GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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| Subject name and code | Physical Chemistry of Real Systems, PG_00045465 | | |
| Field of study | Chemical Technology | | |
| Date of commencement of studies | February 2024 | Academic year of realisation of subject | 2023/2024 |
| Education level | second-cycle studies | Subject group | Optional subject group<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 | Polish |
| Semester of study | 1 | ECTS credits | 5.0 |
| Learning profile | general academic profile | Assessment form | assessment |
| Conducting unit | Department of Physical Chemistry -> Faculty of Chemistry | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | dr hab. inż. Adam Kloskowski | |
| | Teachers | dr hab. inż. Maciej Śmiechowski<br>dr hab. inż. Adam Kloskowski | |

**Lesson types and methods of instruction**

| Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
|---|---|---|---|---|---|---|
| Number of study hours | 45.0 | 15.0 | 0.0 | 15.0 | 0.0 | 75 |

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 | 75 | 10.0 | 40.0 | 125 |

**Subject objectives**

The aim of the subject is to familarize the students with selected problems of advanced physical chemistry and their applications as well as teaching them skills needed for solving such problems in a computational manner.

**Learning outcomes**

| Course outcome | Subject outcome | Method of verification |
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| K7_W05 | Student can collect suitable literature and numerical data as well as plan his/her own algorithm of solving a problem from the area of advanced thermodynamics. | [SW1] Assessment of factual knowledge<br>[SW2] Assessment of knowledge contained in presentation |
| K7_U06 | Student can analyze open systems, work using real gas models and calculate chemical equilibria using thermodynamic constants instead of the simplified ones. | [SU1] Assessment of task fulfilment<br>[SU3] Assessment of ability to use knowledge gained from the subject |

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| Subject contents | LECTURES<br>Thermodynamics: real gas models. Practical utilization of the principle of corresponding states for estimation of thermodynamic functions of gases and their mixtures. Generalized graphs. Advanced undetsranding and uilization of the kinetic theory of gases. Thermodynamics of open systems. Elements of statistical thermodynamics. Advanced theory of phase equilibria, Ehrenfest classification and equations. Analysis of phase diagrams. Criteria od phase equilibrium, metastable phases. Deeper understanding of cryoscopic and ebulioscopic effects. Liquid crystals. Advanced chemical kinetics: tranmsport properties of gases and liquids, derivation and integration of complex rate laws. Advanced electrochemistry: equivalent electrical circuits, concentration cells with ionic transport, ion transfer numbers and ionic structure of electrolytes in solutions. Butler-Volmer equation; Tafel equation. HER mechanism. Assorted advanced electroanalytical methods.<br><br>PROJECT<br>Calculations in advanced chemical thermodynamics. Independent solution of a numerical project using VBA language.<br><br>TUTORIALS<br>Calculations in real gas thermodynamics. Preperation and multimedia presentations of assorted problems complementary to the lecture contents and/or presenting theoretical background of calculation methods and algorithms used in tutorials. |
| Prerequisites and co-requisites | BSc level diploma in chemistry or related studies |

Assessment methods and criteria

| Subject passing criteria | Passing threshold | Percentage of the final grade |
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| performing theoretical calculations | 50.0% | 30.0% |
| problem solving test + multimedia presentation | 50.0% | 30.0% |
| final test in lectures | 50.0% | 40.0% |

Recommended reading

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| Basic literature | 1. P. W. Atkins, Chemia fizyczna, PWN 2001.<br>2. P. W. Atkins, Podstawy chemii fizycznej, PWN 1999.<br>3. P. W. Atkins, Przewodnik po chemii fizycznej, PWN 1997.<br>4. K. Pigoń i Z. Ruziewicz, Chemia fizyczna, PWN 2006. |
| Supplementary literature | All the books belonging to the "Wykłady z chemii fizycznej" series by WNT, Warszawa.<br>1. H. Buchowski i W. Ufnalski, Podstawy termodynamiki<br>2. H. Buchowski i W. Ufnalski, Fizykochemia gazów i cieczy<br>3. H. Buchowski i W. Ufnalski, Gazy, ciecze i płyny<br>4. H. Buchowski i W. Ufnalski, Roztwory<br>5. W. Ufnalski, Równowagi chemiczne<br>6. H. Buchowski, Elementy termodynamiki statystycznej<br>7. A. Molski, Wprowadzenie do kinetyki chemicznej<br>8. A. Kisza, Elektrochemia. Jonika<br>9. A. Kisza, Elektrochemia. Elektrodyka |
| eResources addresses | Adresy na platformie eNauczanie:<br>Fizykochemia układów rzeczywistych 2024 - Moodle ID: 38543<br>https://enauczanie.pg.edu.pl/moodle/course/view.php?id=38543 |

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| Example issues/ example questions/ tasks being completed | Prove that the van der Waals equation is a cubic equation of state.<br><br>What is the fugacity coefficient? How to determine it from the compressibility factor?<br><br>What is the Boyle temperature? Define its relationship with the second viral coefficient and describe its physical sense. Find the Boyle temperature of the van der Waals gas.<br><br>What does Graham's law of effusion state, and what are the conditions for its applicability?<br><br>Three average velocities from the MaxwellBoltzmann distribution: definitions and relations.<br><br>List the transport properties of fluids you know. For each of them, provide the transported quantity and the quantity which gradient is the driving force of the transport.<br><br>The phenomenon of thermodiffusion: thermodynamic description and applications.<br><br>Local equilibrium hypothesis.<br><br>Discuss the influence of external pressure on the saturated vapor pressure of a pure substance.<br><br>Discuss the reasons for the limited miscibility of the liquids and the reasons for the occurrence of the lower or upper critical temperature for a given liquid mixture. Define a hypercritical point.<br><br>How is congruent melting different from incongruent melting in compounds formed in solid phase? |
| Work placement | Not applicable |