GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Computer aided process planning, PG_00064864						
Field of study	Mechanical Engineering						
Date of commencement of studies	February 2027		Academic year of realisation of subject	2027/2028			
Education level	second-cycle studies		Subject group	Specialty 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	English			
Semester of study	2		ECTS credits	4.0			
Learning profile	general academic profile		Assessment form	exam			
Conducting unit	Division of Manufacturing and Production Engineering -> Institute of Manufacturing and Materials Technology -> Faculty of Mechanical Engineering and Ship Technology -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Daniel Chuchała				
	Teachers						
Lesson types	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	46.0	100	
Subject objectives	Transferring systematised knowledge on computer aided methods applied to process planning for diverse mechanical components, under the conditions of flexibly automated manufacturing facilities as well as the development of skills concerning the utilisation of cluster analysis methodology for group technology applications, selection of relevant equipment for the realisation of processing operations, and generation of near-optimal system structures for cellular manufacture.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_K13] is ready for responsible performance of proffesional roles, considering ever-changing need of the society, including self developement and supporting and fullfiling work ethics	Demonstrates a sound understanding of their own professional role, including the need to continually develop their knowledge and skills in the context of society's changing needs; they are aware of their responsibility for the decisions they make in the course of their professional activities and of the need to adhere to the principles of professional ethics, whilst also taking into account non-technical aspects and the environmental impact of industry.	[SK5] Assessment of ability to solve problems that arise in practice [SK1] Assessment of group work skills
	[K7_W13] explains the main principles of individual and teamwork organization, including various forms of entrepreneurship utilizing knowledge from the field of engineering and technical sciences and disciplines relevant to the course of study	Possessing the necessary knowledge of manufacturing process technology planning in the area of modern complex mechanical systems, they understand the need to apply a concurrent engineering approach and a team-based working style when carrying out design and manufacturing work, accordingly with the principles and objectives of PDM/PLM (Product Data / Lifecycle Management) systems.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
	[K7_W02] demonstrates a structured and theoretically grounded knowledge of the key topics in Mechanical Engineering enabling the analysis and modelling of mechanical systems, processes and devices	Possesses the relevant knowledge in the field of mechanical engineering required for computer-aided modelling of manufacturing system structures, planning the sequences of discrete production processes in mechanical engineering, and conducting comparative analyses and evaluating the effectiveness of alternative design solutions for the manufacture of a specific range of products, with a view to improving the system's performance.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
	[K7_U02] formulates and solves technical problems specific to Mechanics and Mechanical Engineering using appropriate tools including CAD and MES systems, and prepares technical documentation	Is able to effectively utilise contemporary techniques and computer-aided tools in the field of mechanical engineering for the purposes of planning and selecting efficient manufacturing process structures for the production of representative components of various mechanical designs, and for selecting machinery resources within the framework of planned, optimised variant solutions manufacturing processes, taking into account the requirements of automated and economically viable production.	[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

Subject contents

Course content – lecture

Technological planning as the system of activities supporting manufacturing (definitions and terms). The planning function, conditions for its implementation with the use of computer assistance. Placement of Computer - aided Process Planning (CAPP) methods in integrated product design and manufacturing (CIM). Formalization of manufacturing process structures. Systematics and scope of decision-making problems in CAPP. Classification of CAPP methods and systems. Variant and generative Process planning systems. The essence and application of classification and coding techniques, PFA analysis, GT (Group Technology), and cluster analysis in variant CAPP. The concept of "features" in planning by generative approach. Techniques of feature identification based on CAD models. Functional structure of advisory CAPP systems. Representation of process knowledge in generative distributed CAPP systems. Inference processes in CAPP based on feature representation. Data models and algorithms for setup planning and operation sequencing in manufacturing of various part types. Computer support in selection of tooling and fixtures, proces working conditions and the determination of worktimes. Planning of structures of complex operations for simultaneous machining (SE) and their optimisation. The essence and objectives of concurrent engineering in in product development cycle. Design for Manufacture and Assembly (DFMA): guidelines for rationalisation in integrated product and process development. Case studies on DFMA applications in mechanical engineering.

Course content – project

Prototyping process structures for a definite spectrum of complex parts as machine routings in manufacturing processes. Creating the incidence matrices: machines - parts types for cluster analysis. Case studies for grrouping parts and machines by Rank Order Clustering (ROC) and the Jaccard method using Excel spreadsheet. Accomplishing the task of cluster analysis in the environment of Statistica®, using agglomerative methods of hierarchical grouping. Distance matrix generation with different values of dissimilarity metrics. Comparative analysis of applied distance measures and facility creation techniques based on cluster formulation. Visualisation of clustering results for the datasets and defining cellular layout configurations. Interpretation of calculation results and the performance evaluation of identified process flows in terms of quantitative criteria. Planning structures of processing operations, along with the selection of adequate tool combinations, incorporating milling the shapes of complex pockets in cuboid part types. Multi-criteria selection of machine tool selection for parts machining operations using AHP (Analytic Hierarchy Proces) methodical approach.

Prerequisites and co-requisites

Knowledge of basic issues concerning modelling with mechanical CAD, part manufacturing technologies incl. basic machining processes and related machine tools, as well as information technologies

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Reports of practical project classes	58.0%	55.0%
Written exam	58.0%	45.0%

Recommended reading

Basic literature

1. Computer-Aided Design, Engineering, and Manufacturing Systems Techniques and Applications, Vol. II. Computer-integrated manufacturing, Chapters 3, 4 and 5, Leondes C.T. (Ed.), Boca Raton-London: CRC Press LLC 2001.
2. Computer-Aided Design, Engineering, and Manufacturing Systems Techniques and Applications, Vol. III. Operational methods in computer-aided design, Chapter 2 and Chapter 5, Leondes C.T. (Ed.), Boca Raton-London: CRC Press LLC 2001.
3. Czajka J., Krot K., Kuliberda M.: Selected issues of production systems organisation and computer aided process planning. Production system organisartion. Wroclaw: Wroclaw University of Technology 2011.
4. Groover M.P.: Automation, production systems and computer-integrated manufacturing, 3rd Edition, Pearson Prentice-Hall, 2008.
5. Rembold U., Nnaji B.O., Storr A.: Computer-integrated manufacturing and engineering. Addison-Wesley Publishers Ltd., 1998.

Supplementary literature

1. Groover M. P.: Fundamentals of modern manufacturing. Materials, processes and systems, 4th Edition, J. Wiley & Sons Inc., 2010.
2. Kalpakjian S., Schmid S.R.: Manufacturing Engineering and Technology, 7th Edition, Pearson Education, Inc 2014.
3. Kuric I., Matuszek J., Debnár R.: Computer aided process planning in machinery industry. Edited by Politechnika Łódzka, 1999.
4. Dell Statistica®. 2016. Data analysis software system, ver.13. Dell Inc., http://software.dell.com

eResources addresses

Example issues/ example questions/ tasks being completed	1. The concept of variant CAPP according to the attributes of a composite part representing a group of technologically similar objects. 2. Key tasks under consideration in the frame of process planning and the evaluation of those proness to computer support utilisation. 3. Generalized models of process structure for complex mechanical components and chief factors determining operation sequences. 4. The procedure underlying the operation of a retrieval CAPP system. 5. Attributes considered within industrial classification and coding systems and used in CAPP. 6. The concept integrated product and process design and time - as well cost related advantages resulting from its introduction. 7. Methods applied to grouping parts into families for the need for successful CAPP. 8. Enabling technologies and means required for the use of generative methods of CAPP. 9. Outline the feature sequencing rules introduced in algorithms applied to CAPP for prismatic - and mill-turn parts. 10. Methods for obtaining technological features from CAD data models. 11. The principles and meaning of DFMA application within the product and process development cycle. 12. Cluster analysis methods in planning applications of group technologies for manufacturing components of processing machines and machinery. 13. Quantitative analysis of manufacturing process flow performance based on BOP (Bill of Processes) specification. 14. Knowledge representation techniques in expert - type CAPP systems. 15. Preliminary conditions and chief characteristics of methodical approach to computer-aided setup planning in machining processes.
Practical activites within the subject	Not applicable

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