Course title: **Exoskeleton ins Mechatronic Systems**

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During the course PhD students will learn about a variety of advanced solutions of exoskeletons systems available and practically used in various interdisciplinary engineering branches like: military, biomedical and rehabilitation engineering.

After a brief introduction to the basic problems of exoskeletons systems the course is going to especially concentrate on non-invasive measuring methods (Holter EKG, EMG – electromyography, MMG – mechanomyography PMG – phonomyography, PCG – phonocardiography, EKG – electrocardiography, EEG – electroencephalography) and executives solutions (classical: dedicated electrical engines, electro-pneumatic and hydraulic drivers; and innovative: dielectric elastomers, shape memory materials, artificial muscles). A special attention being paid also on advanced rehabilitation systems with biofeedback.

The course is planned to embrace both scientific and technical knowledge about advanced techniques and components used in many fields of engineering (physics, mechanics, electrics) and will allow students to understand not only how operating advanced exoskeleton systems, but also how they should be perceived and applied in interdisciplinary engineering branches giving synergy effect.

The course is divided into 5 lectures (3.0 hours each), covering 15 hours in total. This lectures embraces the following issues:

1. **General introduction to exoskeletons systems – case studies**
   - *the nature and structure (systems of: measuring, executive and control) of the exoskeletons,*
   - *example of solutions for military, rehabilitation and to facilitate the daily lives of people with permanent disabilities*,
   - *feedbacks in the human body.*
2. **Measurement systems of exoskeletons**
   - *non-invasive, electrical and mechanical methods: EMG, MMG, PMG, PCG, EKG, EEG, etc.,*
   - *non-invasive, optical methods: Infrared Camera, Light Amplification by Stimulation of Radiation (LASER), Fibber Bragg, Piezoelectric Sensors.*
3. **Executive systems of exoskeletons**
   - *classical solutions: dedicated electrical engines, electro-pneumatic and hydraulic drivers,*
   - *innovative solutions: PAM – Pneumatic Artificial Muscle: McKibben's, based on Shape Memory Alloys, and Dielectric Elastomers.*
4. **Control systems of Exoskeletons**
   - *Structure of Intelligent Assist Device,*
   - *Selected control methods: Swarm Algorithms (BC – Bee Colony, RFD – River Formation Dynamics, etc.), Pairwise Comparison Method.*
5. **Rehabilitation systems with biofeedback**
   - *Selected diseases and methods of their rehabilitation,*
   - *Review of the systems solutions,*
   - *Rehabilitation system design – case study.*