Course unit title : **Fundamental research of metals and physical modeling of thermo-mechanical treatment** *Badania podstawowe metali i modelowanie fizyczne procesów obróbki cieplno-plastycznej*			
Field of study: **Metallurgy / Metalurgia**			Course unit code: **M.P.F.T.3.3**
Type of course unit: **optional**	Level of study: **Study II level**	Type of study: **Stationary studies**	Year: I - II Semester: I - III
Teaching method: **Lecture, Tutorials, Laboratory, Seminar, Project**	Number of hours per week: **1, 0, 1, 0, 0**		Number of ECTS credits: **3 ECTS**

COURSE GUIDE

I. COURSE CARD

COURSE PURPOSES

C1. Transfer of knowledge in the field of basic metal research
C2. To acquaint the student with the methods of physical modeling of thermo-mechanical treatment processes

INITIAL REQUIREMENTS FOR THE KNOWLEDGE, ABILITIES AND OTHER COMPETENCES

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

THE EFFECTS OF TEACHING

EK1 - knows the principles and methods of conducting plastometry and strength tests
EK2 - knows the rules and methods of dilatometric tests
EK3 - is able to design and carry out physical simulation of thermo-mechanical treatment

COURSE CONTENT

Teaching method – LECTURES

W 1 – Strength testing machines - constructions, principles of conducting experiments, measurement data analysis	**2 h**
W 2 – Plastometers - constructions, principles of conducting experiments, measurement data analysis. Changes of microstructure and metal properties as a result of forming	**2 h**
W 3 – Dilatometers - constructions, principles of conducting experiments, analysis of measurement data. Changes in the microstructure and properties of steel as a result of heat and thermo-mechanical treatment	**2 h**
W 4 – Special devices for testing rheological properties of metals under very high strain rates	**1 h**
W 5 – Universal simulators of metallurgical processes	**2 h**
W 6 – Modeling principles for thermo-mechanical treatment processes	**2 h**

W 7 – Impact of device dynamic properties on the results of process modeling	**1 h**
W 8 – Analysis of numerical results of physical modeling of metallurgical processes	**2 h**
W 9 – Optical and electron microscopy in the analysis of modeling results	**1 h**

Teaching method – LABORATORY

L 1 - Static tensile test, upset test, impact test	**2 h**
L 2 - Plastometric test in various deformation states	**2 h**
L 3 - Development of TTTi and TTTc charts	**2 h**
L 4 - Numerical modeling of microstructure changes during thermo-mechanical treatment	**2 h**
L 5 - Examples of modeling of metals forming processes	**2 h**
L 6 - Physical modeling of microstructure changes during thermo-mechanical treatment	**2 h**
L 7 - Numerical analysis of plastometric test results	**1 h**
L 8 – Analysis of material after physical simulation of thermo-mechanical treatment processes	**2 h**

TEACHING TOOLS

1. – lecture using audiovisual means
2. – prepared by the teacher teaching materials
3. – laboratory of testing strength and plastic properties
4. – dilatometric testing laboratory

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	**15 h**
Preparing to pass the course	**15 h**
Total numbers of houres	**∑ 75 h**
TOTAL NUMBER OF ECTS CREDITS FOR THE COURSE	**3 ECTS**

BASIC AND SUPPLEMENTARY LITERATURE

1. Dyja H., Gałkin A., Knapiński M., Reologia metali odkształcanych plastycznie, Seria Monografie Nr 190, Wyd. Politechniki Częstochowskiej, Częstochowa 2010
2. Praca zbiorowa, FIMM2009, Fizyczne i matematyczne modelowanie procesów obróbki plastycznej, Prace Naukowe, Mechanika, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2009
3. Praca zbiorowa, FIMM2011, Fizyczne i matematyczne modelowanie procesów obróbki plastycznej, Prace Naukowe, Mechanika, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2011
4. Gałkin A.M.: Badania plastometryczne metali i stopów. Wyd. Politechniki Częstochowskiej, Częstochowa 1990, 142 s.
5. Gronostajski Z.: Modele konstytutywne opisujące zachowanie się wybranych stopów miedzi w zakresie dużych odkształceń plastycznych. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2000
6. Grosman F., Hadasik E.: Technologiczna plastyczność metali. Badania plastometryczne. Wyd. Politechniki Śląskiej , Gliwice 2005
7. Hadasik E.: Badania plastyczności metali, Monografia, Wyd. Politechniki Śląskiej, Gliwice 2008
8. Hadasik E.: Metodyka wyznaczania charakterystyk plastyczności w próbie skręcania na gorąco, Zeszyty Naukowe Politechniki Śląskiej Nr 1546, Hutnictwo z. 63, Wyd. Politechniki Śląskiej, Gliwice 2002

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

1. dr hab. inż. Marcin Knapiński knap@wip.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_W03, K_W07, K_U09-K_U11, K_K01, K_K03	C1	W1,W2,W4 L1-L2	1,2	F1,P1
EK2	K_W03, K_W07, K_U09-K_U11, K_K01, K_K03	C1	W3, L3-L5	1,2	F1,P1
EK3	K_W03, K_W07, K_U09-K_U11, K_K01, K_K03	C2	W5-W9, L6-L8	1,2	F1,P1

II. ASSESSMENT FORM - DETAILS

	For grade 2	For grade 2	For grade 2	For grade 2
EK1 knows the principles and methods of conducting plastometry and strength tests	The student does not know any rules and methods for conducting plastometric and strength tests	The student is able to list and describe several methods of conducting plastometric and strength tests	The student is able to conduct plastometric and strength tests	The student is fluent in the principles and methods and conducts plastometry and strength tests
EK2 knows the rules and methods of dilatometric tests	The student does not know the rules for conducting dilatometric tests	The student is able to describe the methodology of conducting dilatometric tests	The student is able to conduct dilatometric tests	The student is fluent in the principles and conducts dilatometry tests
EK3 is able to design and carry out physical simulation of thermo-mechanical treatment	The student is not able to design a course of physical 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 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)