Zał. nr 5 do ZW 78/2023

Attachment no. 4. to the Program of Studies

FACULTY of Chemistry

SUBJECT CARD

Name of subject in Polish Ciekłe kryształy dla fotoniki
Name of subject in English LIQUID CRYSTALS for PHOTONICS
Main field of study (if applicable): Advanced Nano and Biomaterials MONABIPHOT
Specialization (if applicable):
Profile: academic
Level and form of studies: 2nd level, full-time
Kind of subject: obligatory
Subject code W03ANB-SM2006W, W03ANB-SM2006L

Group of courses No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		15		
Number of hours of total student workload (CNPS)	75		50		
Form of crediting (Examination / crediting with grade)	egzamin		Crediting with grade		
For group of courses mark (X) final course					
Number of ECTS points	3		1		
including number of ECTS points for practical classes (P)			1		
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,3		0,7		

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. General physics,
2. General chemistry

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SUBJECT OBJECTIVES

C1 To provide students with a general knowledge of chemical structure, interactions and physics of liquid crystals.
C2 To provide students with a knowledge about physicochemical properties of various mesophases: nematics, smectics, and chiral nematics including chiral ferroelectric LCs.
C3 To provide students with deep understanding of LCs optics
C4 To provide students with a knowledge related to applications of liquid crystals in display technologies, optical filtering, spatial light modulators.

C5 To provide students with contemporary photonic devices based on liquid crystals.

SUBJECT EDUCATIONAL EFFECTS

PEU_W01 - Student knows the principles of classification of liquid crystals in view of their structure, symmetry, origin of mesophase and macroscopic organization in bulk.

PEU_W02 - Student understands the liquid crystallinity and physical consequences of this state

PEU_W03 – Student understands in depth optical and dielectric properties of liquid crystals

PEU_W04 – Student knows and is able to identify various mesophases used for different functions like information displaying, processing and dynamic storage.

PEU_W05 - Student understands the advanced technologies of liquid crystal panels fabrication. He knows and understands the functioning of LC in photonics and knows the advantages and limits of these materials.

related to skills:

PEU_U01 – Student is able to make LC panels and characterize their optical properties.

PROGRAMME CONTENT

Lectures		**Number of hours**
Lec 1	Brief introduction to liquid crystalline state. Calamitic and discotic liquid crystals and its chemical structures. Polymorphism. Thermotropic liquid crystals.	2
Lec 2	Systematics of liquid crystals: nematics and smectics, cholesterics and their main properties.	2
Lec 3	Physicochemical properties of liquid crystals. Sequence of phases, phase transitions, textures, defects, viscosity.	2
Lec 4	Order parameter and anisotropy of electric and magnetic susceptibilities, Interaction of LC with electric field, Freedericksz effect, elastic constants K_{11}, K_{22} and K_{33}.	2
Lec 5	Dielectric, optic, elastic, hydrodynamic and thermal methods used for characterization of LCs in their various phases. Polarizing light studies of LCs.	2
Lec 6	Optical properties of liquid crystals. Refractive indices, birefringence, light scattering and light propagation, molecular dichroism).	2

Lec 7	The most important applications of liquid crystals and polymeric liquid crystals - liquid crystal displays and spatial light modulators.	2
Lec 8	Structure and properties of lyotropic liquid crystals. Kraft's plot. Amphiphilic molecules, micelles, mono- and bilayers, biological membranes.	2
Lec 9	Molecular engineering of LCs. Ferroelectric, ferrielectric and antiferroelectric LCs. Blue phases in LCs.	2
Lec 10	Polymeric liquid crystals, polymer dispersed liquid crystals and their applications.	2
Lec 11	Introduction of models of nematic LC description. Phenomenological approach. Free energy and theory of Maier and Saupe.	2
Lec 12	Optical properties of LCs. Mie light scattering.	2
Lec 13	Nonlinear optical phenomena in liquid crystals. Mechanism of giant optical nonlinearity. Laser induced molecular reorientations. Laser-induced dye-assisted molecular reorientations (Janossy effect).	2
Lec 14	Second harmonic generation, stationary degenerate wave mixing, optical phase conjugation, self-modulations effects, soliton formation, light amplification and optical limiting.	2
Lec 15	Review of applications of LCs in display technology and spatial light modulators. Electrically addressed spatial light modulators (SLM) for telecommunications. Real-time holography and use of SLM for optical manipulation of nanoscopic objects "optical tweezers". Tuning of liquid crystals in waveguides and photonic crystals.	2
	Total hours	30

Laboratory		**Number of hours**
Lab 1	Preparation of the LC panel	5
Lab 2	Microscopic studies of LC samples	5
Lab 3	Thermal evaluation of LC samples	5
	Total hours	15

TEACHING TOOLS USED
N1. Lecture with use of multimedia presentation. N2. Lecture with elements of discussion of problems

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
P1 (lecture)	PEU_W01 PEU_W02 PEU_W03 PEU_W04 PEU_W05	Written test. Evaluation of test max. 100 pts 3.0 if 50-60 % pts 3.5 if 61-70 % pts 4.0 if 71-80 % pts 4.5 if 81-90% pts 5.0 if 91-95% pts 5.5 if 96-100 % pts
P1 (laboratory)	PEU_U01	Evaluation of a single report of performed measurements

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Displeje ciekłokrystaliczne – fizyka, technologia, zastosowanie, PWN, Warszawa (1993)
[2] Handbook of Liquid Crystals, D. Demus, J. Goodby, G.W. Gray, H.W. Dpiess, V. Vill, vols. 1-3, Wiely-VCH (1998)
[3] I.C. Khoo, Liquid Crystals, Physical Properties and Nonlinear optical Phenomena, J. Wiley, New York (1995)
[4] L.M. Blinov, V.G. Chigrinov, Electrooptic Effects in Liquid Crystal Materials, Springer (1996)
[5] P. Yeh, C. Gu, Optics of Liquid Crystals, Wiley Intersicence Publication, J. Wiley and Sons, New York (1999)

SECONDARY LITERATURE:

[1] Original scientific articles available through electronic literature database of Main Library of WUST
[2] Materials Today - scientific journal

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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