University of Maribor

FRAMEWORK PROGRAMME OF EARLY STAGE RESEARCHER TRAINING[1]

1. BASIC DATA

Mentor's name and surname	**Gregor Harih**	Mentor's register number at ARIS (SICRIS):	**33256**
Mentor's e-mail:	gregor.harih@um.si	Mentor's tel. no.:	041331160
Research programme (RP) leader's name and surname:	Zoran Ren	RP leader's register number at ARIS (SICRIS):	08779
Title of research programme:	Design of Cellular Structures	RP's Register number at ARIS (SICRIS):	P2-0063
Research organisation (RO) of University of Maribor, where training shall be conducted:	Faculty of mechanical engineering	RO Register number at ARIS (SICRIS):	795
Research field according to ARIS classification:	2.11.02 Special constructions know-how	Research field according to EURAXESS classification	Mechanical engineering

2. DEFINITION OF RESEARCH PROBLEM AND GOALS OF DOCTORAL RESEARCH[2]

Starting point of research task of the early stage researcher and its position in the research programme, where the mentor is included, work hypothesis, research goals and foreseen result with emphasis on an original contribution to science:

Starting point and placement within the research program: Despite the rapid development of additive manufacturing (AM) technologies, they have not yet reached the level of widespread use in serial industrial production. The main obstacles are limited process repeatability, a narrow range of industrial materials, and, above all, the relatively slow production rate per part, which economically constrains high-volume production. However, AM offers a significant strategic advantage in niche applications, high-tech sectors, and small-batch production, where geometric complexity and adaptability are crucial. To justify the adoption of AM in these segments, it is essential to ensure high added value for products through

[1] *Term early stage researcher (ESR) is written in male form and used as neutral for women and men.*

[2] *Research and study programme of training have to harmonise with contents of the research programme, where the mentor is a member.*

multifunctionality (e.g., the integration of vibration damping, heat exchange, or tailorable stiffness into the load-bearing structure).
The research work of the young researcher will be embedded in the research program P2-0063 "Design of Cellular Structures." It will build upon existing knowledge of homogeneous lattice structures through the development of advanced functionally graded and multi-material cellular metamaterials. The focus will be on bridging the gap between complex design and manufacturing constraints using two complementary 3D printing technologies: low-cost systems (FDM/FFF) for developing multi-material concepts and industrial systems (SLA) for ensuring high precision.
Working Hypothesis: By integrating advanced generative design (implicit modeling), supported by artificial intelligence methods (serving as tools for optimization and rapid property prediction), and utilizing multi-material 3D printing strategies, it is possible to develop a new generation of cellular metamaterials. We assume that these materials will exhibit pre-programmed mechanical responses and multifunctionality achievable only through these advanced methods, thereby significantly increasing the added value of products and accelerating the industrial adoption of additive technologies and newly developed multifunctional cellular metamaterials.
Research Objectives:

- **Development of design methodology:** Establish procedures for generating continuous functionally graded and multi-material cellular structures.
- **Integration of AI tools:** Develop and implement physics-informed surrogate models for rapid evaluation and inverse optimization of cellular structures without the need for time-consuming numerical simulations.
- **Experimental validation:** Conduct systematic analysis and printing of samples on FDM and SLA printers and evaluate their mechanical properties.
- **Demonstration of multifunctionality:** Manufacture a physical demonstrator for an industrial application that confirms the superiority of the developed approach compared to conventional solutions.

Expected results and original contribution to science: The expected result is a validated methodology for the design and manufacturing of multi-material cellular metamaterials with a programmed response. The original scientific contribution will be the development of a novel hybrid approach that combines physics-informed machine learning with generative design to solve the problem of inverse design for multi-material structures. The results will provide guidelines for the effective utilization of multifunctionality in AM, enabling a transition from passive "load-bearing" structures to active, smart engineering materials.

3. STUDY PROGRAMME

Foreseen study programme, to which early stage researcher shall be enrolled in academic year 2026/2027:

Doctoral school of Faculty of Mechanical Engineering – Mechanical Engineering

4. DESCRIPTION OF WORK AND TASKS

Implementing projects of scientific research.
Taking part in the design of research programmes.
Cooperating with research sponsors.
Drawing up research and other reports.

Monitoring and coordinating research work according to the grant agreement.
Ensuring safety and health at work.
Organising and instructing employees and students on using personal safety equipment and other safety measures.
Performing other tasks at the behest of the superiors.
Participating in ad-hoc and permanent committees of university or faculty bodies.
Acting on behalf of colleagues and superiors during their absence (upon authorisation).
Participating in annual and other inventories.
Performing other related tasks delegated by superiors.

5. REQUESTED LEVEL OF EDUCATION

VII/2. tariff group

6. REQUESTED FIELD OF EDUCATION

Technical, Natural sciences

7. KLASIUS SRV

Seventh level: Second cycle of higher and similar education/Second cycle of higher and similar education

8. KLASIUS P

01 – Educational sciences and teacher education
05 – Natural Sciences, Mathematics and Statistics
07 – Technology, production technologies and construction

9. REQUESTED KNOWLEDGE

Computer skills: MS Windows, Word, Excel, Internet, e-mail, e-commerce

10. REQUESTED SPECIAL REQUIREMENTS

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11. REQUESTED LANGUAGES

Active knowledge of one world language

12. REQUESTED WORK EXPERIENCE

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13. FORESEEN POSTDOCTORAL TRAINING

Upon successful completion of the doctorate, the candidate will be qualified to independently prepare and submit a competitive postdoctoral project proposal to national and international calls. The proposed project will be based on the findings of the doctoral research but will represent a significant advancement by expanding into the field of smart materials and transferring the methodology to an industrial environment.

Mentor's signature:

Gregor Harih

Digitally signed by Gregor Harih
DN: C=SI, S=Slovenija, OU=individuals, SN=Harih + G=Gregor + CN=Gregor Harih + SERIALNUMBER=24796015120 34
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Research programme leader's signature:

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Location:
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Name and surname of Dean or authorised person[3]:
Red. prof. dr. Matej Vesenjak

Signature of dean or authorised person:

Digitally signed by Matej Vesenjak
Date: 2026.01.29 11:46:36+01'00'

Place and date:

Maribor, 29. 01. 2026

Stamp:

[3] The training program is signed by the dean of the member where the ESR's employment and training will take place.