GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Computer aided process planning, PG_00057404		
Field of study	Mechanical Engineering		
Date of commencement of studies	February 2023	Academic year of realisation of subject	2023/2024
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	English
Semester of study	2	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Zakład Technologii Maszyn i Automatyzacji Produkcji -> Institute of Manufacturing and Materials Technology -> Faculty of Mechanical Engineering and Ship Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Mieczysław Siemiątkowski	
	Teachers	dr inż. Mieczysław Siemiątkowski	

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	8.0	47.0	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_W10] possesses knowledge on the methods of technical and economic analysis of industrial systems and optimization of manufacturing systems; is familiar with the general principles of initiating and developing forms of individual entrepreneurship, particularly for innovative projects using the knowledge	Acquired knowledge of available methods and technical solutions withn the scope of cooperation of technological machines performing operations of the manufacturing process incl. the equipment for material storage, the means implemented for performing the material flows as well as the the essence of operation of functionally integrated production systems for various forms of their organization in relation to encountered and representative solutions currently found in industrial practice.	[SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects
[K7_W09] possesses profound knowledge on the directions of development of construction of machines, devices, calculating methods and systems aiding the design, materials and their properties, manufacturing methods and diagnostics, control-measurement equipment	Acquired basic knowledge on the design forms, functional features and technological capabilities of modern automated CNC machines and other technical equipment in the aspect of their use as components of stationary type systems and multimachine systems, taking into account specific conditions concerning the type and form of organization of production processes.	[SW1] Assessment of factual knowledge
[K7_U07] is able to perform a preliminary economic analysis of the undertaken engineering actions within the range of design, production and operation of machines and technical devices	Demonstrates the ability to quantify the performance of production systems and to perform a preliminary economic analysis of implied engineering activities aimed at automation of manufacturing processes and machinery oeraration. Has knowledge of methods concerning the selection of processing equipment and planning iefficient processes under the conditions of functional production intedration.	[SU1] Assessment of task fulfilment [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools

Subject contents

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 and their optimization. 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.

LABORATORY: 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
Written exam	58.0%	45.0%
Reports of practical project classes	58.0%	55.0%

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	Adresy na platformie eNauczanie: Computer aided process planning, w/p, MiBM - IDE, 2. st., sem. 02, zimowy 2023/2024 (PG_00057404) - Moodle ID: 34274 https://enauczanie.pg.edu.pl/moodle/course/view.php?id=34274

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.
Work placement	Not applicable