COURSE DESCRIPTION CARD - SYLLABUS

Course name
Modeling of materials technologies [S2MiBM2>MPB]

Course

Field of study
Mechanical Engineering

Year/Semester
1/2

Area of study (specialization)
Virtual Engineering Design

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
30

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

dr hab. inż. Paweł Popielarski prof. PP
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Lecturers

Prerequisites

Student has basic knowledge of physics, mechanics, materials science (including heat transfer, flows, stresses, materials science, crystallization, phase transformations), CAD geometry systems and the basics of manufacturing engineering. Has also skills in Acquiring information from literature survey and internet, is able to use the acquired knowledge to choose a technology selection strategy and understand the necessity to learn, taking new knowledge and collaboration in a workgroup.

Course objective

Student should obtain knowledge about modeling and computer simulation methods in materials technologies applying in projects and manufacturing of products.

Course-related learning outcomes

Knowledge:
1. Student has basic knowledge related to the basics of hard and soft modeling, knows how to define the principles of model formulation and the conditions of uniqueness for basic technological processes.
2. Has basic knowledge of the requirements for CAD geometry for transfer to the simulation system.
3. Has knowledge of the preparation and control of the course of numerical calculations carried out by

computer using a commercial simulation system and knows how to analyze the obtained results.
4. He/she has knowledge of the theory of elasticity and plastic deformations, knows the basics of the theory of elasticity and plastic deformations. Knows what phenomena in nature and technology relate to the theory of elasticity and plastic deformations.
5. He/she detailed information in the field of material technologies, knows contemporary trends and development directions in foundry, metal forming.
6. Has knowledge of the main development trends in the field of mechanical engineering.
7. Has in-depth and extended knowledge of engineering materials. Knows modern engineering materials with specific properties and their use as elements of machines and tools.
8. Has structured, theoretically based knowledge of the use of information systems in the design of machines and technological processes.
9. Has structured, theoretically based knowledge of the use of information systems in the design of machines and technological processes

Skills:
1. Can develop databases for simulation calculations and test their usefulness.
2. Is able to complete the task of virtualization of the technological process, e.g. casting, after mastering the indicated simulation system.
3. Is able to analyze the simulation results (post-processing) and plan and carry out validation studies on the obtained results.
4. Is able to select and design modern construction and tool materials. Is able to use the selected technology to produce a composite material with assumed properties.
5. Is able to use IT systems in the design of machines and technological processes relevant to mechanics and machine construction. Is able to use CAx systems to design machines and simulate engineering issues.
6. Is able to design, apply and research modern technologies in production processes typical of mechanics and machine construction.
7. Is able to obtain information from literature, databases and other properly selected sources in the field of mechanics and machine construction; is able to integrate the information obtained, interpret and critically evaluate it, as well as draw conclusions and formulate and fully justify opinions.
8. Able to work individually and in a team. Is able to use information and communication techniques appropriate to carry out tasks, communicate using various techniques in a team and environment in the field of mechanics and machine construction, and conduct a debate. He is able to manage the work of a team of people.
9. Is able to determine the directions of further learning and implement the self-education process and guide others in this area.

Social competences:
1. Can work on a given task independently and cooperate in a team.
2. Understands the need for continuous training to improve professional qualifications.
3. Is able to determine the importance of knowledge in solving cognitive and practical problems and to seek the opinion of experts in case of difficulties in solving the problem independently.
4. Able to think and act in a creative and entrepreneurial way.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture:
Written test of general questions (positive note for minimu 50.1% correct answers: <50% - ndst, [50.1% - 60.0%]- dst, [60.1% -70.0%]- dst+, [70.1% - 80 %]db, [80.1% - 90.0%] - db+, [90.1% - 100%]- bdb)
Laboratorium:
Oral or written test of questions related to each experiment done in laboratory, written report of each experiment (according to lecturer instructions). To get credit every exercise must be passed (test and report).

Programme content

Lecture:
Principles of formulating mathematical and physical models. Identification of models in the technological process. The certain conditions in terms of the necessary model simplifications. Analytical

and numerical solutions. Macro and micro modeling of phenomena. Theoretical basis of flows. The basics of heat flow. Tthe basics of diffusion. An outline of the basics of filtration. Direct and inverse modelling. Material and physical coefficients determined from inverse problems. Modeling of coupled phenomena. Modeling in application to computer simulation. Outline of the basics of the state of stress and strain. Examples of applications in foundry technology. Introduction to the design and mathematical modeling of metal forming processes. Methods for selecting parameters of computational methods. Methods for selecting process parameters based on numerical experiment. Modeling and simulation of metal forming processes. Modeling and simulation of sheet metal forming processes.
Laboratory:
CAD-CAE systems and application rules. Examples of virtual product designs (concept, geometry, geometry transfer in specific formats). CAE modules for foundry processes: Magmasoft, NovaFlow & Solid. Independent preparation and implementation of the casting process simulation. Identification of phenomena on the basis of simulation results. Forecasting the quality of products on the basis of examples of cast products. Introduction to software dedicated to simulations of metal forming processes. Modeling and simulating solid metal processing processes, axisymmetric problems. Selection of process parameters: machines, tools, tool material, friction coefficient. Modeling and simulation of sheet metal forming processes, axisymmetric problems. Selection of process parameters: machines, tools, tool material, friction coefficient. Modeling and simulation of sheet metal forming processes - joining sheets in metal forming processes, axisymmetric problems. Selection of process parameters: machines, tools, tool material, friction coefficient.

Course topics

none

Teaching methods

Lecture: multimedia presentation, illustrated with examples on the board.
Laboratory classes: practical exercises.

Bibliography

Basic:
1. Poradnik Odlewnika Tom II. Komputerowe wspomaganie produkcji odlewów, Kraków 2023
2. Magmasoft academy, Kom-Odlew, Kraków 2022
3 Z. Ignaszak, Podstawy modelowania CAD/CAE. Wybrane zagadnienia, e-skrypt, Poznań, 2008
4. Nova Flow&Solid CV manual, 2021
5. Erbel S., Kuczyński K., Marciniak Z.:Obróbka plastyczna. Warszawa: PWN 1986.
6. Morawiecki M., Sadok L., Wosiek E.: Teoretyczne podstawy technologicznych procesów przeróbki plastycznej, Wyd. Śląsk, 1986
7. Jaskulski A., Autodesk Inventor 2020 PL, Podstawy metodyki projektowania, Wydawnictwo Naukowe PWN, Warszawa 2019

Additional:
1. W. Przybylski, M. Deja Komputerowe wspomagane wytwarzanie maszyn. Podstawy i zastosowanie, , WNT, 2007
2. Z. Ignaszak Virtual prototyping w odlewnictwie, Bazy danych i walidacja. WPP Poznań 2002
3. E. Chlebus Techniki komputerowe CAx w inżynierii produkcji, WNT, 2000
4. Muster A.: KUCIE MATRYCOWE Projektowanie procesów technologicznych, Oficyna Wydawnicza Politechniki Poznańskiej, Warszawa 2002.
5. B. Mochnacki, J. Suchy Modelowanie i symulacja krzepnięcia odlewów, PWN, 1993
6. M. Ustasiak, P. Kochmański: OBRÓBKA PLASTYCZNA Materiały pomocnicze do projektowania, Politechnika Szczecińska, Szczecin, 2004.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,50