BACHELOR'S PROGRAMME
2nd YEAR OF STUDY, 2nd SEMESTER

COURSE TITLE	**VACUUM PHYSICS AND TECHNOLOGY**
COURSE CODE	
COURSE TYPE	full attendance
COURSE LEVEL	1st cycle (bachelor's degree)
YEAR OF STUDY, SEMESTER	2nd year of study, 2nd semester
NUMBER OF ECTS CREDITS	3
NUMBER OF HOURS PER WEEK	4 (2 lecture hours + 2 laboratory hours)
NAME OF LECTURE HOLDER	Prof. univ. dr. habil. Lucel SIRGHI
NAME OF SEMINAR HOLDER	Prof. univ. dr. habil. Lucel SIRGHI
PREREQUISITES	Advanced level of English

A GENERAL AND COURSE-SPECIFIC COMPETENCES

General competences:

- Implementation, improvement and extension of the use of physical models and their validation using experimental devices capable of validating a physical model.
- Applying efficient work techniques in a multidisciplinary team on various hierarchical levels.
- Identifying opportunities for continuous training and efficient use of resources and learning techniques for their own development.

Course-specific competences:

- Identifying the basic concepts of applied engineering sciences.
- Explaining the structure and operation of the components of different types of equipment using specific theories and tools.
- Implementation of applications in engineering practice in the field of specialization, using theoretical foundations of applied engineering sciences.
- Explaining and interpreting physical phenomena and operationalizing key concepts based on the appropriate use of laboratory equipment.
- Critical evaluation of the experiment results, including the degree of uncertainty of the experimental results obtained.

B LEARNING OUTCOMES

Upon successful completion of this discipline, students will be able to:

- Explain physical phenomena specific to the vacuum technique.
- Describe the operation of vacuum pumps, instruments used for pressure measurements, mass flow measurement instruments.
- Use pumps and vacuum measuring instruments.
- Acquiring the design elements of an installation to create a vacuum.

C LECTURE CONTENT

Introductory concepts. Definitions. Vacuum characteristic quantities. Vacuum in nature, in laboratory installations and in industrial installations. Brief history of vacuum science. Applications of vacuum in science, industry, measuring instruments and in experimental installations.
Elements of kinetic theory of gases. Laws of perfect gases. Flow of rarefied gases. Real gases. Thermal conductivity, viscosity and diffusion of rarefied gases
Physical-chemical processes at the vacuum-solid interface. Adsorption and desorption. Contamination rate of surfaces of solid bodies in vacuum.
Methods of producing vacuum. Vacuum pumps: mechanical pumps, driving jet vacuum pumps and turbomolecular pumps.
Condensation vacuum pumps and gas sorption vacuum pumps.
Pressure sensors for coarse vacuum, medium, high and ultrahigh vacuum.
Control of gas mass flow in vacuum installations. Conductance of components used in vacuum installations
Elements of design of vacuum installations for research and industrial applications. Choice of pump types and construction materials used for installations. Choice of construction solutions and dimensioning of vacuum systems.
Operation of vacuum installations in research and industry. Particularities of use of vacuum pumps and instruments for measuring low pressures in vacuum installations with corrosive gases.
Vacuum systems used in electron microscopy, X-ray photoelectron spectrometry, particle accelerators
Mass spectrometry in vacuum technology. Measurement of partial pressures and analysis of residual gases. Control of the tightness of vacuum installations.
Vacuum systems used in thin layer deposition. Preventive and remedial measures in case of contamination of vacuum installations.

D RECOMMENDED READING FOR LECTURES

1. G. Marin – Tehnica vidului si aplicatiile ei in industrie, Ed. Tehnica, Bucuresti, 1983
2. Gr. Alexandru – Pompe de vid, Bucureşti, Ed. Tehnică,1972

	3. Pramod K. Naik - Vacumm science, technology and applications, CRC Press Taylor & Francis Group, 2018 4. A. Roth – Vacuum Technology, Editia a-III-a, Elsevier, 1996.
E	**LABORATORY CONTENT**
	Preliminary notions of vacuum science. Pressure and laws of ideal gas. Physical quantities characteristic of vacuum (seminar). Calculation of particle density, flux densities and contamination rate of solid surfaces in vacuum (seminar). Calculation of conductance of elements of vacuum installations (seminar). Study of thermal conduction of rarefied gases (laboratory). Determination of pumping speed of a pump at constant volume and constant pressure. Study of Boyle-Mariotte law in vacuum (laboratory) Calibration of a needle valve for controlling mass flow rates of rarefied gases (laboratory). Study of thermal flow meter (laboratory). Study of thermal probe (laboratory) Study of hot cathode ionization probe (laboratory) Electrical discharges in direct current in rarefied gases. Measurement of ignition voltage of hot cathode discharge (laboratory). Methods of cleaning and tightness control of vacuum installations (laboratory). Mass spectrometry in vacuum technology. Measurement of partial pressures and analysis of residual gases (laboratory). Evaluation of practical laboratory activity (seminar)
F	**RECOMMENDED READING FOR LABORATORY/SEMINARS**
	1. G. Marin – Tehnica vidului si aplicatiile ei in industrie, Ed. Tehnica, Bucuresti, 1983 2. Igor Bello, Vacuum and Ultravacuum, CRC Press, Taylor and Francis Group, Boca Raton, FL 2018. 3. G. Popa, D. Alexandroaei, Îndrumar de lucrări practice pentru fizica plasmei, Ed. Universităţii Alexandru Ioan Cuza, Iaşi, 1991 4. G. Popa, L. Sîrghi – Bazele fizicii plasmei, Ed. Universităţii Alexandru Ioan Cuza, Iaşi, 2000 5. N. Dumitrascu – Introducere in fizica plasmei, Iasi, Ed. Junimea, 1999 6. O. B. Malyshev, Vacuum in Particle Accelerators, Willey-VCH Wenheim, Germany, 2020
G	**EDUCATION STYLE**
LEARNING AND TEACHING METHODS	Lecture, debate, discovery, problematizing, algorithm, debate, individual project
ASSESSMENT METHODS	• Two written papers (week 7 and week 14) • Laboratory reports
LANGUAGE OF INSTRUCTION	• English