SYLLABUS 2017/2018

Level of study	Master's Course

Course title in Ukraine	Термодинаміка и статистична фізика		
Course title in English	Thermodynamics and Statistical Physics		
Course code		ECTS credits	5
Lecturer(s)	Dr Renata Bujakiewicz-Korońska, rbk@up.krakow.pl Prof. Ryszard J. Radwański sfradwan@up.krakow.pl		

Course objectives (learning outcomes)	This course aims to get students acquainted with knowledge of laws, issues and concepts of statistical physics. The course concentrates on knowledge of phase transitions, course on Statistical Physics and Thermodynamics, especially phase transitions theory.

Knowledge	Knowledge of algebra and mathematical analysis.
Skills	Ability to differentiate, integrate, solve ordinary and partial differential equations, transform tensors.
Courses completed	

Learning effects:

	Learning effects of the course	Relation of the learning effects to the specialization
Knowledge	**W01** A student knows **Classical Thermodynamics** **W02** A student knows **Fundamentals of Statistical Mechanics** **W03** A student knows description of **Classical gases** **W04** A student knows description of **Quantum Gases** **W05** A student knows description of **Phase Transitions** **W06** A student knows description of **magnetic systems** in statistical physics formalism	W01 – W10

	Learning effects of the course	Relation of the learning effects to the specialization
Skills	**U01** A student applies thermodynamics laws , thermodynamics functions and relations in description of physical systems, **U02** A student constructs Microcanonical Ensemble, Canonical Ensemble, Chemical Potential, Grand Canonical Ensemble. **U03** A student constructs Classical Partition Functions, is able to describe Ideal Gas; can use the Maxwell Distribution, van der Waals interactions **U04** A student applies Density of States; can use in practice the formalism of the Debye Model of Vibrations in a Solid, Bose-Einstein Distribution and Bose-Einstein Condensation, Fermi-Dirac Distribution and Fermi Gas	

	U05 A student can study properties of systems with phase transitions, use Landau Theory and Landau-Ginzburg Theory for description of the phase transitions **U06** A student can study set of paramagnetic ions and on the its example : entropy, number of states, calculations of Z for choosen systems , relations between microscopic statistical properties and macroscopic electronic and magnetic properties.	U01 – U07

Social skills	Learning effects of the course	Relation of the learning effects to the specialization
	K01. A student has the creativity and the ability to conceptual thinking. **K02** A student is able to present and justify the personal point of view. **K03** A student is able to use the aquired knowledge and skills for the communication with the scientific community. **K04** A student is aimed to expand personal knowledge and skills. **K05** A student has the legal erudition.	K01 – 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	30		30				1
Semester	3						
Language	English						

Teaching methods:

The course consists of open for discussion and questions lectures and classes.
In-class exercises are designed to probe knowledge with emphasis on how well students have understood the underlying topics of the course.

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		
W03								x	x		x		

W04								x	x		x		
W05								x	x		x		
W06								x	x		x		
U01						x	x	x	x		x		
U02						x	x	x	x		x		
U03						x	x	x	x		x		
U04						x	x	x	x		x		
U05								x	x		x		
U06								x	x		x		
K01							x	x	x		x		
K02							x	x	x		x		
K03							x	x	x		x		
K04							x	x	x		x	x	
K05							x	x			x	x	

Assessment criteria:

Grades	The grading scale will be as follows: 90 – 100 % - **A** including **A**- **excellent** (eq. in Ukraine:відмінно (very good)) 82–89 % : **B** including **B** – **very good** (eq. in Ukraine: добре (good)) 74–81 %: **C** including **C** - **good** (eq. in Ukraine: добре (good)) 64–73 %: **D** including **D** – **satisfactory** (eq. in Ukraine: задовільно (satisfactory)) 60–63 %: **E** including **E** – **acceptable** (eq. in Ukraine: задовільно (satisfactory)) < 59 %: **F** **failded** (eq. in Ukraine: незадовільно (unsatisfactory))
Criteria	**A.** 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. **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. **C.** 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. **D.** 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. **E.** A student knows only several terms and concepts mentioned in W1-W5, U1- U5 and K1-K5 and can solve only a simple problem. **F**. 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.

Course content (topics list):

Topics	**1. Fundamentals of Statistical Mechanics:** Introduction; Microcanonical Ensemble; Entropy and the Second Law; Temperature; Two-State Spin System; First Law of Thermodynamics; Canonical Ensemble; Energy Fluctuations; Chemical Potential; Grand Canonical Ensemble. **2. Classical Gases:** Classical Partition Functions; Ideal Gas; Equipartition; Maxwell Distribution; Diatomic Gas; Interactions; van der Waals Equation of State; Cluster Expansion; Debye-Huckel model. **3. Quantum Gases:** Density of States; Blackbody Radiation; Debye Model of Vibrations in a Solid; Diatomic Gas Revisted, Bose-Einstein Distribution and Bose-Einstein Condensation; Fermi-Dirac Distribution and Fermi Gas; White

	Dwarfs; Pauli Paramagnetism; Landau Diamagnetism. **4. Classical Thermodynamics:** Temperature and the Zeroth Law; The First Law; The Second Law; Carnot Cycles; Entropy; Adiabatic Surfaces; Maxwell Relations; The Third Law. **5. Phase Transitions:** van der Waals equation Revisited; Phase Equilibrium; Maxwell Construction; Clausius-Clapyron Equation; Critical Point; Ising Model; Mean Field Theory; Critical Exponents; Ising Chain; Low Temperature Expansion and Peierls Droplets; High Temperature Expansion; Kramers-Wannier Duality; Landau Theory; Lee-Yang Zeros; Landau-Ginzburg Theory; Fluctuations and Correlations. 6. **Magnetism:** set of paramagnetic ions and on the its example : entropy, number of states, calculations of Z for choosen systems , relations between microscopic statistical properties and macroscopic electronic and magnetic properties.

Literature:

Compulsory reading	David Tong: Lectures on Statistical Physics (pdf in the Internet) Kerstin Huang: Introduction to statistical Physics
Recommended reading	L.D.Landau, J.M.Lifshitz: Statistical Physics David R. Gaskell: Introduction to the Thermodynamics of Materials

Estimation of the total working time of students:

Contact hours	Lectures	60
	Classes in small group	
	Other (consultation, meetings)	10
Students' work hours (without the lecturer)	Reading books and preparation for the lectures	20
	Preparation to the seminar	
	Preparation of an individual presentation	10
	Preparation to the exam	25
Total works' hours		125
ECTS credits 1 ECTS = 25 h		5