16. Metal Forming I

GENERAL INFORMATION ABOUT THE COURSE		
Course coordinator	Josip Cumin, PhD, assistant professor	
Course name	**Metal Forming 1**	
Study program	**Mechanical Engineering**	
Course status	Compulsory/Elective	
Year	1st year of the graduate program	
Semester	2nd semester	
Number of credits and teaching methods	ECTS student load coefficient	5
	Number of hours (lectures + seminars + exercises)	30 + 0 + 30

1. DESCRIPTION OF THE COURSE
1.1. Course objectives
Explain metal forming technologies to students, including the necessary parameters in metal forming and in making forming tools. Familiarising students with the fundamentals of plasticity theory.
1.2. Course enrolment prerequisites *(if applicable)*
There are no prerequisites for course enrolment
1.3. Expected course learning outcomes
1. Explain the classification of forgings and production technologies for all types of forgings. 2. Explain the reasons in using certain methods for positioning workpieces in a forging die. 3. Apply forging technologies for a certain set product shape and certain group of forgings. 4. Apply acquired knowledge to construct forging tools from given drafts. 5. Resolve specific production problems relating to the operation of forging and apply one’s knowledge to drafting complete technological documentation for a constructed forged tool. 6. Explain the plasticity theory.
1.4. Course content
1. Forging die technologies. Selecting the group of forged pieces. Approximate volume calculation. 2. Selecting the machinery. Flashes for processing and manufacturing tolerances. Real volume calculation. 3. Draft angle and radius. Punching plates.

4. Flash gaps (Type 1, 2, 3, 4 and 5). Parting plane and line of the die structure. Technical drawing of a forged piece.
5. Forging technology for group 1 forged pieces. Reduced forged pieces. Combined reduced forged pieces.
6. Forging technology for group 2 forged pieces. Phases in forging round forgings.
7. Forging the third group of forged pieces. Calculating deformation operation.
8. Opening for forging pliers and pouring channel. Material for die forges. Compensating horizontal forces.
9. Heating materials. Types of heating furnaces and the specificities.
10. Unconventional procedures in forging metals.
11. Flow stress for tri-axial stress state. Stress tensor and associated components.
12. Bloc diagram for analytical solutions in metal forging. Material flow. Equations for resolving metal forging (10 equations with 10 unknowns).
13. Local deformation and speed. Homogeneous shaping. Material model.
14. Transformation of stress state. Main axes and invariants. Deviator of stress state and flow conditions.
15. Movement. Continuity equation. Speed of deformation in tensor form. Flow law in tensor form. Equilibrium equations: in right angle and cylindrical coordinates.

1.5. Types of teaching	☒ Lectures ☐ Seminars and workshops ☒ Exercises ☐ Distance learning ☐ Field work	☒ Autonomous exercises ☐ Multimedia and network ☐ Laboratory ☒ Mentor assistance ☐ Other types
1.6. Comments		

1.7. Student obligations *(attendance at classes, lectures, tutorials, seminars)*

Attendance at classes/exercise. Drafting and submission of program.

1.8. Tracking student work (proportion of individual activities in terms of ECTS credits based on the total number of ECTS credits)

Class attendance	2	Class participation		Seminar paper		Experimental work	
Written exam	2	Oral exam		Essay		Research	
Project	1	Continual assessment of knowledge		Written seminar paper		Practical work	
Online activity							

1.6. Grading and assessment of student work during the semester and for the final exam *(colloquiums, written exam, oral exam)*

- 3 colloquiums / or entire exams consisting of three parts (forging / heating / elementary plasticity theory).
- Submission of prepared program.

1.9. **Mandatory literature** (relevant at the time of submitting the proposed study program)
- Grizelj, B.: "Oblikovanje metala deformiranjem", Strojarski fakultet Slavonski Brod 2002. - Grizelj, B.: "Alati i naprave", Strojarski fakultet Slavonski Brod 2004.
1.10. Supplementary literature (relevant at the time of submitting the proposed study program)
- Povrzanović, A.: "Obrada metala deformiranjem", Fakultet strojarstva i brodogradnje Zagreb, 1996. - Hribar, J.: "Plastična obrada metala", Fakultet strojarstva i brodogradnje Zagreb, 1975 - Musafija, B.: "Obrada metala plastičnom deformacijom", Svjetlost Sarajevo, 1988. - Lange, K.: "Umformtechnik" Band I-IV, Spring Verlag, 1989. - 1993. - Fritz, H.; Schulze, G.: "Gertigungstechnik", VDI VERLAG, 1995. - Math, M.: "Uvod u tehnologiju oblikovanja deformiranjem", Fakultet strojarstva i brodogradnje, Zagreb, 1999.
1.11. Manner of tracking quality to ensure the acquisition of exit knowledge, skills and competences
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2. COMBINING THE LEARNING OUTCOMES, TEACHING METHODS AND ASSESSMENT OF THE LEARNING OUTCOMES

2.1. Class participation	*2.2. Student participation*	*2.3. Learning outcome*	*2.4. Assessment method*
Class attendance	Attendance and active participation	1 - 6	Records along with brief assessment of knowledge
Drafting the program	Participation in exercises and drafting the program	1 – 6	Assessment of the quality of the drafted program
Final exam	Written assessment of knowledge	1 – 6	Assessment of theoretical section of the written exam. Assessment of the solved task in the written exam (application of theoretical knowledge for solving a specific problem)