COURSE SPECIFICATION

Course code	full-time programme:	**M#2-S1-ME-KWW-611**
	part-time programme:	
Course title in Polish	**Wspomaganie komputerowe projektowania procesów obróbki plastycznej**	
Course title in English	**Computer-Aided Design for Metal Forming**	
Valid from (academic year)	**2024/2025**	

GENERAL INFORMATION

Programme of study	**MECHANICAL ENGINEERING**
Level of qualification	**first-cycle**
Type of education	**academic**
Mode of study	**full-time programme**
Specialism	**Computer-Aided Manufacturing**
Department responsible	**Department of Metal Science and Manufacturing Processes**
Course leader	**dr inż. Tomasz Miłek**
Approved by	**dr hab. Jakub Takosoglu, prof. PŚk, Dean of the Faculty of Mechatronics and Mechanical Engineering**

COURSE OVERVIEW

Course type		**specialism-related**
Course status		**compulsory**
Language of instruction		**English**
Semester of delivery	full-time programme	**Semester VI**
	part-time programme	
Pre-requisites		**Fundamentals of Metal Forming, Metal forming**
Examination required (YES/NO)		**NO**
ECTS value		**2**

Mode of instruction		**lecture**	**class**	**laboratory**	**project**	**seminar**
No. of hours per semester	full-time programme	**15**			**15**	
	part-time programme					

LEARNING OUTCOMES

Category of outcome	Outcome code	Course learning outcomes	Corresponding programme outcome code
Knowledge	W01	On completion of the course, students will have fundamental knowledge of the possibilities of FEM-based computer programs designed to simulate forging processes.	MiBM1_W03 MiBM1_W09
	W02	On completion of the course, student will have theoretical knowledge of computer-aided design and manufacturing for metal forming processes especially hot die forging of circularly symmetric forgings.	MiBM1_W03 MiBM1_W09 MiBM1_W11
Skills	U01	At the end of this course, students will have the skills required to performing computer modeling of die forging processes for circularly symmetric forgings in QForm software.	MiBM1_U02 MiBM1_U04 MiBM1_U08 MiBM1_U12
	U02	By the end of this course, students will be able to select the right boundary conditions for modeling of hot die forging process.	MiBM1_U02 MiBM1_U12
	U03	On completion of the course, students will be able to carry out computer simulations of die forging processes for circularly symmetric products in QForm software and draw appropriate conclusions from the simulation results.	MiBM1_U02 MiBM1_U06 MiBM1_U12
Competence	K01	Students are aware of the need to critically assess and update their expertise from metal forming and by exchanging knowledge and experiences with other metal forming experts	MiBM1_K01

COURSE CONTENT

Type of instruction lecture	Topics covered
lecture	Introduction: the aim of the theoretical analysis of metal forming processes, directions of development of modern metal forming processes, review of softwares used in metal forming based on FEM method. The application of the QFORM-2D software to solve technological problems in different metal forming methods, especially: open-die forging, die forging, forward and backward extrusion and wire drawing. Characteristics of QFORM-2D software. Theoretical foundations and assumptions of QFORM-2D. Technical data and software parameters. Overview of available commands in QFORM-2D. Source data required for simulation by QForm: geometry data (billet and dies drawings in AutoCAD or SolidWorks) and technological parameters (material properties, equipment, lubricant, other process parameters). Discussion of errors in preparing data for simulations. Analysis of results in the QFORM-2D software (analysis of distributions of effective strain, flow stress, temperature in cross section of forgings and changes of force in function of displacements of tools). Interpretation of modeling results from the point of view of a technological engineer. Application of the finite element method (FEM) to modeling metal forming processes

project	The project consists in carrying out a computer simulation of the hot die forging process of a circular-symmetric forgings on a crank press or on a steam-air hammer in the QForm software and the analysis of the obtained numerical results. Students have to prepare and deliver a presentation (Powerpoint software) to discuss the results of an engineering project. Preparation of geometric data for the simulation based on AutoCAD or SolidWorks software (drawings of tools, shape and dimensions of the workpiece). Defining drawing objects in the Q-Draft software. Determining and entering into the QFORM software the technological parameters of the die forging process on the press or on the hammer, a such as following: type of simulated process, time of cooling in air, grade of steel, heating temperature of the workpiece, tool parameters, lubricant, forging equipment, final distance between tools. Performing a numerical calculations by using QForm software. Analysis of the obtained simulation results for die forging in terms of material flow, the degree of material filling of the dies, distributions of workpiece temperature, flow stress, effective strain in the longitudinal section of the forgings and changes of the force vs. displacement of tools. Input data correction owing from the analysis of the obtained numerical results. Additional simulations of die forging for corrected boundary conditions. Development of the project with interpretation of modeling results in the form of a multimedia presentation. Discussion of the results obtained in engineering project.

ASSESSMENT METHODS

Outcome code	Methods of assessment *(Mark with an X where applicable)*					
	Oral examination	Written examination	Test	Project	Report	Other
W01			X			
W02			X			
U01				X		
U02				X		
U03				X		
K01						X

ASSESSMENT TYPE AND CRITERIA

Mode of instruction	Assessment type	Assessment criteria
lecture	non-examination assessment	The pass mark is a minimum of 50% for the final in-class test
project	non-examination assessment	Regular class attendance. A pass mark is a minimum of 50% for process planning project.

OVERALL STUDENT WORKLOAD

ECTS weighting												
No.	Activity type	Student workload										Unit
		full-time programme					part-time programme					
1.	Scheduled contact hours	L	C	Lb	P	S	L	C	Lb	P	S	h
		15			15							
2.	Other contact hours (office hours, examination)	2			2							h

3.	**Total number of contact hours**	**34**		h
4.	**Number of ECTS credits for contact hours**	**1,4**		ECTS
5.	**Number of independent study hours**	**16**		h
6.	**Number of ECTS credits for independent study hours**	**0,6**		ECTS
7.	**Number of practical hours**	**25**		h
8.	**Number of ECTS credits for practical hours**	**1,0**		ECTS
9.	**Total study time**	**50**		h
10.	**ECTS credits for the course** *1 ECTS credit = 25-30 hours of study time*	**2**		ECTS

READING LIST

1. QFORM 2D/3D. Metal forming simulation program. 2D simulation User's Guide. QuantorForm Ltd. 2008
2. Pacanowski J., Chałupczak J.: Design of die forging processes of circular-symmetric elements on presses and hammers. Kielce University of Technology. Kielce, 2011(in Polish)
3. Pietrzyk M.: Numerical methods in metal forming of metals. Wydawnictwa AGH. Kraków 1992 (in Polish)
4. Dyja H.S., Banaszek G.A., Grynkevych V.A., Danchenko V.N.: Modeling of open die forging processes. Wydawnictwo Politechniki Częstochowskiej. Częstochowa 2004 (in Polish)
5. Lange K: Handbook of metal forming, MCGraw-Hill Book Company
6. Muster A.: Die forging. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2002 (in Polish)
7. Ming Wang Fu. Design and Development of Metal-Forming Processes and Products Aided by Finite Element Simulation. Part of the book series: Engineering Materials and Processes (EMP), Springer, stron 246, 2017
8. Shiro Kobayashi et al. Metal Forming and the Finite-Element Method. Oxford University Press, Online ISBN:9780197560006, 1989
9. https://www.qform3d.com/processes
10. Polish Standards