Subject card

Subject name and code	Computer simulation and optimization of production processes, PG_00059507
Field of study	Management and Production Engineering

Date of commencement of studies	February 2024	Academic year of realisation of subject	2024/2025
Education level	second-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	1	Language of instruction	Polish
Semester of study	2	ECTS credits	3.0
Learning profile	general academic profile	Assessment form	assessment

Conducting unit	Department of Manufacturing and Production Engineering -> Faculty of Mechanical Engineering and Ship Technology
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Mieczysław Siemiątkowski
	Teachers	

Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	30.0	0.0	45
	E-learning hours included: 0.0						

Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
	Number of study hours	45	9.0	21.0	75

Subject objectives	Imparting structured knowledge in creating models, preparing experiments and conducting simulation analysis of production processes running in systems of different forms and layout organization as well as defining optimisation problems. Development of the ability to formulate optimisation models in the environment of interactive computer simulation and with the use of analytical approach, along with quantitative evaluation of the experimentation results, including the generated descriptive type statistics.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_U09] is able to define the directions of further learning and implement the process of self-education	Can independently determine the directions of his/her own work in a continuous process of self-education and in the light of new challenges in his/her professional activity.	[SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools
	[K7_U04] is able to plan and carry out experiments, including measurements and computer simulations, interpret the obtained results and extract conclusions; can use analytical, simulation and experimental methods to formulate and solve engineering tasks	Demonstrates the ability to develop a computer model of variant process runs based on of a specified conceptual model within the framework of a simulation analysis task, to carry out a cycle of assumed experimental studies of these runs according to formulated scenarios, and perform semantic and statistical evaluation of results derived; moreover, students gain the ability to formulate optimization problems in the area of production engineering and solve them using analytical techniques of operations research.	[SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools [SU5] Assessment of ability to present the results of task [SU2] Assessment of ability to analyse information
	[K7_U07] is able to communicate fluently using various techniques in professional environment and in other environments, also in English or another foreign language recognized as the language of international communication in a given engineering discipline	Shows the ability to work as part of a team and to communicate effectively in a professional and international context, using English fluently in the field of technology consistent with the field of study of study pursued.	[SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment
	[K7_K05] is able to integrate the possessed knowledge from various scientific disciplines, and in the innovative implementation of engineering tasks also take into account system and non-technical aspects, including ethical ones	In solving engineering tasks, is able to use the acquired technical knowledge from different fields, in a consistent manner and according to the system approach; in tasks that require an innovative approach - also take into account non-technical elements while demonstrating the characteristics of ethical conduct.	[SK1] Assessment of group work skills [SK5] Assessment of ability to solve problems that arise in practice
	[K7_W02] has extended knowledge covering key issues characterizing production processes	Possesses extended knowledge of modelling, planning, and testing of production and logistics process flows in the field of mechanical engineering using computer simulation and analytical methods, including applications of structural and parametric optimization techniques for these runs.	[SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge

Subject contents	
	LECTURE: Structure and decomposition of discrete manufacturing processes (DPP). Computer simulation in the analysis and planning of DPP. Forms for representation and visualization of DPP runs. Scheduling of cellular DPP runs realise sequentially or in-prallel. Mapping the DPP organization using selected descriptive methods, i.e. IDEF0 (Integrated Definition for Function Modeling) and BPMN (Business Process Modelling Notation), Classification of simulation models in the analysis of system behaviour dynamics. Procedure for running a simulation project. Factorial analysis, developing its scenarios and organization of simulation experiment. Validation and verification in simulation modelling. Semantic and statistical interpretation of the results of simulation studies. Discrete linear programming in optimization tasks of planned DPP implementation. Comparative evaluation of analytical and simulation modelling applications in studying production runs.

PROJECT ACTIVITIES: Analysis and evaluation of functionalities and the capability of Witness® interactive simulation studies of discrete manufacturing processes (DPP). Analysis of material flow structures and optimisation of operational schedules for a specific production programme and system capacity within Preactor APS (Advanced Planning & Scheduling) software environment. Conceptual modelling of process variants with resource-defined cellular machining system; development of a computer model development of its operation using libraries of structural objects and visualisation of DPP runs, considering the variability factors; validation and verification of models and experimentation with alternative process variant, generation of reports for quantitative evaluation of scheduled process runs. Parametric factorial analysis - and interpretation of generated descriptive statistics. Analysis and evaluation of fabrication processes of welded mechanical structures, incl. formulation of objective function and related constraints in analytical modelling; selection of optimised solutions for DPP organisation, using linear programming technique in discrete sets.

Prerequisites and co-requisites	Knowledge of the basic issues of technological machinery features, process organization and operation of production systems, as well as operations research and statistical data analysis.		

Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	The written test for credit	58.0%	40.0%
	Final report of design work	58.0%	60.0%

Recommended reading

Basic literature

1. Gola A.: Modelowanie i symulacja procesów wytwórczych (Workbook). Zintegrowany Program Rozwoju Polit. Lubelskiej, www.pl2022.pollub.pl, Lublin 2020.

2. Kusiak J., Danielewska-Tułecka A., Oprocha P.: Optymalizacja. Wybrane metody z przykładami.. Wyd. Naukowe PWN, Warszawa 2021.

3. Sawik T.: Optymalizacja dyskretna w elastycznych systemach produkcyjnych. WNT, Warszawa 1992.

4. Stadnicki J.: Teoria i praktyka rozwiązywania zadań optymalizacji, z przykładami zastosowań technicznych. WNT, Warszawa 2006.

Supplementary literature

1. Antczak P., Antczak A., Witkowski T.: Optymalizacja przepływu produkcji seryjnej. PWE, W-wa 2016.

2. Zdanowicz R.: Modelowanie i symulacja procesów wytwarzania, Wyd. Politechniki Śląskiej, Gliwice 2002.

3. Witness Horizon v.24.0, Simulation modelling software, User manual & tutorials, www.lanner.com, Lanner Group Ltd, Redditch, Worcs 2021.

eResources addresses

Adresy na platformie eNauczanie:

Example issues/ example questions/ tasks being completed

Classification of production systems in terms of applications in the tasks of their simulation analysis.
Formulation of optimization models in linear programming for discrete variables.
Algorithmisation of discrete production processes (DPP) using Petri net formalism and the concept Grafcet.
Technical-organizational calculations for cellular - and flow-type organisation forms of production processes.
Descriptive formalisation of production process flow and the form of their representation as an object of simulation studies.
Graph modelling and formalization of activity network notation in the description of the courses of diverse categories of production processes.
The essence of deterministic and stochastic models, with a comparison of their usability in simulation analysis.
Specification of selected of production planning and systems engineering in terms of the adequacy in computerised discrete simulation.
Introduction of variability into the simulation model of discrete manufacturing systems: typical applications of random variable distributions for parameters with integer and real values.
The procedure of activities realised within a simulation project concerning the operation of a production system.
The principles of creating a plan for simulation studies of factors of variation in the alternative runs of production process.
The function and importance of validation and verification of dynamic simulation models of the manufacturing process.
Selected descriptive statistics of simulated production process runs and forms of their visualization and interpretation in an experiment.
Techniques for modelling and visualization of DPP runs for simulation

Work placement

Not applicable