University *of Ljubljana*
Faculty *of Mechanical Engineering*

Additive Technologies 5 ECTS

Lecturer: **E. Govekar, D. Klobčar**

Lectures: 30h | Tutorials: 14h | Labs: 16h | Project: 0h | Lang. :

Objectives

The course on Additive technologies covers the field of additive manufacturing (AM) of metals. By lectures, tutorials and hands-on work in the lab students acquire the knowledge and skills required to perform the whole AM production chain including AM specific product design, AM process selection, AM system and manufacturing steps, as well as post processing. In-depth knowledge of metal AM is enriched by practical lab work on different AM processes including wire-arc (WAAM), direct laser deposition (DLD) and selective laser melting (SLM).
Thus, the objectives of this course are the:

- Learning the possibilities and potentials of AM technologies and the elements of the entire AM process dependant production chain from product model, AM simulations to the final functional product.
- Learning about the systems and processes of AM for metals and identifying cost-effective technology and business opportunities for successful implementation to achieve added value.
- The ability to identify and select appropriate AM technology for the product according to the product functional requirements and to master the entire process chain of AM, to produce the final functional product.
- The ability to analyse and determine the influence of the main AM process parameters on product properties.

Programme

Basic concepts and motivation for AM technologies; Overview of metal AM processes; Materials for AM – Overview, manufacturing and characterization, Physical processes, defects and weldability; Digital part of AM - Design for AM and Software for AM; Post processing and quality control; Wire arc additive manufacturing – Types, power sources, process parameters, materials, applications, Process chain, path strategies, sensors and control, post-processing; Laser based AM processes – Overview and comparison, laser light matter interaction; Direct laser deposition – Systems, applications, materials, process chain, design rules, path strategies, DLD of wire/powder – Deposition heads, powder nozzles, process parameters, instabilities and process control, functional graded materials; SLM – process and systems, applications, process chain, design rules, process parameters, post processing, Examples of added values using AM.

Prerequisites

In order to successfully achieve this course, the students must have:

- Basic knowledge in physics (radiation, wave, electron beam, laser light, heat conduction, etc.).
- Basic knowledge in metal materials (properties of metals).

Learning outcomes

After attending this course, the student will obtain:

- In-depth theoretical, methodological and analytical knowledge with elements of research in the field of AM technologies, product modeling, material knowledge, post-processing
- Mastering highly demanding, complex workflows and methodological tools in a specialized broader field of AM technologies.
- Preparation and implementation of elementary experiments to analyse the effects of process parameters on the properties of AM products .

Assessment

Contribution to the final grade:

- 50% theoretical written exam (lectures).
- 30% laboratory work (including reports).
- 20% seminar work as home assignment

Literature

I. Gibson, D. W. Rosen, B. Stucker: Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer New York Heidelberg Dordrecht London, 2010.
John I. Milewski Additive Manufacturing of Metals From Fundamental Technology to Rocket Nozzles, Medical Implants and Custom Jewellery, Springer series in material sciences, 2017.