



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

High vacuum technology [S1ETI2>TWP]

### Course

Field of study

Education in Technology and Informatics

Year/Semester

3/5

Area of study (specialization)

–

Profile of study

general academic

Level of study

first-cycle

Course offered in

Polish

Form of study

full-time

Requirements

elective

### Number of hours

Lecture

30

Laboratory classes

30

Other

0

Tutorials

0

Projects/seminars

0

### Number of credit points

4,00

### Coordinators

dr hab. inż. Wojciech Koczorowski prof. PP  
wojciech.koczorowski@put.poznan.pl

### Lecturers

### Prerequisites

asic knowledge on: physics, thermodynamics and chemistry, including: gas definition, interactions of molecules, concepts of ideal and real gas, gas transformations, pressure. Technical drawings preparation - including software support, analytical skills, using the Internet to obtain the necessary information. Ability to work in a group, active attitude to solve problems.

### Course objective

1. . In terms of knowledge: presentation to students the knowledge defined by the course content, 2. In terms of skills: mastering the basics of high vacuum techniques and the ability to design, operation and use vacuum measurement systems. 3. In terms of social competences: developing teamwork skills.

### Course-related learning outcomes

Knowledge:

The student will be able to:

1. Explain vacuum systems constructing principles, including identification and selection of materials used in the discussed techniques,
2. Explain the principles of operation of: pumps, gauges and other vacuum devices, and standard ways of

connecting elements.

3. Explain the laws concerning the gas properties of under reduced pressure and thermodynamics.]

Skills:

The student will acquire the following skills:

1. Identify typical defects of selected devices, including their diagnostics and indication of their advantages.
2. Independent design of systems for selected technological processes, properly apply, install and operate vacuum devices.
3. Use professional vocabulary and work with catalogs of vacuum companies, correctly describe the standard assembly elements system.

Social competences:

The student will acquire the following social competences:

1. Express and justify a critical assessment of specific design solutions based on the acquired knowledge and skills.
2. Develop the ability to cooperate in a team.

### 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, on the basis of:

- (1) the current verification of the project implementation
- (2) assessment of preparation for classes

b) In the scope of the lecture, on the basis of:

- (1) answers to questions about the material discussed in previous lectures

Summative assessment:

a) In the scope of the project, on the basis of:

- (1) the correctness and form of the prepared project
- (2) public presentation of the completed project
- (3) discussion after both self-presentation and others

b) Within the scope of the lecture, on the basis of the written exam under written test with open questions consists of 7 -10 questions. The rating is based on the number of points scored (0-50% - rating 2,0; 50,1-60% - rating 3,0; 60,1-70% - rating 3,5; 70,1-80% - rating 4,0; 80,1-90% - rating 4,5; 90,1-100% - rating 5,0)

### Programme content

Lecture:

1. Fundamentals of kinetic theory of gases and thermodynamics
2. Phenomena under reduced pressure
3. Description and mechanisms of gas flow
4. Physical and chemical phenomena occurring on the surface of a solid at reduced pressure: sorption, desorption and adsorption
5. Materials used in vacuum technology
6. Structure and properties of vacuum elements
7. Methods of obtaining vacuum and its control
8. Leaks in vacuum systems and their detection
9. Elements of cryogenics
10. Application of vacuum technology

Laboratory:

1. Properties of gas under reduced pressure
2. Selection and parameters of basic vacuum elements
3. Pumping and measuring systems
4. Principles of designing vacuum systems
5. Design of a vacuum system (in groups of two) design assumptions drawn by students. The project consists in designing a system that implements individual design assumptions.
6. Presentation of completed projects and discussion

### Course topics

#### Lecture:

1. Fundamentals of the kinetic theory of gases and thermodynamics
2. Viscous and molecular conditions
3. Phenomena of viscosity, effect, 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. Materials used in vacuum technology
7. Construction and properties of vacuum elements
6. Basics of vacuum technology
7. Methods of obtaining a vacuum and its control
8. Classification and operation of vacuum pumps
9. Criteria for the selection of pumps systems
10. Basics of vacuum measurement
11. Division and principle of operation of pressure gauges
12. Mass spectrometry
13. Leaks in vacuum systems and their detection
14. Basics of cryogenics, basic definitions
15. Properties of liquid gases and materials at low temperatures
16. Application of the vacuum technique and cryogenics

#### Laboratory:

1. Properties of gas under reduced pressure
2. Performing calculations in the field of thermodynamics, properties of gases under reduced pressure
3. Selection and parameters of basic vacuum elements
4. Pump systems: selection, technological parameters
5. Methods of measuring total and partial pressure
6. Principles of constructing vacuum systems
7. Presentation of vacuum systems for various applications
4. Getting acquainted with the terminology and catalogs of vacuum elements
5. Schematic representation of vacuum systems
6. Designing the vacuum system (in groups of two) design assumptions randomly selected by students. The project consists in designing a system that implements individual design assumptions, including:
  - designing the vacuum chamber, designation
  - selection of the pumping and measuring system
  - determination of pumping speed in viscous and molecular conditions for the proposed solution
  - selection of additional elements such as: windows, culverts
7. Presentation of completed projects and discussion

### Teaching methods

1. Lecture: multimedia presentation, discussion, problem-based learning.
2. Laboratory exercises: practical exercises, team work, development of individual vacuum system designs, problem-based learning, Oxford discussion.

### Bibliography

#### Basic:

1. Catalogs and manuals for manufacturers of vacuum devices
2. Technika Próźni, A. Hałas, OWPW, Wrocław, 2017
3. Technika wysokiej próźni, 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 pdf

#### Additional:

1. Technologia wysokiej próźni, A. Hałas, PWN, Warszawa, 1980
2. Urządzenia próźniowe, 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	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	40	1,50