GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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| Subject name and code | Integrated manufacturing systems, PG_00057375 | | |
| Field of study | Mechanical Engineering, Space and Satellite Technologies | | |
| Date of commencement of studies | February 2024 | Academic year of realisation of subject | 2023/2024 |
| Education level | second-cycle studies | Subject group | Obligatory subject group in the field of study<br>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 | 1 | ECTS credits | 4.0 |
| Learning profile | general academic profile | Assessment form | assessment |
| 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. Dawid Zieliński<br>dr inż. Mieczysław Siemiątkowski | |

| Lesson types and methods of instruction | Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
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| | Number of study hours | 30.0 | 0.0 | 15.0 | 15.0 | 0.0 | 60 |
| | 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 |
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| | Number of study hours | 60 | 10.0 | 30.0 | 100 |

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| Subject objectives | Transfer of systematized knowledge on design, planning, and operation of modern production systems based on flexible automation, and using means of logistic and informational integration for material flows. Presenting the possibilities for production rationalisation and optimisation based on available material handling and processing capabilities of machinery and related tooling, including practising with prototyping and quantitative analysis of generated process flow alternatives. |

| Learning outcomes | Course outcome | Subject outcome | Method of verification |
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| | [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 a developed ability to quantify the performance of production systems and to perform a preliminary economic analysis of planned engineering activities in the field of automation of production systems and the operation of machinery and technical equipment. Has knowledge of the operation of automated manufacturing systems and methods of selection of means of implementation of tasks and components of the process and planning its course in the conditions of systematic integration of production. | [SU1] Assessment of task fulfilment<br>[SU3] Assessment of ability to use knowledge gained from the subject<br>[SU4] Assessment of ability to use methods and tools |
| | [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 and the existing limitations in the scope of cooperation of technological machines performing operations of the manufacturing process with equipment for storage of material objects, means of implementation of tasks of their internal transport (material flows), inspection control and supervision of the production process. The assimilated knowledge includes understanding 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 |
| | [K7_W06] possesses organized, profound knowledge necessary for designing and optimization of complex technological processes, modelling and calculations using numerical methods, knows modern manufacturing methods and tools for designing manufacturing processes of machines, devices, their elements and components | Possesses profound and adequate knowledge of the factors determining the course of discrete production processes in mechanical technology and comparative analysis and evaluation of the effectiveness of variant solutions of production system structures for the production of a specific range of items, with the participation of solutions taking into account the introduction of specific process-type innovations, and aimed at improving the operation of this system. | [SW1] Assessment of factual knowledge<br>[SW3] Assessment of knowledge contained in written work and projects |

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| Subject contents | LECTURE: Elements of a manufacturing process (definitions and terms). The structure and functions of a production system. Integration forms of process components: machining (manufacturing), material flow (transportation), information flow and process control. Classification of machine tool control technologies. Numerical control and automatic regulation. Automation components for machine tools and their systems. Automation versus flexibility and production scale. Productivity and the degree of system autonomy. Flexibly automated CNC machine tools, machining centers and autonomous machining stations in integrated manufacturing systems (IMS). Flexible manufacturing systems (FMS). Factors and measures for FMS integration: transportation and material (part/tooling) handling subsystems using manipulators and industrial robots. Integration of process flow functions. Surveillance and diagnosis in FMS. FMS operation and process flow control. Typologies of production facility organisation. The stationary system layout. Cellular and linear forms of layout organisation. The means for hybrid manufacturing technology realisation.<br><br>PROJECT WORK: Criteria-based selection of prts spectrum and specific assortment items manufactured in cellular type manfacturing system. Development of 3-D models for parts - representatives of different technological types. Formulating conditions for integrated group machining by the model of flexibly automated production. Formalising the description of requirements and structures of processes and mapping the material flows using graph modelling. Selecting machine resources for realisation of technological operations. Selecting solutions concerning the transport structure, means of transport tasks execution and techniques for storage and palletising of semi-finished and finished products, under conditions of functional integration of system components. Basic manufacturing calculations in terms of discrete process flow for the established system layout pattern and form of its organisation.<br><br>LABORATORY: Comparative analysis of capabilities of technological machines in operations of automated machining of objects of various classes using catalogue resources and internet databases. Construction of a system using a defined set of resources for the realisation of tasks of functionally integrated manufacturing. Development of a relational database structure model for specific lists of machine resources of a functionally integrated manufacturing system of the socket type, established sequences of technological operations and adequate material flows with the implementation in the Preactor APS (Advanced Planning and Scheduling) software environment. Visualisation of material flows and their quantitative evaluation. Analysis of conditions concerning the changeover of system resources. Analysis of variant solutions of the manufacturing process taking into account flexibility and system integration conditions. Generation of results of production system operation in the form of operational schedules and their interpretation. Analysis and assessment of conditions of realisation of different concepts of operation of the examined manufacturing system. |
| Prerequisites and co-requisites | Basic knowledge of manufacturing technologies, the structure and operation of machine tools as well as production organisation. |

Assessment methods and criteria

| Subject passing criteria | Passing threshold | Percentage of the final grade |
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| Final report of design work | 58.0% | 25.0% |
| Raports of laboratory activities | 58.0% | 25.0% |
| Final written colloquium of lectures | 58.0% | 50.0% |

Recommended reading

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| Basic literature | 1. Design of flexible production systems, Methodologies and tools, T. Tolio (Editor), Springer-Verlag, Berlin Heidelberg, 2009.<br>2. Groover M.P.: Automation, production systems, and computer-integrated manufacturing, 3rd Edition, Pearson Prentice - Hall, New Jersey 2008.<br>3. Honczarenko J.: NC controlled machine tools (in Polish), Warszawa, WNT, Warszawa 2008.<br>4. Stephens M. P., Meyers F. E.: Manufacturing facilities design and material handling. Pearson Education Intl. 2010. |
| Supplementary literature | 1. Kalpakjian S., Schmid S.R.: Manufacturing Engineering and Technology, 7th Edition, Pearson Education, Inc 2014.<br>2. Machine tools for high performance machining, L.N. Lopez de Lacalle, A. Lamikiz (eds), Springer Verlag London Ltd. 2009.<br>3. Pająk E.: Production management. Product, technology, organisation (in Polish), PWN, Warszawa 2013.<br>4. Preactor® APS (Advanced Planning & Scheduling), Operation manual, Preactor Intl. Ltd. UK, Chippenham, Wiltshire 2009.<br>5. Rembold U., Nnaji B.O., Storr A.: Computer-integrated manufacturing and engineering, Addison-Wesley Publishers Ltd., 1999. |
| eResources addresses | Adresy na platformie eNauczanie:<br>Integrated Manufacturing Systems, w/l/p; MiBM, IDE+AT, st. 2, sem. 01; letni 2023/2024 (PG_00057375) - Moodle ID: 37858<br>https://enauczanie.pg.edu.pl/moodle/course/view.php?id=37858 |

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| Example issues/ example questions/ tasks being completed | 1. The concepts of concentration and differentiation of process operations in the view of the increase in its productivity. Measures taken to create structures of integrated operations in parts machining.<br><br>2. The idea of total (complete) machining and the possibilities for its realisation considering the processing capabilities of contemporary work centres.<br><br>3. Techniques and the means used in modelling manufacturing systems operation and related process flow.<br><br>4. The functional structure of a typical FMS, including basic means designated to perform those functions.<br><br>5. Quantitative metrics used in the description of automation level and flexibility attributes of process performance in single- and multi-machine parts manufacturing systems.<br><br>6. Geometric structures and kinematics of definite types of flexibly automated CNC machine tools applied to integrated manufacturing systems for: a) rotational , and (b) prismatic parts.<br><br>7. Technical and organisational conditionings determining the realisation capabilities of multi-part machining in integrated manufacture.<br><br>8. The determiners of manufacturing facility layouts along with machine tool selection versus production quantity and the requirements concerning the parts spectrum manufactured.<br><br>9. Layout classification and operational attributes of multi-machine integrated machining systems.<br><br>10. Classification factors for the typology of complex parts processing operations, performed in single-machine based FMSs<br><br>11. Palletization equipment and workpiece flow integration for machine tools operation in integrated production systems<br><br>12. Material handling techniques and capabilities of the resources concerning parts flow used in dedicated flexible manufacturing cells.<br><br>13. Classification scheme and related features of machines used in integrated manufacturing processes of differentiated parts spectrum.<br><br>14. Application features and criteria used in equipment selection for parts and tooling storage under the demands of integrated production.<br><br>15. Part inspection technologies and relevant measurement equipment used in automated and integrated systems of production. |
| Work placement | Not applicable |