Study programme: Applied Mechanics

	Téma disertační práce	Školitel	Katedra
1.	**Experimental and theoretical research of the mechanical properties of composites with the matrix of acrylic resin reinforced by natural fibres and textiles of natural fibres. Numerical modelling of their response using FEM based on a suitable material model** **Annotation:** Experimental and theoretical research on mechanical properties of composites with the matrix of acrylic resin reinforced by natural fibres and textiles made of natural fibres. Numerical modelling of their response using FEM. Water-based acrylic resins are suitable for composites with natural fibres reinforcement for good wettability. Such composites are 100% green as even during their cure do not release any harmful organic substances. The composites are lightweight and are used in the automotive and aerospace industries.	prof. Ing. Iva Petríková, Ph.D.	KMP
2.	**Experimental and theoretical research of magnetorheological foams** **Annotation:** Experimental and theoretical research of magnetorheological foams, comprised of micro-sized magnetically permeable particles dispersed in the foam matrix Magnetorheological foams are a new class of lightweight smart materials based on a polymeric matrix with embedded magnetic micro-particles. The application of a magnetic field during the foaming of samples induces the alignment of magnetic particles. The micro-particles are improving the mechanical stiffness and dynamical modulus. The magnetorheological behaviour is obtained at the relatively low intensity of magnetic field. The subject of research is the preparation of MR foams and the determination of their elastic and viscoelastic response to a compressive qualities and dynamic loading.	prof. Ing. Iva Petríková, Ph.D.	KMP
3.	**Mechanical Properties of Flexible Structural Materials** **Annotation:** The volume of structural materials is filled with structural elements. In our case, we are inspired by naturally occurring structural materials, such as polyurethane foam. The structure of such materials can be replicated in various ways, ranging from filling space with regular geometric patterns to methods based on space-partitioning algorithms with a certain degree of randomness, for example by applying Voronoi tessellation. Using 3D printing technology, the artificially designed structure can then be manufactured. The geometric and material properties of the structure influence its mechanical response	doc. Ing. David Cirkl, Ph.D.	KMP

	under loading. The research includes investigation of force response, the amount of dissipated energy, and deformation at the microstructural level. The work also involves the development of a simulation model of a flexible material with an internal structure and its experimental validation, as well as the design of the structural geometry. Another objective is to explore the possibilities of targeted structural geometry design based on requirements for the quantitative or qualitative characteristics of the aforementioned phenomena. Methods that can be employed for this purpose include artificial intelligence techniques or, for example, genetic optimization.		
4.	**Deformation behavior of shape memory alloys at micro- and nano-scale** **Annotation:** Deformation behavior of shape memory alloys (SMA) stems from the motion of interfaces between austenite and martensite structures. The thesis will be focused on the size and crystallography effects on the mobility of these interfaces and how it affects the functional behavior of miniature SMA components. The subject will be addressed by experimental as well as theoretical research approaches. The former will be based on in-situ and ex-situ experiments using Femtotools nanomechanical testing system analysis, electron microscopy and x-ray diffraction methods. The latter will be based on numerical simulations implementing mathematical theory of martensitic transformation.	Ing. Luděk Heller (Fyzikální ústav AV ČR, heller@fzu.cz) prof. Ing. Iva Petríková, Ph.D.	KMP
5.	**Microstructure-property relationships in shape memory alloys** **Annotation:** Functional thermomechanical behavior of shape memory alloys (SMAs) is based on crystallographically anisotropic mechanisms of diffusionless volume preserving martensitic transformation and twinning in martensite phase. The thesis is aimed at answering the question how preferential orientations of microstructures (texture) affect structural and functional behavior of SMAs. This topic will be addressed technologically by microstructure modifications using selected thermomechanical processing routes and subsequent microstructure characterizations using electron microscopy and x-ray diffraction. Furthermore, the structural and functional behavior of samples with prepared microstructures will be characterized. Finally, the relationships between the microstructure and properties will be analyzed with help of theory of martensitic transformations and numerical calculations and simulations. The ultimate goal will be to provide a tool for optimization of microstructures with respect to thermomechanical behavior required by applications.	Ing. Luděk Heller (Fyzikální ústav AV ČR, heller@fzu.cz) prof. Ing. Iva Petríková, Ph.D.	KMP
6.	**Artificial Intelligence in Reactor Physics and Nuclear Energy**	prof. Ing, Radek Škoda, Ph.D.	KEZ

	Annotation: The use of Artificial Intelligence (AI) in reactor physics offers a new perspective for computational simulations of nuclear reactors, optimization of core loading patterns, and ensuring nuclear safety. This work will focus on the analysis and application of modern AI methods, especially machine learning, neural networks, and data analysis methods, which can improve modeling and simulation in nuclear energy. The content of the work includes an overview of existing calculation methods in reactor physics and the application of AI to increase the accuracy of computational simulations. It will also involve an evaluation of the advantages and disadvantages of implementing AI technologies in terms of the reliability and safety of nuclear facility operation. Literature: Zhang, R., Zhu, S., et al. (2025). "Artificial Intelligence in Reactor Physics: Current Status and Future Prospects."		
7.	**Utilization of Nuclear Sources for Nonelectric Applications** **Annotation:** The heat produced in nuclear reactors is usable for many industrial processes. This work will focus on the technical and economic evaluation of utilizing new and existing nuclear sources for pulp or paper production, the rubber industry, fertilizer production, the chemical industry, and metallurgy. Finally, it will also cover the economics of hydrogen production. Literature: IAEA Technical Documents (TECDOCs): "Nuclear Heat for Industrial Processes," and "Small Modular Reactor (SMR) applications."	prof. Ing, Radek Škoda, Ph.D.	KEZ
8.	**Utilization of Nuclear Sources for Heat Production** **Annotation:** Nuclear reactors in existing nuclear power plants do not utilize more than half of the produced heat. This work will focus on the technical and economic evaluation of utilizing new and existing nuclear sources for district heating (NDH), both in the Czech and the global context. Literature: IAEA Technical Documents (TECDOCs): "Non-Electric Applications of Nuclear Energy," and "Small Modular Reactor (SMR) applications."	prof. Ing, Radek Škoda, Ph.D.	KEZ