Anexa nr. 2

Subject Content

1. **Program information**

1.1 University	West University of Timişoara
1.2 Faculty	Physics
1.3 Department	Physics
1.4 Field of study	Physics
1.5 Study cycle	Master
1.6 Study programme	Physics and technology of advanced materials

2. **Subject matter information**

2.1 Module name			Chemical and physical properties of crystals **PM2305**				
2.2 Module leader			Victor E. Ambruş				
2.3 Problem classes leader			Victor E. Ambruş				
2.4 Laboratory leader			-				
2.5 Study year	II	2.6 Semester	I	2.7 Assessment type	E	2.8 Subject type	Ob

3. **Study time allocation**

3.1 Hours per week	4	of which course:	2	seminar	2	laboratory	-
3.2. Total hours per semester	56	of which course	28	seminar	28	laboratory	-
3.3. Time distribution:							**hours**
Study from lecture notes, course material, bibliography, notes							30
Additional documentation in the library, electronic specialist platforms							8
Seminar / laboratory preparation, homework, portfolio and essays							30
Tutoring							4
Examination							6
Other activities……							-

3.4 Total independent study hours	**78**	
3.5 Total hours per semester	**134**	
3.6 Number of credits	**6**	

4. **Preconditions (where applicable)**

Curriculum	• Complements of solid state physics and statistical physics • Complements of material physics • Electricity and magnetism • Solid state physics and semiconductors
Skills	-

5. **Preconditions (where applicable)**
6. **Specific skills gained**

Professional skills Competențe transversale	• Knowledge and understanding - Define the main terms - Classification of tensors - Graphic representation of tensors • Explanation and interpretation: - Brief explanation of the presented phenomena • Practical aptitudes: - Solving problems • Skills in research ethics • Skills in research project management • Team work in a research activity. • Efficient use of informational and communication resources in English language. • Capacity for critical evaluations and autoevaluation • Capacity for communication inside a group • Concern for permanent improvement of quality

7. Course objectives

7.1 Main objective	• Knowledge of physical phenomena in rheology.
7.2 Specific objectives	• Training skills to understanding phenomena own this discipline. • Ability to put into practice the knowledge gained, the spirit of teamwork. • Developing the capacity for organization and investigation. • Growing scientific environment based on value and quality.

8. Table of content

8.1 Course	**Teaching method**	**Obs**
Chapter 1. Preliminary notions 1.1. Crystalline state 1.2. Crystal unit cell; Bravais lattices 1.3. Symmetry elements and operations	Blackboard interactive.	2 hours

1.4. Crystallographic planes and Miller indices 1.5. Crystallographic directions indices		
Chapter 2. Tensor properties of crystals 2.1. Introduction and notations, definitions 2.2. Transformation of tensor components through axis rotation	Blackboard interactive.	2 hours
2.3. Graphical representation of tensors; symmetrical and antisymmetrical tensors; diagonalization of a tensor, the Neumann's principle; some examples of tensors.	Blackboard interactive.	2 hours
Chapter 3. Crystal Optics 3.1. Dielectrical constant tensor 3.2. Electrical susceptibility tensor 3.3. Electrical conductivity and electrical resistivity 3.4. Diffusion	Blackboard interactive.	2 hours
3.5. Thermal conductivity and thermal resistivity 3.6. Heat transfer in crystals.	Blackboard interactive.	2 hours
3.7. Plane wave structure in an anisotropic medium 3.8. Fresnel’s equation for normal velocities	Blackboard interactive.	2 hours
3.9. Birefringence 3.10. Fresnel's equation for radial velocities	Blackboard interactive.	2 hours

3.11. Wave surface equation		
3.12. Wave surface in the uniaxe anisotropic media 3.13. Indices surface	Blackboard interactive.	2 hours
3.14. Light refraction in various media. Huygens' construction (case of isotropic media, case of uniaxial anisotropic media) 3.15. Obtaining of polarized light	Blackboard interactive.	2 hours
Chapter 4. Notions of nonlinear optics 4.1. Introduction	Blackboard interactive.	2 hours
4.2. Light self-focusing 4.3. Pockels effect (linear electro-optic effect)	Blackboard interactive.	2 hours
4.4. Kerr effect (quadratic electro-optic effect)	Blackboard interactive.	2 hours
4.5. Second order harmonics generation. Second order nonlinear polarization; phase synchronism	Blackboard interactive.	2 hours
4.6. Interferential nature of phase synchronism, coherence length phase synchronism regarded as a spatial resonance 4.7. Phase synchronism condition for generation of second harmonic 4.8. Light scattering/dispersion.	Blackboard interactive.	2 hours
8.2 Seminar	**Teaching method**	**Obs**
Symmetry elements and operations Crystallographic planes and Miller indices	Blackboard interactive.	2 hours

Crystallographic directions indices		
Transformation of tensor components through axis rotation	Blackboard interactive.	2 hours
Graphical representation of tensors; symmetrical and antisymmetrical tensors; diagonalization of a tensor	Blackboard interactive.	2 hours
Tensors	Blackboard interactive.	2 hours
Thermal conductivity and thermal resistivity	Blackboard interactive.	2 hours
Fresnel’s equation for normal velocities	Blackboard interactive.	2 hours
Fresnel's equation for radial velocities	Blackboard interactive.	2 hours
Wave surface equation; indices surface	Blackboard interactive.	2 hours
Huygens' construction	Blackboard interactive.	2 hours
The polarization of light due to the phenomenon of birefringence.	Blackboard interactive.	2 hours
Optical activity of crystal; axial tensor.	Blackboard interactive.	2 hours
Experimental study of Pockels effect.	Blackboard interactive.	2 hours
The study of birefringence induced by an electric field. Kerr effect.	Blackboard interactive.	2 hours
Presentations of essays.	Blackboard interactive.	2 hours

Bibliografy

1. D. R. Lovett, Tensor properties of crystals (CRC Press, 2nd edition, 1999). ISBN: 978-0-750-30626-3

2. J. F. Nye, Physical properties of crystals: Their representation by tensors and matrices (Oxford University Press, 1985). ISBN: 978-0-198-51165-6.

3. Irina Nicoară, Cvasiparticule în teoria solidului (Tipografia Universității din Timișoara, 1998).

4. A. J. Dekker, Solid State Physics (Prentice Hall Inc, 1962),

5. C. Kittel, Introduction to solid state physics, 8th edition (Willey, 2004). ISBN: 978-0-471-41526-8

6. G. Cone, Optica electromagnetică a mediilor anizotrope (Ed. Tehnică, 1990).

7. A. Belea, Optică neliniară (Ed. Universității din București, 1999). ISBN: 973-575-298-0.

9. Relation between subject content and the expectations of employers

Chemical and physical properties of crystals gives work skills in almost all domains in which the future graduate

can work.

10. Assessment

Activity type	Assessment criteria	Assessment method	Percent of final mark
9.1 Course	The assimilation level of knowledge gained.	Oral	60%
9.2 Seminar	Capacity of solving specific problem	Written.	40%
Minimum performance standards			
Mark 5 corresponds to the minimum accumulated knowledge, i.e. for the student capacity to: • Define the main terms • Classification of tensors • Graphic representation of tensors • Brief explanation of the presented phenomena			

Data completării	Semnătura titularului de curs	Semnătura titularului de seminar
09. 11.2015	Victor E. Ambruș	Victor E. Ambruș

Data avizării în catedră/departament

Semnătura şefului catedrei/departamentului