SYLLABUS 2019/2020

Level of study	Master's degree

Course title in Ukraine	Вступ до мезоскопічної фізики		
Course title in English	Introduction to Mezoscopic Physics		
Course code		ECTS credits	4
Lecturer(s)	Dr.Sci., prof. Skalozub V.V. Email address: fttkaf@i.ua		

Course objectives (learning outcomes)	The subject of this course is a set of physical phenomena that are observed in bodies of finite size containing microscopic heterogeneities, which are connected with unobstructed properties of bodies under various realizations of random inhomogeneities. This manifests itself in the fact that in bodies that are characterized by the same geometric dimensions, the concentration of impurities, temperature, etc. macroscopic parameters, a number of properties are different. The aim of this course is familiarizing students with modern problems of mesoscopic physics and creating their ideas about how to construct a quantum theory of an ensemble of disordered small systems that are in the same macroscopic state, but differ in the implementation of disorder (the concept of "impurity ensemble ")

Prerequisites:

Knowledge	Knowledge of mathematics and physics on the level of bachelor in physics or applied physics
Skills	Mathematical and physical skills on the level of bachelor in physics or applied physics
Courses completed	The bachelor in physics or applied physics.

Learning effects:

	Learning effects of the course	Relation of the learning effects to the specialization
Knowledge	**W01** A student knows how quantum dots are implemented in a two-dimensional electron gas. **W02** A student to possess the technique of theoretical study of transport of electrons and thermoelectric effects. **W03** A student to investigate the phenomenon of resonance tunneling in mesoscopic systems.	W01 – W10

	Learning effects of the course	Relation of the learning effects to the specialization
Skills	**U01** A student is able to to investigate physical phenomena in mesoscopic systems. **U02** A student is able to to use the concepts and methods of quantum mechanics to study mesoscopic phenomena. **U03** A student use the concept of qubits in studies of systems in mixed states. **U04** A student is able to calculate the physical characteristics of quantum dots in the conditions of the Coulomb blockade.	U01 – U07

	Learning effects of the course	Relation of the learning effects to the specialization
Social skills	**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 information technologies 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. **K06** A student concerned about the environmental safety of physical experiment.	K01 – K06

Course organization:

Form of classes	Lecture (W)	Group-exercises					
		A (large group)	K (small group)	L (Lab)	S (Seminar)	P (Project)	Exam
Contact hours	14		14				1
Semester	2						
Language	Ukrainian						

Teaching methods:

Classes will be performed in tutorial system on a weekly basis using multimedia presentation and internet in a form of the lectures open for discussion and questions.
In-class exercises are designed to probe knowledge developed through this process, with emphasis on how well students have understood the underlying mathematical and physical ideas.
The students will prepare one individual presentation.

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	Test
W01						x		x					X
W02						x		x					X
W03						x		x					X
U01							x	x					X
U02							x	x					X
U03							x	x					X
U04							x	x					X
K01						x		x	x				X
K02							x	x					X
K03							x	x	x				X
K04						x	x	x					X
K05													X
K06													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-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. **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. **C.** A student knows all terms and concepts mentioned in W1-W4, U1- U4 and K1-K4, however needs a help when decision of specific problem. **D.** 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. **E.** A student knows only several terms and concepts mentioned in W1-W4, U1- U4 and K1-K4 and can solve only a simple problem. **F**. 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.

Course content (topic list):

Topics	1. Introduction. 2. Basic postulates of quantum mechanics. 3. Kubites and quantum computing. 4. Coherent transport of electrons that are do not interact. 5. Thermoelectric effects. 6. Fluctuations of current and noise in quantum systems. 7. S-matrix and T-matrix. 8. Resonance scattering. 9. Coulomb blockade. 10. The "Golden Rule" of Fermi and the calculation of the probabilities of transitions electrons in quantum dots. 11. Electron-phonon interaction in quantum dots. 12. Persistent current in quantum rings. 13. Casimir effect.

Literature:

Compulsory reading	1. Имри Й. Введение в мезоскопическую физику. М.: Физматлит, 2004. 2. Свидзинский А.В. Пространственно-неоднородные задачи теории сверхпроводимости. М.: Наука, 1982. 3. Свидзинский А.В. К теории сверхтекучих ферми-систем. К.: АН УССР ин-т математики, 1964. 4. Рязанов М.И. Электродинамика конденсированного вещества: Учебное пособие. М.: Наука, 1984. 5. Толмачев В.В. Теория ферми-газа. М.: Изд-во Моск. ун-та, 1973.
Recommended reading	1. Datta S. Electronic Transport in Mesoscopic Systems. –Cambrige University Press. –1995. -377P. 2. "Mesoscopic Electron Transport" edited by L. P. Kouwenhoven, G. Schoen, and L. L. Sohn, NATO ASI Series E (Kluwer Academic Publishing, Dordrecht). Посилання на електронне джерело: http://www.physics.drexel.edu/~goran/nano/references/QD/ElectronTransportQD.pdf 3. Weinnmann D. The Physics of Mesoscopic Systems. Посилання на електронне джерело: http://www-ipcms.u-strasbg.fr/IMG/pdf/petra.pdf

Estimation of the total working time of students:

Contact hours	Lectures	28
	Seminars	
	Other (consultation, meetings)	12
Students' work hours (without the lecturer)	Reading books and preparation for the lectures	20
	Preparation to the seminar	
	Preparation of an individual presentation	20
	Preparation to the test -exam	20
Total works' hours		100
ECTS credits 1 ECTS=25h		4