

## SYLLABUS 2019/2020

Level of study	Master's Course
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Course title in Ukraine	Обрані проблеми в сучасній фізиці		
Course title in English	Selected Problems of Modern Physics		
Course code		ECTS credits	5
Lecturer(s)	Dr hab. Irena Jankowska-Sumara, Dr hab. Dorota Sitko		

Course objectives (learning outcomes)	This course aims to get students acquainted with knowledge of laws, issues and concepts of modern physics. The course concentrates on knowledge of nanotechnologies, nanostructures, spintronics.
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### Prerequisites:

Knowledge	Knowledge of algebra and mathematical analysis, basic knowledge in Physics
Skills	Ability to differentiate, integrate, solve ordinary and partial differential equations, transform tensors.
Courses completed	First step studies in Physics

### Learning effects:

	Learning effects of the course	Relation of the learning effects to the specialization
Knowledge	<p><b>A student knows</b></p> <p>W01 - basic physical principles of matter structure, recognizes what impacts are responsible for the formation of crystalline bonds,</p> <p>W02 - a basic concept defining a structure such as a simple and inverse lattice</p> <p>W03 - methods of studying the structure of matter: X-ray diffraction, electron diffraction</p> <p>W04 - correlated lattice vibrations, the concept of phonon and dispersion dependencies, concept of polarization</p> <p>W05 - magnetic properties of solid states.</p> <p>W06 - knows the energy structure of solids (band structure) and its impact on electrical, thermal and optical properties of solid states</p> <p>W07 - electrical properties of metals in quantum approximation (free electrons gas)</p>	K_W01 – K_W05

Skills	Learning effects of the course	Relation of the learning effects to the specialization
	<p>U01 A student has extended knowledge in general physics and advanced in a selected physics field; knows the history of the development of physics and its significance for the progress of the exact and natural sciences, to know the world and social development</p> <p>U02 can apply the scientific method in solving physical problems, carrying out experiments and applying</p>	K_U01 – K_U05

Social skills	Learning effects of the course	Relation of the learning effects to the specialization
	<p><b>K01.</b> A student has the creativity and the ability to conceptual thinking.</p> <p><b>K02</b> A student is able to present and justify the personal point of view.</p> <p><b>K03</b> A student is able to use the acquired knowledge and skills for the communication with the scientific community.</p> <p><b>K04</b> A student is aimed to expand personal knowledge and skills.</p> <p><b>K05</b> A student has the legal erudition.</p>	K_K01 – K_K05

### Course organization:

Form of classes	Lecture (W)	Group-exercises							
		A (large group)	K (small group)	L (Lab)	S (Seminar)	P (Project)	E (Exam)		
Contact hours	30		30				1		
Semester	3								
Language	English								

### Teaching methods:

1. Traditional lecture using transparencies, slides, demonstrations and demonstrations
2. Calculation exercises - solving and discussion of tasks.
3. Own work - solving tasks in preparation for the exercises.
4. Own work - independent studies on the material presented during the lecture.
5. Calculation exercises - written tests, reports
6. Consultations

**Assessment methods:**

	Other	Written exam	Oral exam	Written assignment (essay)	Student's presentation	Discussion participation	Group project	Individual project	Laboratory tasks	Field classes	Classes in schools	Didactic games	E – learning
W01		X	X		X	X	X	X					
W02		X	X		X	X	X	X					
W03		X	X		X	X	X	X					
W04		X	X		X	X	X	X					
W05		X	X		X	X	X	X					
W06		X	X		X	X	X	X					
W07		X	X		X	X	X	X					
U01		X	X		X	X	X	X					
U02		X	X		X	X	X	X					
K01		X	X		X	X	X	X					
K02		X	X		X	X	X	X					
K03		X	X		X	X	X	X					
K04		X	X		X	X	X	X					
K05		X	X		X	X	X	X					

**Assessment criteria:**

Grades	<p>The grading scale will be as follows:</p> <p>90 – 100 % - <b>A</b> including <b>A - excellent</b> (eq. in Ukraine: відмінно (very good))</p> <p>82–89 % : <b>B</b> including <b>B – very good</b> (eq. in Ukraine: добре ( good))</p> <p>74–81 %: <b>C</b> including <b>C – good</b> (eq. in Ukraine: добре ( good))</p> <p>64–73 %: <b>D</b> including <b>D – satisfactory</b> (eq. in Ukraine: задовільно (satisfactory))</p> <p>60–63 %: <b>E</b> including <b>E – acceptable</b> (eq. in Ukraine: задовільно (satisfactory))</p> <p>&lt; 59 %: <b>F failed</b> (eq. in Ukraine: незадовільно (unsatisfactory))</p>
Criteria	<p><b>A.</b> A student knows all terms and concepts mentioned in W1-W5, U1- U5 and K1-K5. A student can work without any assistances, his/her knowledge's are creative and easily applied to decision of specific problem.</p> <p><b>B.</b> A student knows all terms and concepts mentioned in W1-W5, U1- U5 and K1-K5, yet needs a little help when decision of specific problem.</p> <p><b>C.</b> A student knows all terms and concepts mentioned in W1-W5, U1- U5 and K1-K5, however needs a help when decision of specific problem.</p> <p><b>D.</b> A student knows the most of terms and concepts mentioned in W1-W5, U1- U5 and K1-K5 and has difficulty in decision of specific problem.</p> <p><b>E.</b> A student knows only several terms and concepts mentioned in W1-W5, U1- U5 and K1-K5 and can solve only a simple problem.</p> <p><b>F.</b> A student does not know most of terms and concepts mentioned in W1-W5, he/she did not reach the satisfactory level of knowledge this course.</p>

**Course content (topic list):**

Topics	<p>Knowledge at the academic level of the basic knowledge of crystallography, band structure of solid states, electrical and thermal properties of solids</p> <p>Program content</p> <p>1 States of aggregation</p> <ul style="list-style-type: none"> <li>- liquid state - solid state</li> <li>- superfusion</li> <li>- phase transitions</li> </ul> <p>2 Structure of a solid (crystals):</p> <ul style="list-style-type: none"> <li>- types of crystal bonds,</li> <li>- crystalline structures,</li> <li>- X-ray diffraction on crystals,</li> <li>- reciprocal lattice - "pseudoprops", Brillouin zones,</li> <li>- crystal lattice defects.</li> </ul> <p>3. Obtaining crystals:</p> <ul style="list-style-type: none"> <li>- Czochralski's method,</li> <li>- Bridgeman method,</li> <li>- methods for obtaining crystalline layers</li> </ul> <p>4. Mechanical, electrical and thermal properties of crystals:</p> <ul style="list-style-type: none"> <li>- lattice vibrations - quantum approach - phonons (optical and acoustic branch),</li> <li>- Raman effect,</li> <li>- dielectric constant and dielectric function,</li> <li>- Non-linearity - spontaneous polarization,</li> <li>- specific heat of the solids (Einstein model, Debay model),</li> <li>- thermal conductivity.</li> </ul> <p>5. Electrical properties of a solid:</p> <ul style="list-style-type: none"> <li>- energy structure (phenomenological approach),</li> <li>- Fermi electron gas,</li> <li>- electrical conductivity (Drude's model and quantum model),</li> <li>- band structure (quantum approach),</li> <li>- Bloch functions, energy bands in the Brillouin I zone and in the developed zone system, crystals with a straight break and sloping gap.</li> </ul>
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**Literature:**

Compulsory reading	<p>1. C. Kittel, Introduction to Solid State Physics</p> <p>2. D.P. Woodruff, T.A. Delchar, Modern techniques of surface science (Cambridge University Press. 1990).</p> <p>3. P. W. Atkins, Physical Chemistry</p>
Recommended reading	Berkeley course in Physics

**Estimation of the total working time of students:**

Contact hours	Lectures	60
	Seminars/classes	

	Other (consultation, meetings)	10
Students' work hours (without the lecturer)	Reading books and preparation for the lectures	10
	Preparation to the seminar	10
	Preparation of an individual presentation	10
	Preparation to the exam	25
Total works' hours		125
ECTS credits 1 ECTS = 25 h		5