 - 482.

### 1.2

Sell, Raivo; Seiler, Sven; Ptasik, Dennis (2012). Embedded System and Robotic Education in a Blended Learning Environment Utilizing Remote and Virtual Labs in the Cloud, Accompanied by 'Robotic HomeLab Kit'. International Journal of Emerging Technologies in Learning (iJET), 7(4), 26 - 33.

Aleksandrov, D.; Penkov, I. (2012). Fluid flow optimization on semiautomatic code marker base. Journal of Energy and Power Engineering, 6, 916 - 920.

Aleksandrov, D.; Penkov, I. (2012). Increasing of Power Characteristics of Mini UAV Helicopter by Changing of its Geometrical Parameters. Machines, Technologies, Materials, 6, 30 - 32.

### 1.3

## 2.1

## 2.2

Minh, T. V. (2012). Advanced Vehicle Dynamics. University of Malaya Press

Laaneots, R.; Mathiesen, O.; Riim, J. (2012). Metroloogia. Õpik kõrgkoolidele. Tallinn: Tallinna Tehnikaülikooli Kirjastus

## 3.1

Kiitam, A.; Tammaru, T. (2012). Impact of Application of Excellence Models on Organizational Performance. Proc. of the 8th Int. Conf. of DAAAM Baltic Industrial Engineering. 19-21st April 2012, Tallinn, Estonia (152 - 157). Tallinn: Tallinn University of Technology Press

Aryassov, G.; Barashkova, T.; Gornostajev, D. (2012). Estimation of Complex Derivatives and Application for Fault Diagnosis. In: Annals of DAAAM for 2012 & Proceedings of the 23rd International DAAAM Symposium "Intelligent Manufacturing & Automation: Power of Knowledge and Creativity": 23 nd International DAAAM Symposium, University of Zadar, Zadar, Croatia, 21-28th October 2012. (Toim.) B.Katalinic. DAAAM International, Vienna, Austria, EU, 2012: DAAAM International Vienna, 2012, (CDROM version; No.1), 0469 - 0472.

Parker, M. et al (2012). Accurate measurements of electrical conductivity of metals in the range from 2 MS/m to 14 MS/m. In: Proc.of the 8th International Conf. of DAAAM Baltic, Industrial Engineering: 8th International Conf. of DAAAM Baltic, Industrial Engineering, Tallinn, Estonia, 19-21 April, 2012.: (Toim.) T. Otto. Tallinn, Estonia: Infotrükk OÜ, 2012, 700-704.

Põlder, Ahti; Juurma, Märt; Tamre, Mart (2012). Automatic Products Identification Method. In: Proc.of the 8th International Conf. of DAAAM Baltic, Industrial Engineering: 8th International Conf. of DAAAM Baltic, Industrial Engineering, Tallinn, Estonia, 19-21 April, 2012. (Toim.) Ed. by T.Otto. Tallinn, Estonia: Tallinn Technical University Press, 2012, 338 - 344.

Tiimus, Kristjan; Tamre, Mart (2012). Camera Gimbal Performance Improvement with Mechanical Gyroscopes on a Multi Rotor VTOL Platform. In: Proc.of the 8th International Conf. of DAAAM Baltic, Industrial Engineering: 8th International Conf. of DAAAM Baltic, Industrial Engineering, Tallinn, Estonia, 19-21 April, 2012. (Toim.) Ed. by T.Otto. Tallinn, Estonia: Tallinn University of Technology Press, 2012, 361 - 366.

Hudjakov, Robert; Tamre, Mart (2012). Comparison of Aerial Imagery and Satellite Imagery for Autonomous Vehicle Path Planning. In: Proc.of the 8th International Conf. of DAAAM Baltic, Industrial Engineering: 8th International Conf. of DAAAM Baltic, Industrial Engineering, Tallinn, Estonia, 19-21 April, 2012. (Toim.) Ed. by T.Otto. Tallinn, Estonia: Tallinn University of Technology Press, 2012, 301 - 308.

Aryassov, G.; Zhigailov, S.; Zinovjev, E. (2012). Development of movement algorithms for a robot manipulator . In: Proceedings of the 8th International Conference of DAAAM Baltic Industrial Engineering 19-21st April 2012, Tallinn, Estonia: 8th International Conference of DAAAM Baltic Industrial Engineering, Tallinn, Estonia, 19-21 april 2012. (Toim.) O.Tauno. Tallinn University of Technology, 2012, 262 - 267.

Väljaots, Eero; Sell, Raivo (2012). Dynamic Motion Energy Efficiency Measurement of Ground Vehicles. In: Proceedings of the 8th International Conference of Daaam Baltic Industrial Engineering: 8th International Conference of Daaam Baltic Industrial Engineering. Tallinn: Tallinna Tehnikaülikooli Kirjastus, 2012, 367 - 372.

Sell, R; Aryassov, G; Petritshenko, A; Kaeeli, M (2012). Kinematics and dynamics of configurable wheel-leg. In: Proceedings of the 8th International Conference of DAAAM Baltic INDUSTRIAL ENGINEERING: 8th DAAAM Baltic Conference INDUSTRIAL ENGINEERING, 19-21 April 2012, Tallinn, Estonia. (Toim.) Otto, T. Tallinn University of Technology, 2012, 345 - 350.

Shvarts, Dmitri; Tamre, Mart (2012). Local and Global Descriptors for Place Recognition in Robotics. In: Proc.of the 8th International Conf. of DAAAM Baltic, Industrial Engineering: 8th International Conf. of DAAAM Baltic, Industrial Engineering, Tallinn, Estonia, 19-21 April, 2012. (Toim.) Ed. by T.Otto. Tallinn, Estonia: Tallinn University of Technology Press, 2012, 351 - 356.

Hiiemaa, Maido; Tamre, Mart (2012). Low Speed Motion Feedback for the Unmanned Ground Vehicle. In: Proc.of the 8th International Conf. of DAAAM Baltic, Industrial Engineering: 8th International Conf. of DAAAM Baltic, Industrial Engineering, Tallinn, Estonia, 19-21 April, 2012. (Toim.) Ed. by T.Otto. Tallinn, Estonia: Tallinn University of Technology Press, 2012, 293 - 300.

Aruväli, T.; Serg, R.; Otto, T. (2012). Machinery utilization monitoring and pause identification prototype model design. In: Proceedings of the 8th International Conference of DAAAM Baltic Industrial Engineering 19-21st April 2012, Tallinn, Estonia: 8th International Conference of DAAAM Baltic Industrial Engineering, Tallinn, Estonia, 19-21 April 2012. (Toim.) Otto, T.. Tallinn: Tallinna Tehnikaülikooli Kirjastus, 2012, 256 - 261.

Kulderknap, Edi; Pandis, Argo (2012). Measuring instruments calibration near zero value. In: Proceedings: XX IMEKO World Congress, Busan, 9-14 September 2012. (Toim.) IMEKO. IMEKO, 2012.

Kulderknap, Edi (2012). Modelling of symmetry measurement uncertainty using Monte-Carlo method. In: Proceedings: 8th DAAAM Baltic Conference. (Toim.) Tauno Otto. Tallinn: Tallinna Tehnikaülikool, 2012, 496 - 499.

Arjassov, G.; Žigailov, S. (2012). Optimal Design of System of Cross-Beams. In: The 8th International Conference Mechatronics Systems and Materials: 8th Conference Mechatronic Systems and Materials 2012, MSM'2012 Bialystok , POLAND July 8-13, 2012. (Toim.) Zdzislaw Cosiewski and Zbigniew Kulesza. Bialystok Technical University, Bialystok, Poland: Bialystok Technical University, 2012, 120 - 121.

Aleksandrov, Dmitri; Penkov, Igor. (2012). Optimal Gap Distance Between Rotors of Mini Quadrotor Helicopter. In: Proceedings of the 8th International Conference of DAAAM Baltic Industrial Engineering: 8th International Conference of DAAAM Baltic Industrial Engineering. Tallinn University of Technology Press, 2012, 251 - 255.

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Conference of DAAAM Baltic Industrial Engineering, [vol 1] : 19-21st April 2008, Tallinn, Estonia: 8th International Conf. of DAAAM Baltic, Industrial Engineering, Tallinn, Estonia, 19-21 April, 2012. (Toim.) Otto, Tauno. Tallinn: Tallinn University of Technology, 2012, 357 - 360.

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Petrishenko, A; Sell, R (2012). Wheel motion resistance and soil thrust traction of mobile robot. In: Proceedings of the 8th International Conference of DAAAM Baltic INDUSTRIAL ENGINEERING: 8th International DAAAM Baltic Conference INDUSTRIAL ENGINEERING, 19-21 April 2012, Tallinn, Estonia. (Toim.) Otto, T. Tallinn University of Technology, 2012, 332 - 337.

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Aryassov, G.; Zhigailov, S. (2012). An Alternative Approach to Solving of the Inverse Kinematics . 12th International Symposium "Topical Problems in the Field of Electrical and Power Engineering\* Doctoral School of Energy and Geotechnology", Kuressaare, Estonia, 11-16 Juuni 2012. (Toim.) Estonian Society of Moritz Hermann Jacobi. Tallinn University of Technology, 2012, 164 - 165.

Tiimus, Kristjan; Tamre, Mart (2012). Camera gimbal performance improvement with spinning-mass mechanical gyroscopes. In: Proc. of 12th International Symposium, Topical Problems in the Field of Electrical and Power Engineering: 12th International Symposium, Topical Problems in the Field of Electrical and Power Engineering, Kuressaare, 2012. (Toim.) Lahtmets Rain. 2012: Elektriajam, 2012, 160 - 163.

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Seiler, Sven; Sell, Raivo;Ptasik, Dennis (2012). Lab Description Language - A framework approach for describing and mediating remote and virtual labs . 13th International Workshop on Research and Education in Mechatronics, Paris, . , 2012.

Hiiemaa, Maido; Tamre, Mart (2012). Low Speed Motion Feedback from the Unmanned Ground Vehicle Wheels by Single-pole Magnetic Encoders. In: Proc of 12th International Symp Topical Problems in the Field of Electrical and Power Engineering: 12th International Symp Topical Problems in the Field of Electrical and Power Engineering, Kuussaare, 2012. (Toim.) Rain Lahtmets. Tallinn:, 2012, 145 - 146.

Seiler, Sven; Sell, Raivo;Ptasik, Dennis (2012). Microcontroller Based Intelligent Platform for Research and Education in Mechatronics . 13th International Workshop on Research and Education in Mechatronics, Paris. , 2012.

Aruväli, Tanel (2012). Nanodevices expectations in construction engineering. In: Proceeding of the 11th International Symposium "Topical Problems in the Field of Electrical and Power Engineering. Doctoral School of Energy and Geotechnology II": 11th international symposium: Topical Problems in the Field of Electrical and Power Engineering. Doctoral School of Energy and Geotechnology II. (Toim.) Zakis, Janis. Pärnu: Elektriajam, 2012, 289 - 294.

Aryassov, G.; Zhigailov, S. (2012). Optimal Design of Elastic Elements of Ladder Frames. 11th International Symposium "Topical Problems in the Field of Electrical and Power Engineering\* Doctoral School of Energy and Geotechnology", Pärnu, Estonia, 16-21 January 2012. (Toim.) Estonian Society of Moritz Hermann Jacobi. Tallinn, Estonia: Tallinn University of Technology, 2012, 287 - 288.

Aleksandrov, D.; Penkov, I. (2012). Optimization Mini Unmanned Helicopter Energy Consumption by Changing Geometrical Parameters of Coaxial Rotor Pairs. In: Topical Problems in the Field of Electrical and Power Engineering, Doctoral School of Energy and Geotechnology II: Tallinn: Elektriajam, 2012, 139 - 141.

Aleksandrov, D.; Penkov, I. (2012). Optimization mini unmanned helicopter energy consumption by changing parameters of coaxial rotor pairs. In: Proc. of 12th International Symposium, Topical Problems in the Field of Electrical and Power Engineering: 12th International Symposium, Topical Problems in the Field of Electrical and Power Engineering. (Toim.) Lahtmets Rain. Tallinn: Elektriajam, 2012, 139 - 141.

Põlder, Ahti (2012). Overview of automatic paper sorting. In: Proc. of 12th International Symposium, Topical Problems in the Field of Electrical and Power Engineering: 12th International Symposium, Topical Problems in the Field of Electrical and Power Engineering, Kuussaare, 2012. (Toim.) Lahtmets Rain. Tallinn: Elektriajam, 2012, 166 - 168.

### 3.3

Laaneots, R.; Laaneots, A. (2012). Seletav metroloogia oskussõnastik. Inglise-Eesti. 1 - 45.

4.1

5.1

**2.9** Struktuuriüksuses kaitstud doktoriväitekirjade loetelu (*NB! struktuuriüksus lisab struktuuriüksuse töötaja juhendamisel mujal kaitstud doktoriväitekirjade loetelu*)

**Sven Seiler**, mehhatroonikainstituut

Teema: *Laboratory as a Service – A Holistic Framework for Remote and Virtual Labs*  
(Laboratoorium kui teenus - kaug- ja virtuaallaboritele holistiline raamistik)

Juhendajad: vanemteadur Raivo Sell ja emeriitprof Rein Laaneots

Kaitses: 16.11.2012

Omistatud kraad: filosoofiadoktor (mehhatroonika)

**2.10** Struktuuriüksuses järel doktorina T&A-s osalenud isikute loetelu (*ETIS-e kaudu esitatud taotluste alusel*)

**2.11** Struktuuriüksuses loodud tööstusomandi loetelu

**EP2483849** (EP10775694.2)

Transponder and method for its application

Taotlus esitatud: 27.04.2012

Autorid: Märt Juurma, Ahti Põlder, Priit Põdra, Mart Tamre

Omanik: TTÜ

**EE05527B1**

Transponder ja meetod selle paigaldamiseks

Patent välja antud: 16.04.2012

Autorid: Märt Juurma, Ahti Põlder, Priit Põdra, Mart Tamre

Omanik: TTÜ

**3. Struktuuriüksuse infrastruktuuri uuendamise loetelu** (*summa eurodes*)

PV007435, Printer 3D BFB Touch Double, 1.08.2012 (3 567,17)

PV007436, Tarkvara IAR Embedded Work-, 1.08.2012 (4 093,00)

PV007488, Robotino XT V-306, 23.10.2012 (11 000,00)