

## SYLLABUS 2019/2020

Level of study	Master's Course		
Course title in Ukraine			
Course title in English	Research practice		
Course code		ECTS credits	6
Lecturer(s)	PU : Dr hab. Irena Jankowska-Sumara Email address: <a href="mailto:ijsumara@up.krakow.pl">ijsumara@up.krakow.pl</a> , DNU : Prof. Trybitsyn M.P. <a href="mailto:trubitsyn_m@ua.fm">trubitsyn_m@ua.fm</a>		

Course objectives (learning outcomes)	<p>This course is intended to give the students hands-on experience with some of modern techniques In physics, polarizing microscopy, dielectric spectroscopy, X-Ray Fluorescence (XRF), AFM, differential scanning calorimetry, electromechanical properties of dielectrics.</p> <p>An introduction of the physical phenomena - basics of the methods will deepen the students' understanding of the relations between experiments and theories.</p> <p>The students will learn how each of the experimental set-up works, how to obtain the best possible data. The students will get their own knowledge and experiences during participating to the experiments conducted in the research laboratories and data processing as well as during performing some simple experiments.</p> <p>DNU: The aim and objectives of the research practice is to master modern methods of controlling the structure and physical properties of materials using modern equipment. To get acquainted with the principles of organization of research works, sources of their financing, rules of reporting. Learn to effectively use in his work the special and scientific literature.</p> <p>During the practice student will learn the technology for the manufacture of solid state electronic devices, methods for controlling the parameters of materials and devices used in production, computer simulation methods that are used in the design of semiconductor devices or in the study of materials; techniques for conducting a physical experiment and processing and analyzing its results.</p>
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### Prerequisites:

Knowledge	Knowledge of optic, solid state physics and semiconductor physics on the level of bachelor of physics or applied physics.
Skills	Skills use the physics conceptions for practical applications.
Courses completed	The bachelor of physics or applied physics.

### Learning effects:

Knowledge	Learning effects of the course	Relation of the learning effects to the specialization
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	<b>W01</b> A student knows the physical principles of advanced experiments <b>W02</b> Student knows modern research methods in the field of solid state physics, optics, nuclear physics and general physics. <b>W03</b> Student has the ability to develop experiment results and how to present them.. <b>W04</b> Student is prepared for systematic and reliable work.	K_W01 – K_W10
	Learning effects of the course	Relation of the learning effects to the specialization
Skills	<b>U01</b> Student understands the principles of modern physics <b>U02</b> Students performing experiment have the possibility to apply practical knowledge gained during lectures.. <b>U03</b> Student acquires proficiency in skillful handling of advanced research equipment. <b>U04</b> Experiment provided Individually or in group of two allow to actively participate in the next stages of the experiment: planning, measuring and analyzing data.	K_U01 – K_U07

	Learning effects of the course	Relation of the learning effects to the specialization
Social skills	<b>K01.</b> Student has the creativity and the ability to conceptual thinking. <b>K02</b> Student is able to present and justify the personal point of view. <b>K03</b> Student is able to use the information technologies for the communication with the scientific community. <b>K04</b> Student is aimed to expand personal knowledge and skills. <b>K05</b> Student has the legal erudition. <b>K06</b> Student concerned about the environmental safety of physical experiment.	K_K01 – K_K06

### 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					180				Credit with a grade
Semester	2								
Language	English								

### Teaching methods:

This class consists of a 1-hour lecture and a 1-hour lab once a week in general. The lectures will be performed in a tutorial system using multimedia presentation open for discussion and questions. The students will be then participate to the experiments conducted in Laboratories. The time-table will be flexible depending on the duration and schedule of possible research experiments.

Students are expected to work in pairs but **each student must write his or her own separate reports, including his or her analysis.** The reports should emphasize data analysis especially the determination of experimental uncertainty and should include a brief introduction, sections on the data collection and analysis and a conclusion.

#### Assessment methods:

	E – learning	Didactic games	Classes in schools	Field classes	Laboratory tasks	Individual project	Group project	Discussion participation	Student's presentation	written assignment (essay)	Oral exam	Written exam	Other
W01					X			x					x
W02					X			x	x				x
W03					X			x	x				x
W04					X			x					x
U01					X		x	x					x
U02					X		x	x					x
U03					X		x	x					x
U04					X		x	x	x				x
K01					X			x	x				x
K02					X		x	x	x				x
K03					X		x	x	x				x
K04					X		x	x	x				x
K05					X		x	x					x
K06					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-W4, U1- U4 and K1-K4. 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-W4, U1- U4 and K1-K4, 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-W4, U1- U4 and K1-</p>

	<p>K4, 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-W4, U1- U4 and K1-K4 and has difficulty in decision of specific problem.</p> <p><b>E.</b> A student knows only several terms and concepts mentioned in W1-W4, U1- U4 and K1-K4 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-W4, he/she did not reach the satisfactory level of knowledge this course.</p>
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### Course content (topic list):

Topics	<p>PU :</p> <p><b>W1.</b> Measurements, Errors and Graphs File. Data analysis and computing tools .</p> <p><b>W2.</b> Determination of the characteristics of the photo-elements.</p> <p><b>W3.</b> Interatomic interactions. Atomic force microscopy (AFM). Manipulation of atoms at room temperature.</p> <p><b>W4.</b> Measurement of specific heat using differential scanning calorimetry</p> <p><b>W5.</b> Polarized light microscopy and birefringence.</p> <p><b>W6.</b> Dielectric spectroscopy: methods and measurements.</p> <p><b>W7.</b> Examination of the elastic and piezoelectric properties of ferroelectric PZT ceramics.</p> <p><b>W8.</b> Examination of Hall Effect and its applications.</p> <p><b>W9.</b> Applications of selected experimental methods to Physics of Condensed Matter, Materials Science, Nuclear Physics, Atomic and Molecular Physics and also to related research areas such as Chemistry and Biology</p> <p>DNU :</p> <p><b>W1.</b> Introduction to the principles of organization of scientific research. Passing safety instruction.</p> <p><b>W2.</b> Writing a schedule of work with practitioners.</p> <p><b>W3.</b> Work with sources of information regarding individual tasks.</p> <p><b>W4.</b> Execution of work according to the schedule. Collection of materials for master's work.</p> <p><b>W5.</b> Analysis of the results, conclusions formulation.</p> <p><b>W6.</b> Making a report on practice and required documents.</p> <p><b>W7.</b> Development of computer presentation of the results of research and development.</p> <p><b>W8.</b> Preparing to protect the report.</p>
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## Literature:

Compulsory reading	<p>A.C. Melissinos, J. Napolitano. Experiments in Modern Physics. Second ed. 2003. ISBN-13: 978-0124898516</p> <p><a href="http://www.feynmanlectures.caltech.edu/">http://www.feynmanlectures.caltech.edu/</a> Feynman Lectures on Physics</p> <p><a href="https://archive.org/details/PhysicsForTheEnquiringMind">https://archive.org/details/PhysicsForTheEnquiringMind</a> Eric M. Rogers, Physics for the Enquiring Mind Oxford ( Princeton University Press ) 1960</p>
Recommended reading	<p>The UK Surface Analysis Forum, Introductions to Many Surface Science Techniques, <a href="http://www.uksaf.org/tech/list.html">http://www.uksaf.org/tech/list.html</a></p> <p>A.C. Melissinos, J. Napolitano. Experiments in Modern Physics. Second ed. 2003. ISBN-13: 978-0124898516</p> <p><a href="http://www.microscopyu.com/articles/polarized/index.html">http://www.microscopyu.com/articles/polarized/index.html</a></p> <p>A. K. Jonscher, The universal dielectric response, Nature 267 (1977) 673 – 679.</p> <p>B. Jaffe, Piezoelectric Ceramics (e-Book Google), Elsevier, 2012, 328.</p> <p>Fundamentals and Applications, Springer, 2011.</p> <p>S. Svanberg, Atomic and Molecular Spectroscopy, 2<sup>nd</sup> ed, Springer-Verlag, 1992.</p> <p>W. Demtröder, Laser spectroscopy: Basic concepts and instrumentation, Springer-Verlag, 1988.</p> <p>Lecture notes will be also provided.</p>

## Estimation of the total working time of students:

Contact hours	Lectures	180
	Seminars	
	Other (consultation, meetings)	
Students' work hours (without the lecturer)	Reading books and preparation for the lectures	
	Preparation to the seminar	
	Preparation of an individual presentation	
	Preparation to the exam	
Total works' hours		180
ECTS credits 1 ECTS = 30 h		6