Course Unit Descriptor

Study Programme: Physics, Professor of Physics
Course Unit Title: Quantum statistical physics
Course Unit Code: F18KSF
Name of Lecturer(s): Full Professor Milan Pantić
Type and Level of Studies: Bachelor Academic Degree
Course Status (compulsory/elective): Elective
Semester (winter/summer): Summer
Language of instruction: English
Mode of course unit delivery (face-to-face/distance learning): Face-to-face
Number of ECTS Allocated: 6
Prerequisites: Quantum mechanics, Statistical physics
Course Aims: Introduction to modern methods of quantum statistical physics as well as their applications in some fields of physics of condensed matter.
Learning Outcomes: After taking the course, the students should have developed: **General abilities**: basic knowledge of this field, following the literature, analysis of various solutions and the choice of the most adequate solution, application in practice and other subjects. **Subject-specific abilities:** Upon completion of the course, the student should master some modern methods of statistical physics (Green's functions, the second quantization method for interacting particle systems). The knowledge is sufficient to monitor other advanced courses.
Syllabus: *Theory* Nonrelativistic many-particle systems, Second quantization for systems of identical particles. Many particle states, Examples. States and opservables of identical particles - bosons and fermions. General single- and many-particle operators. Field operators. Small oscillations and phonons in 1d and 3d. Nonequilibrum statistical operator. Basics of Quantum kinetic theory, Fluctuation-disipation theorem. Linear response of the system and Greens function. Double-time Green's functions, Equation pof motion. Spectral representation of Green's and correlation functions. Exact expressions, The Kramers-Kroning relation. Wick's theorem for boson and fermi systems. Application of Greens methods in the theory of magnetism. Magnetism: the quantum nature of magnetism; exchange interaction; Heisenbergs model: ground state and spin wave; concept of quasiparticels - magnons. Exactly solvable models, Izing model. Phenomenon superfluidity, Landau superfluid condition. Non ideal Bose gas at low temperatures. Effective Hamiltonian, Microtheory of Bogolyubova. Phonons and rotons. Superfluidity He4. A Phenomenological theory of superconductivity: The Ginzburg–Landau theory and the Josephson effects. Superconductivity. Cooper's phenomenon, Cooper's pairs. Electron-phonon interaction and superconductivity. Frohlich's ttransformation and effective electron-electron interactions. BCS theory. Unitary u-v transformation, spectrum and energy superconductors. *Practice* Problem solving.
Required Reading: 1. N.N. Bogolyubov, N.N. Bogolyubov (Jr.), Introduction to quantum statistical mechanics,World Scientific, 1982. 2. E.M. Lifshitz, L.P. Pitaevskii, Statistical Physics, Part 2: Vol. 9 (Elsevier, 2000). 3. E.M. Lifshitz, L.D. Landau, Statistical Physics – Course of Theoretical Physics, Vol. 5 (Elsevier, 2000). 4. F. Schwabl, Statistical mechanics, 2nd ed. Springer-Verlag (2006)

Weekly Contact Hours:	**Lectures:** 3	**Practical work:** 2

Teaching Methods: Lectures
Knowledge Assessment (maximum of 100 points):

Pre-exam obligations	points	**Final exam**	points
Active class participation	5	written exam	20
Practical work		oral exam	50
Preliminary exam(s)	20	…….	
Seminar(s)	5		
The methods of knowledge assessment may differ; the table presents only some of the options: written exam, oral exam, project presentation, seminars, etc.			