University *of Ljubljana*
Faculty *of Mechanical Engineering*

Advanced Forming Processes 5 ECTS

Lecturer: **T. Pepelnjak**

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

Objectives

The objectives of this course are to make students aware of the new trends in forming technologies and their future challenges in the context of Industry 4.0. To be competitive in a global industrial environment, modelling the entire production chain and creating digital twins of forming processes is a crucial step. Competitive forming technologies require smart tooling concepts with implemented sensors and actuators to adapt the process to the disturbances that occur during its course.
Thus, this course will address:

- The ability to manufacture products using advanced forming processes and select the appropriate technological process.
- In-depth knowledge of standard and innovative processes for forming metallic and non-metallic materials and the optimization of their influencing parameters
- Building on the knowledge of existing forming processes, design of forming processes and their key technological parameters.
- The ability to set-up an adaptive forming process whose control is based on the developed digital twin. The forming process is performed by smart tools with integrated sensors and actuators.

Programme

1. Introduction to the context of forming technologies for metals and non-metals
2. Flexible metal forming technologies (incremental forming, flexible bending, flow forming)
3. Introduction of digital twin in forming processes
4. Smart forming tools (concepts, adaptive forming of sheet metals, adaptive forming of polymers)
5. Flexible forming systems (smart forming tool, modern forming machine, flexible auxiliary equipment)

Prerequisites

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

- Meeting the enrolment conditions for the Master's study programme of Mechanical Engineering - Research and Development program.
- Good knowledge in materials science of metals and non-metals.
- Good knowledge in mechanics of materials (elastic-plastic behaviour).
- Basic knowledge in material forming.
- Basic knowledge of the concept of digital twins

Learning outcomes

After attending this course, the student will:

- Be aware of the benefits and requirements of various forming processes
- Be able to select product-oriented forming technology
- Be aware of the benefits of modern flexible forming technologies
- Be able to evaluate advantages and drawbacks of selected forming technology
- Be able to create a simple digital model of the forming process
- Be able to create a digital twin of a simple forming process

Assessment

Contribution to the final grade:

- 50% theoretical written exam with the mutual exam.
- 30% laboratory work (including reports).
- 20% seminar work as home assignment (One oral presentation in groups with self-assessment by the classmates). The topic will be related to one of the key aspects from the course and based on a research paper in the literature.

Literature

X. Guo: Flexible Metal Forming Technologies, Principles, Process and Equipment, Springer 2022.

Lee, H., Park, N., Kim, M. *et al.* Recent Developments and Trends in Flexible Forming Technology. *Int.J Automot. Technol.* **23**, 741–763 (2022). https://doi.org/10.1007

Hoppe, F., Pihan, C., Groche, P. Closed-loop control of eccentric presses based on inverse kinematic models, *Procedia Manufacturing,* **29**, 240-247 (2019). https://doi.org/10.1016/j.promfg.2019.02.132.