BACHELOR 'S PROGRAMME 3rd YEAR OF STUDY, 1st SEMESTER

COURSE TITLE	PLASMA PHYSICS
COURSE CODE	
COURSE TYPE	full attendance
COURSE LEVEL	1st cycle (bachelor's degree)
YEAR OF STUDY, SEMESTER	3rd year of study, 1st semester
NUMBER OF ECTS CREDITS	5
NUMBER OF HOURS PER WEEK	5 (3 lecture hours + 2 seminar hours)
NAME OF LECTURE HOLDER	Prof. univ. dr. habil. Lucel Sirghi
NAME OF SEMINAR HOLDER	Conf.univ.dr. Claudiu COSTIN
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:

- Explains the phenomenology and fundamental processes of plasma
- Describe the methods and models used in the study of plasma
- Use appropriately the physical sizes and specific parameters of the plasmas
- Analyze the processes that take place in plasma and how to produce plasma in the laboratory, in plasma fusion plants and in industrial plants.
- Calculate values of plasma specific parameters.

C LECTURE CONTENT

- Introduction. Plasma in Nature, Laboratory and Industry. Plasma of luminescent discharge in rarefied gases. Properties specific to plasma. Plasma concentration and temperature .
- Particle distribution functions, mean values, thermal current densities. Floating potential. Frequency of plasma
- Plasma shielding and Debye length. Differential equation of space charge sheeth. The Bohm Criterion. Child-Langmuir Law. Double layers
- Plasma theoretical models: single-particle model and fluid model. The kinetic model
- Electrical methods of plasma diagnosis. Langmuir probe and electrostatic analyzer.
- Optical methods of plasma diagnosis. The relative intensity of the spectral lines. Doppler widening of spectral lines.
- Single-particle model of plasma. Movement of plasma particles in the static and uniform magnetic field. The magnetic moment. The electric drift
- Approximation of finite Larmor radius. Particle motion in static and non-uniform magnetic field. Gradient drift and curvature drift.
- Magnetic mirrors and traps. Natural magnetic traps. Moving particles into a uniform and non-stationary magnetic field.
- Plasma particle movement in static and uniform magnetic field and in uniform and non-stationary electric field. Tensor of conductivity. Hall effect. Anomalous resistivity of plasma
- Description of binary collisions in asymptotic approximation. Classification of collisions
- Description of binary collisions in dynamic approximation. Differential and total collision cross sections.
- Elementary processes in plasma volume and at plasma surface. Ionization, electronic emission, cathode spraying, physical and chemical adsorption.

- Free particle diffusion in low ionized plasma. Ambipolar diffusion in the non-magnetized plasma.
- Diffusion of particles in magnetized and totally ionized plasma. Diamagnetic drift. Bohm diffusion. Neoclassical diffusion (banana diffusion in TOKAMAK)
- Interaction of electromagnetic waves with plasma. The dispersion equation. Frequency cutting method and interferometry method for determining plasma concentration.
- The general equation of plasma dispersion. The instability criterion. Ion-acoustic wave and ionization wave.
- Electric discharge into rarefied gases. Luminescent discharge. Cavity cathode discharge. Magnetron discharge
- AC current discharge. Electric discharge in multi-polar magnetic confinement device. The electric arc
- Thermo-ionic converter and machine Q. Experimental devices for the production of hot plasmas of thermonuclear interest.
- Magnetic confinement in Tokamak device. The Lawson Criterion. Inertial confinement. Focused plasma device

D RECOMMENDED READING FOR LECTURES

1. R. J. Goldstone, P. H. Rutherford, Introduction to Plasma Physics, Taylor &Francis,1995.
2. Paul M. Bellan, Fundamentals of Plasma Physics, Cambridge University Press 2006.
3. G. Popa, L. Sîrghi – Bazele fizicii plasmei, Ed. Universităţii Alexandru Ioan Cuza Iaşi, 2000
4. R. Fitzpatrick, Plasma Physics. An Introduction, Taylor &Francis,2015
5. F.F. Chen – Introduction to plasma physics, Plenum Press., 1985
6. C. Gray, Morgan, Handbook of Vacuum Physics, Vol 2. Part 1, Fundamentals of Electric Discharges in Gases, Pergamon Press 1965.
7. D. Ciubotariu, I.I. Popescu, Bazele fizicii plasmei, Ed. tehnică, 1987
8. E. Badarau, I.I. Popescu - Fizica descărcărilor în gaze, Ed. tehnică, 1965

E SEMINAR CONTENT

Typical plasma parameters Prerequisites of vacuum science (seminar)
Measurement of low pressures and of the pumping speed (laboratory)
Determination of the gas breakdown voltage of the luminescent discharge. Paschen Law (Laboratory)
Determination of the I-V characteristic of the electrical discharge in the multipolar magnetic confinement device (laboratory)
Child-Langmuir Law and Floating Potential (Seminar)
Langmuir probe (laboratory)
Electron energy distribution function (laboratory)
Measurement of speed components of fast electron beam emitted by a hollow cathode in a luminescent discharge (laboratory)
Particle Movement in Electrical and Magnetic Fields (Seminar)
Coefficients □ and □ Townsend (laboratory)
Ambipolar Diffusion Study (Laboratory)
Transport phenomena (seminar)
Determination of effective cross section for resonance charge transfer (laboratory)
Laboratory colloquy

F RECOMMENDED READING FOR SEMINARS

1. G. Popa, D. Alexandroaei, Îndrumar de lucrări practice pentru fizica plasmei, Ed. Universităţii Alexandru Ioan Cuza, Iaşi, 1991
2. G. Popa, L. Sîrghi – Bazele fizicii plasmei, Ed. Universităţii Alexandru Ioan Cuza, Iaşi, 2000

G EDUCATION STYLE

LEARNING AND TEACHING METHODS	Lecture, thematic debates, application, discussion, explanation, demonstration, problem solving
ASSESSMENT METHODS	• Summative evaluation (final) - oral exam. • Formative (ongoing) and summative (final) evaluation - laboratory colloquium.
LANGUAGE OF INSTRUCTION	English