# GDAŃSK UNIVERSITY OF TECHNOLOGY

## Subject card

| Subject name and code | Modelling of mechatronic systems, PG_00038863 | | | | | | |
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| Field of study | Mechatronics, Mechatronics | | | | | | |
| Date of commencement of studies | October 2020 | | Academic year of realisation of subject | | 2022/2023 | | |
| Education level | first-cycle studies | | Subject group | | Obligatory subject group in the field of study | | |
| | | | | | 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 | 3 | | Language of instruction | | Polish | | |
| Semester of study | 5 | | ECTS credits | | 4.0 | | |
| Learning profile | general academic profile | | Assessment form | | exam | | |
| Conducting unit | Zakład Mechatroniki -> Institute of Mechanics and Machine Design -> Faculty of Mechanical Engineering and Ship Technology | | | | | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | | prof. dr hab. inż. Krzysztof Kaliński | | | | |
| | Teachers | | dr inż. Natalia Stawicka-Morawska | | | | |
| | | | prof. dr hab. inż. Krzysztof Kaliński | | | | |

| Lesson types and methods of instruction | Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
|---|---|---|---|---|---|---|---|
| | Number of study hours | 15.0 | 0.0 | 15.0 | 15.0 | 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 | 6.0 | 49.0 | 100 |

| Subject objectives | Introduction to modeling of mechatronic systems. | | |
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| Learning outcomes | Course outcome | Subject outcome | Method of verification |
| | K6_U06 | The student identifies the phenomena related to the functioning of mechatronic systems. The student defines team tasks of modeling mechatronic systems. | [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools |
| | K6_W03 | The student develops physical models of mechatronic systems. The student recognizes the methods of modeling the structure of mechatronic systems and the observed signals. | [SW1] Assessment of factual knowledge |
| | K6_U07 | The student designs models of open and closed mechatronic systems in interdisciplinary teams. | [SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools |
| | K6_W10 | The student presents the mastery of the methods of modeling stationary mechatronic systems. The student designs models of open and closed mechatronic systems in interdisciplinary teams. | [SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects |
| | K6_W01 | The student presents the mastery of the methods of modeling stationary mechatronic systems. | [SW1] Assessment of factual knowledge |

| Subject contents | LECTURES. Basic terms. Creation of calculation models: Models of mechatronic systems components. Modelling of multi-body systems. Structural models. Modal models. Mathematical description: Analogies between physical environments. Dynamic equations in generalised coordinates. Control of mechatronic systems: Multidimensional control systems. Linear optimal control. Modal control. Closed-loop systems. Control systems design. Examples of modelling of mechatronic systems: Industrial robot. Chosen problems of vehicle dynamics. LABORATORY Introduction. Physical models of mechanical, electric, hydraulic and thermal systems. Modelling of multi-body systems. Structural modelling of mechatronic systems. Creation of dynamic equations of mechatronic systems in generalised and state coordinates. Modal analysis. Synthesis of multidimensional control system. Multidimensional linear optimal control system. Chosen example of modelling of mechatronic systems. PROJECT The students perform 2 projects in their own interdisciplinary teams, at simultaneous distribution of competences between several members. The tasks depend on creation of calculation models of the mechatronic systems with diversified physical nature, and on multidimensional control systems design. The first project concerns modelling of open-loop systems, while the second one considers additionally existence of feedbacks, due to accompanying working processes. During the projects performance one ought to focus a special attention on modelling in mechatronic systems as well the structure, as the signals. |
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| Prerequisites and co-requisites | Knowledge on Mechanics and Strength of materials. Knowledge and experience on Fundamentals of automatic control. Knowledge and experience in Informatics (sem. II, IV). Knowledge on Mechatronic systems components. |

## Assessment methods and criteria

| Subject passing criteria | Passing threshold | Percentage of the final grade |
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| Reports from laboratory exercises | 100.0% | 25.0% |
| Project | 100.0% | 25.0% |
| Written exam | 50.0% | 50.0% |

## Recommended reading

| Basic literature | 1. Heimann B., Gerth W., Popp K.: Mechatronika. Komponenty metody przykłady. Warszawa: Wyd. Nauk. PWN 2001.<br>2. Gawrysiak M.: Mechatronika i projektowanie mechatroniczne. Białystok: Wyd. Polit. Białostockiej 1997. (jest dostępna w internecie)<br>3. Cannon R. H.: Dynamika układów fizycznych. Warszawa: WNT 1973.<br>4. Kaliński K. J.: Nadzorowanie procesów dynamicznych w układach mechanicznych. Gdańsk: Wydawnictwo Politechniki Gdańskiej 2012.<br>5. Metoda elementów skończonych w dynamice konstrukcji. Gawroński W., Kruszewski J., Ostachowicz W., Tarnowski J., Wittbrodt E. Warszawa: Arkady 1984.<br>6. Kaczorek T.: Teoria sterowania i systemów. Warszawa: Wyd. Nauk. PWN 1993. |
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| Supplementary literature | 1. Mechatronika. Analiza, projektowanie i badania wybranych elementów i systemów. (Red. K. Kluszczyński). Warszawa: Wydawnictwo PAK 2013.<br>2. Skoczyński W.: Sensory w obrabiarkach CNC. Warszawa: Wydawnictwo Naukowe PWN S.A. 2018.<br>3. Grzegożek W., Adamiec-Wójcik I., Wojciech S.: Komputerowe modelowanie dynamiki pojazdów samochodowych. Kraków: Politechnika Krakowska im. T. Kościuszki 2003. |
| eResources addresses | Adresy na platformie eNauczanie: |

| Example issues/ example questions/ tasks being completed | 1. Elements of mechatronic systems that store kinetic energy<br>2. Multidimensional control systems. Dynamics equations. Operator transmittance matrix<br>3. Modal control at the energy quality indicator. Optimum control signal<br>4. Closed loop systems. Modeling responses with an observer<br>5. Modeling of the robot's support system. Control modeling |
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| Work placement | Not applicable |