COURSE DESCRIPTION CARD - SYLLABUS

Course name
High vacuum techniques [S1FT2>TWP]

Course

Field of study
Technical Physics

Year/Semester
3/6

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
30

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

Basic knowledge of physics, thermodynamics, and chemistry, including states of matter, interactions of matter, basic properties of ideal and real gases, state parameters, and gas transformations. Preparation of technical documents and drawings, including software support, analytical skills, and Internet use to obtain the appropriate information (catalogues). Ability to work in a group and an active problem- solving attitude.

Course objective

1. In terms of knowledge: presentation to students, the issues defined by the course content. 2. In terms of skills: mastering the basics of high vacuum techniques and fabrication methods at low temperatures, as well as the ability to design, operate, and use vacuum systems. 3. In terms of social competencies developing teamwork, communication, and presentation skills.

Course-related learning outcomes

Knowledge:
The student will learn the following knowledge:
1. Explanation of the laws concerning the properties of gases under reduced pressure, indicate the basic properties of cryogenic liquids, and discuss the basic low temperature equipment

2. Principles of operation of: pumps, gauges and other vacuum-cryogenic devices
3. Principles of constructing vacuum systems, with the recognition and selection of materials used in the techniques discussed

Skills:
The student will acquire the following skills:
1. Using professional vocabulary, work with catalogues of vacuum companies, and correctly describe the assembly of elements within system connection standards
2. Can independently design systems for selected technological processes, correctly apply, install, and operate vacuum-cryogenic devices
3. Can perform diagnostics of selected devices, including identifying typical faults and defect

Social competences:
The student will acquire the following social competencies:
1. Can express and justify a critical assessment of specific design solutions based on acquired knowledge and skills
2. Develop the skills of self-presentation, communication, and teamwork

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:
a) In the scope of the project, based on:
(1) Current progress of the project implementation.
(2) assessment of preparation for class - colloquium.
b) In the scope of the lecture, based on:
(1) answers questions about the material discussed in previous lectures.
Summative assessment:
a) In the scope of the project, based on:
(1) evaluation of the colloquium (3-5 questions in the field of introductory knowledge, assessment criteria: 0-50% - grade 2.0; 50.1-60% - grade 3.0; 60.1-70% - grade 3.5; 70.1-80% - rating 4.0; 80.1-90% - rating 4.5; 90.1-100% - rating 5.0);
(2) the accuracy and form of the prepared project;
(3) public presentation of the completed project;
(4) Discussion after both self-presentation and others,
b) Within the scope of the lecture, based on the written exam, under open questions consists of 7 -10 open questions (assessment criteria: 0-50% - grade 2.0; 50.1-60% - grade 3.0; 60.1-70% - grade 3.5; 70.1-80% - rating 4.0; 80.1-90% - rating 4.5; 90.1-100% - rating 5.0).

Programme content

LLecture:
1. Basic properties of gases, including in the rarefied state
2. Kinetic theory of gases
3. Phenomena related to pressure changes
4. Effects of gases interacting with the surfaces
5. Materials used vacuum technology
6. Elements of vacuum systems
7. Vacuum pumps
8. Measurement of total and partial pressure
Lab:
1. Identification of applications of various vacuum systems
2. Design of the vacuum system
3. Presentation of the projects and discussion

Course topics

ecture:
1. Fundamentals of the kinetic theory of gases and thermodynamics taking into account reduced pressure conditions

2. Viscous and molecular conditions
3. Phenomena of viscosity, diffusion, and thermal conductivity of gases under reduced pressure
4. Description and mechanisms of gas flow
5. Physical and chemical phenomena occurring on the surface of a solid at reduced pressure: sorption, desorption, and adsorption
6. Basics of vacuum technology
7. Materials used in the low-pressure technique, vacuum connection systems
8. Elements of vacuum installations and the principles of design and hygiene of work in vacuum technology
9. Methods for obtaining an ultra-high vacuum and its control
10. Classification and operation of vacuum pumps
11. Criteria for the selection of pumps
12. Basics of vacuum measurement
13. Principle operation and division of pressure gauges
14. Mass spectrometry basics
15. Type of leaks in vacuum systems
16. Basics of cryogenics
17. Properties of liquid gases and materials at low temperatures
19. Application of vacuum and cryogenic techniques
Laboratory:
1. Introductory issues to the construction of vacuum devices
2. Basic types of vacuum, pump and measuring elements
3. Ultrahigh vacuum generation procedure
4. Identification of applications of various vacuum systems
5. Analysis of parameters of available elements and subassemblies based on catalogues of vacuum elements
6. Schematic representation of vacuum systems
7. Designing a vacuum system (in groups of two), design assumptions drawn by students. The project consists in designing a system that implements individual design assumptions, including:
• design of the vacuum chamber
• selection of the pumping and measuring system
• selection of additional elements such as viewports, feedthroughs, valves
8. Presentation of completed projects and discussions

Teaching methods

1. Lecture: multimedia presentation, problem discussion, brainstorming.
2. Laboratory exercises: practical exercises, teamwork, development of projects of individual vacuum systems, debate.

Bibliography

Basic:
1. Catalogues and manuals for manufacturers of vacuum devices
2. Technika Próżni, A. Hałas, OWPW, Wrocław, 2017
3. Technika wysokiej próżni, J. Groszkowski, PWN, Warszawa, 1978
4. Technika doświadczalna w fizyce niskich temperatur, G. K. White, PWN, Warszawa, 1965
5. Vacuum Technology Know How dostępny na stronie:
http://www.pfeiffer-vacuum.com/downloads/container, w formacie pd

Additional:
1. Technologia wysokiej próżni, A. Hałas, PWN, Warszawa, 1980
2. Urządzenia próżniowe, J. Groszkowski, WSiP, Warszawa, 1982
3. Experimental techniques in Low-Temperature Physics, G. K. White, P. J. Meeson, Clarendon Press, Oxford, 2002
4. Matter and Methods at Low Temperatures, F. Pobell, Springer, Berlin, 1996

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	62	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	38	1,50