Course unit title : **Modelling of plastic working processes (MSc)**			
Field of study: **Metallurgy / Metalurgia**			Course unit code: **71F5200**
Type of course unit: **optional**	Level of study: **Study II level**	Type of study: **Stationary studies**	Year: ..... Semester: .....
Teaching method: **Lecture, Tutorials, Laboratory, Seminar, Project**	Number of hours per week: **1, 0, 1, 0, 0**		Number of ECTS credits: **4 ECTS**

COURSE GUIDE

I. COURSE CARD

COURSE PURPOSES

C1. Transfer of knowledge in the field of modeling in metal forming
C2. To acquaint the student with the basics and chosen methods of physical and numerical modeling of metal forming processes

INITIAL REQUIREMENTS FOR THE KNOWLEDGE, ABILITIES AND OTHER COMPETENCES

1. Well-established knowledge of informatics and math
2. Knowledge in the field of the theory of plasticity and elasticity
3. Ability to use CAD computer programs
4. Ability to use literature sources and online resources.
5. Ability to work independently.
6. The ability to correctly interpret one's own actions.

THE EFFECTS OF TEACHING

EK1 - knows the basics of metal forming processes.
EK2 - knows the basics of numerical and physical modeling methods of metal forming processes.
EK3 - is able to design and carry out physical and numerical simulation of metal forming processes.

COURSE CONTENT

Teaching method – LECTURES

W 1 – Basics and taxonomy of the modeling processes	**1 h**
W 2 – Mathematical dependencies describing chosen metal forming processes.	**2 h**
W 3 – Theory of the forging process	**2 h**
W 4 – Theory of extrusion process	**2 h**
W 5 – Theory of the rolling process	**2 h**
W 6 – Theory of the stamping and drawing process	**1 h**
W 7 – Physical modeling of the metal forming processes	**2 h**
W 8 – Numerical modeling of the metal forming processes	**2 h**
W 9 – Machines and tools for metal forming processes	**1 h**

Teaching method – LABORATORY

L 1 - Introduction to the numerical modeling of metal forming processes	**1 h**
L 2 - Presentation of chosen software use to modeling metal forming processes	**1 h**
L 3 - Preparation of input data for numerical modeling. Determination of initial and boundary conditions, determination of rheological properties of the material. Introduction of the rheological properties (mathematical model) of the examined material to the material database of the numerical modeling software	**2 h**
L 4 - Numerical modeling of selected metal forming process	**6 h**
L 5 - The analysis of numerical modeling results.	**2 h**
L 6 - Physical modeling of selected metal forming process	**2 h**
L 7 - The analysis of physical modeling results.	**1 h**

TEACHING TOOLS

1. – lecture using audiovisual means
2. – prepared by the teacher teaching materials
3. – Plastometric Research Laboratory
4. – Laboratory of Metal forming Processes
5. – Laboratory of Numerical Modeling of Metal forming Processes
6. – Laboratory of Physical Simulations of Metal forming Processes

WAYS OF ASSESSMENT (F – FORMING, P – SUMMARY)

F1 - assessment of activity during classes
P1 - assessment of mastery of the teaching material that is the subject of lectures – colloquium

STUDENT WORKLOAD

Activity type	**Average number of hours to complete the activity**
Contact hours with the teacher	**15L, 15Lab → 30 h**
Getting acquainted with the indicated literature	**15 h**
Preparing to the laboratory	**30 h**
Preparing to pass the course	**30 h**
Total numbers of hours	**∑ 105 h**
TOTAL NUMBER OF ECTS CREDITS FOR THE COURSE	**4 ECTS**

BASIC AND SUPPLEMENTARY LITERATURE

1. J. Sińczak i inni: Procesy przeróbki plastycznej. Wyd. AGH, Kraków, 2003
2. Kubiński W., Pacyna J.: Podstawowe wiadomości z walcownictwa i obróbki cieplnej prętów stalowych Kraków, 1999
3. Cichoń C., Dyja H., Łabuda E.: Przeróbka plastyczna metali - ćw. laboratoryjne, Wyd. PCz., 1991
4. Wasiunyk P., Jarocki J.: Kuźnictwo i prasownictwo. Wyd. Szkol. i Pedagog. Warszawa, 1973.
5. Theis H.E.: Handbook of Metal Forming Processes, Marcel Deccer Inc., New York Basel, 1999
6. Kazutake Komori: Ductile Fracture in : Modeling and Simulation, Academic Press, Elsevier, 2020
7. Praca zbiorowa, FIMM2011, Fizyczne i matematyczne modelowanie procesów obróbki plastycznej, Prace Naukowe, Mechanika, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2011
8. Henry S. Valberg: Applied Metal Forming: Including FEM Analysis, Cambridge University Press, 2010
9. O.C. Zienkiewicz, R.L. Taylor, J.Z. Zhu: The Finite Element Method: Its Basis and Fundamentals, The Boulevard, Oxford, UK, 2001
10. Deviatov V., Dyja H.S., Stolbov V.Y., Trusov P.V., Łabuda E.T.: Matematyczne modelowanie i optymalizacja procesów wyciskania., Wydawnictwo Wydziału Inżynierii Procesowej, materiałowej i Fizyki Stosowanej, Seria Metalurgia nr 38, 2004, ISBN 83-87745-27-8.

LEADING TEACHER (NAME, SURNAME, E-MAIL ADDRESS)

1. Szymon Berski Ph.D, szymon.berski@pcz.pl

THE MATRIX OF EDUCATION EFFECTS REALISATION

The effect of teaching	The reference of the effect to the effect defined for the entire program (PEK)	Course purposes	Course content	Teaching tools	Ways of assessment
EK1	K_W02, K_W06, K_W07	C1	W2-W6 L1, L6, L7	1,2,4	F1,P1
EK2	K_W09	C1	L1, W1, W7-W9	1-6	F1,P1
EK3	KU_01, K_U04	C2	W1, W7-W9, L1-L7	1-6	F1,P1

II. ASSESSMENT FORM - DETAILS

	For grade 2	For grade 3	For grade 4	For grade 5
EK1 knows the basics of metal forming processes	The student does not know any rules basics of metal forming processes	The student has basic knowledge of metal forming processes	The student has good knowledge of metal forming processes	The student has excellent knowledge of metal forming processes
EK2 knows the basics of numerical and physical modeling methods of metal forming processes	The student does not know any numerical and physical modeling methods of metal forming processes	The student has basic knowledge of numerical and physical modeling methods of metal forming processes	The student has good knowledge of numerical and physical modeling methods of metal forming processes	The student has excellent knowledge of numerical and physical modeling methods of metal forming processes
EK3 is able to design and carry out physical and numerical simulation of metal forming processes	The student is not able to design an analysis of physical and numerical modeling of any process	The student is able to select and develop modeling conditions for the selected technological process	The student is able to develop the conditions and model the selected technological process	The student is fluent in adapting the conditions of physical and numerical modeling to a specific technological process

III. OTHER USEFUL INFORMATION ABOUT THE COURSE (Web site of FPE&MT)

1. Information where presentation of classes, instruction, subjects of seminars can be found, etc
2. Information about the location of the classes
3. Information about the date of the course (day of the week/time)
4. Information about the consultation (time and place)