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**ACADEMIC INTERNSHIP PROGRAM  
BRAZIL – CZECH REPUBLIC  
2014/2015 RESEARCH PROJECTS**

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# **ELECTROTECHNICAL / COMPUTING ENGINEERING**

## **Czech Technical University in Prague, Faculty of Electrical Engineering Department of Measurements**

### **Conversational Temperature Measurements**

*Task: to analyze recorded telephone conversation and evaluate conversational temperature value*

*Requirements: capability of using Matlab for signal analysis, basics of audio signal processing*

### **Speaker Alternation Rate Measurements**

*Task: to analyze recorded telephone conversation and evaluate speaker alternation rate parameter*

*Requirements: capability of using Matlab for signal analysis, basics of audio signal processing*

### **Intracranial electroencefalography signal processing for epilepsy patients**

*Task: Development and implementation of signal processing techniques, analyses of real data*

*Requirements: Signal processing knowledge (e.g. FFT, Statistical measure...), Matlab scripting*

### **Modular viewer for biologic signals**

*Task: Implementation of viewer modules in .NET C#*

*Requirements: Requirement: knowledge of .NET C#*

### **Small Satellite Platform development project - electronics**

*Task: to design a PCB converting signal of an optical sensor measuring speed of a reaction wheel to logical levels*

*Requirements: experience with any CAD for electronics – preferred OrCAD, KiCAD and Altium.*

### **Small Satellite Platform development project – control**

*Task: propose method of Small Satellite Platform stabilization – design a controller.*

*Requirements: at least minimal knowledge of Matlab.*

### **Small Satellite Platform development project – software**

*Task: design a SW gateway that will distribute data from Small Satellite Platform to multiple computers.*

*Requirements: knowledge of C language and Microsoft Visual C++ preferred.*

### **Design of CAN Controller with Flexible Data Rate Support.**

*Task: to convert our CAN (Controller Area Network) controller implementation in AHDL (Altera Hardware Description Language) into VHDL and extend the implementation with suport of the new flexible data rate feature.*

*Required knowledge: some experience with VHDL and digital circuits design.*

### **Design of CAN Generator and Trigger with Flexible Data Rate Support.**

*Task: to convert our CAN (Controller Area Network) Test Generator and CAN Trigger implementations in AHDL (Altera Hardware Description Language) into VHDL and extend the implementation with suport of the new flexible data rate feature.*

*Required knowledge: some experience with VHDL and digital circuits design*

**Distributed sensor modules communication control**

*Task: to implement communication control to distributed sensor.  
Requirements: knowledge of C and C++ programming language.*

**Transducer Electronic Data Sheets generator for embedded systems**

*Task: to develop generator of TEDS memory content for embedded systems.  
Requirements: knowledge of C++ or C# programming language.*

**Tactical grade accelerometer data evaluation**

*Task: to measure data from 3 orthogonal accelerometers and evaluate their noise parameters and deterministic errors  
Requirements: capability of using Matlab, basic knowledge of signal processing and their description, navigation means*

**Tactical grade gyroscope data evaluation**

*Task: to measure data from 3 orthogonal gyroscopes and evaluate their noise parameters and deterministic errors, gyro compassing  
Requirements: capability of using Matlab, basic knowledge of signal processing and their description, navigation means*

**Mathematical modeling of inertial sensors**

*Task: to design mathematical models of inertial sensors for implementation into Kalman filtering procedure  
Requirements: capability of using Matlab, basic knowledge of adaptive signal processing, Kalman filtering*

**Navigation systems with non-inertial aiding systems**

*Task: to develop measurement system relying on ultrasound distance sensors capable of distance and attitude evaluation  
Requirements: capability of using Matlab, basic knowledge of signal processing and their description, navigation means*

**Wireless monitoring system for animal behavior analysis**

*Task: Design and realize a device to monitor an animal behavior by measuring acceleration and/or other variables (temperature). The device will be based on low-power micro-controller and radio transceiver.  
Requirements: basic experience with embedded systems and programming.*

**Czech Technical University in Prague, Faculty of Electrical Engineering  
Photovoltaic laboratory****System for evaluating of failures and defects of PV panels**

*Task: to design a database system for evidence and evaluating of PV panels' failures and defects.  
Requirements: knowledge of MS office tools (esp. Access).*

### **Impact of irradiation history on amorphous PV panels**

*Task: literature research followed by experimental work.*

*Requirements: basic orientation in the field of PV systems.*

### **Mathematical model of PV system**

*Task: to design mathematical model of PV system.*

*Requirements: knowledge of PV systems, capability of using Matlab for system simulations.*

### **Analysis of diagnostic methods of PV panels**

*Task: to analyze measuring methods of PV panels used in the lab and propose optimization.*

*Requirements: knowledge of measuring methods of PV panels.*

### **Thermographic measuring of PV systems**

*Task: proposal and evaluation of applicable methods of measuring using thermocamera.*

*Requirements: knowledge of thermography and related methodology.*

### **Time and behavior of response of different PV panels to light impulse**

*Task: to design and realize system for measuring of the response time of the PV panels.*

*Requirements: knowledge of design and implementation of electric circuits.*

### **Thermography versus flash test**

*Task: evaluation of previously measured data, creation of knowledge database.*

*Requirements: knowledge of statistical methods, knowledge of MS office tools (esp. Access).*

## **Czech Technical University in Prague, Faculty of Electrical Engineering Department of Electro technology**

### **An utilisation of FMEA (Failure Mode and Effects Analysis) method concerning construction and operation of solar module**

*Task: case study and execution of FMEA method on an exemplary solar module.*

*Requirements: knowledge of quality management and solar technique are advantageous.*

*Recommended for students of electrical and mechanical engineering.*

### **A literature review of product and/or process ontology**

*Task: literature study and construction of an ontology based conceptual model of an exemplary manufacturing process and/or product.*

*Requirements: good knowledge of information modelling technique is advantageous.*

*Recommended for students of informatics, electrical engineering and cybernetics.*

### **A literature review of suitable tools supporting FMEA method**

*Task: literature study, testing and comparison of selected available tools supporting FMEA method.*

*Requirements: knowledge of FMEA method is advantageous.*

*Recommended for students of informatics, electrical engineering and cybernetics.*

### **A literature review of suitable tools supporting ontology modelling**

*Task: literature study, testing and comparison of selected available tools for ontology modelling.*

*Requirements: knowledge of ontology and information modelling are advantageous.*

*Recommended for students of informatics, electrical engineering and cybernetics.*

## **Czech Technical University in Prague, Faculty of Electrical Engineering**

### **Department of Circuit Theory**

#### **Electronic Circuit Analysis in Maple program (minimal participation for 12 weeks)**

*Task: The project is focused on creation new functions for standard digital filters design. The software for implementation is mathematical program Maple. Syntfil package exists for analog electric filter design in Maple, see <http://syntfil.feld.cvut.cz/index.html.en>. The goal of the project is to develop new function of Syntfil package for standard digital filters design. Syntfil package enables the design of transfer functions of continuous-time analog filters, including the synthesis of analog electrical circuit of the filter. The project would include design converting procedures from analog filters to digital filters (from  $s$  variable to a variable  $z$ ), i.e. design IIR filters. Function for FIR filter design could be an advantage.*

*Requirements: Basic knowledge of digital and analog filter design. Knowledge of the Maple program and its programming language is an advantage. Suitable for students in the final year, graduated students and MSc. students.*

*References (the project is closely related to work presented in the following papers):*

- [1] D. Schlichthärle: *Digital Filters: Basics and Design*, Springer, 2nd edition, 2011, ISBN-13: 978-3642143243.
- [2] R. W. Hamming: *Digital Filters*, Dover Publications, 3rd edition, 1997, ISBN-13: 978-0486650883.
- [2] Shumann, R., Ghausi, M. S., Laker, K. R.: *Design of Analog filters*. Prentice-Hall, New Jersey 1990, ISBN 0-13-200288-4.
- [3] J. Hospodka and J. Bičák: *Syntfil - Synthesis of Electric Filters in Maple*, MSW 2004 [CD-ROM]. Waterloo, ON: Maplesoft, a division of Waterloo Maple Inc., 2004.

## **University of West Bohemia in Pilsen, Faculty of Mechanical Engineering,**

### **New Technologies Research Center**

#### **Information system development**

*Task: To participate on development of information system for monitoring parameters of human body, such as temperature, motion activity, and more by miniature wireless sensors. The candidate should have good practical experience in at least one of these areas: the design and implementation of software (C or Java or web technologies like PHP, Javascript, CSS, ...), the design of microprocessor based electronic devices (circuit proposal, simulation, PCB design,...), design of high frequency antenna (simulation, validation, optimisation).*

*Requirements: Good knowledge of at least one area listed in task description.*

## **MECHANICAL AND MATERIAL ENG. / MECHANICS / BIOMECHANICS**

**University of West Bohemia in Pilsen, Faculty of Mechanical Engineering,  
New Technologies Research Center**

### **Robustness testing of human body model**

*Task: Incorporate existing human body model to predefined impact scenario, run impact tests using various initial and boundary conditions (position, velocity etc.) in PAMCRASH computational system, analyse results and write final report*

*Requirements: Capability of using MATLAB for data processing, basic knowledge of MBS and FEM, experience in some CADsystem (HYPERMESH welcome) and some computational package (PAMCRASH or LS-DYNA welcome)*

### **Virtual reconstruction of human walking**

*Task: Incorporate experimental data from walking cycle measurement into mathematical software Anybody (including scaling the reference model to the experimental subject), reconstruct the walking by calculation, analyse muscle action during the process and write final report*

*Requirements: Capability of using MATLAB for data processing, basic knowledge of MBS, experience in some computational packages (Anybody software welcome)*

**University of West Bohemia in Pilsen, Faculty of Mechanical Engineering,  
The Research Centre of Forming Technology**

### **Metallographic analysis of materials**

#### **Thermal processing of steels**

*Long-term goals of the projects:*

- *Creation of material-technology models for highly complex dynamic forming processes*
- *Attaining excellent combinations of mechanical properties of multiphase steels using controlled microstructure development*
- *Preparation of processing technologies for hard to form materials*
- *Reducing energy and time demands of thermomechanical processes*
- *Optimisation and development of thixoforming technology for small components*
- *Development of new technologies for hydroforming in the field of rapid prototyping and hydrojoining*
- *Developing alternative ways of connecting high strength materials via forming techniques*

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### **A literature review of suitable tools supporting ontology modelling**

*Task: literature study, testing and comparison of selected available tools supporting ontology modelling.*

*Requirements: knowledge of ontology and information modelling are advantageous.  
Recommended for students of informatics, electrical engineering and cybernetics.*

### **Research Center of Membrane Processes, Stráž pod Ralskem**

#### **Research on the mechanical properties of a new module for electrodeionization (EDI) M10 and its components**

*Research of EDI module deformation under a pressure load (up to 8 bar). Design optimization of EDI module components in order to increase its mechanical resistance - design of distributor as a polypropylene frame, end frame from polypropylene, clamping and pressure plates made of aluminum...*

#### **Complete design of a steel structure for clamping plates of a new electrolysiser using full-width of RALEX ® membrane (width approx. 800 mm).**

*Technical solution and design of the structure (steel plate or a welded frame from steel profiles).  
Stiffness calculation of the structure, production costs estimation, ways of production and preparation of manufacturing documentation.*

#### **Research on the mechanical properties of a bed from granular material (ion-exchange resin).**

*To determine force vs. (elastic) deformation dependence, cracking of the resin beads...*



## **CIVIL ENGINEERING**

### **Czech Technical University in Prague, Faculty of Civil Engineering, Department of Materials Engineering and Chemistry**

#### **Researched topics (long-term research plan) – to be further discussed at the department:**

- 1) *Analysis of currently used experimental methods for determination of thermal, hygric and mechanical properties with a concentration on advanced measuring technologies.*
- 2) *Analysis of available mathematical models and computer simulation tools suitable for design, improvement and testing of building materials and their multi-layered systems.*
- 3) *Assessment of experimental methods appropriate for application to various types of materials in laboratory conditions, semi-scale conditions, production lines of material producers and on building sites.*
- 4) *Assessment of computer simulation tools suitable for design, improvement and testing of building materials and their multi-layered systems.*
- 5) *Construction of complex system of methods for directed design and assessment of functional properties of building materials including both experimental and computational techniques.*
- 6) *Verification of functionality of the proposed system on several types of materials and material systems commonly used in building industry.*
- 7) *Application of the proposed system on the directed design of new or improved building materials and their multi-layered systems using laboratory techniques, semi-scale techniques and computer simulation tools*

### **Czech Technical University in Prague, Faculty of Civil Engineering, Department of Irrigation, Drainage and Landscape Engineering**

#### **Research topics:**

- 1) **Monitoring of rainfall-drainage processes at small agricultural-land basin**  
*Field research, evaluation of measured data, collecting and analysis of samples*
- 2) **Monitoring of rainfall-drainage processes at small mountainous forest basin**  
*Field research, evaluation of measured data, collecting and analysis of samples*
- 3) **Work on terrain rainfall simulator**  
*Evaluation of previously measured data*
- 4) **Laboratory measurement and analysis of soil samples in order to analyze influence of air closed in pores to hydraulic conductivity**
- 5) **GIS analysis of large areas and basins in order to analyze rainfall-drainage, erosion and transport processes using mathematical models**
- 6) **Evaluation of suitability of various localities for renewal of vanished ponds - creation of methodology using mathematical models and GIS analysis.**

## CHEMICAL ENGINEERING

**Charles University in Prague, Faculty of Science,  
Department of Inorganic Chemistry**

### **Synthesis of ferrocene building blocks**

*This project is aimed at developing student's practical synthetic skill through the synthesis of several ferrocene derivatives suitable for further organometallic synthesis, namely acetylferrocene, ethynylferrocene, ferrocenecarboxylic acid and possibly also other compounds. All compounds prepared are supposed to be characterized by conventional analytical methods (NMR and IR spectroscopy). The expected duration is up to 8 weeks (September-October 2012). The duration would be further discussed.*

### **The study of photoactive nanofibers**

*In the research group photoactive nanofibers made of different polymers doped with porphyrin and phthalocyanine photosensitizers were employed. These materials exhibited excellent photosensitizing properties, as proven by the effective photogeneration of  $O_2(1\Delta g)$ , and antibacterial properties under visible light illumination. Considering the industrial scale of nanofiber material production, unlimited source of active species (oxygen) from atmospheric air and the fact that the bacteria cannot pass through the pores of the nanostructured material, the photosensitizing and antibacterial properties make these nanofiber materials a very prospective sterile and auto-photodisinfecting material for broad applications in medicine. The nanofiber materials were also tested as oxygen sensors and for  $O_2(1\Delta g)$  imaging inside nanofibers.*

*In this project they would like to focus on surface modification (chemical or plasma treatment) of yet prepared nanofiber materials. These modification gives an opportunity for innovation of photoactive nanomaterials and transfer of scientific results into real applications such as preparation of photooxidizing, antibacterial, virucidal and light-triggered drug releasing nanofiber materials with an externally bound charged (cationic and anionic) photosensitizer and/or a nonpolar photosensitizer encapsulated inside. (September-October 2012)*

### **Novel materials for non-linear optics**

*This project is focused on preparation and basic characterization of novel crystalline materials based on hydrogen-bonded salts and cocrystals of selected organic bases. The student will prepare new compounds via isothermal crystallization (polar solvents) and characterize them by spectroscopic (IR, Raman and UV/VIS spectroscopy) and diffraction methods (powder and single crystal X-ray diffraction) within the project. Finally, linear and non-linear optical properties of the materials will be studied. (September-October 2012)*

**Charles University in Prague, Faculty of Science,  
Department of Analytical Chemistry**

### **Biological active organic substances of environmental importance at the UNESCO Laboratory of environmental electrochemistry.**

*Research in the field of modern electroanalytical chemistry.*

*There are no special prerequisites. Staff members of UNESCO Laboratory of electroanalytical chemistry have long time experience in this field so that no preliminary background in electroanalytical techniques is requested.*

*The department has close cooperation with Heyrovsky institute of physical chemistry of the Academy of Sciences of the Czech Republic and electroanalytical chemistry has a long tradition in the Czech Republic since the discovery of polarography by Professor Heyrovsky. Moreover, we the department has long-time cooperation with several Brazilian research institutions (FIOCRUZ etc.) and with several Brazilian universities. The exact research project will be prepared in cooperation with prospective visitor as far as the technique, analyte, matrix etc. are concerned. The laboratory is well equipped with modern electroanalytical instrumentation, HPLC systems with electrochemical detection, FIA systems with electrochemical detection etc. The staff pays attention to the determination of environmental carcinogens, ecotoxic substance, pesticides, anticancer drugs and other biologically active organic substances using different electroanalytical techniques, non-traditional electrodes, new-type of electrochemical sensors etc.*

**Identification and determination of fatty acids in membranes of selected microorganisms by fast-GC-MS-TOF.**

*This project is devoted to bioanalytical chemistry.*

**Modern spectrometric methods in environmental analytical chemistry.**

**Charles University in Prague, Faculty of Science,  
Department of Organic and Nuclear Chemistry**

**Catalysis in Organic Synthesis**

*The research endeavors focus on several objectives. They encompass development of new methodologies based on the use of transition-metal compounds and their application syntheses of various compounds. Individual projects concern synthesis of new chiral Lewis bases for enantioselective processes, synthesis of natural and biologically active substances, synthesis of new ferrocene and carborane derivatives, Dewar benzene application in organic synthesis, and the C–C bond activation.*

**Sacharides**

*For a period of almost 20 years the laboratory devoted a big effort toward synthesis of different monosaccharides substituted with various substituents e.g. halogeno, amino, thio, cyano groups. These sugars have been used also for the synthesis of selected oligosaccharides. Currently the staff focus their effort (in collaboration with Prof. Werner Reutter, FU Berlin) to synthesize GNE inhibitors which are active in vivo, enabling us to identify further characteristics of Neu5Ac in glycoconjugates, especially with respect to their role in the surface of tumor cells protecting them from the interaction with cells of the immune system.*

**Bioorganic and Medical Chemistry of Nucleic Acids:**

*Joint laboratory of IOCB and Charles University. Novel types of modified derivatives and analogues of nucleobases, nucleosides, nucleotides and nucleic acids are designed and prepared for applications in all areas of biomedical sciences (medicinal chemistry, biochemistry, chemical biology, bioanalysis etc.).*

**Supramolecular Chemistry**

*Group of supramolecular chemistry focuses mainly on the development of new methods for synthesis of cyclodextrin derivatives and on utilization of these derivatives in areas like separation science, new materials or chemosensors.*

### **Research of Reaction Mechanisms**

*Research program of the laboratory is focused on studying elementary steps in organic and organometallic reactions using mass spectrometry, ion spectroscopy and quantum chemistry. The aim is a deeper understanding of reaction mechanisms and formulation of new general concepts in organic and organometallic reactivity.*

### **Organic Synthesis**

*Research within the group revolves around two independent topics: the medicinal chemistry theme focuses on the design and synthesis of small molecules, which are able to prevent HIV bugs from maturation (so-called self-assembly inhibitors). The ongoing project runs in tight collaboration with biochemists.*

*Interest in catalysis centers on chemists' key transformation – C-C bond formation. Research spans from fundamental to applied catalysis with particular respect to a catalyst heterogenization.*

### **EcoChemistry of organic compounds, phytoremediation, labeled compounds, radiopharmaceuticals**

*The main objective of the research is the study of the fate of organic compounds in the environment and the possibilities of their removal using plant biotechnology (phytoremediation). The studied compounds are preferably from the group of pharmaceuticals and/or their metabolites, eventually organic chemicals from consumer chemistry products. The further investigations are focused to the synthesis of radioactively labeled compounds for metabolic experiments and radiopharmaceuticals.*

### **Laboratory of Constitutional Dynamic Chemistry**

*Research in the Laboratory of Constitutional Dynamic Chemistry is focused on design, synthesis and study of molecular interactions that can generate dynamic systems whose constitution and evolution can be influenced by the physical and chemical stimuli. The aim of our work is the understanding and description of the molecular systems at the level of dynamic interactions, and self-assembly of supramolecular structures and dynamic combinatorial systems.*

## **Research Center of Membrane Processes, Stráž pod Ralskem**

**Research on the mechanism of ion-exchange membranes fouling in various applications for electromembrane processes.**

**Research on the transport properties and structure of ion-exchange membranes in complex mixtures of electrolytes.**

### **Research on the transport and kinetic characteristics of bipolar membranes**

- *Effect of a composition and structure of bipolar membrane's contact layer on the kinetics of water dissociation*
- *Influence of the composition and structure of the individual layers on the transport properties of the bipolar membrane*
- *Design and validation of appropriate methodologies to characterize bipolar membranes*

## **Research on the separation properties of composite membranes for gas separation**

### **Research on the selectivity of membranes**

- *Characterization of selective properties of different types of membranes (IM, MF, IM with high porosity, different structures IM, etc.)*
- *Determining which of the membranes is more selective to monovalent ions, which on the other hand is not selective at all, etc. All this in relation to the structure of the IM / MF.*
- *Determination of the possibility of further modifications IM in order to improve their selective properties.*

### **Study of nanostructure and microstructure of membranes**

- *Characterization of micro and nano structures in membranes*
- *Interaction of ion-exchange compounds and surrounding binder*
- *The effect of the distribution and concentration of the ion-exchange compounds in relation to the type of binder*
- *The principle of forming of different types of structures*
- *Effect of water content on the structure and properties of the membranes*

### **Development of new basic materials**

- *Ion-exchange material as a filler for heterogeneous membrane*
- *Polymeric matrices for heterogeneous membranes*
- *Ion-exchange material for production of a homogenous membrane*
- *Materials for gas separation*

### **The development of new types of membranes**

- *Reinforced membrane*
- *Unreinforced membrane foil*
- *Composite membrane foil*
- *Multi-layer membrane*
- *Surface-modified membrane*

### **Development of membranes for specific applications**

- *Membrane foil for EDI*
- *Thin film membrane*
- *Membrane optimized for demineralization of whey*
- *Membrane for ED stabilization of wine*
- *Membrane for high temperature processes*
- *Membrane with increased chemical resistance*
- *Ion-exchange membrane for membrane electrolysis*

**Development and implementation of new optimized methods to characterize membranes and materials**

- *Measurement of the rheological properties of membrane production mixtures and PE*
- *Characterization of bipolar membranes*
- *Mechanical properties of membranes*
- *Porosimetry*
- *Characterization of membranes for pressure membrane processes*
- *Characterization of membranes for gas separation*

**Development and validation of industrial technologies for production of new types of membranes**

- *Study on mixture modification in order to improve processing characteristics and operational properties of membranes*
- *Study on optimal composition of membrane composite and on optimal processing conditions*
- *Effect of the moisture content of ionex and granules on the structure and properties of membranes*
- *The influence of the production technology on the structure of the membrane*

**Development and implementation of methodology to study kinetics and mass transfer characterization of ion-exchange membranes on a rotating disk membrane**

**Mathematical modeling of electro-dialysis process with bipolar membranes**

**Optimizing of configuration and operation mode of electro-membrane modules for industrial applications**

**Research of deformation and design optimization of components in electro-membrane modules with internal mechanical stress**

**Research on the effect of manufacturing tolerances of the components on transport properties and operational stability of electromembrane modules**

**Research on limit electric current in electro-dialyser and its influence on the behavior of industrial equipment**

**Research on the process of electro-dialysis for the selected application with bipolar membranes**

**Research on the optimal configuration and operating conditions of membrane processes in dairy industry**

**Research on the use of membrane for processing of sugar solutions**

**Research on the integration of membrane processes in order to rationalize water management in energetic industry**

**Research on the process of membrane separation of energy-rich gas mixtures in order to enhance their application**

**Mathematical modeling of processes with integrated membrane technologies**

**Research on the membrane and AOP processes. Their comparison for treatment of sewage waters with high organic content**

**Research on the use of membrane processes in integrated technologies for manufacturing of beverages**

**Research on the preparation of ultra-pure water for pharmaceutical industry and other special applications**

**Research on the membrane separation of toxic gases**